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DESIGN ACROSS BORDERS UNITED IN CREATIVITY

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Escuela de Arquitectura, Arte y Diseño

DESIGN ACROSS BORDERS
UNITED IN CREATIVITY

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Design Across Borders: United in Creativity.
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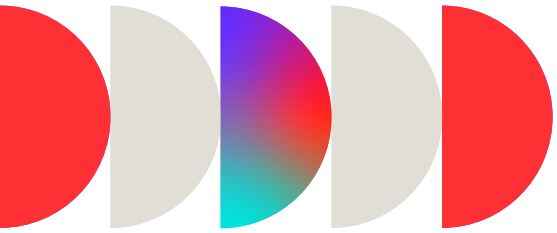


Preface

In a world shaped by constant transformation and global interconnectedness, design emerges as a bridge between people, places, and ideas. Cumulus Monterrey 2024: Design Across Borders – United in Creativity invited the international design community to reflect on the profound potential of design to transcend cultural, geographic, and disciplinary boundaries, uniting us in the shared pursuit of innovation, inclusion, and positive change.

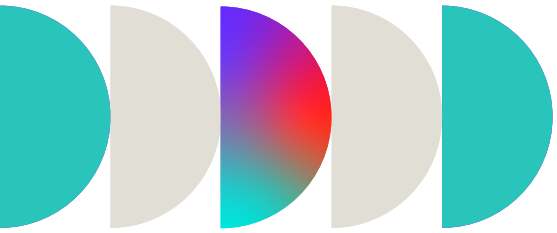
This edition of the Cumulus Proceedings gathers contributions that respond to urgent questions: How can design foster empathy and intercultural understanding? In what ways does it become a catalyst for social transformation in a complex, globalized world? Can design truly become a universal language—and what are the challenges in achieving that ideal?

The richness of perspectives represented in these proceedings speaks to the global nature of the Cumulus network. Authors, researchers, educators, and practitioners from across continents have come together to share insights, experiences, and provocations within four thematic tracks:

- Design for Change explores design's role in social innovation, sustainability, equity, and the circular economy—highlighting projects that place co-creation and inclusion at their core.
- Speculative Futures ventures into emerging territories shaped by technology, artificial intelligence, and immersive experiences, imagining the future of creative practice.
- Education in Art and Design focuses on pedagogical innovation, interdisciplinarity, and the challenges and opportunities of digital transformation in global learning environments.
- Translocality brings critical attention to issues of migration, decolonization, and the Global South, recognizing the importance of diverse voices and perspectives in shaping a more equitable world through design.

Together, these contributions reflect a collective commitment to harnessing creativity as a force that transcends barriers—linguistic, political, cultural—and brings people together around shared values and visions.

We are proud to present this volume as a testament to the power of design to imagine, inspire, and unite. May it serve not only as a record of this important moment in time but also as a spark for continued dialogue, collaboration, and transformation in the global design community.



Design Across Borders: United in Creativity

Lorenzo Imbesi
Full Professor, Sapienza University of Rome
President, Cumulus Association

The Cumulus Monterrey 2024 Conference marked a timely and vital moment in the global conversation about the role of design in shaping a better world. Hosted at the prestigious design institutions of Tecnológico de Monterrey and Universidad de Monterrey (UDEM), the international gathering has been further enhanced by the unique Monterrey's rich heritage and cultural identity, contributing to a thriving ecosystem of creative exchange for scholars, researchers, and practitioners across various design disciplines.

The central theme of the conference, "Design Across Borders: United in Creativity," provided an inspiring gateway for exploring how design holds the possibility to transcend geographical, cultural, and disciplinary boundaries. In particular, the conference was framed by four imperative trajectories: "Design for Change," investigating how design practices can drive social innovation and sustainable development; "Design Futures," exploring the interplay between technology and creativity, immersive experiences, virtual realities, and the implications of artificial intelligence; "Education in Art and Design," investigating pedagogical approaches in the field; and "Translocality," addressing complex issues of migration, decolonisation, and North-South dynamics. Themes highlight the broad scope of contemporary artistic and design pursuits.

At the heart of the conference was a shared recognition that design can be a dynamic force for empathetic understanding and intercultural dialogue. Through a rich program of keynote lectures, panel discussions, workshops, exhibitions, and informal exchanges, the international community demonstrated determination to work collaboratively across geographical and cultural divides, confirming the foundational premises of the conference: that creativity knows no boundaries, and through design, we can forge connections that transcend the limitations of space, time, and cultural difference. In an era of unprecedented global challenges, from climate change to technological acceleration, from cultural conflicts to social inequities, designing without boundaries means identifying areas of commonality, intersection, and convergence, highlighting them in ways that resonate with and reflect the spirit of our transborder region. As traditional confines between nations, disciplines, and cultural contexts become increasingly permeable, the design community must find itself uniquely equipped to harness this fluidity. Rather than resisting uncertainty, design must embrace it, transforming constraints into opportunities for innovative problem-solving and cross-cultural exchange.

The proceedings collected in this edition offer an extensive variety of perspectives on the ideas and projects discussed at the event. They include case studies, speculative work, educational reflections, and practical strategies, all pointing to the evolving role of design to shape societal interactions, encouraging intercultural dialogue, and building a more harmonious and interconnected world. However, these proceedings capture only a portion of the energy and insight shared during the conference, with the remaining impact continuing to reverberate through ongoing collaborations and dialogues within our global community.

As we move forward, the conversations from Cumulus Monterrey 2024 remind us that creativity thrives not in isolation, but in community. And in a time marked by division and uncertainty, design, when practiced with care and intention, can truly serve as a bridge. One that brings us together to learn, to act, and to imagine a positive change.

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PAPERS

NGAUA TE PAE HAMUTI: RISE TO THE CHALLENGE: TETHERING COMMONALITY AND CONTRAST TO CREATE OPPORTUNITIES FOR POSITIVE SOCIAL AND ENVIRONMENTAL CHANGE

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ABSTRACT | In an effort to mitigate the ongoing impacts of hegemony in design, experienced as a result of Modernist storyline this research seeks to reconsider and recalibrate the Universal narrative. Reflecting on the dogged legacy of modernism, this research proposes that design has much to gain by exploring its past as, not one Universal history, but a series of intersecting and diverging narratives. Being place-based, in Aotearoa, New Zealand, this research begins by elucidating untold moments of intersection and divergence between *mātauranga* Māori (Māori knowledge), Pasifika ideology and design's solitary history. Having identified these moments, this work exemplifies the impact of including more diversified understandings of the past, and the knowledge it holds for the future. In these works, design students embrace Indigenous knowledge, specifically Māori and Pasifika worldviews, to guide their methods and mindsets, and showcase the benefits of incorporating these often-overlooked approaches on both global and local scales. Their work challenges linear perceptions of time and space and helps position them in relation to the problem and the solution. This research posits that our histories shape our futures, and that design has much to learn from Indigenous worldviews, and what they offer both design pedagogy and practice by, as reflected in the 2015 Transition Design Provocation, looking to the past to create solutions in the present with future generations in mind. *Ki muri ka mua* - I walk backwards into the future.

KEYWORDS | INDIGENOUS KNOWLEDGE, DESIGN FOR CHANGE, MATAURANGA MĀORI,TRANSITION DESIGN

1. Introduction - Pulling a thread and unravelling the knitting.

Important to this research is its positionality. It is undertaken in Aotearoa, New Zealand, a bi- cultural nation first and foremost. It recognizes The Treaty of Waitangi, (Te Tiriti o Waitangi), as New Zealand's founding document, signed in 1840 between 500 Indigenous Māori chiefs and the British Crown. Guided by that, this research speaks to the principles of equality, equity, collaboration, and self-determination that are also central to our curriculum at Te Kura Hoahoa, The School of Design Innovation (Victoria University of Wellington, Te Herenga Waka) in Aotearoa, New Zealand. Our responsibilities include acknowledging Māori (as New Zealand's Indigenous people) as distinctive and equal partners, and whose beliefs and knowledge systems are not to be blended through cooperation into commonness. To meet these responsibilities and enable changes to our current and future practice as designers the need to firstly acknowledge and include Māori in our design history is necessary. To understand my motivation to undertake this work is the recognition of my own positionality as Tangata Tiriti, and a Pākehā (white, New Zealander). As a design academic and educator, my responsibilities to Te Tiriti o Waitangi explicitly reference protecting Māori interests, caring for future generations with and for Māori and affirming New Zealand's unique identity. The next step which uncovers the connections and divergences within our design history as a part of or distinct from the dominant Universal version, was like pulling a thread and unravelling the knitting.

This work is greatly buoyed by Arturo Escobar assertion of the emergence of,

—"a transnational space, anchored chiefly, but not exclusively in the Global South, that problematizes anew design's embeddedness in global historical relations of power and domination, variously explored in terms of design's relation to histories of colonialism and imperialism, its functioning within modern/colonial matrix of power, the geopolitics of knowledge (Eurocentrism), racism, and patriarchal capitalist colonial modernity" —

(ESCOBAR, A. 2021).

This article promotes the shift towards the transnational space Escobar speaks to and away from the creed of universality, historically devised to unify, and whose history is inherently Eurocentric and linear. Highlighted are numerous unacknowledged intersections between indigeneity and the Euro/American-centric storyline that elucidate the duplicity and shortsightedness its embeddedness to a singular modernity. This research describes and exemplars how, in Aotearoa, Te Ao Māori (the Māori worldview), *mātauranga Māori* (Māori knowledge), and *tikanga Māori* (Māori values and protocols) guide design towards creating inclusive, equitable, and self-determined futures. By understanding and respecting this knowledge as an eco-system, and not as parallel or diverging narratives, the opportunity exists to grow design practice modelling what Buckminster Fuller fittingly described as Spaceship Earth (Fuller, 1969). This research asserts that design curricula and practice should embrace the tensions of this ecosystem, recognizing and respecting both commonality and contrast as critical. The examples offered articulate and demonstrate design that is rooted in the Māori *tikanga* of: (the fluidity and longevity of reciprocity), *whanaungatanga* [authentic connections through collaboration and understanding], *manaakitanga,* (the care offered), and *kaitiakitanga*, (active guardianship) through the recognition of responsibilities to, not for, people and place.

To provide some context, in Aotearoa, we often identify or position ourselves to Te Tiriti o Waitangi in one of three ways; Tangata Whenua, being people of the land (Māori lineage), Tangata Tiriti, people who abide by the Tiriti o Waitangi (non-Māori lineage), and Tangata Moana, (people of Pasifika lineage living in Aotearoa). The Pacific Ocean that surrounds Aotearoa covers one third of the Earth's surface. The island nations of the Pacific are home to around one third of all the world's languages and cultures. Although the number of people in our region is relatively small, they are enormously diverse. Although separated geographically we are also bound together by a common body of water. As a result, we view the Pacific region, as a sea of islands, peoples and places connected forever as part of a reciprocal and sustaining relationship (Hau'ofa, 1994). This relationship brings to the surface an opportunity to challenge the singularity of the Universal; asking how it might acknowledge and accommodate more plural, and inclusive methods and mindsets in its narratives and works. In Aotearoa, our dependence on a Euro-American centric design lens is now being contested, with our design history being rewritten, expanded and retold. This research seeks to rewrite and recalibrate what are currently culturally limited and limiting histories and practices. The aim is to elucidate the relevance of place-based and Indigenous knowledges as a part of design's models and mindsets within current, and for future iterations of social, cultural and environmental innovation and co-designing practices.

Translated into English from Te Reo (the Indigenous language of Māori), the title of this paper, *Ngaua Te Pae Hamuti* means Rise to The Challenge. More colloquially it means Eat the Shit Stick. This perhaps best describes the difficulties we all experience when undertaking design for change. It is difficult and often projected, and we as designers are required to get our hands dirty doing the work needed to address the challenges and changes sought firstly, within ourselves, and then the communities we serve. This study asserts that by re-evaluating our individual and collective reliance on the Universal and learning from what we currently consider old and outmoded knowledge, we can better respect, enable and understand each other - ensuring we are no longer blended through universality into a common-ness.

—"Indigenous knowledge is not old knowledge or knowledge relevant to distant, now outmoded times. Quite distinctly from Western knowledge, Indigenous knowledge has continued to evolve through rebellious, resistant, and resilient practices of its own"—

(O'SULLIVAN, 2018).

Dori Tunstall claims that design itself needs to be redesigned (Tunstall, 2013). Aligning with Tunstall, this article asserts the need to reconsider and recalibrate the Universal narrative, that as designers and devotees of aesthetic beauty we credit to the Modernist doyens. We have continued to rely on this version to seed our aesthetic and social aspirations, but in recent years a growing number in the discipline of design, believe a shift to be well overdue. Exploring the aesthetic and social narratives that the Universal Euro-centric history tells us define modernism and continue to dominate our practice, this research challenges design to retell its history, as histories. It proposes that with a fuller appreciation of the contributions and influences of others, as well as their discrete knowledges, the solutions design offers can be more representative and inclusive of the communities it seeks to serve. Arturo Escobar describes the Universal as "one storyline conceived from the perspective of the Euro-American experience and exported to many world regions over the past few hundred years", (Escobar, 2015). Renata Leitão expands this critique saying, "the leading role of the modern man entails that we live in a planet with only one storyline: the heroic story of the modern man"(Leitaō, 2018). Leitaō also added, "there are numerous cultures in the world whose knowledge could be mobilized in order to remake the relationship between humans and nature and Western conceptions of productivity, consumption, and evolution"(Leitaō, 2018). Building on this criticism, this work proposes that the telling our own histories within an interconnected network would help to better represent our pasts and as a result better enable and elucidate opportunities for designing futures that recognize both the connections and distinctions needed within the solutions we seek. Most importantly, this needs to be as a part of a reciprocal relationship. In response to Tunstall's lament that, "few studies in the design discipline

have focused on the future making process of translating Indigenous values into tangible experiences", (Tunstall, 2013), this article offers an example of how this endeavour is being addressed as a part of design education, social innovation and co-design practice in our School. It may be difficult to appreciate how our specific approach and aspirations can directly relate to a global context or to your (reader) specific context. But in response to this, this article emphasizes the space that Te Ao Māori, *mātauranga* Māori, and *tikanga* Māori already hold, albeit untold, in the design history you know, and throws light, rather than the historic shade usually imposed, on the relevance and capacity that numerous Indigenous knowledges have to contribute to current practices and the more holistic and optimistic outcomes we all seek. It is at this point in the discussion the advocacy Transition Design brings to Indigenous knowledge is acknowledged. This article claims that by reflecting on and sharing how we have begun our journey, in Aotearoa, to embrace and learn our Indigenous wisdoms and knowledges and to recognize the opportunities and connections that these offer us as a bi-cultural nation and multicultural society, it will hopefully become more apparent to others how they could better assist in the mobilization of other Indigenous knowledges, and the aspirations of a pluriverse that Leitão, Tunstall and Escobar also provide to our discipline.

1.1 Kia whakatōmuri te haere whakamua. I walk backwards into the future with my eyes fixed on my past.

This *whakatauakī* (Māori proverb), explains that to begin moving forward, or casting into the future, we need to look backwards. This study illustrates how the history of the Universal looks when viewed from Oceania. This is not to reconstruct all of design's history or to completely debunk it. The aim is to inspire reflection, expansion and adjustment from what is currently a linear trajectory to an intersecting model that is reflective of all of us – as both similar and unique. To initiate this discussion, the familiar and indoctrinated version of design history is challenged by firstly removing the established start line for the Universal. This enables an exploration of design history beyond the early 20th century starting line of Modernism to include other beginnings, and other connections. These include exposing synergies that exist between Indigenous visual-spatial languages and the core tenets of the Universal. Initially comparing the historic trajectory of Māori and Pasifika visual storytelling and their codification of visual codes, some anomalies appear in the history most told. This is then extended to spatial strategies and the synergies between Te Ao Māori, Ta Vā and the educational reforms of Friedrich Froebel (1782–1852) who has been credited with having had a direct "influence within the history of modernism beyond any predictable proportion" (Brosterman, 1997). The conclusion of this first section asserts that the continuation of the duplicities told,

the exclusion of Indigenous knowledge as a part of a design history, and the continued dominance of Euro- centricity are no longer, nor were they ever, justified. The rationalized graphic codes that delineated the order and beauty Modernism and the Universal sought so eagerly, provide a poignant beginning to this claim.

2. E ngaki ana a mua e tōtō mai ana a muri. First clear the weeds, then plan (Elder,2020).

This *whakatauakī* asks that we challenge what we think we know before plant anew. To date modernism and Indigenous knowledge is discussed as two disconnected storylines. Modernism is told in linear and quite separated way from Indigenous knowledge and they have never been investigated as connecting with each other. Highlighting the current roadblock for Indigenous knowledge Santos explains,

—"this knowledge is largely wasted because the theories and concepts developed in the global North and employed by academia (and the commercial world) do not identify such alternatives. When they do, they do not value them as being valid contributions towards constructing a better society"— (Santos, 2016)

To start rectifying the oversight of Indigenous contributions within design history, we begin with the history of ornament. Aesthetic education has long celebrated the work of Vitruvius (c. 90– c.20 BCE) and Leon Battista Alberti (1404–1472). Ornament was highly valued for centuries, culminating in its extravagant use in the late nineteenth century, which led to a backlash against it as excessive. Lumped into this initial criticism were cultural, religious, and historic visual languages. Reacting to the excesses of the Rococo style, mass-production horrors, and the widening economic social divide, theorists like Owen Jones (1809–1874) and John Ruskin (1819– 1900) began scrutinizing ornament. Their ideals in the late nineteenth and early twentieth centuries aimed to democratize society through education based on aesthetic appreciation, making it accessible to all classes and ethnicities. Contradicting the wider assumptions that like the Rococo, cultural visual languages were irrational or excessive, Jones study of ornament immediately pointed to Oceania for examples of rationalized ornament that uniquely related to form and function. This article highlights the importance of Jones' acknowledgment. Jones spoke to Māori and Pasifika ways of seeing, doing, and being that we refer to as Te Ao Māori (the Maori worldview) and Ta-Vā (the Theory of Reality). Understanding these perspectives helps us appreciate what Jones celebrated in his seminal 1856 work, The Grammar of Ornament: A Visual Reference of Form and Colour in Architecture and the Decorative Arts. Te Ao Māori and Ta-Vā emphasize the eternal connection between people and place, involving both tangible and intangible links between humans, nature, and objects. Māori author and anthropologist Amiria Henare explains that "in the Māori world,

people and things have close relations that collapse spatial and temporal boundaries." (Henare, 2015). Similarly, Ta-Vā, a Tongan ideology, describes these relationships as, "All things, in nature, mind and society, stand in eternal relations of exchange" (Mahina,2010). Jones's The Grammar of Ornament depicts a comprehensive historical assemblage of ornamentation across time and the globe. With this anthology Jones highlighted and applauded the aesthetic strategies of Indigenous graphics and flat patterning that was woven, engraved, or drawn into Indigenous artefacts, on bodies and onto tools from the Pacific region. Quizzically, these visual strategies were later sought after within modernism and appear to have been appropriated into the Modernist mindset. Jones recognized the advanced capabilities of Māori in ornament, pattern, abstraction, and innovation. He noted, "There is scarcely a people, in however early a stage of civilization with whom the desire for ornament is such a strong instinct" .This research asserts that these strategies, initially rooted in Indigenous cultures, were later integrated into Modernist aesthetics, albeit predominantly uncredited. At the outset of his writing Jones noted, of Maori culture, "There is scarcely a people, in however early a stage of civilization with who the desire for ornament is such a strong instinct" (Jones, 1856). He went on to claim,



(JONES, 1856).

Figure 1. Image from Owen Jones' 1856 The Grammar of Ornament: A Visual Reference of Form and Colour in Architecture and the Decorative Arts. Depicts the carvings and abstracted designs of Māori. Includes *waka* (canoe) paddles, *patu onewa* (club), and handles from the long staff weapon, *taiaha*.

——"Nothing is more primitive and yet the arrangement shows the most definition and skill. Their eye, accustomed only to look upon Nature's harmonies, readily enters into the perception of the true balance both of form and color. The beautiful New Zealand paddle would rival works of any civilization. (Figure 1) The swelling form of the handle where additional weight is required is most beautifully contrived. True art (design) consists of idealizing (abstracting), and not copying the forms of nature"——

In the production of form, the visualization of narratives, and the expression of both symbolic and pragmatic meanings, ornament has always been a fundamental tool. But as an article of culture, it has also been misunderstood, maligned and misused. It has also been refuted, no more vitriolically than by Adolf Loos (1870–1933) when in 1908 and as a part of his seminal work Ornament and Crime. Despite Jones earlier praise for the reductive and abstractive skill shown by both Māori and Pasifika in their toi (creative practices), and the French reformist Eugene Grasset (1845–1917) who stated, "The return to the primitive sources of simple geometry is a certain guarantee of the soundness of our method" (Grasset, 1905) Loos took offence. Perhaps motivated by who would claim to have bragging rights over the origins of this soundness and not the truth, Loos disagreed and boldly discredited expressions of Indigeneity stating, "The modern man who tattoos himself is either a criminal or a degenerate" and further condemned indigeneity stated it should be considered "as counteractive to the evolution of modern culture" (Loos, A. 1913). This defamation was one of the earliest, most fanatical and this author proposes, most shameful outbursts against Indigenous cultures and knowledges in the history of design or architecture.

It initiated the turning point in which any acknowledgement of expressions of culture, or Indigenous ideologies to inform aesthetics, form or functionality were, rather hypocritically as we can see, eliminated from the curricula or vernacular of design and architecture.

Ruskin and Jones are attributed with a significant contribution in the shift towards a Universal visual language. Building from their work and towards the reductive graphic code design history claims was established in the early part of the twentieth century by (but not exclusively) the Bauhaus Masters, more questions need to be asked. The implication, if Loos and numerous others are to be believed is that this happened in somewhat of a Eurocentric vacuum. Again, let us remove the starting line and consider the educational philosophies of the educational reformist Friedrich Froebel (1782-1852) and compare them to Te Ao Māori and Ta Vā. Froebel's impact on the legacy of modernism is palpable, albeit clouded by the individual claims of the Grandfathers of Modernism. Both Ruskin and Jones were recipients of Froebel's non-conformist teachings. Also not often told as a part of the Eurocentric design history is that Froebel's teachings also influenced the founding ideals and social ideologies of the Bauhaus founder Walter Gropius (1893-1969) and his Bauhaus Masters; Johannes Itten (1888–1967), Paul Klee (1879–1940), Wassily Kandinsky (1866–1944), Lázsló Moholy-Nagy (1888–1967) and Charles- Édouard Jeanneret (1833–1965), known to all as Le Corbusier. In addition, prominent American architects and designers Frank Lloyd Wright (1867–1959), Charles Eames (1907–1978) and Buckminster Fuller (1895–1983) were, like the others also recipients of Froebel's teachings. What has not been considered in the history told or the attribution of these tenets beyond a single source, are the profound synergies between

Froebel's teachings, Te Ao Māori and Ta Vā. All seek distinction *(mana)*, legacy *(whakapapa)*, connection *(whanaungatanga)* and collective understanding *()* through visual and spatial language and perception.

2.1 Poipoia Te Kākano Kia Puāwai. Nurture the seed and it will grow.

(ELDER,2020).

The central learning from this *whakatauakī* is we all need 'care' to fully realize our potential and is also a core belief in the teachings of Froebel. Froebel approached education from both a biological and a spiritual perspective. He believed that a connection with nature and the spiritual world offered a more holistic understanding of world we live in. He balanced science with the environment and promoted physical well-being and emotional connection with the natural world. He had devised curricula and designed tools called The Gifts. In combination these introduced a reductive graphic code based on a sparse grammar of lines and curves, acknowledging relationships within space and building his pedagogy upon holistic, sensory, spatial, and social ideals. Froebel believed that incorporating simple visual and physical elements into education, alongside sensory learning, one could better enable equity and unity within struggling societies. His work, like the Te Ao Māori and Ta-Vā, embraced all things in nature as connected. This offers an early connection between Western thought and Indigenous knowledge systems. Froebel introduced, more correctly, re-introduced, values that emphasized, nurtured, and respected the individual, acknowledging their ongoing or intergenerational connection to a larger collective, whether that is family, community, or the environment. To summarize, the drive by the Reformist, embraced subsequently by the early Modernists, was to initially rationalize, simplify, unify, and empower the individual and the collective through a codified visual language. To most succinctly illustrate the influence, correlations and/or influence of Indigenous visual language on or as a part of the Universal, a visual timeline has been devised in Figure 2. This illustrates resemblances and synergies, those of us in the Pacific regions, seek recognition of. The trajectory illustrates the evolution of reductive, abstracted visual languages from the perspective of Māori who *whakapapa* to (recognize their lineage) and Pasifika peoples, as beginning with the Lapita Peoples of Oceania. It begins the with the visual grammars observed in P.V. Kirch's 1997 work, The Lapita Peoples: Ancestors of the Oceanic World. Identified are the dentate stamping on Lapita pottery from as far back as 3200- 2700 AD. (Figure 2). This illuminates what this research proposes is the first link between traditional Indigenous practices from Oceania and what aesthetic educators ironically refer to as the inception of the Modernist approach, some centuries later. The next intersection came In The Grammar of Ornament, Owen Jones references numerous ancient cultures, taking from them theories and skills of visual representation and abstraction. Not discussed yet, but illustrated in Figure 2 is the incorporation, further application, and

development of these by the Bauhaüsler. The author assumes that the 1919 – 1933 Bauhaus chapter in the history of the Universal is tacit within readers knowledge of design. The timeline, having firstly pointed to the connection, if not the origin, of a reductive and codified visual language, in Oceania, it then clearly shows ongoing correlations between the Lapita, Maori and Pasifika creative practice, onto Jones, into the Bauhaus and beyond as a part of our continued reliance on this approach.



Figure 2. Depicted is a visual lineage of a reductive graphic code claimed by early Modernist's to have been devised and established in the early twentieth century as a Universal Visual Language. A Lapita dentate pottery markings (circa 3200- 2700 AD), B. Māori pre–colonial tukutuku wood and weaving, C. Pacific pre–colonial tapa cloth designs. D. 1850 Froebel workbook – reductive codes, E. 'Savage' Tribes plate from Owen Jones's 1856 Grammar of Ornament, depicting Māori and Pacifika patterns. F. Gunta Stölzl,1928 Bauhaus Weaving Workshop.

3. Te Rerenga Hui-te-Rangiora — follow the footsteps of our ancestors to protect our planet

(ELDER,2020).

By holding fast to the memories of our ancestors, this *whakatauakī* speaks to the of our roles as Kaitiaki, which within the Māori worldview means our role as guardians of both knowledge and the earth; being responsible to it, not for it. This research now goes beyond the discussion of visual language to include the holistic spatial, temporal and social ideologies espoused as a part of early Modernism and their parallel to Te Ao Māori and Ta-Vā. Both Te Ao Māori and Ta-Vā hold the belief that humans, nature and things are connected by both tangible and intangible factors. Froebel also taught this, with Ruskin and Jones expanding the Western appreciation of it. But duplicities start to appear in the dissemination of such knowledge as a part of the Universal. This was particularly evident in the experiences of Itten, and Moholy-Nagy. Despite Gropius, while teaching at Harvard Graduate School of Design, praising Moholy-Nagy's conception of space, saying it "opened design considerations to the problems of the fourth dimension and a modern conception of space" (Bayer, Gropius,Gropius,1938), Moholy's efforts continued to be questioned. His efforts, perpetuated by his widow, Sybil Moholy-Nagy were however resurrected in the mid twentieth century by Buckminster Fuller (Fuller, 1969) and Victor Papanek (Papenek, 1982). Both Fuller and Papanek acknowledged Indigenous ways of knowing and being in their work, with Fuller travelling to New Zealand to further his knowledge of it. But like Itten, and Moholy-Nagy, their efforts went mostly unheeded in their own lifetimes. This work has been picked up in recent years by several of design's leaders, that includes Transition Design and DESIS supported by Design for Social Innovation practices. In concert with both Te Ao Māori and Ta-Vā, Escobar explains, that within the pluriverse no living being exists independently of the Earth and where humans and non-humans are in ever changing entanglements as a part of the Earth's vital forces and processes (Escobar, 2015). The entanglement Escobar speaks to is where, as a part of Te Ao Māori and Ta-Vā, Indigenous knowledge is experienced as an active state of connection, where they nurture and forge positive change. Understanding that Te Ao Māori and Ta-Vā consider space as a relationship that maintains tangible and intangible connections between humans, nature and things that collapse boundaries of time and space is central to the next step in the telling of our design history in Aotearoa. As Tongan academic 'Okusitino Māhina explains,

— "People are thought to walk forward into the past and walk backward into the future, both taking place in the present, where the past and future are constantly mediated in the ever-transforming present".—

(MĀHINA, 'O. 2010).

Froebel, inspired by Jean Jacques Rousseau (1712–1778) and Johann Pestalozzi (1746–1847). All three, similarly to the Māori world, embraced all things in nature as connected, offering an early synergy between Western thinking and Indigenous knowledge systems. Froebel built his pedagogy on holistic, sensory, spatial, and social ideals and explained relationships within space through physical experimentation with perception, connection and divisibility. Jumping forward, Buckminster Fuller would later reference this relationship within his perception of the world as Spaceship Earth. Perhaps a residual implication of Loos' slur, any reference to Indigenous knowledge systems introduced to the Western world by Jones as being relevant to the teaching of relationships between humans and the environment also went unacknowledged. This limitation was also experienced by Itten and Moholy-Nagy within the changes they sought to embed within their holistic and socially orientated pedagogy that considered space and the immaterial. Itten proposed immaterial is an interwoven spatial relationship saying,

—"Walls with windows and doors form the house, but the emptiness in them establishes the essence of the house. The essence of a material is its effect of space, the immaterial. Space is the material of the immaterial."—

(BADURA-TRISKA, 1990)

Moholy- Nagy proposed space as, "shapes which are ordered into certain well defined, if invisible, space relations; shapes which represent the fluctuating play of tension and force". (Bayer, Gropius,Gropius,1938) Fuller proposed "there is no space there are only relationships" (Fuller 1969). Tongan understandings propose space as the in-betweenness, where connection is experienced as an eternal tether.

——"Vā is the space between, the in-betweenness, not empty space, not space that separates but, space that relates, that Vā holds separate entities and things together, the space that is context, giving meaning to things" ——

(WENDT, 1996).

Putting this knowledge of reciprocity into practice we ask students to consider Indigenous knowledge as a perspective from which to frame a critical standpoint on a global issue. Using the ideology of Ta-Vā as the nexus, students articulate their concerns for the spaces inhabited between humans and humans, humans and nature and humans and things. The students used Ta-Vā to discuss how respect, reciprocity, mutuality, and balanced socio-spatial relationships could be engendered into their design investigations. The student examples provided discuss Tā-Vā as offering them ways to investigate and relate to design issues around sustainability, mass-consumption, customization and inter-personal relationships. Their ability to appreciate and utilize the concept of eternal connections between the past, present and future is noteworthy. Students discussed historic experiences and impacts, future aspirations, and noted that the present is

the time when any negotiations towards change need to be undertaken. The first (Figure 3 left to right) argues that to be more considerate of future generations and less consumer driven design has a fundamental responsibility to restructure their thinking and production processes to include responsibility for our past actions and guardianship of next generations. The next argued that virtual relationships contain reduced capacity for empathy and social connection and as a result, human interactions and perceptions of behavior are changing. The student asserted that the design of digital communication technologies comes with a responsibility to better enable the human-to-human relationships it seeks to profit from. They discuss the relationship between humans and computers as fraught with inequities that include a lack diversity, poor accessibility, and minimal safety. The key finding was that a relationship devoid of authentic connectivity, riddled with filters, inaccurate translations, fakeness, dark patterns, inequitable access and dangerous spaces is not a sustainable model to build meaningful and trusted human communication and connection on. To the far right the student argues the need to reconsider what and how we use knowledge. She proposes we honour the past, disrupt the present, and recognize the potent value of taking risks and challenging the status–quo can have on our collective future.



Figure 3. (left to right) Students did typographically designed versions of the abstracts from research essays written to reflect their appreciation of Ta Vā. Student A: Speaks to inter-relational tensions between the planet and consumption. Student B: speaks to the intangible space of virtual communications but the tangible impacts. Student C: Argues for a disruption of Western linear frameworks within design thinking as a circular method not a linear one.

3.1 Kei Te Ahua O Te Kounga O Nga Whakairo O Te Tangata Te Ahua O Te Kounga O Tana Ao: The quality of one's individual thoughts inform the quality of their world (ELDER,2020).

Having outlined from the perspective of Aotearoa, the motivations, cultural context, and historic inaccuracies within the dissemination of the Universal, this article shifts to include examples of student work that, guided by the Te Herenga Waka's design curriculum, acknowledges and incorporates Indigenous knowledge. By expanding students appreciations of time, space and connectivity through Ta-Vā and Te Ao Māori, students have an opportunity to critique the past, and to recognize the relevance of Indigenous knowing and being to current and future behaviors and mindsets. This also encourages students to do this work in the present but situate it within the active space between the past and the future. We explain that this is the only space, in this sequential transition through time, where we can hold conversations, mitigate challenges, and navigate our pathways, using ALL the tools and knowledge available to us in the quest towards positive change, with, not for our communities.

In previous sections I have identified what I believe to be a place for Indigenous knowledge, specifically that of the Pacific region, within both the foundations of design and the future of its practice. This may not be your history, but it is a part of ours and offers design in Aotearoa, New Zealand the agency and confidence to move forward guided by the knowledge, methods and mindsets that Ta-Vā and Te Ao Māori embrace and offer us. To enable a more global approach this work can be considered alongside Transition Design and led by some of its founding words that "design has much to learn from these (Indigenous) approaches to designing and their symbiotic relationship with the natural environment" (Irwin, Krissoff, 2015). Transition Design proposes that in order for designers to act as agents for change, new approaches to design and problem solving must be based upon a deep understanding of both social and natural systems. It asks designers to examine their own value system and the role it plays in the design process. It argues that Transition solutions will be best conceived within a more holistic worldview that can inform new, more collaborative, and responsible interaction. Transition Design acknowledges Indigenous wisdom, specifically that offered by the seventh-generation principle from the Great Law of Iroquois Confederacy. This states that decisions made in the present must result in a sustainable world seven generations into the future. "An important ability of the Transition Designer will be to think about designing in the present and the potential impact of their work to affect the future"(Irwin, 2015).

To best illustrate this, an example from our curriculum is offered. Agents of Change - *Kaiwhakatinana Panonitanga* is a final year project in our undergraduate program. This article now returns full circle to the opening *whakatauakī, Kia whakatōmuri te haere whakamua,* I walk backwards into the future with my eyes fixed on my past.

This course is taught as three strands of knowledge.

- The past: to understand who you are.
- The present: To understand the current context and impact.
- The Future: To frame and propose viable, sustaining and sustainable solutions for future generations.

Importantly *tikanga* Māori are introduced into this work. *Tikang*a are the values and protocols that we engage as a part of the design process, the research we do and the solutions we propose. These tikanga ask that we; show respect, engage authentically, listen, hear, empathize, show compassion and generosity, collaborate, co-design, communicate throughout the design process and most importantly, give the agency or decision0making power to those impacted.

This project specifically engages with external communities and follows the guidance of Te Aho Tū Roa. This is an established social programme working with communities that embrace Māori culture, language and wisdom. Te Aho Tū Roa is the cord that connects and sustains us, joining us to those who have gone before and to those who will come after us. As a social programme, Te Aho Tū Roa seeks to strengthen connection: 'People to People' - including past, current and future generations, and 'People to Place' - embracing every element including the physical, spiritual, and living aspects of our world. Agents of Change engages the *tikanga*,

- Whanaungatanga: the establishment of authentic connections grown and demonstrated over time.
- Kaitiakitanga: guardianship–not ownership or authority.
- Mana: Understanding and respecting other knowledges and worldviews Importantly this must remain intact throughout the entirety of the process, solutions and beyond.
- Nga manakura: empathy and understanding – understanding who/what is impacted by the problem and who/what will be impacted by the solution.
- Manaakitanga: generosity, hospitality and reciprocity– works alongside whanaungatanga and shares stories, kai (food), experiences, knowledge and space with all those involved in the work.
- Rangatiratanga – autonomy and agency. Appreciating that the solution needs to be identified, created, implemented and success measured by, when, where, and how those who will be impacted by the solution, and their next generations, determine.

THE PAST: Pepeha and Positionality. (Figure 4).

Pepeha: Ko mai au? Who am I? Where and what do I *whakapapa* (connect) to. A *pepeha* is the Māori word for introduction. It starts with the student telling their history of connection to the world. What mountain, water mass, tribe, and or area/country they originate from. Only once these connections to place are established do they say their name.

Positionality: The next step in this design process is defining the *tikanga* (values) that will guide the student throughout the work. Asking them to consider what is important to them and how that benefits the work. What role does this afford them? What might they bring to the process? How are they connected to, or disconnected from the problem? Knowing this we then ask if they have the knowledge or experience to address the situation and if not, where will that knowledge come from? The concept of *whakapapa* (genealogy) situates them and is imperative to enabling *nga manakura* (empathy) and establishing the space for *rangatiratanga* (self-determination) where those impacted by the problem and the solution hold agency.



Figure 4. (with student permission) This student work (Agents of Change) depicts the introductory page in which students introduces themselves using a Māori protocol of the Pepeha. As part of this this protocol, one's connections to place and people are described before introducing yourself by name. Students are encouraged to undertake this in Te Reo (Māori language), but also their own first language or English. Positionality is described above.

Methodology: (Figure 5). This part of the project is guided by *manaakitanga* (generosity). It incorporates *mana,* (respectful) face to face activities that acknowledge research as a reciprocal relationship. Engaging *nga manakura* (empathy) these sessions are undertaken with Māori as *wananga* (open discussion sharing different perspectives, opinions and experiences) and with Pasifika peoples as talanoa (dialogue that bring people together to share opposing views). methods bring with them both recognition and *mana* for those with the knowledge sought and often involves a koha as payment (appropriate gifting that is defined by the participant). These sessions also incorporate the sharing of kai (food). This stage seeks to establish whanaungatanga (establishing authentic connections) and requires the student to recognize their own knowing and being and that of others. The project introduces students to the Māori health model, Te Whare Tapa Whā. Created in 1984 by Sir Mason Durie, it is a model devised by Māori for Māori and speaks to the foundations of wellbeing and health as *whenua* (the land) with the four walls of the *whare* (home) building and sustaining spiritual, physical, social and emotional health. Acknowledging that all five components are required throughout the design process and the resultant outcome ensures that the process, participants, forms of participation, how, where, and when to participate (or not), and the appropriate roles and responsibilities of all involved are considered and delivered as a critical measure of the outcome.

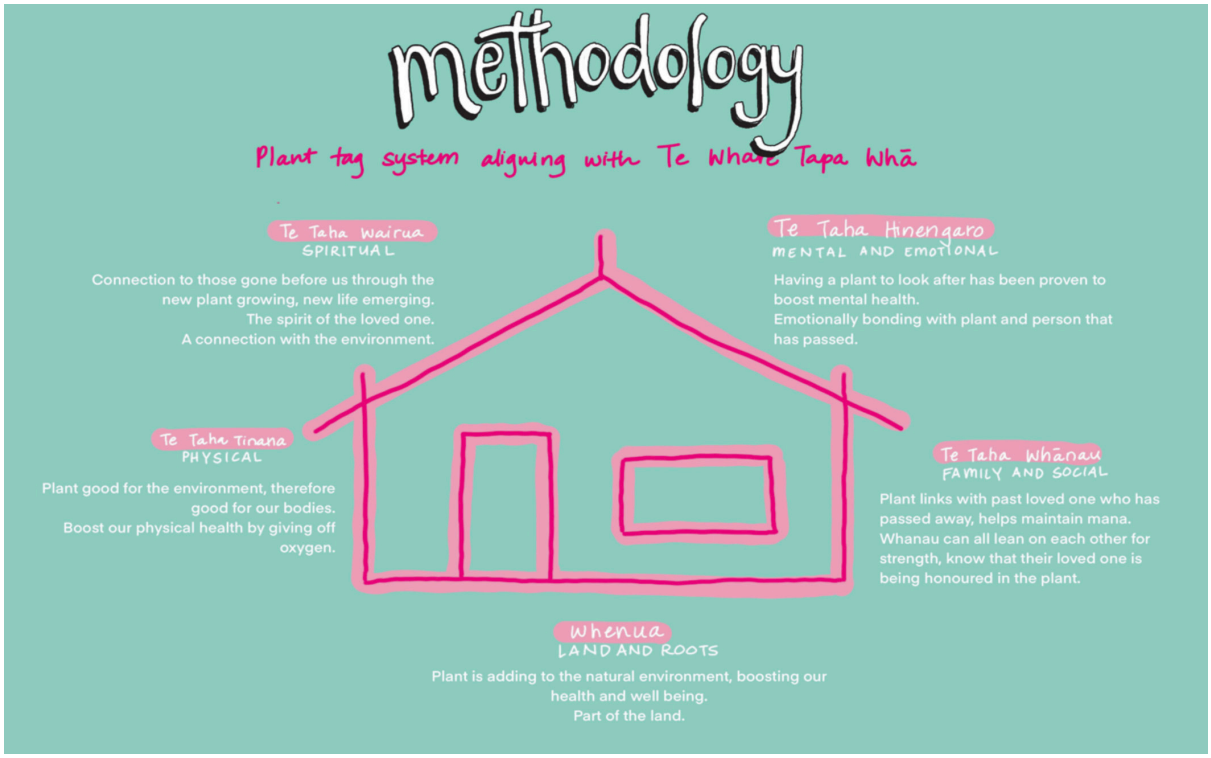

Figure 5. (with student permission) This page in the student project depicts an illustration of the Whare Tapa Wha Health Model. It shows the whare (home) and the interconnected and interdependent structure required to make it stand. It also describes that the stronger the foundations and the connections are, the stronger the whole.

Outcomes: (Figures 6 and 7). Each student, having identified their role and those of their participants and in collaboration with these collectives, formalizes a strategic plan for engagement and learning. Next, and alongside the chosen community, students develop a working prototype that reflects *akoranga* (the knowledge shared between them and the participants), *whanaungatanga* (meaningful engagement) and *rangatiratanga*, an understanding of how the intervention or activation might be enacted or disseminated with or by these communities. With the three threads of knowledge gained from past, present, and future considerations students are enabled to weave or knit together a strong understanding of self and others and how to help enable *kaitiakitanga,* the sustaining and sustainable solutions they and the participants seek as guardians of people, knowledge and their place. The examples provided address food sovereignty for Māori. Engaging with The Museum of New Zealand, Te Papa Tongarewa, the students were asked to create opportunities of visitors to engage with and learn about *Maramataka,* the Māori lunar calendar. The students focused on enabling both sustaining and sustainable solutions. Their goal was to create outputs that both grew and sustained Māori knowledge, were considerate of next generations and that promoted sustainable being.

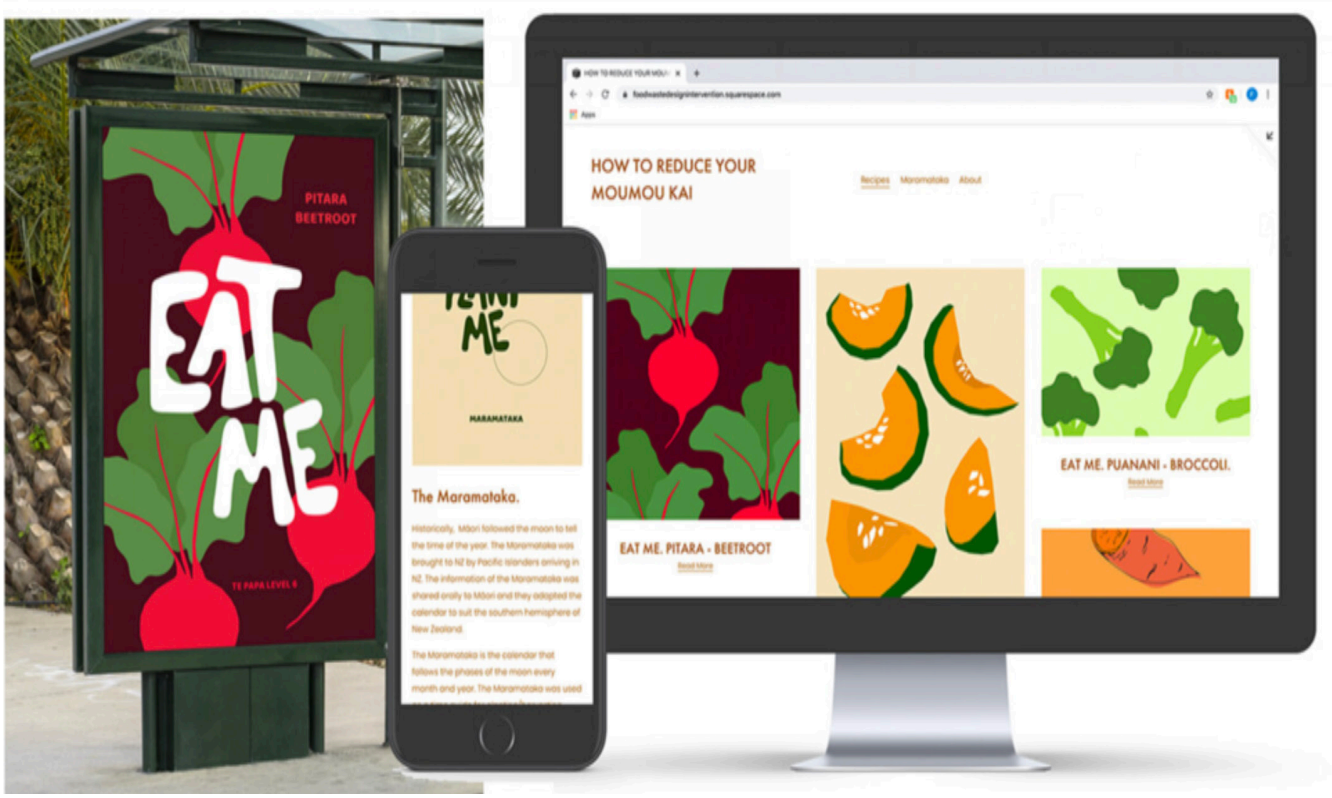

Figure 6. (with student permission) Eat Me, is a project undertaken in Agents of Change: Food sovereignty and sustainability for Māori. A social media campaign and an App were designed to promote healthy and sustainable eating and the use of both fresh food and food scraps.



Figure 7. (with student permission) Maramataka Maumaharatanga: Memory Calendar, Agents of Change: Again, focusing on food sovereignty and sustainability for Māori, this project a card game was designed to enable a resurgence in knowledge for the Māori Lunar calendar and in celebration of Matariki – Māori New Year. It illustrates and prompts discussions around intergenerational knowledge, methods of cultivation, narratives and planting times.

Although this article offered, as a starting point, a very abridged summary of the dominant design history, the overarching aim is to prompt questions about what we understand to be the truths and origins of the design tenets and practices that have driven and continue to drive much of our disciplinary knowledge and development of practice. As a succinctly overview of the Universal design history, John Ruskin gave design New Ways of Seeing, the Bauhaus gave discipline New Ways of Doing, and Richard Buchanan et al, expanded the purpose of design, giving it New Ways of Thinking. Despite the authors doubts as to the accuracy of that, this research suggests that our next step lies in listening to the wisdoms; past, present, and future of Indigenous knowledges that, I propose offer design New Ways of Being. This shift offers design a set of values that can enrich our perceptions, beliefs, mindsets and behaviours. This research points to the integration and appreciation of Indigenous values as being highly beneficial within design practice and asserts that they can enable the much-needed shift from the singular Universal to more inclusive and collective approaches. In doing so we might better accommodate and utilize the commonality and contrast needed to co-exist within reciprocal and respectful

relationships between all of our Spaceship's people and our places.

Acknowledging design in and of Aotearoa, building from our history and acknowledging our place, people and creative strengths, this research positions the Eurocentric version of design as simply one version. I suggest that there is nothing to be lost and everything to be gained by rewriting design's history as an eco-system of histories. In doing so, I propose more culturally diverse, inclusive, empathetic, sympathetic, articulate and sustaining solutions can be found for our futures. The take-away I hope to convey is, that there are numerous scales of collective knowledge, and many more individual perceptions and experiences with, and of our world, that design has yet to acknowledge, listen to, see, or engage with, let alone use its privilege to enable.

The last *whakatauakī* offered is, Ko te mauri, he mea hunaki te maona, powerful aspects of life are often hidden in plain sight. (Elder,2020).

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3D PRINTING OF ENERGY-EFFICIENCY WINDOWS.

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ABSTRACT | Simulations indicate that adding a second or even third layer of glazing with low-E coating compared to traditional windows will reduce heat transfer through the façade. However, incorporating additional glazing layers remains an impractical technology for the Mexican population, especially in vulnerable sectors. The cost of a double-glazed window can escalate up to 10 times that of a typical single-glazed window. Furthermore, only 2% of the national housing stock currently features double-glazed windows. Given that 70% of the country's housing stock is naturally ventilated, it is essential to consider insect screens in window design to maintain household health. These screens can reduce heat transfer by up to 7% when placed on the internal face and up to 14% when positioned externally. Consequently, this research aims to propose innovative solutions, including designs produced through 3D printing and non-conventional, economically viable materials—potentially sourced from recycled materials—to make energy-efficient windows accessible across all sectors.

KEYWORDS | SUSTAINABILITY, CLIMATE CHANGE, SOCIAL INNOVATION.

1. Introduction

The United Nations (UN) provided the right to adequate housing on its declaration of human rights (UN, 2014). Concurrently, the World Health Organization (WHO) set the right and parameters for healthy housing, highlighting a strong relationship between environmental conditions and well-being (WHO, 2018). Yet, this is not the case in at least 30% of the Mexican homes (INEGI, 2017).

Prolonged exposure to high temperatures poses severe health risks, including cardiovascular diseases and even mortality (Bonfigli et al., 2017). The events of the 2003 heatwave in Paris, which resulted in approximately 700,000 deaths, predominantly among the elderly, highlight the lethal consequences of extreme heat events exacerbated by climate change. As the planet continues to warm, the necessity for housing that provides both thermal comfort for today's climate, and resilience against rising temperatures becomes increasingly urgent. A critical factor in the thermal dynamics of buildings is heat transfer through the different elements of the building skin. Undesirable openings, such as cracks, can compromise thermal insulation, exacerbating energy poverty and undermining the health and well-being of residents. This issue is particularly severe in northeastern Mexico, where widespread poverty coincides with extremely high temperatures.

This region heavily relies on energy-intensive air conditioning systems. Contrary to popular belief, even vulnerable populations, such as low-income groups, use these types of technologies. Additionally, air conditioning systems with inverter technology tend to be more expensive, leading those with lower incomes to purchase cheaper systems, even though this results in higher energy consumption in the long run. Addressing these challenges requires practical solutions that enhance energy efficiency while ensuring affordability and accessibility. Extensive research has explored adding insulation to walls and examining the applicability and effectiveness of the NOM-020 standard related to heat transfer (Romero-Pérez, RodríguezMuñoz, Alpuche-Cruz, & Martín-

Domínguez, 2017; Zepeda-Gil & Montiel-Castro, 2023). However, to date, there has been little attention on providing low-cost solutions for windows, being the element of the façade that contributes most to heat transfer. In fact, the NOM-020 standard does not require double glazing in Mexican homes. This paper examines the role of glazing, particularly in mitigating thermal transmittance through windows, through 3D printing and HDPE (high density polyethylene), we highlight the transformative potential of simple, costeffective interventions.

As climate change accelerates and the threat of prolonged heat exposure increases, the urgency of fortifying vulnerable areas of buildings, such as windows, cannot be overstated. This paper calls for scalable solutions that empower university students and educators worldwide to engage in community-driven initiatives. By fostering awareness and advocating for accessible improvements in housing infrastructure, we aim to contribute to a future where every individual can reside in environments that safeguard health, dignity, and resilience in the face of a warming world and advocating for accessible improvements in housing infrastructure, we aim to contribute to a future where every individual can reside in environments that safeguard health, dignity, and resilience in the face of a warming world.

1.1 State of the art

Filament-based three-dimensional printing technology, also known as Fused Deposition Modeling (FDM), has been employed in a myriad of applications, ranging from the construction of small accessories or adaptations for existing commercial parts to the fabrication of car bodies or even yachts. The primary challenges of this technology in most fields can be enumerated as follows:

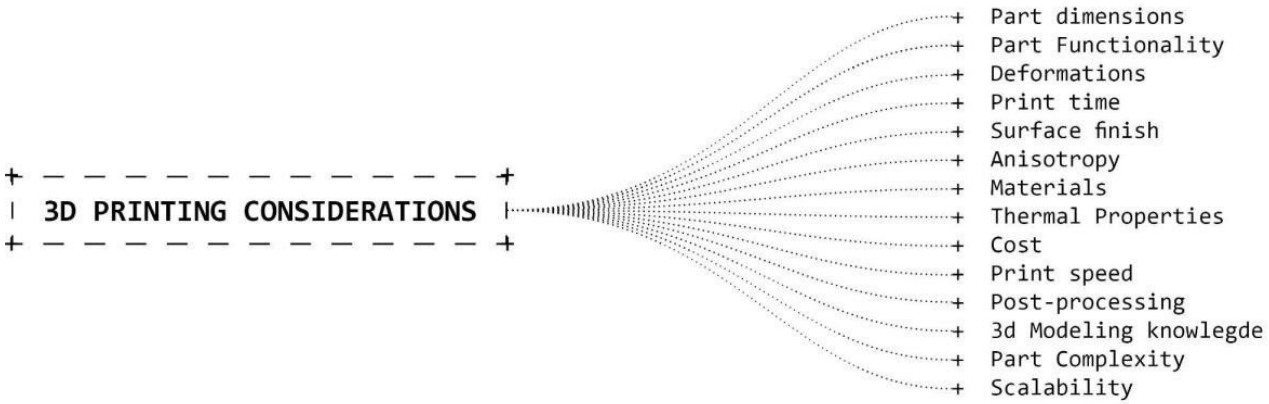

Figure 1 - 3D printing considerations

The following section describes the parameters to anticipate some challenges, as well as the opportunity area represented by the research and development proposal.

1. **Part Dimensions:** Commonly constrained by the dimensions of the printing platform of the equipment used, which can vary between Delta and Cartesian printer configurations.

2. **Part Functionality:** This involves determining whether the part will experience mechanical stress along any of its axes (x, y, z) or if it is produced for didactic or entertainment purposes, where exceptional resistance is not required. The mechanical properties of 3D printed parts can vary based on the material used, layer orientation, print speed, layer height, and other factors.

3. **Deformations:** Larger parts (exceeding 20 cubic centimeters) typically experience greater deformation during cooling, caused by internal stresses.

4. **Print Time:** While current speeds range from 300 to 600 mm/s, increasing the print speed can lead to greater deformation in the resulting part.

5. **Surface Finish:** Directly related to layer height, the surface finish can range from rough or stratified to relatively smooth if the layer separation is less than 30% of the nozzle diameter.

6. **Anisotropy:** Closely related to the orientation of the part within the printing platform.

7. **Materials:** Continuously evolving, current materials include composites like glass or carbon fiber mixed with PLA, ABS, or ASA. However, compared to the wide range of industrial plastics, the available options remain limited.

8. **Thermal Properties:** Affected by the manufacturing process itself, as low-temperature thermoplastics are used, limiting their application in high-temperature environments.

9. **Cost:** While the accessibility of 3D printing has become more affordable over the years, specialized materials and large part dimensions can increase costs.

10. **Print Speed:** As mentioned earlier, this directly affects surface finish and can impact productivity in serial production since it is not designed for repetitive industrial use.

11. **Post-processing:** Necessary for parts where the surface finish needs to mimic molded parts. Otherwise, it is recommended to avoid post-processing to reduce production time and costs.

12. **3D Modeling Knowledge:** While open-source repositories can provide solutions, specialized designs require a deeper understanding of specialized software."

13. **Part Complexity:** This can necessitate the use of support structures during the build process and extend print time.

14. **Scalability:** A characteristic closely related to the possibility of large-scale

production. When designing window profiles using 3D printing, we face the challenge of managing the variable properties of the parts, which are directly influenced by the printing parameters. A clear example is the relationship between layer separation and surface finish. Increasing this separation accelerates the process, but at the cost of a lower quality surface finish. Similarly, the orientation of the part can affect its mechanical strength due to the need to use fewer supports.

These challenges will be presented in the following proposal and will be considered when making decisions regarding the research line and production of the pieces to be created.

2. Methodology

2.1 Design process

This study proposes a comprehensive review of existing literature on FDM printing for profiles as a first step. The scarcity of research in this area underscores the need for our work, which aims to pioneer the use of rapid prototyping in the construction accessories industry. Companies like *Liniar*® have already demonstrated the potential of 3D printing for agile product development. By enabling low-cost, in-house prototyping, 3D printing offers immediate feedback on dimensions and finishes, accelerating the design process.

3D printing has been widely used to validate theoretical designs by comparing them to physical prototypes. Various simulation tools are employed to create virtual environments and test designs under different conditions. This study will utilize simulation software to explore the relationship between profile characteristics and thermal performance. By employing this approach, we aim to gain a deeper understanding of how design choices impact the overall performance of the system. The Mexican standard NMX-R-060-SCFI-2013(hereafter referred to as NMX-060). will be used as a benchmark in the design, development, and evaluation of the proposed materials to be obtained as part of the research process, as it provides us with the basic aspects that windows and architectural products for exterior facades must comply with. Although not mandatory, this list of guidelines allows us to understand the control points and properties that must be considered in the design of enclosures. The following are listed:

a. **Resistance to wind load.** Property of a window or enclosure indicating its ability to withstand a specific wind intensity without significant deformation or destruction.

b. **Water tightness.** It is defined as the ability of a window or enclosure to resist water penetration. Water penetration is the continuous or repeated wetting of the inner face of the frame or of parts not designed to be wet when water drains towards the outer face.

c. **Air permeability.** Defines the ability of a window to resist air infiltration through its joints and cracks when subjected to a differential pressure caused by wind.

d. **Acoustic insulation** (of a window). Measures the sound level difference (in dB) transmitted through a window or enclosure separating two spaces or the exterior and interior.

e. **Thermal insulation.** Overall heat transfer coefficient (K): This is the amount of heat that a construction system allows to pass through per square meter when there is a temperature difference of 1 K.

f. **Weather resistance,** g) Functional resistance and integrality of the enclosures, h) Other specifications of the enclosure hardware system, i) Glazing. Use requirements, j) Installation on site.

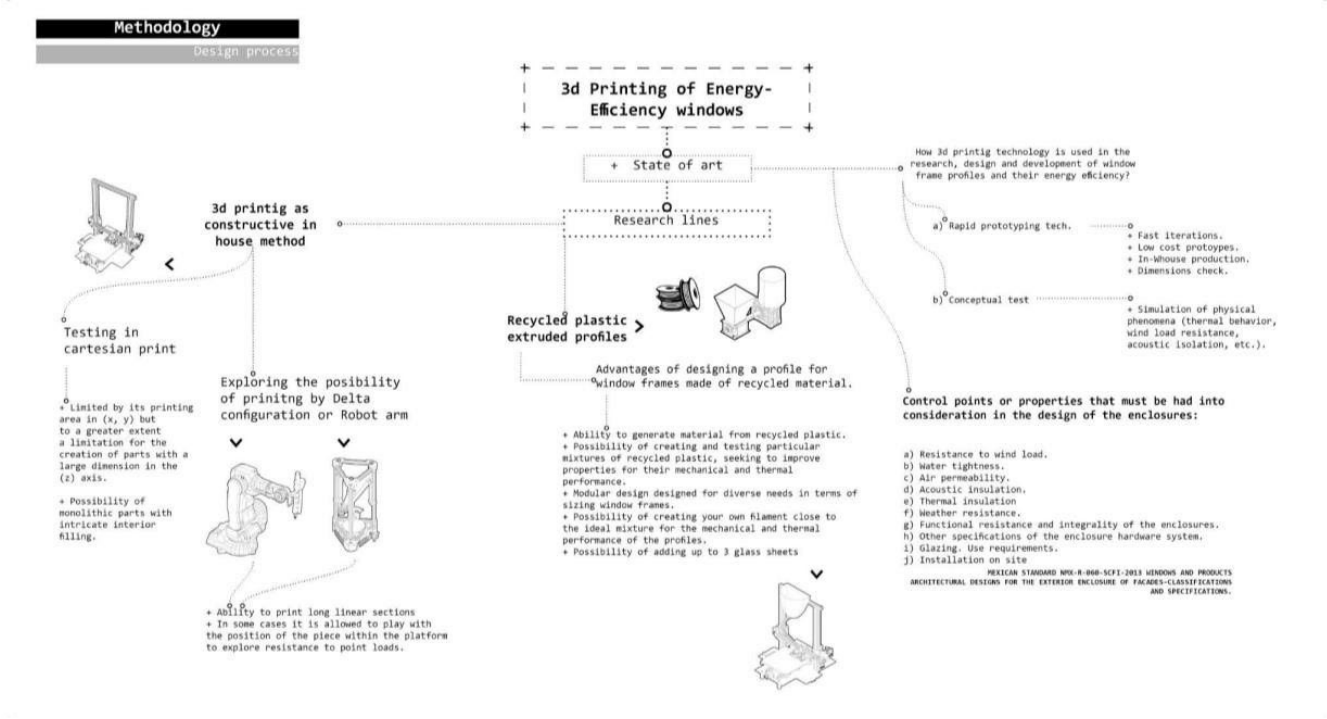

Figure 2 - Figure 2. Methodology | Design process.

2.2 Materials

A crucial aspect in the design of any industrially or semi-industrially manufactured product is the material to be used for its materialization. For the following research, polymers are proposed as the primary material for the development of test prototypes. Due to their physicochemical properties, they are an excellent option to meet the expected performance of window profiles and frames. Polymers have been widely used in various industries, from food packaging to tool coatings and automotive parts. Just as there has been a significant evolution in the design

and development of polymers, this material has also been adapted for use in additive manufacturing processes such as FDM.

For use in the FDM process, polymers can be presented as small granular spheres, which are introduced into a hopper where they are melted and then extruded through nozzles with diameters ranging from 0.4mm to 1mm commercially. Another presentation in which we can find polymers prepared for FDM, and which is the most commercial presentation we will find on the market, is in the form of filament (thread/cable), which is standardized to a diameter of 1.75mm so that it can be fed to the extrusion nozzle.

Similarly, it can be mentioned that the most commonly used material in the commercial sector is polylactic acid (PLA). This material has the great advantage that in its composition, since it is a thermoplastic monomer derived from renewable organic sources such as corn starch or sugarcane. The use of biomass resources differentiates the production of PLA from most plastics, which are produced using fossil fuels through the distillation and polymerization of petroleum.

ASA (Acrylic Styrene Acrylonitrile) is a technical material that is considered a successor to ABS. Compared to ABS, ASA is more UV resistant, warps less, and doesn't smell as much. ASA is a tough and resilient material that is, thanks to its UV and temperature resistance (up to 93 °C), suitable for outdoor use and for making technical parts. The main disadvantage of ASA is significant warping caused by temperature differences between the model and its surroundings. Another disadvantage is that ASA releases potentially dangerous fumes during printing - this means you should keep your printer in a well-ventilated area. ASA can be easily sanded both wet and dry.

We could continue enumerating and demonstrating the various materials used in the FDM process, their properties, their printing behavior, their final surface quality, etc.; however, a relevant aspect of the present study is the possibility of using recyclable plastic waste (e.g., HDPE - High-Density Polyethylene), subjecting it to a washing, drying, and grinding process to be used as raw material in the construction of window profiles. A significant contribution of this work is believed to lie in the obtaining of a proprietary recycled plastic mixture, which would be designed to provide improved thermal efficiency in the frames, while also complying with the parameters established in the aforementioned NOMs.

2.3 Standard NMX-R-060-SCFI-2013

The standard classifies windows according to their properties based on the list below. It ranks the elements from 0, V1-V5, and exceptional. The different charts of accepted ranges can be seen in Annex 1.

a. **Wind load resistance.** The test includes a minimum load that the item should resist, and the window frontal deflection.

b. **Water tightness.** This should meet the requirements of Table 3 from Annex 1.

c. **Air permeability.** This should meet the requirements of Table 4 from Annex 1.

d. **weather resistance** This is divided into subsections based on the material. As we are selecting materials with properties similar to PVC, our goal will be to fulfil the requirements specific to this material.

i) For temperatures > 25 °C, it should be able to resist a total solar annual over a horizontal surface of ≥ 5 GJ/m2.

ii) Impact resistance in PVC-U main profiles is measured by a mass drop test at -10 °C.

e. **Thermal insulation.** Although the standard does not measure this, it is possible to recreate the conditions of the materials and simulate the thermal behaviour of the window, as presented in by Van Den Bossche et. Al., (Van Den Bossche, Buffel, & Janssens, 2015)

3.0 Expected results, and future work.

This paper aims to present the methodology, materials, and testing methods for designing a low cost, easily accessible window frame, that also allow for a U-Value of 2 W/m2K or lesser, equal to a double glazing window in the market.

3.1 Prototypes

3.1.1 Prototype 1: 3D Printed Model

The objective of prototyping is not only to identify the best materials for creating strong windows, but also that meet the NMX-060 standards in terms of strength, durability and overall sustainability. Hence, we will determine a series of polymers, composites, and other from recycled sources, providing that the window must be able to reduce heat transfer, must be UV resistant, and mechanically strong, while being a much cheaper option than those in the market.

Another aspect that will be considered is Design optimization. 3D Printing allows for creating complex geometries and infills that are not possible to produce with traditional extrusion methods. Through grasshopper, we aim to explore distinct infill patterns for the window profiles so eventually we can produce a model that is both light and strong. The iterations will also be based on optimizing parameters such as print speed and temperature settings. As mentioned in the methodology, all our prototypes will be tested according to the NMX-060.

To address sustainability, we will conduct a comprehensive lifecycle assessment (LCA) utilizing SIMAPRO software. This analysis will facilitate a comparative evaluation not only in terms of costbenefit but also in environmental impact. We anticipate a substantial reduction in CO2 emissions compared to traditional window manufacturing methods, as our

process will predominantly utilize recycled materials. The LCA includes the entire production cycle, from material extraction to endof-life disposal, ensuring a thorough assessment of the environmental footprint.

3.1.2 Extruded

The main advantage of considering extruded profiles with recycled materials, is that basically any HDPE (high density polyethylene) can be transformed into high quality and highly resistant pellets. This has significant environmental benefits, reducing waste and the need for using raw materials.

3.1.3 Prototypes using robotic Arms

Robotic arms offer a more advanced approach to 3D Printing. They are more flexible and precise, particularly when dealing with printing at larger scales. In this aspect, we aim to explore materials that are suited for arm-based 3D printing such as recycled HDPE (high density polyethylene) produced inhouse.

The primary advantage of this technique is its capacity to fabricate larger profiles in a single production run, thereby eliminating the need to join multiple pieces and potentially compromising the structural integrity of the final element. In light of this capability, our objective is to investigate novel infill geometries that are not feasible with conventional 3D printing methods. This exploration aims to enhance both the mechanical properties and design flexibility of the produced components.

4.0 Conclusions and limitations

This paper presents the methodology that will be undertaken to create a low cost highly insulated window. Our methodology focuses on various aspects from exploring different materials, aggregates and composites, prototyping and design, parametrization, testing under the NMX-060, economic feasibility and cost benefit analysis, and finally a life cycle assessment. Our primary focus is to use conventional and non-conventional 3d Printing and to incorporate recycled materials. Our main objective is to foster circular economy, create windows with lower carbon footprints, and overall to enhance the living conditions of vulnerable sectors in Mexico.

While we present a detailed methodology, we acknowledge that at present, no empirical data nor physical prototypes have been created to test our proposed approaches. We are also aware of potential limitations with our approach such as the quality of recycled materials, unexpected problems when dealing with robotic arms, the potential problems of scalability to massproduce our successful prototypes given availability of recycled materials and 3d Printing times, and the possibility that the properties of the considered materials may not be able to mimic those in the market. These limitations will be addressed by testing various polymers, composites and recycled materials, aiming to identify the best options. Testing and performance evaluations are key aspects of finding the best mix to achieve the goals of this research. Although data and prototypes are yet to be developed, these will be rigorously tested and validated to ensure their feasibility.

This work aims to fill a gap in research, and a inherent need from the most vulnerable sectors through novel technologies like 3D Printing, promoting a more sustainable construction industry and innovative design solutions.

ANNEX

Annex 1 – Classification ranges according to the NMX-060

CLASE DE VIENTO	P_1 (Pa)	P_2 a) (Pa)	P_3 (Pa)
0	Ventana no ensayada		
V1	X ≤ 400	X ≤ 200	X ≤ 600
V2	401 < X ≤ 800	201 < X ≤ 400	601 < X ≤ 1200
V3	801 < X ≤ 1200	401 < X ≤ 600	1201 < X ≤ 1800
V4	1201 < X ≤ 1600	601 < X ≤ 800	1801 < X ≤ 2400
V5	1601 < X ≤ 2000	801 < X ≤ 1000	2401 < X ≤ 3000
Excepcional b)	2001 < X	1001 < X	3001 < X
a) Estas presiones son repetidas 50 veces.			
b) Una muestra de ensayo ensayada con una carga de viento superior a la Clase 5 se clasifica Exxxx, donde xxxx es la presión de ensayo actual P1 (ej., 2350, etc.) X = Resultado de carga en cada etapa de ensayo.			

Table 1 - Classification Ranges. Wind load resistance according to the minimum load they must withstand

Flecha Frontal Relativa Máxima Admisible	Clasificación
L/200	A
L/300	B
8 mm	C

Table 2 - Classification ranges. Wind load resistance according to the maximum allowable relative frontal deflection

CLASE DE PERMEABILIDAD AL AIRE	P (Pa)	Q (m^3 / h / m^2)
SIN CLASIFICAR	100	> 50
Clase 1		27 < Q ≤ 50
Clase 2		9 < Q ≤ 27
Clase 3		3 < Q ≤ 9
Clase 4		Q ≤ 3

Table 4 - Classification ranges. Air permeability.

PRESIÓN DE ENSAYO (Pa)	CLASIFICACIÓN	
	METODO A	METODO B
-	0	0
0	E1 A	E1 B
50	E2 A	E2 B
100	E3 A	E3 B
150	E4 A	E4 B
200	E5 A	E5 B
250	E6 A	E6 B
300	E7 A	E7 B
450	E8 A	-
600	E9 A	-
>600	EE_{xxx}	-
NOTA 4:		
El método A es apropiado para productos que estén totalmente expuestos.		
El método B es apropiado para productos que estén parcialmente protegidos.		

Table 3 - Classification ranges. Water tightness.

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ANALYSES OF SUSTAINABLE DEVELOPMENT IN CITY VISUAL IMAGE DESIGN: A STUDY BASED ON CITESPACE KNOWLEDGE MAPPING METHOD.

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ABSTRACT | The city visual image, acting as a vital conduit for disseminating urban culture and nurturing city brands, is crucial for enhancing a city's competitive edge and also plays a significant role in driving social transformation and fostering inclusive development. This study applies the CiteSpace knowledge mapping approach to provide an extensive review and strategic foresight into the academic discourse on city visual image design. Employing bibliometric methods of collaboration network analysis, co-citation, and co-occurrence analysis, we have identified key areas in urban visual image design, including artificial intelligence, social media, visual perception, and brand development. The research indicates three directions for future studies: (1) Deepening systematic studies of city visual image to promote intercultural and intergroup dialogue, reflecting the diversity of cultural expressions and values, thereby enhancing social inclusivity and appeal; (2) Enhancing stakeholder engagement in the discourse and decision-making processes of city visual image design to foster a stronger sense of social belonging and responsibility; (3) Exploring the integration of artificial intelligence and leveraging digital technologies to expand public engagement and steer society towards greater openness and innovation. This research extends the boundaries of city visual image design, infusing the discipline with renewed vigor. It delivers essential practical insights to urban planners, designers, and policymakers, ensuring that city visual images are pivotal in driving social transformation and fostering an environment of inclusivity and participatory development.

KEYWORDS | CITY VISUAL IMAGE DESIGN, BIBLIOMETRIC ANALYSIS, KNOWLEDGE MAPPING, CITESPACE

1. Introduction

As integral players in the process of globalization, cities have emerged as potent catalysts for innovation and development. They have transformed into pivotal hubs for the dissemination and exchange of culture (Guimarães, Ribeiro, & Machado, 2021), the integration and innovation of technology (X. Chen, 2019), and the cultivation of social sustainability (Dias et al., 2024). The city's visual image, a cornerstone of cultural soft power (Dong, Liang, Liu, & Wang, 2022), is instrumental in crafting a unique city brand (Hsun & Jie, 2022) and deepening its cultural narrative . It accentuates cultural diversity and inclusiveness, energizing community engagement (Kallus, 2016). Such engagement is crucial for enhancing a sense of identity and belonging among residents, which is essential for fostering social transformation and inclusive development (Belabas & George, 2023; Paganoni, 2012). Therefore, the visual image of city is key to enhancing urban attractiveness and competitiveness (Sevin, 2014) and serves as a crucial engine driving future urban change and development.

Despite the considerable advancements in the study of the ontology, media, and audience aspects of city visual image research, there is a discernible gap in the availability of review studies. As the academic literature expands, the necessity for bibliometric analysis and visualization techniques has become more pronounced. Bibliometrics, esteemed for its methodological rigor, serves as a powerful tool for exploring the vast expanse of scientific data. It not only enables in-depth analysis and scrutiny of extensive datasets but also furnishes crucial insights for mapping the progression and identifying nascent trends across various scholarly disciplines (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). Currently, bibliometric inquiries into city image design have extended across diverse dimensions, encompassing pivotal themes such as the image of city tourism destinations (Guo, 2023), urban landscapes (Yang & Lu, 2022), the evolution of smart cities (Zhou, Zhang, Liu, Zhang, & Zhao, 2020), and the crafting of creative cities (Ren, Zhong, & Sun, 2023). As the corpus of research knowledge grows and the quest for a profound examination of city visual images intensifies, the reliance on conventional

qualitative and quantitative research methodologies has become inadequate to fulfill the evolving demands of the field. Consequently, the integration of bibliometric and visualization analysis tools stands out as an essential component, vital for nurturing the synthesis and innovation of knowledge within this domain.

This paper undertakes a systematic analysis of the academic discourse in the field of city visual image design, covering the period from 2013 to 2024. Through an exhaustive search within the Web of Science (WoS) Core Collection database, the research meticulously selects and synthesizes seminal literature to curate an extensive and nuanced dataset.

Utilizing the visualization capabilities of CiteSpace, the study aims to address three pivotal inquiries:

- What is the current state of scholarly research on city visual images;
- What constitutes the knowledge framework of city visual image, and how has it evolved;
- What are the prospective research directions for both theoretical scholars and practitioners in the field of city visual image.

This study aims to achieve the following objectives:

- To provide a macro perspective on the academic landscape by deeply analyzing the contributions of different countries, institutions, and key scholars in the field of city visual image design;
- To elucidate the foundational knowledge and the structural framework of city visual image design by scrutinizing co-cited references and co-cited journals. This process entails identifying pivotal literature and authoritative journals, thereby providing a deeper understanding of the evolution and dissemination of knowledge within this scholarly domain;
- To identify and explore research hotspots and emerging themes in city visual image studies through keyword co-occurrence and clustering analysis using cooccurrence network analysis. Additionally, by integrating keyword timelines and keyword bursts, this study aims to forecast future development trends, offering prospective guidance for research in this field.

Through bibliometric and visualization analysis, this study systematically reviews the current research status and knowledge structure in the field of city visual image design. It identifies key research hotspots and frontier areas, providing a scientific basis for decision-making and directional guidance for researchers. Furthermore, this endeavor aims to support innovation and development in cities within a global context. It facilitates social transformation, promotes inclusive growth, and enhances community engagement, thereby contributing to the broader goals of sustainable urban development.

2. Research Methods and Procedures

The overall research framework of this study is depicted in Figure 1, which primarily consists of three stages: data collection, data cleaning, and data analysis.

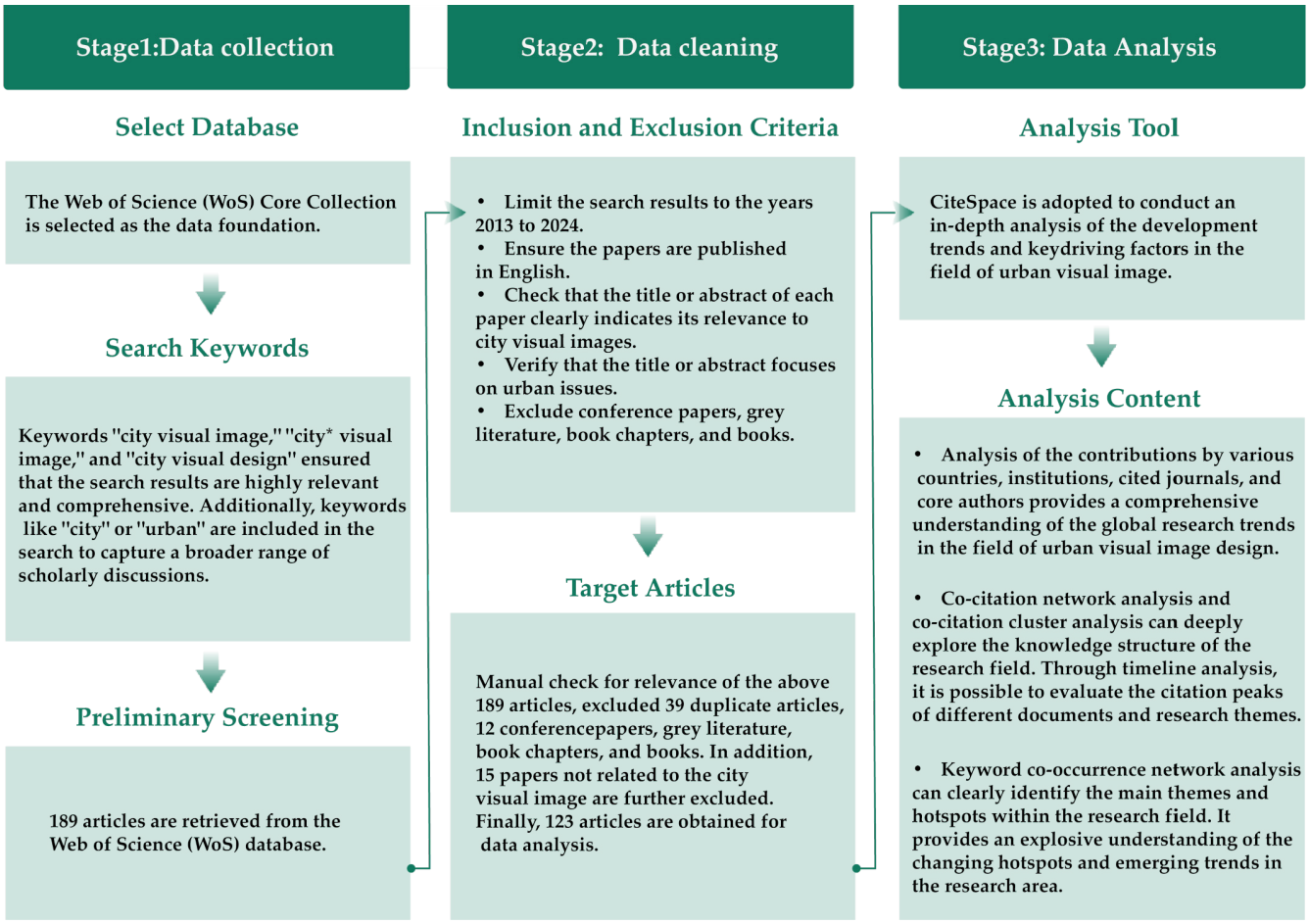

Figure 1. Research Framework.

2.1 Data Collection

In this study, the Web of Science (WoS) Core Collection was selected as the data foundation, with the CiteSpace tool employed to assist in the keyword search strategy, ensuring both depth and breadth in the research. WoS, as an authoritative platform for bibliometric analysis, provides extensive bibliographic and citation resources and includes high-quality scholarly articles that have undergone rigorous peer review, thus ensuring the reliability and authority of the research. The citation analysis capabilities of WoS further enhance the ability to identify key trends and themes within the discipline. Given the multidimensional nature of city visual images, this study adopted a precise keyword

search strategy. The core keywords 'city visual image,' 'city* visual image,' and 'city visual design' were carefully selected to ensure high relevance and comprehensiveness of the search results. To broaden the research perspective, terms such as 'city' or 'urban' were also included in the search to capture a wider range of academic discussions. The research period, spanning from 2013 to 2024, was intentionally selected to facilitate a focused examination of the most recent scholarly contributions to the city visual image discipline. This timeframe enables an in-depth analysis of the field's knowledge advancements and offers a sharp perspective on the dynamic trends shaping the academic vanguard. Utilizing a strategic combination of keywords in the Web of Science (WoS) database, we have curated a collection of literature that is both extensive and pertinent. This compilation forms a solid basis for a detailed analysis of the progression of city visual images within the academic community. As a result, the study is poised to engage with this complex and rich topic in a manner that is both exhaustive and insightful.

2.2 Data Cleaning

This study established inclusion and exclusion criteria to ensure that the analysis was based solely on the most pertinent literature. Throughout this process, non-target documents, including conference papers, gray literature, book chapters, books, and duplicate articles, were meticulously excluded. By employing the CiteSpace software, documents were systematically organized by title, author, and publication year, effectively identifying and eliminating duplicates. To guarantee the study's quality and reliability, the research was focused exclusively on peerreviewed journal publications, thereby excluding other types of publications. This strategic decision ensured that the literature under review was of high quality and had undergone rigorous peer review, thereby more accurately reflecting the research topic. In the subsequent screening phase, three independent reviewers evaluated the titles, abstracts, and keywords, which were pivotal in the decision-making process. Any discrepancies among the reviewers were resolved through collaborative discussion, thereby mitigating the influence of personal bias on the study's results. During the abstract screening stage, studies that were not pertinent to city visual images were meticulously excluded to ensure the high relevance of the literature to the research topic. Ultimately, 123 articles were selected as samples for further analysis based on their relevance to the research theme.

The inclusion and exclusion criteria were as follows:

- The time range was confined to the period from 2013 to 2024;
- Papers had to be published in English;
- The title or abstract of the paper must explicitly indicate its relevance to city visual images;

- The title or abstract must primarily address city issues;
- Excluded were conference papers, gray literature, book chapters, and books.

Through this rigorous screening process, the study ensured that the analyzed literature met the required standards for both quality and relevance, laying a solid foundation for an in-depth exploration of city visual images.

2.3 Data Analysis

The CiteSpace tool was employed to conduct a profound analysis of the development trends and pivotal drivers within the realm of city visual image studies (C. Chen, 2004). It simplifies complex scientific literature into digestible visual representations and offers a suite of visualization tools, including collaboration, co-citation, and co-occurrence networks. By generating knowledge maps, CiteSpace facilitates an in-depth examination, synthesis, and summarization of the leading trends and knowledge linkages in the field, providing critical insights for future scholarly endeavors (C. Chen, 2006, 2017).

Initially, an exhaustive examination of the distribution of contributions from countries, institutions, and key authors offers a holistic view of the global research landscape in city visual image design (Martínez-López, Merigó, Valenzuela-Fernández, & Nicolás, 2018). This analysis not only pinpoints principal contributors and gauges the research's collective quality and impact (Bahroun, Anane, Ahmed, & Zacca, 2023) but also lays the groundwork for future international collaboration, knowledge dissemination, and resource amalgamation.

Subsequently, the application of co-citation analysis for references and journals explores the research field's knowledge base and structure. Co-citation analysis of references surfaces the seminal literature, uncovering the academic community's foundational texts with considerable sway (Shiau, Dwivedi, & Yang, 2017). Extended co-citation analysis of journals unveils the thematic spread and research emphases of various journals, charting the evolution of knowledge and offering a comprehensive grasp of the field's knowledge architecture.

Ultimately, keyword co-occurrence and clustering techniques distinctly delineate the research field's focal points and areas of intense interest (Zhu & Zhang, 2020). Moreover, keyword timeline analysis assesses the citation peaks of diverse literature and thematic areas, revealing the temporal influence of research outcomes and identifying seminal works that have significantly propelled the field's development at particular junctures (Li, Ma, & Qu, 2017). Additionally, the surge in certain keywords often signals the advent of new research frontiers or directions. A scrutiny of these terms' distribution sheds light on emerging trends, shifts in research priorities, and the dynamics of current research hotspots, thereby aiding in the prognostication of the field's prospective directions (Guo, 2023).

3. RESULTS AND ANALYSIS

3.1 Collaboration Network Analysis

The publication output in the field of city visual image design, as indexed in the Web of Science (WoS) database, has experienced significant and sustained growth from 2013 to 2024, reaching its zenith in 2023, as illustrated in Figure 2.

Further examination of the collaboration networks among nations in city visual image research, illustrated in Figure 3, reveals that China, the United States, Japan, the United Kingdom, Malaysia, Russia, and South Korea are the principal contributors to this field. China is particularly prominent, occupying a central position in the international research network and engaging in extensive collaborations with the United States, South Korea, Russia, and other nations. Table 1 presents a quantitative overview, with China at the forefront, publishing 55 papers, followed by the United States with 19 and Japan with 6. The betweenness centrality metric, which quantifies a country's capacity to facilitate connections within the network, is highest for China (0.54), underscoring its pivotal role in global research collaboration. The United Kingdom also demonstrates considerable influence, with a betweenness centrality value of 0.24, indicating its impact in the field.

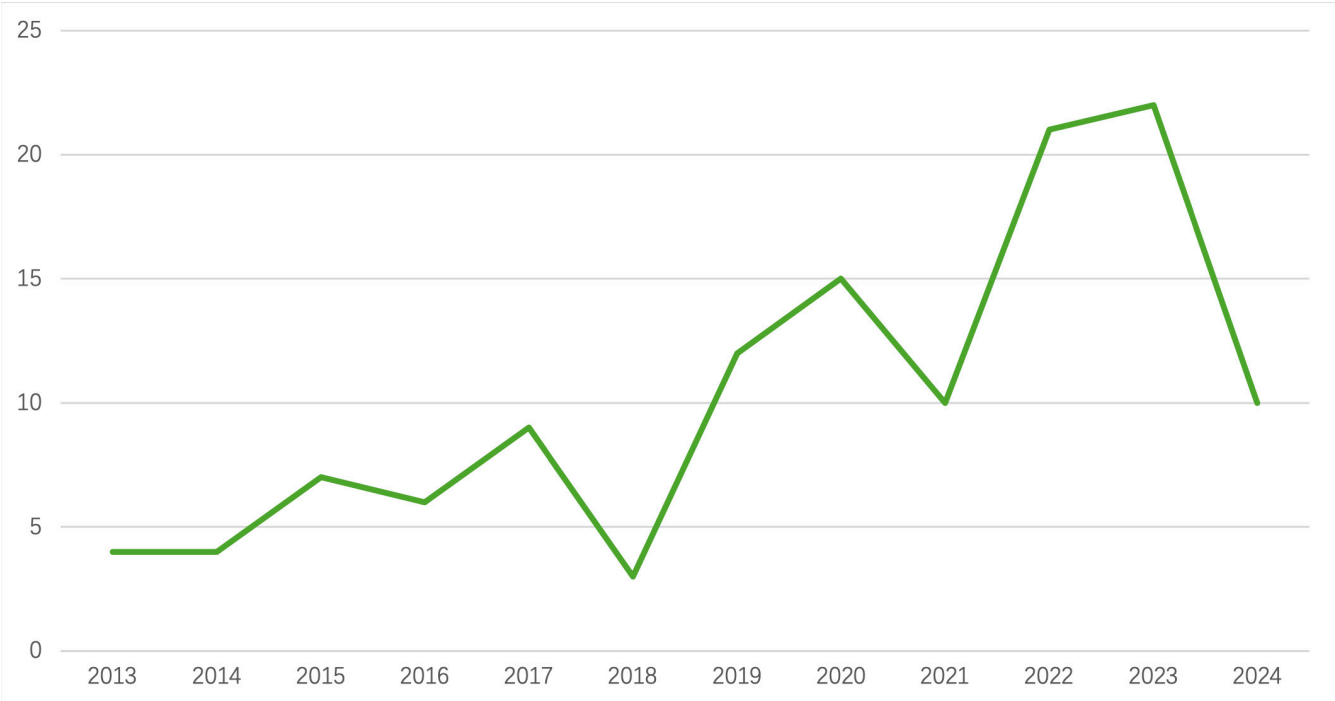

Figure 2. Annual Publication in City Visual Image Research on WoS from 2013-2024.

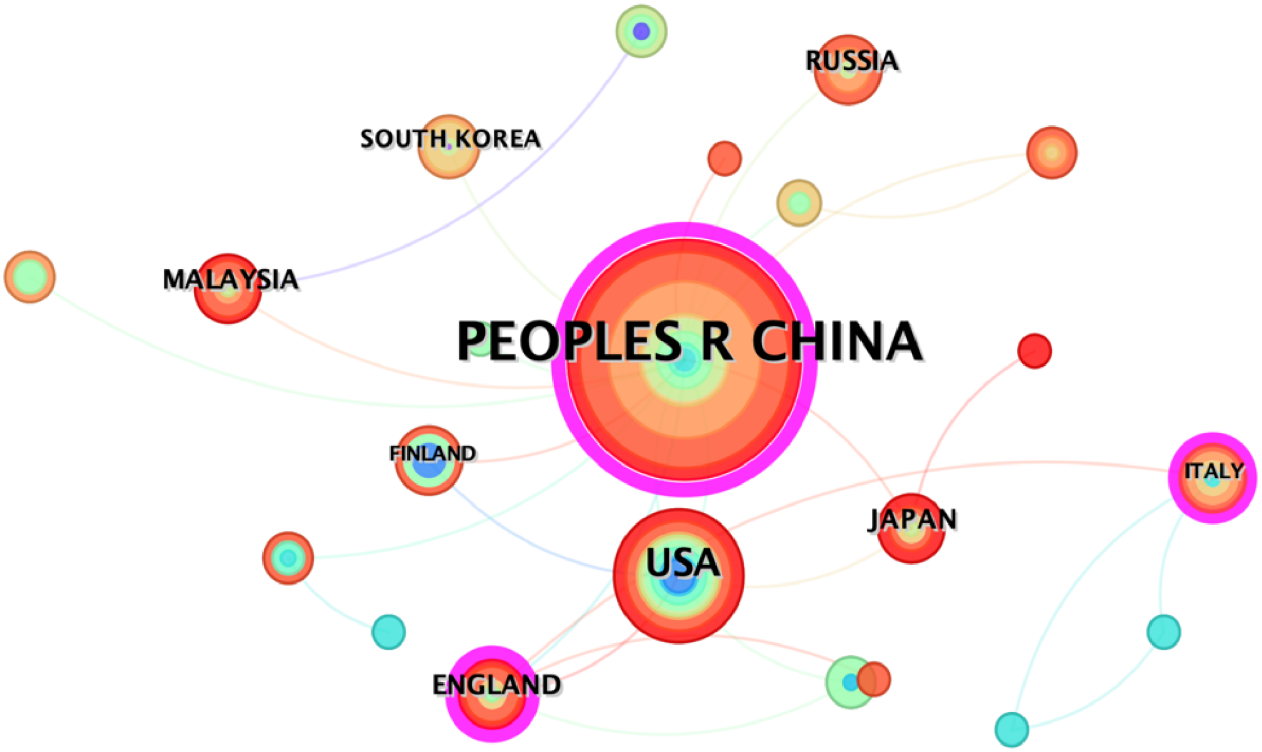

Figure 3. The Network of Countries for City Visual Image Research.

Table 1. Leading Countries in City Visual Image Research.

Country	Frequency	Country	Centrality
PEOPLE 'S REPUBLIC OF CHINA	55	PEOPLE 'S REPUBLIC OF CHINA	0.54
USA	19	ENGLAND	0.24
JAPAN	6	ITALY	0.12
ENGLAND	6	USA	0.06
MALAYSIA	6	JAPAN	0.06
RUSSIA	6	MALAYSIA	0.06
SOUTH KOREA	5	SWITZERLAND	0.06

The institutional collaboration network in city visual image research, as illustrated in Figure 4, highlights the significant collaborative roles of institutions such as the Hong Kong University of Science and Technology, Massachusetts Institute of Technology (MIT), Peking University, and City University of Hong Kong. The figure vividly represents the close-knit cooperative ties among these institutions, especially the pronounced interactions between the Hong Kong University of Science and Technology and its peers, through the network's connecting lines.

Table 2 quantifies the publication output, centrality, and burstiness of leading institutions in this research domain. Institutions like MIT, the University of Helsinki, and Delft University of Technology showcase their active engagement through substantial publication volumes.

Centrality, an indicator of an institution's prominence within the collaboration network, peaks at 0.04 for the Hong Kong University of Science and Technology, with MIT closely trailing at 0.03, emphasizing their influential roles in promoting inter-institutional partnerships. Burstiness, which signifies a notable surge in publication activity over a defined period, is most pronounced for Delft University of Technology, with a value of 1.45. This metric suggests a swift escalation in the institution's interest and commitment to the field of city visual image research.

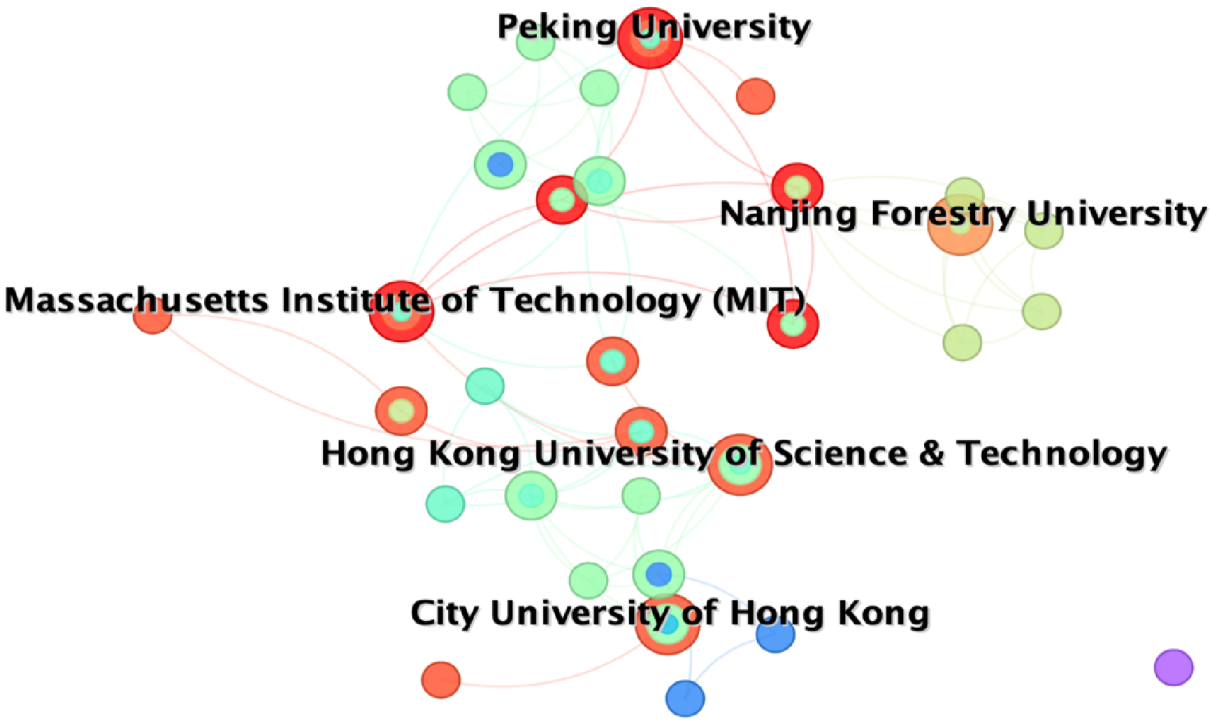

Figure 4. The Network of Institutions for City Visual Image Research.

Table 2. Contributing Institutions by Frequency, Centrality, and Burst.

Institutions	Frequency
Massachusetts Institute of Technology (MIT)	3
University of Helsinki	3
Delft University of Technology	3
City University of Hong Kong	3
Hong Kong University of Science & Technology	3
Peking University	3
Tsinghua University	3
Nanjing Forestry University	3
Institutions	**Centrality**
Hong Kong University of Science & Technology	0.04
Massachusetts Institute of Technology (MIT)	0.03
Chinese University of Hong Kong	0.02
Nanjing Normal University	0.02
Chinese Academy of Sciences	0.01
Peking University	0.01
ETH Zurich	0.01
Jiangxi Normal University	0.01
Institutions	**Burst**
Delft University of Technology	1.45
Nanjing University	1.29
Xi'an Jiaotong-Liverpool University	1.14
National Cheng Kung University	1.14
Tongji University	1.03
Chinese University of Hong Kong	1.03
Nanjing Forestry University	1.01

Table 3 enumerates seven distinguished authors in the field of city visual image research: Ammar Al-sharaa, Azizam Aziz, Hangyu Gao, Yu Liu, Suhardi Maulan, Binh Nghiem-phu, and Minna Valjakka. The majority of these scholars initiated their research endeavors in 2023, accentuating their engagement in this burgeoning area. Notably, Yu Liu has been active in related research since 2018, marking an early and sustained contribution to the field.

The author collaboration network depicted in Figure 5 positions Yu Liu as a central figure, having established fruitful collaborations with scholars such as Min Chen, Michael Batty, Fabio Duarte, and Gary Hack. The network's interconnections not only delineate the collaborative efforts among these researchers but also highlight Yu Liu's critical role in mediating academic discourse and disseminating knowledge. This pattern of interdisciplinary and interinstitutional collaboration serves as a powerful catalyst for innovation and the advancement of city visual image research.

Table 3. Contributing Authors by Number of Publications.

Authors	Publications	Year Begin
Al-sharaa, Ammar	2	2023
Aziz, Azlizam	2	2023
Gao, Hangyu	2	2023
Liu, Yu	2	2018
Maulan, Suhardi	2	2023
Nghiem-phu, Binh	2	2015
Valjakka, Minna	2	2015

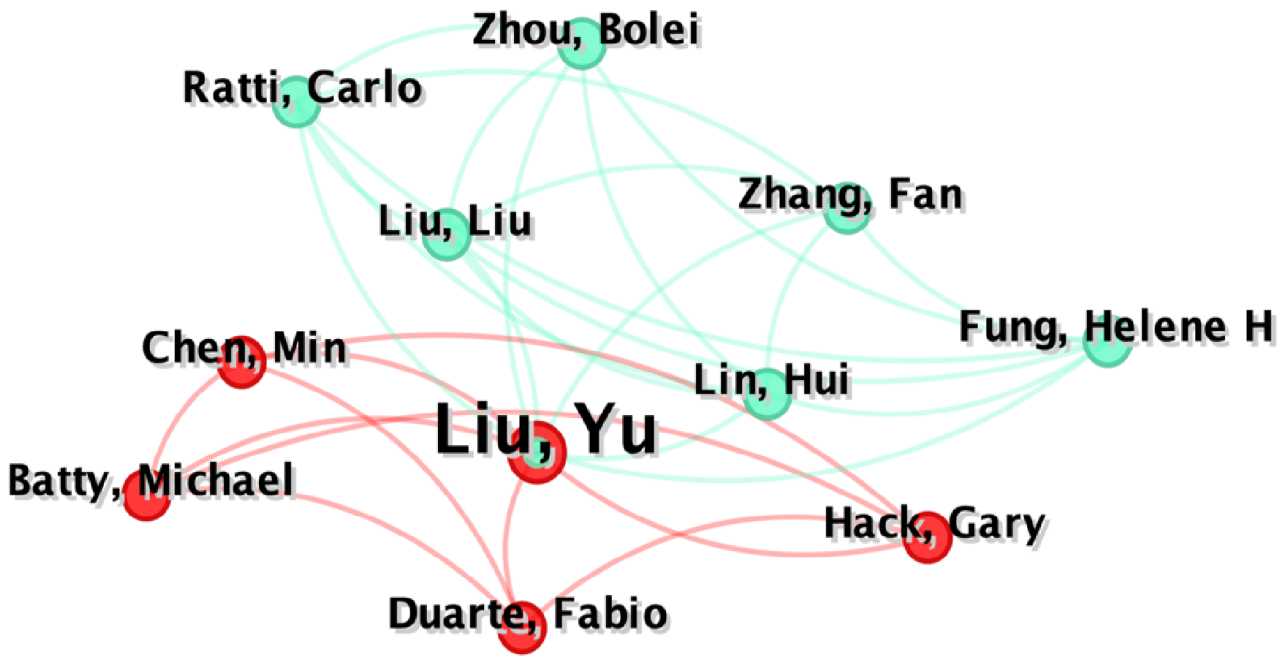

Figure 5. The Network of Contributing Authors.

3.2 Co-Citation Analysis

The co-citation network diagram in Figure 6 visually represents the academic prominence of papers by the size of their nodes, with larger nodes indicating higher citation frequencies (Xie, 2015). The connectivity between nodes illustrates the density of co-citation relationships. Tang JX (2019) and Zhou H (2019) are particularly conspicuous for their substantial node sizes, underscoring their influential status within the academic sphere. The central positioning of the Tang JX (2019) node, with its numerous connections to various research themes, signifies its pivotal role and broad academic influence. The pronounced linkage to Bijecki F (2021) suggests a frequent co-citation of these works, reinforcing their significance in city visual image design research.

Table 4 enumerates 25 papers with notable increases in citation rates, denoting their emergence as focal topics of research within specific timeframes. The citation surge for Tang JX (2019) and Zhou H (2019) between 2023 and 2024 is particularly striking, indicating a marked academic impact during this period. Additionally, the papers by Ma XY (2021) and Bijecki F (2021) have exhibited robust citation growth since their publication, establishing themselves as new research focal points. The robust co-citation ties among these works indicate a close thematic interrelation, reflecting their collective contribution to the discourse on city visual image design.

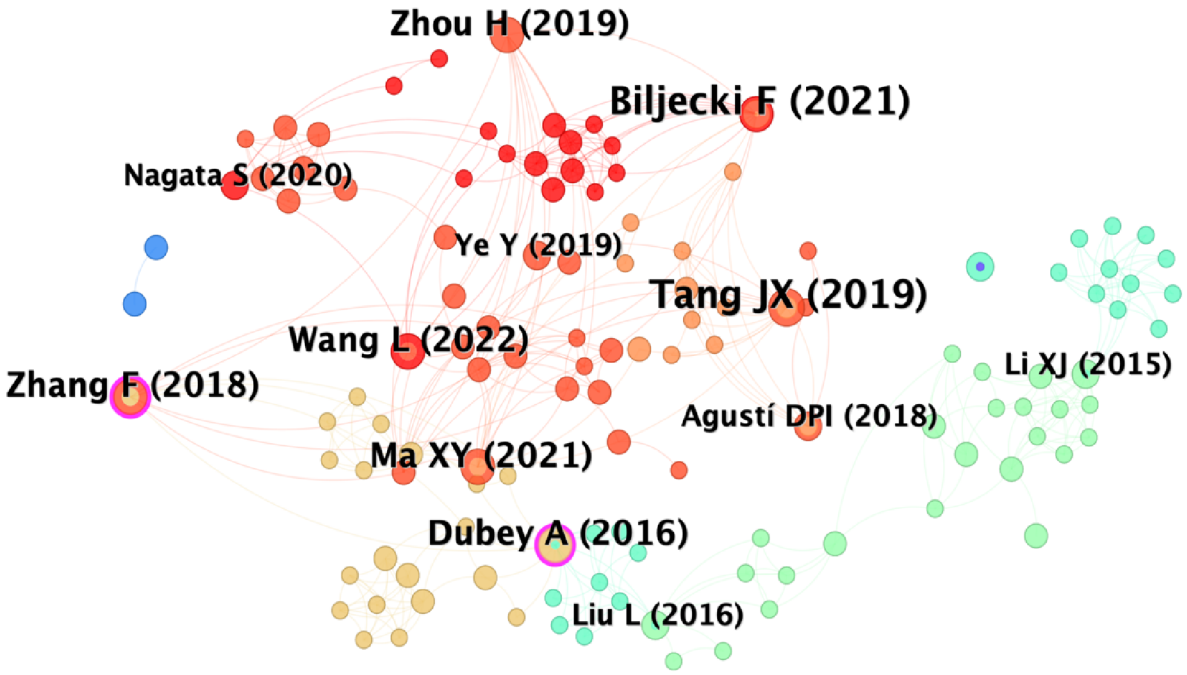

Figure 6. The Network of Cited Reference.

Table 4. Top 25 References with the Strongest Citation Bursts.

References	Year	Strength	Begin	End
Tang JX, 2019, LANDSCAPE URBAN PLAN, V191, P	2019	2.21	2022	2024
Zhou H, 2019, SUSTAIN CITIES SOC, V50, P	2019	2.13	2023	2024
Ma XY, 2021, CITIES, V110, P	2021	1.77	2022	2024
Wang L, 2022, ISPRS J PHOTOGRAMM, V190, P215	2022	1.77	2023	2024
Biljecki F, 2021, LANDSCAPE URBAN PLAN, V215, P	2021	1.76	2022	2024
Dubey A, 2016, LECT NOTES COMPUT SC, V9905, P196	2016	1.75	2021	2021
Liu L, 2016, GEOJOURNAL, V81, P817	2016	1.65	2018	2019
Li XJ, 2015, URBAN FOR URBAN GREE, V14, P675	2015	1.65	2018	2019
Ye Y, 2019, LANDSCAPE URBAN PLAN, V191, P	2019	1.59	2023	2024
Agustí DPI, 2018, ANN TOURISM RES, V73, P103	2018	1.32	2022	2024
Krizhevsky A, 2017, COMMUN ACM, V60, P84	2017	1.28	2020	2020
Wang MQ, 2015, CHINA INFORM, V29, P176	2015	1.25	2015	2015
Marinelli M, 2015, CHINA INFORM, V29, P154	2015	1.25	2015	2015
Parke E, 2015, CHINA INFORM, V29, P226	2015	1.25	2015	2015

Visser Robin, 2010, CITIES SURROUND COUN, V, P	2010	1.25	2015	2015
Bain Lesley, 2012, LIVING STREETS: STRATEGIES FOR CRAFTING PUBLICSPACE, V, P	2012	1.22	2017	2017
Naik N, 2014, IEEE COMPUT SOCCONF, V, PP793	2014	1.22	2018	2018
Long J, 2015, PROC CVPR IEEE, V, PP3431	2015	1.22	2019	2019
Hu YJ, 2015, COMPUT ENVIRON URBAN, V54, P240	2015	1.22	2019	2019
Xu G, 2017, ENVIRON MODELL SOFTW, V91, P127	2017	1.22	2019	2019
Hunter WC, 2016, TOURISM MANAGE, V54, P221	2016	1.22	2021	2021
Zhang K, 2019, TOURISM MANAGE, V75, P595	2019	1.22	2021	2021
Yin L, 2016, APPL GEOGR, V76, P147	2016	1.22	2021	2021
Gascó-Hernandez M, 2018, COMMUN ACM, V61, P50	2018	1.22	2022	2022
Harvey C, 2017, ENVIRON PLAN B-URBAN, V44, P668	2017	1.22	2022	2022

The Cited Journals Network depicted in Figure 7 distinctly highlights journals that wield considerable academic influence in the field of city visual image design. The high-citation journal analysis in Table 5 underscores the prominence of *Landscape and Urban Planning, Cities*, and *Sustainability-Basel*, each amassing over 25 citations, indicating their esteemed status within the academic community.

Table 6 provides an in-depth analysis of the citation intensity among these journals, with *Sustainability-Basel* emerging as a journal of significant influence, boasting a high citation intensity of 2.45. This figure attests to its prominent role in shaping scholarly discussions within the academic community. Regarding centrality, Cities plays a key role, serving as a bridge across diverse research themes with a centrality score of 0.22. This value emphasizes its integral position within the academic network. *Computational Environment and Urban Systems*, with a centrality of 0.17, is recognized for its meaningful contributions to urban environment research. *Annals of Tourism Research,* holding a centrality of 0.16, affirms its substantial influence in the domain of tourism research.

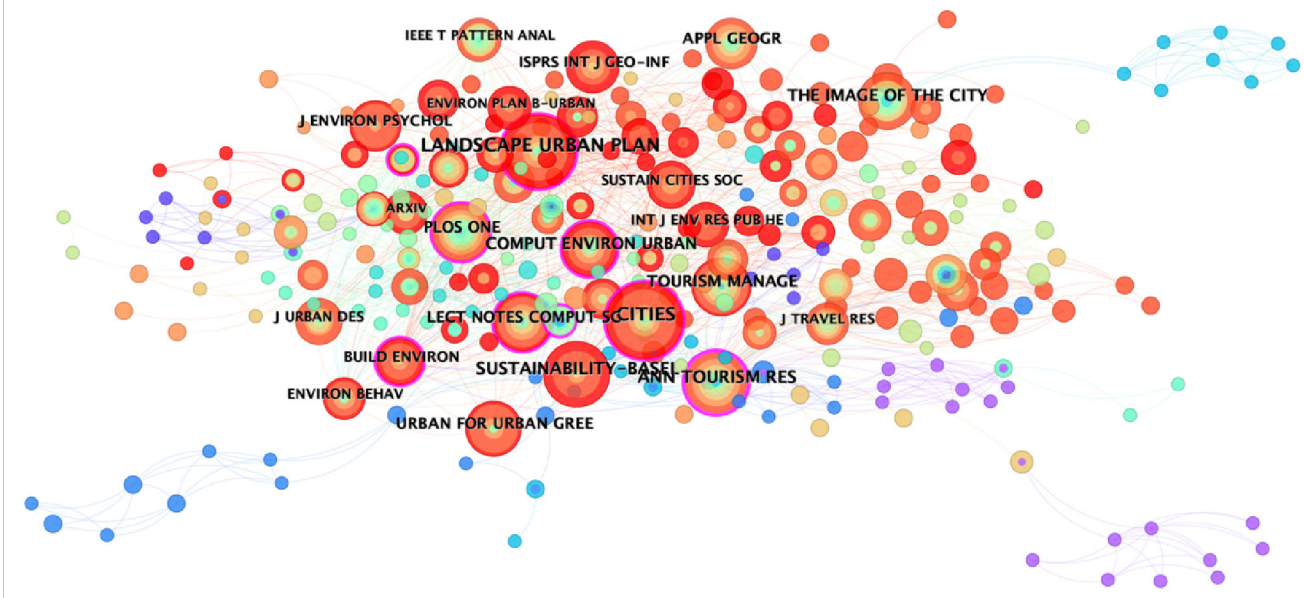

Figure 7. Cited Journals Network.

Table 5. Journals with More than 10 Citations.

Source	Frequency	Year	Centrality
Landscape and Urban Planning	28	2014	0.05
Cities	27	2013	0.22
Sustainability-Basel	25	2018	0.01
Computers, Environment and Urban Systems	19	2015	0.17
Urban Forestry & Urban Greening	17	2016	0.02
Tourism Management	15	2008	0.13
ISPRS International Journal of Geo-Information	15	2020	0.06
PLOS ONE	14	2013	0.04
Sustainable Cities and Society	14	2018	0.01
Annals of Tourism Research	12	2010	0.16
International Journal of Environmental Research and Public Health	12	2019	0.00
Building and Environment	12	2018	0.03
arXiv	12	2016	0.13
Environment and Planning B: Urban Analytics and City Science	11	2017	0.04

Table 6. Top Cited Journals by Citation Bursts and Centrality.

Journals	Strength
Sustainability	2.45
Tourism Management	2.26
Forests	2.22
Lecture Notes in Computer Science	2.16
International Journal of Environmental Research and Public Health	2.12
Land-Basel	2.04
Journals	**Centrality**
Cities	0.22
Computers, Environment and Urban Systems	0.17
Annals of Tourism Research	0.16
Tourism Management	0.13
arXiv	0.13
Communications of the ACM	0.13
Visual Studies	0.12
Ethnography	0.10

3.3 Co-Occurrence Analysis

The co-occurrence network is dissected across three dimensions—Term, Keyword, and Category—with the analysis of keywords being of paramount importance. This section concentrates on keyword co-occurrences, clustering, timeline analysis, and burst detection to uncover the research focal points and developmental trajectories within the field. The keyword co-occurrence analysis, as depicted in Figure 8, illustrates each keyword as a node, sized according to its prevalence in the literature, and the node connections represent the frequency with which keywords appear together in documents. This visualization highlights the pivotal keywords that dominate academic discourse in the field. For example, the keyword 'city' stands out with a large node size, underscoring its centrality to discussions on city visual image research. Additionally, keywords like 'destination image,' 'built environment,' and 'deep learning,' which exhibit high co-occurrence rates, indicate the

interdisciplinary nature of city visual image research and its intersections with urban tourism, urban design, and machine learning, respectively.

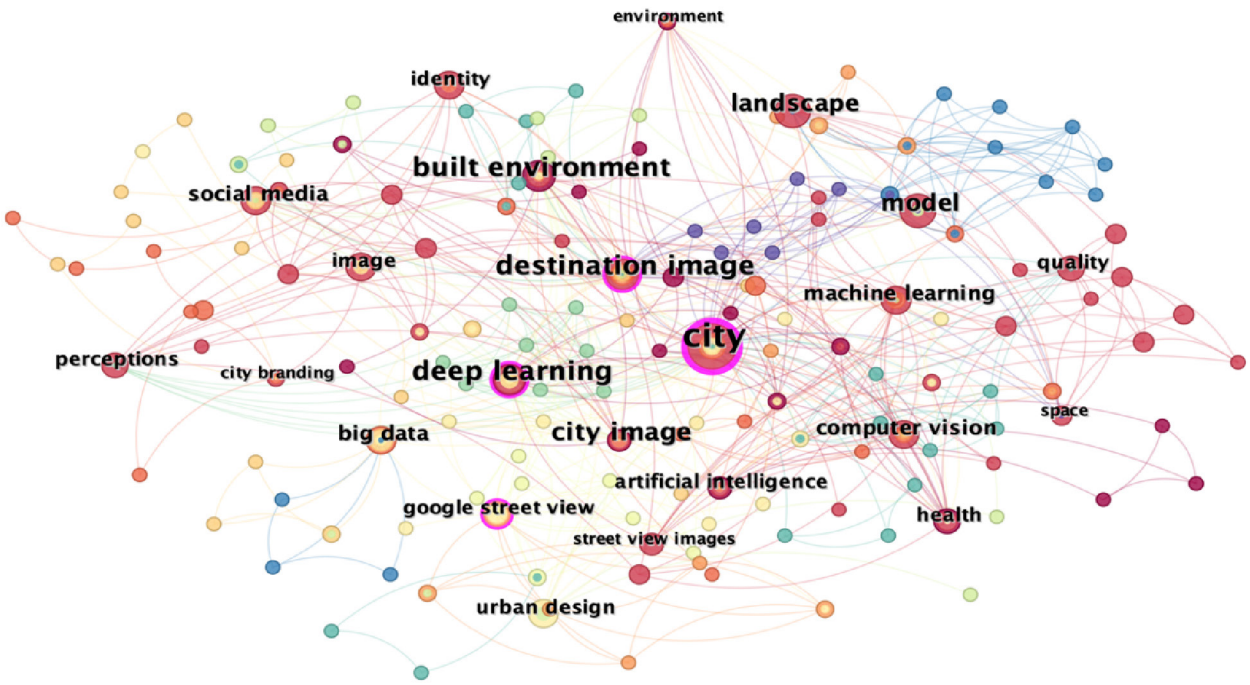

Figure 8. The Network of Keywords Co-occurrence.

Figure 9, employing a multidimensional approach to keyword clustering distribution, precisely identifies seven primary clusters, each addressing distinct research foci and represented by different colored regions. An S-value exceeding 0.5 signifies a robust clustering evaluation, and the high value of 0.8665 substantiates the effectiveness of the clustering. The 'City Image' cluster investigates the conceptualization, dissemination, and assessment of city images, with a particular emphasis on the role of social media in research. The 'Deep Learning' cluster examines the integration of deep learning in the analysis of city visual imagery, encompassing themes such as urban health, streetscape image processing, and environmental impact. The 'Google Street View' cluster is dedicated to the utilization of Google Street View and GIS tools for the examination of urban built environments and spatial configurations. The 'Urban Design' cluster delves into the perception of visual imagery in urban design, consumer behavior, and the establishment of symbolic capital. The 'Artificial Intelligence' cluster discusses the application of AI technologies, especially computer vision, in analyzing urban density and structural elements. The 'Perception Approach' cluster concentrates on the methodologies used to study the public's perception of city visual images, including

visual preferences, quality assessments, and user-generated content. As the most extensive cluster, the 'Destination Image' cluster underscores the development of city destination images, urban branding, and the integration of big data in destination image research.

The interconnections within the figure reveal the relationships between clusters, reflecting the interdisciplinary nature and mutual reinforcement of research themes. For instance, the strong association between the city image and destination image clusters underscores their interdependence in academic inquiry. These clustering analyses offer valuable insights into current research hotspots and trends, such as the escalating significance of deep learning and AI in city visual image studies, and the ongoing emphasis on urban design and perception methodologies.

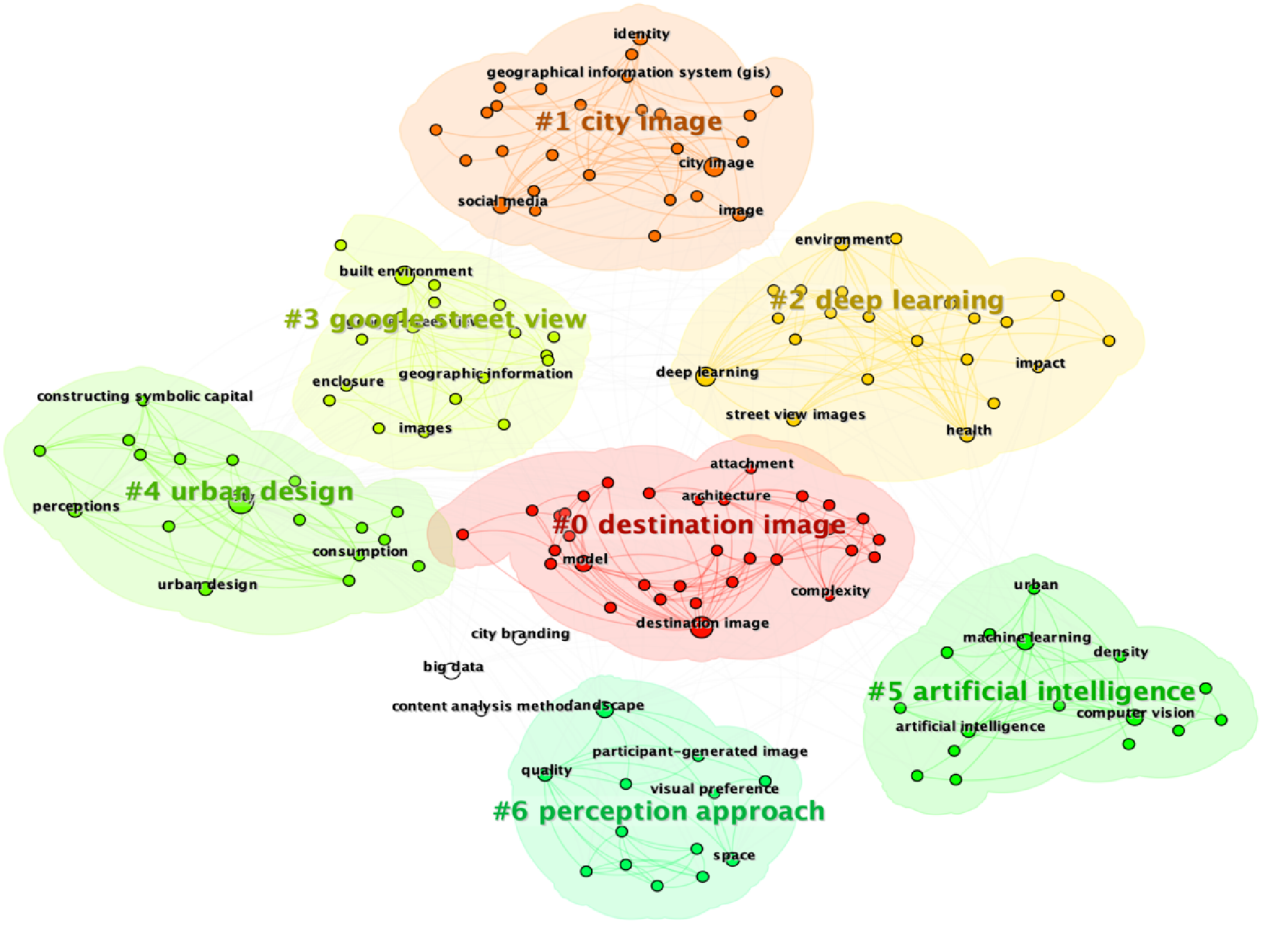

Figure 9. Clusters of Keywords.

Figure 10 presents a keyword timeline that visually maps the progression of key terms in city visual image research, tracing the field's development over the past decade and highlighting the varying activity and influence of keyword clusters across time.

The ‘Destination Image’ cluster has maintained a consistent presence in the research landscape since 2013, initially emphasizing content analysis, model development, and the intricacies of architectural design. More recently, the focus has shifted towards understanding the nexus between complexity and destination image perception. Interest in ‘City Image’ has been on an upward trajectory since 2015, with a surge in associated keywords such as ‘social media,’ underscoring the significance of promotional strategies in shaping city visual imagery. Research in the ‘Deep Learning’ domain has expanded since 2015, with an increase in keywords like ‘urban environment,’ indicating the growing application of deep learning techniques in the analysis of city visual images. The ‘Google Street View’ and ‘built environment’ clusters have seen a significant uptick in research post-2015, mirroring the effective incorporation of geographic information systems and streetscape imagery in the study of city visual images. The ‘Urban Design’ cluster has shown a steady increase since 2013, with keywords such as ‘perception’ and ‘consumption behavior’ underscoring the pivotal role of visual images in urban design processes. Investigations into ‘Artificial Intelligence’ and ‘computer vision’ have witnessed a marked increase since 2015, reflecting the escalating relevance of these technologies in the analytical framework of city visual image research. Finally, the ‘Perception Approach’ cluster has gradually gained momentum since 2015, with keywords like ‘visual preference’ and ‘space’ indicating a deepening exploration of the methodologies employed to perceive city visual images.

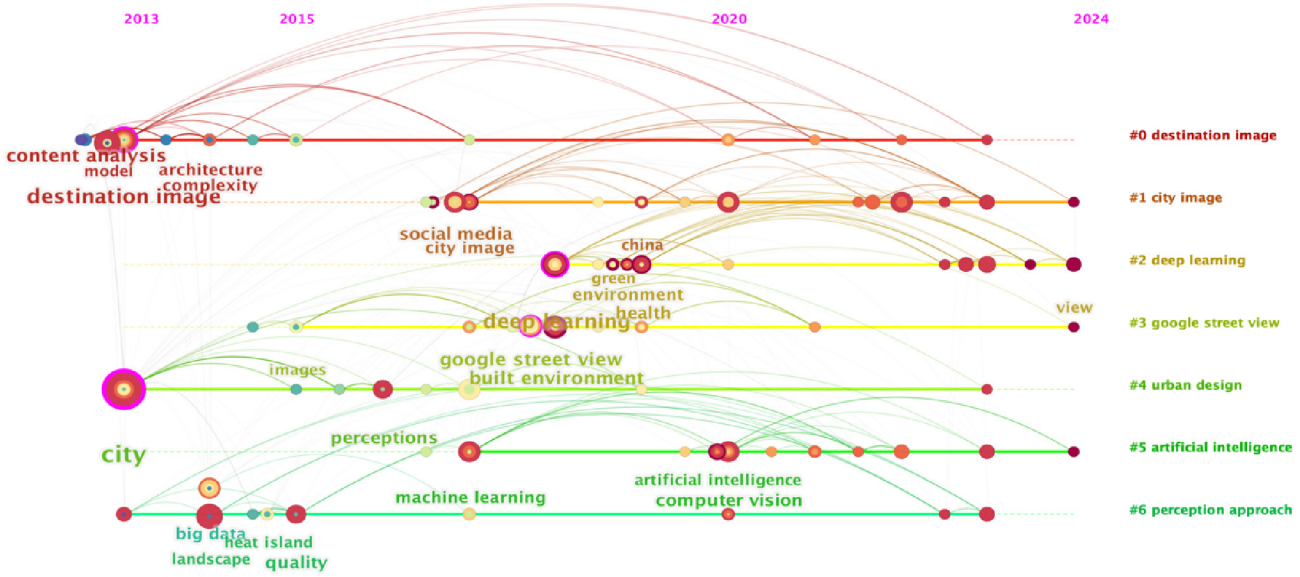

Figure 10. The Timeline of Keywords from 2013 to 2024.

Keyword bursts in the field of city visual image research are indicative of evolving research trends and focal points over time. Table 7 offers a comprehensive snapshot of these bursts, detailing the keyword, burst strength, start year, and end year, thereby mapping the dynamic trajectory of the research.

In the early years from 2013 to 2014, a significant surge in the keyword 'Content analysis' indicated an initial concentration on methodologies for content analysis within the discipline. Moving forward, between 2015 and 2017, there was a discernible rise in interest in 'Brand image' and 'Images,' while 'Urban design' peaked from 2017 to 2019, signifying a shift in research emphasis. The period from 2018 to 2024 saw 'Deep learning' and 'Google Street View' emerge as prominent areas of study, suggesting a growing focus on technological applications in the analysis of city visual images. Additionally, 'Big data' and 'Social media' garnered considerable attention in 2019 and 2020, underscoring the increasing relevance of data-driven approaches in the field. Since 2022, advancements in 'Artificial intelligence' and 'Computer vision' have begun to draw the interest of researchers, indicating a pivot towards more sophisticated technological integration and innovation in city visual image research.

Table 7. Top 25 keywords with Strongest Citation Bursts.

Keywords	Year	Strength	Begin	End
Content Analysis	2013	1.23	2013	2014
Brand Image	2015	1.01	2015	2017
Images	2015	0.93	2015	2018
Urban Design	2017	2.00	2017	2019
Deep Learning	2018	1.78	2018	2020
Google Street View	2018	1.70	2018	2021
Built Environment	2018	1.07	2018	2019
Big Data	2014	1.22	2019	2020
Color	2019	1.04	2019	2020
Geographic Information	2019	0.93	2019	2021
Attachment	2020	1.10	2020	2021
Image	2020	1.05	2020	2020
social media	2017	0.97	2020	2020

computer vision	2020	0.86	2020	2024
density	2021	1.06	2021	2022
identity	2022	1.28	2022	2024
network	2022	1.17	2022	2022
urban	2022	1.17	2022	2022
machine learning	2017	0.90	2022	2024
landscape	2014	1.90	2023	2024
street view images	2023	1.29	2023	2024
model	2013	1.19	2023	2024
quality	2015	1.02	2023	2024
perceptions	2016	1.02	2023	2024
urban studies	2023	0.86	2023	2024

4. Discussion, Conclusions and Research Agenda

4.1 Discussion and Conclusions

The primary objective of this study is to systematically dissect the structural evolution and trend directions in the field of city visual image design from 2013 to 2024. This analysis aims to deepen the academic community's understanding of existing research and to provide insights into potential paths and future development directions for city visual image studies. The optimization of city visual images not only significantly enhances a city's attractiveness and competitiveness (Sevin, 2014)) but also effectively promotes societal transformation and inclusive growth ((Belabas & George, 2023; Paganoni, 2012). Despite numerous researchers having explored city visual images from various perspectives and methods, the field as a systematic area of study is still in its developmental stages. This paper employs bibliometric analysis using CiteSpace software to thoroughly review the research dynamics in city visual image design, with the intention of offering new insights and methodological support for academic research and practical applications in this domain.

RQ1 of this study aims to explore the current academic status of city visual image design research. By examining the quantity

of scholarly publications, international collaboration networks, institutional cooperation networks, and collaborations among scholars, we have provided an in-depth response to this question. The study's findings indicate a significant increase in the number of academic papers indexed in the Web of Science (WoS) database from 2013 to 2024, peaking in 2023 as illustrated in Figure 2. Furthermore, as shown in Figure 3, researchers from various countries including China, the United States, Japan, the United Kingdom, Malaysia, Russia, and South Korea have begun in-depth explorations of city visual image. This trend of cross-cultural engagement suggests that city visual image has become a widely recognized research focus globally, with its importance increasingly highlighted. Within the timeframe of this study, China has exerted the greatest influence in the field of city visual image research, establishing solid cooperative relationships with countries such as the United States, South Korea, and Russia, as shown in Table 1. Further analysis of inter-institutional collaboration networks (refer to Figure 4 and Table 2) reveals the significant roles of institutions like the Hong Kong University of Science and Technology, the Massachusetts Institute of Technology (MIT), Peking University, and the City University of Hong Kong in this field. Table 3 lists the outstanding scholars in the field, outlining the influential collaboration networks they have built. As the field of city visual image design expands globally, enhancing international cooperation and academic exchange is crucial for further development in this area. Concurrently, it is anticipated that scholars will focus more on city visual image research in cross-cultural countries, aiming to promote knowledge sharing and academic innovation worldwide.

RQ2 is dedicated to uncovering the literature and journals that hold significant influence within the field of city visual image design. Tang JX (2019) and Zhou H (2019) are key documents in this domain, with their high citation frequency and strong linkage relationships in Figure 6 and Table 4, highlighting their central position in academic research. Journals such as Landscape and Urban Planning, Cities, and Sustainability-Basel have a notable impact in this area, as shown in Figure 7 and Table 5, particularly excelling in citation intensity and centrality as per Table 6. The analysis of co-cited literature and journals reveals the interdisciplinary nature of city visual image research, spanning various academic fields including sociology, design studies, and management science. Within these widely cited documents, researchers have employed big data and deep learning technologies for empirical studies on urban forms, which not only deepen our understanding of city visual images but also provide new perspectives on their evolution through model simulation and prediction. This is essential for accurately grasping the perception of city visual images. The study of city visual images is a field where multiple disciplines intersect, and future research should focus on deepening the theoretical foundations, innovating research methods and technology applications, and constructing

a comprehensive knowledge system to better understand the construction process of city visual images and their profound impact on urban development.

RQ3 investigates the key themes and keywords in city visual image research, probing into future research prospects. The co-occurrence analysis of keywords, as seen in Figure 8, indicates emerging interdisciplinary integration with fields such as urban tourism, environmental studies, and machine learning. Cluster analysis, depicted in Figure 9, reveals seven major research themes, emphasizing the growing significance of deep learning and artificial intelligence, while sustaining ongoing interest in urban design and perceptual methodologies. Timeline analysis, tracked in Figure 10, monitors the evolution of keywords in city visual image research over the past decade, highlighting shifts in the activity and influence of keyword clusters at various points in time. Burst analysis, detailed in Table 7, shows that the “content analysis” methodology garnered considerable attention between 2013 and 2014. Subsequently, from 2018 to 2024, “deep learning” and “Google Street View” emerged as prominent research areas, indicating an increasing focus on the application of technology in city visual image analysis. Furthermore, “big data” and “social media” received significant attention in 2019 and 2020, underscoring the growing relevance of data-driven approaches in the field. Since 2022, advancements in “artificial intelligence” and “computer vision” have begun to attract the attention of researchers, signaling a shift towards deeper technological integration across the industry. Looking ahead, research will continue to focus on the integration of city visual image with cutting-edge technologies such as artificial intelligence, further deepening the understanding of perceptual theories, urban branding, and cultural interactive communication. Through comparative case studies of multiple instances, the harmonious coexistence of urban spaces and technology will be fostered, laying a solid foundation for constructing smarter and more inclusive future cities.

4.2 FUTURE RESEARCH AGENDA

Based on the analysis, we have observed that the field of city visual image research is continually expanding. This has provided us with a clearer understanding of the importance of city visual images. Consequently, we propose three key themes that hold potential and value for further research.

This first set of agenda is dedicated to an in-depth investigation of city visual image systematic research, employing distinctive branding strategies to bolster urban competitiveness. Through an intensive study of keyword cluster 0, we have garnered theoretical support for the development of city brands with personalized characteristics. In the crafting of city brands, highlighting the uniqueness of the city is a crucial step. The distinctive features of a city are not only the foundation of city brand development but also embody the city’s unique charm, core values, cultural diversity, and historical depth. Researchers can perform case studies on

various city types, such as historical cities, tech-oriented new cities, and cities renowned for their natural scenery, to uncover their historical narratives, cultural identities, natural landscapes, and social frameworks, thereby creating city visual images and brands that inspire a sense of identity and belonging. Future research on city visual image can closely integrate urban characteristics with personalized branding to facilitate dialogue and understanding among different cultures and social groups, establishing a foundation for a more harmonious and inclusive social environment. This approach not only enhances residents' identification with their local culture but also serves as a key strategy for the sustainable development of the city visual image.

The second set of agenda focuses on enhancing stakeholder engagement in the design of city visual images. Within keyword clusters 1 and 4, we have identified that social media and consumer behavior play a pivotal role in driving stakeholder participation in the dissemination of city visual images. Social media has not only transformed the modes of city image communication but also propelled urban consumer behavior towards diversification and personalization. On one hand, user-generated content on social media has become a central conduit for the propagation of city images. The public's perception of cities is significantly influenced by the sharing and recommendations on social media platforms. On the other hand, the personification and emotional expression of city image communication content, through storytelling that resonates with the public, can effectively enhance a city's appeal and approachability. In future research on city visual images, scholars can focus on exploring effective cross-cultural communication strategies to stimulate active involvement of city residents and visitors in the construction of city images. Such participation not only fosters innovation in city visual image design, making it more vivid and diverse, but also improves the quality of urban planning decisions and their broad acceptance by the public.

The third set of agenda is committed to actively exploring artificial intelligence and utilizing digital technology methods to enhance the interactivity and user experience of city visual image. We are actively exploring the integration of artificial intelligence (AI) and digital technologies to improve the interactivity and user experience of city visual images. Our focus on keyword clusters 2, 3, and 5 highlights the potential of AI and digital technology in enhancing the perception of city visual images. By utilizing AI, we can conduct detailed analyses of vast amounts of urban data, covering various aspects such as resident behavior, traffic flow, and environmental conditions. This provides urban planners with a solid data foundation, enabling them to develop more precise and efficient strategies for city visual images. Furthermore, the advancement of new media technologies allows us to offer customized visual experience services based on individual user needs, creating unique and immersive visual effects. For example, through innovative tourism route design and augmented reality

(AR) navigation technology, we not only expand the boundaries of traditional visual experiences but also pioneer new interactive modes by blending the virtual and the real. Looking ahead, the integrated application of artificial intelligence and new media technologies will propel society towards a more open and innovative direction.

Limitations

This study has yielded affirmative outcomes in its in-depth examination of sustainable development within city visual image design. However, it is not without its limitations. Deliberately narrowing the research scope, while beneficial for concentrating on pivotal issues, may have inadvertently excluded certain perspectives essential for a holistic grasp of city visual image design. Moreover, the study's reliance on English-language publications could have inadvertently marginalized studies in other languages that might offer valuable contributions to the global academic discourse. The exclusive use of the Web of Science (WoS) as the primary database might also have constrained the inclusion of diverse research viewpoints available in other databases.

To address these limitations, subsequent research endeavors should consider the following strategies to enhance the study's comprehensiveness and profundity:

- Broaden the research scope to encompass additional databases such as Scopus and Google Scholar, thereby amplifying the diversity and representativeness of the research sample;
- Undertake cross-linguistic studies to ensure a global and inclusive research outcome, encompassing insights from various cultural perspectives;
- Embrace sophisticated technologies like artificial intelligence and machine learning to investigate their potential to influence research methodologies and practices in city visual image design, uncovering innovative avenues and analytical tools.

By implementing these measures, future research will be positioned to explore the sustainable development of city visual image design more exhaustively, offering more profound insights and guidance for urban planning and design. This will, in turn, stimulate innovation and advancement in the realm of city image construction.

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“THE EUROPEAN FUSILLI PROJECT IN THE CITY OF TURIN: THE SYSTEMIC DESIGN OF CIRCULAR AGRI-FOOD PROPOSALS INVOLVING LOCAL ACTORS OF MIRAFIORI SUD DISTRICT”.

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ABSTRACT | The topic of enhancing food waste and preventing wastefulness in all phases of the food value chain is nowadays increasingly prevalent to respond to some complex contemporary challenges. When the food issue is treated outside the industrial context, covering the urban scenarios, it also involves the dimension of neighborhoods and micro-communities. In this background, transdisciplinary Systemic Design projects originate which aim to plan and implement Circular Economy for Food activities in the catering, agricultural, and domestic sectors, aimed at inclusively involving the diversified communities of local citizens. The objective of this contribution is to illustrate the results that the European H2020 FUSILLI project is bringing within the city of Turin (Piedmont, Italy), in particular in the peripheral neighborhood of Mirafiori Sud, where different migratory flows have stratified over the years. Specifically, through the Systemic Design methodology, a circular restaurant and a circular kiosk were developed through co-creation processes within a Sustainable FoodLivingLab, based on the valorization of the less noble parts of food. In particular, the aim is to increase levels of food awareness in terms of recovery and valorization of food, still characterized by sensorial and nutritional properties, respecting the gastronomic cultures of the different ethnic groups of the neighborhood and triggering virtuous behavioral change. The project was supported by the collaboration of the University of Gastronomic Sciences of Pollenzo, the Fonda azione Comunità di Mirafiori, Orti Generali, the University of Turin and, obviously, the City of Turin, and required the trans-disciplinary collaboration of designers, gastronomes and local administrators.

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KEYWORDS | SYSTEMIC DESIGN, CIRCULAR ECONOMY FOR FOOD, FOOD LIVING LAB, FOOD WASTE, H2020 EUROPEAN PROJECT

1. Introduction
1.1 Food Waste in the Catering and Household Sectors

Our economy exceeds the planet's limits (Rockström et al., 2009) and social limits (Raworth, 2017), adopting unrestrained predatory behavior without limits on a planet that, instead, is limited. It is a parasitic symbiosis that damages our common house (Pope Francis, 2015). However, the greatest crises often mark decisive transitions between epochs, destabilizing the categories of thought with which human beings interpret life. The erosion of natural capital accelerated in recent decades mainly due to food production, has already partly compromised the stability of cultural capital (Bourdieu, 1980). At a time when social inequality is widening more and more, dividing those who have access to quality food and those who do not, acting and designing for change, in collaboration with others, can restore hope in the community, moving away from linear, high-impact models of production and consumption. Environmental and social degradation are the main consequences of these models, in which food waste, in its broadest sense, plays a significant role, resulting in a loss of the nutritional, social, and educational value of food (Kowalewska et al., 2018; Niaki et al., 2017), as well as of the resources used in its production. There are two broad definitions of food waste: the first distinguishes between loss and waste throughout the food supply chain, while the second focuses on the difference between loss and waste of edible and inedible food.

According to the FAO (Food and Agriculture Organization), food waste refers to food suitable for human consumption that is discarded, lost or wasted along the entire food chain, from operators in the sector to final consumers (FAO, 2019). Food is discarded even when it is still edible and safe for human consumption. This definition includes waste in both domestic and industrial settings (restaurants, hospital and school canteens, supermarkets, farms, etc.) and is broader than the definition of the Environmental Protection Agency of the United States (EPA, 1997), considering advances in food logistics and

increased environmental awareness. Concretely, food waste includes discarded, overproduced, unsold, and leftover food (CalRecycle, 2009). Furthermore, according to the Waste & Resources Action Programme (WRAP, 2009), food waste can be divided into three categories: avoidable, possibly avoidable, and unavoidable. The first two categories include 'edible waste', i.e. food that is discarded while still being eatable, or food that some people eat and others do not (e.g. bread crusts, apple peels, etc.). The third category, on the other hand, concerns 'inedible food waste', which includes waste from food preparation (such as bones, eggshells, etc.). This last concept, however, may vary considerably depending on the gastronomic culture of the territory analyzed. In fact, the "maximum efficiency" of an agro-food product cannot be achieved if the raw material is considered inedible. In this sense, the boundaries of defining what is considered inedible should be re-evaluated.
In the catering sector, between 4% and 10% of the food purchased is wasted in kitchens before reaching the consumer (LeanPath, 2008). Another significant portion is served but not consumed. The main causes of this wastage include the size of the portions prepared and served, the quality standards required by specific restaurant chains, the need to maintain large stocks in order to constantly offer a wide choice of offerings (Kantor, 1997), the difficulty in planning food purchases, and the lack of widespread practices in which unconsumed food is taken home by customers (Barilla, 2012). The behavior and culture of kitchen staff also significantly influence the generation of food waste. In the United States, for example, plate waste accounts for the largest fraction of food losses. On average, customers left over 17% of their meals, and 55% of these potential leftovers are not taken home (Buzby, 2011). In particular restaurant scenarios, centralized management may make waste prevention more difficult, due to the lack of flexibility at the local level that prevents the creative valorisation of food and leftovers. However, household food waste is also a major critical issue, as much food that is still edible ends up directly in municipal solid waste (Gaiani, 2013). For example, in Italy, it is estimated that each citizen wastes about 566g of food weekly (Waste Watcher Report, 2024). In this scenario, the main cause of waste is not only the perishability of food, but also an increasingly robust relationship between the food sector and hyper-consumerism, which includes growing overproduction, excessive food shopping (with an increase in the selection of products on promotion or close to expiry), limited knowledge of how to preserve food, the tendency to prepare and serve excessive quantities of food, and frenetic lifestyles that are less and less inclined to autonomy in preparing daily meals.

1.2 The Circular Economy Lever for Food

Food consumption and management habits can change considerably according to historical and geographical contexts. Globally, developing countries show significantly lower levels of household food waste than developed countries. For example, in the

United States, the amount of food wasted at the household level is ten times higher than in Southeast Asian countries, highlighting significant differences in consumption habits and food management policies between different regions of the world (FAO, 2011). In this regard, in the context of the Circular Economy applied to food, there is a growing interest in the anthropological theme of "agricultural bricolage" (Lévi-Strauss, 1962). This concept refers to the ability of traditional societies to operate on material and immaterial knowledge by creatively recombining it, to enhance it to the maximum and avoid the generation of waste. Historically, this mode of operation was typical of women, who with few resources were able to feed an extended family, composed of people from different generations with different nutritional needs. Thanks to this mentality, traditional dishes were born that today represent the history of Italian gastronomy, such as the more international meatballs, invented in Roman times (between 25 and 35 B.C.) as a good practice to utilize leftover cooked meat. Today, these processes can be described as a true "short cycle" typical of "biological metabolism" in the kitchen, using the conceptualisations of the Circular Economy found in the "Butterfly Diagram" developed by the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2015) to describe the essence of the new economic paradigm.

Reference is made to the 'cascade cycle' when the food chain does not end with human consumption, but supports the needs of animals or agriculture, in line with the most recent European directives on the "Food Waste Hierarchy" (European Commission, 2018). So, the circular economy applied to food is not a new concept, but it is rooted in the domestic economy and reminds us that underlying this constant action-research, besides economic scarcity, there is exploratory thinking and a deep dialogue with ecosystems.

In conclusion, the Circular Economy for food identifies itself as a sustainable practice aimed at addressing urgent contemporary issues, such as the inefficient use of resources and their consequent waste, the impacts of human actions in terms of climate change and soil and ocean pollution (Esposito et al., 2020; Jurgilevich et al., 2016). However, when analyzing in depth many case studies that claim to adopt circular economy practices, risks emerge related to an approach that could encourage manipulative design for waste, which paradoxically could accelerate planned obsolescence (Fassio & Tecco, 2019). The complexity of the food system therefore requires the adoption of a long-term holistic perspective, typical of Systemic Design and Gastronomic Sciences, based on a new knowledge paradigm that can trigger a virtuous change in current design and action models. With this awareness, the H2020 FUSILLI project was developed at European level.

[1] The priorities of the European Food 2030 policy are the development of sustainable and healthy diets and that of smart and sustainable food systems, the pursuit of circularity and waste reduction, and finally, innovation and community empowerment)

1.3 The European project H2020 FUSILLI in the city of Turin

FUSILLI is a project funded in 2021 by the European Horizon 2020 programme, which aims to transform the urban food system through the implementation of Innovative Living Labs (FUSILLI Project, n.d.). In detail, the acronym FUSILLI literally means 'Fostering the Urban Food System Transformation through Innovative Living Labs Implementation'. In fact, the project intends to trigger an integrated holistic transition towards sustainable, healthy and inclusive food systems in urban, peri-urban and rural areas, through innovative and replicable urban policies, leading to the implementation of improvement actions at all stages of the food value chain, consistent with the priorities of the European FOOD 030 Policy[1] (European Commission, 2021). In order to achieve this objective, a real network has been developed between 12 different European cities[2], which, through the development and implementation of Living Labs of various natures and identities, are launching concrete actions in the diverse European scenarios. Specifically, a Living Lab is a place, but more than that, it is a real-life context characterized by a deep-rooted social dimension, supported by the involvement of several stakeholders through inclusive and participative methods. Collaboration between citizens and stakeholders is defined as fundamental in order to give rise to experimentation processes aimed at achieving innovative objectives. In the case of the FUSILLI project, the aim is to start a sustainable transition of the urban food system by involving the multifaceted dimension of food. Living Labs are characterized by extreme dynamism, as they necessarily adapt to the urban environment within which they develop. Moreover, they are strongly based on the legitimate inclusion of different groups of citizens, sometimes suffering from a state of even acute vulnerability. Generally, where possible, in such contexts, the domination of a few actors is avoided and the broad participation of local communities is favored, encouraging a participatory continuity in the project paths undertaken. Indeed, it is not uncommon for a cohesive and thriving community to develop around a Living Lab, characterized by the sharing of common values, through which co-design and innovation processes can be facilitated (Bason at al., 2017). In the last decade, more and more Living Labs have been dedicated to the topic of sustainable food systems, with a particular focus on urban food production (Dell'Era & Landoni, 2014; Blay-Palmer et al, 2016; Balzan et al., 2020). In this, in Europe, the FUSILLI project has been a substantial encouragement (Wilde, 2022). The discipline of Design is well suited to act in such open contexts that welcome innovative transdisciplinary approaches.

[2] The cities involved in the project are Athens (Greece), Castelo Branco (Portugal), Differdange (Luxembourg), Kharkiv

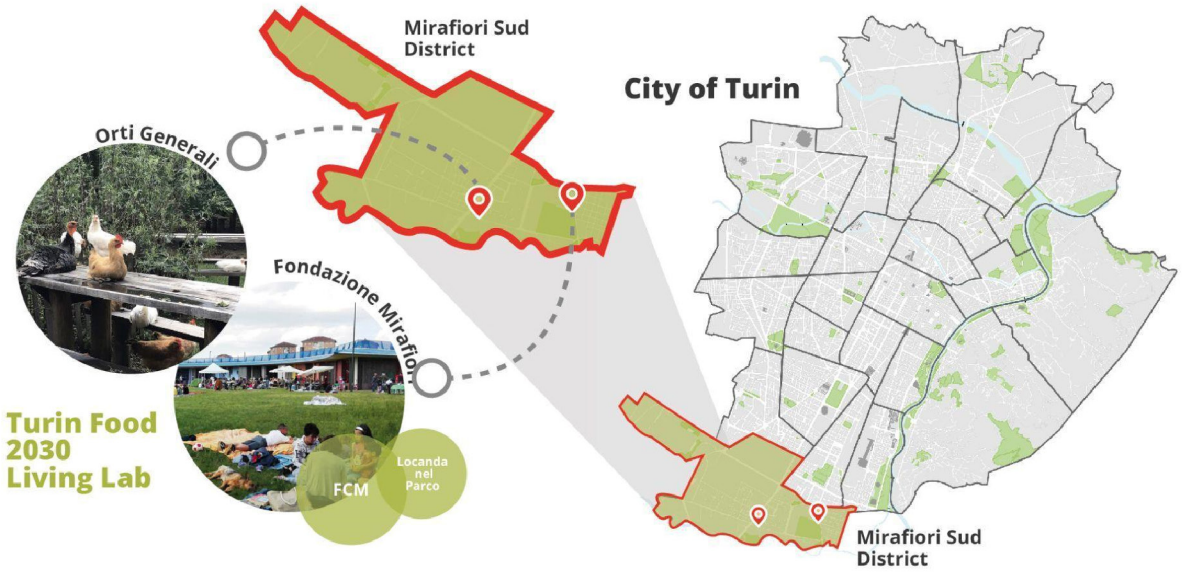

Figure 1. The suburban district of Mirafiori SUD (Turin, Piedmont, Italy) involved in the European Project H2020 FUSILLI

Among the cities involved in the project, which will still be ongoing until the end of 2024, the City of Turin (Piedmont, Italy) stands out for its achievements. Many partners are involved in it, including the Municipality of Turin, the University of Gastronomic Sciences of Pollenzo (UNISG, Cuneo, Piedmont, Italy), the University of Turin (UNITO), the Mirafiori Community Foundation (FCM) (Mirafiori Foundation, n.d.) - within which the Locanda nel Parco social restaurant is also located - and, finally, the suggestive urban agriculture community, Orti Generali (Orti Generali, n.d). The latter are located in Mirafiori SUD, a suburban district of Turin, primarily involved in the FUSILLI project (Figure 1) and they represent the roots of Turin's first Food Living Lab.

Mirafiori Sud was originally a historical center, but it underwent rapid expansion between 1960 and 1970 to accommodate mainly migratory flows from southern Italy, attracted by the jobs available in the FIAT factories, a major Italian automobile company. Thus, the district embraced the critical issues typical of fast-growing neighborhoods: housing challenges, distance from essential services, and a concentration of complex social and economic problems. However, towards the end of the 1990s, a long process of redevelopment began, which involved significant project interventions to improve the area and support the communities. Among these, the various European projects activated stand out, such as the H2020 ProGireg Project, which designed, tested,

(Ukraine), Kolding (Denmark), Nilufer (Turkey), Oslo (Norway), Rijeka (Croatia), Rome (Italy), Turin (Italy), San Sebastián (Spain), Tampere (Finland).

[3] The Food Council is a set of governance tools that create and support the network of parties involved in all urban and peri-urban food-related issues, defining the spheres of action, the objectives and processes necessary to elaborate, implement, and measure the policies of a territory.

and implemented different nature-based solutions to activate an urban regeneration of post-industrial areas in Europe and China, based also and above all on the design of new behavioral models (Nohra, 2019).

All of the partners in the FUSILLI project are working together on many goals, including:

- the definition of a system of sustainable food policies, which will generate a real Food Council[3] for the city of Turin, as already exists in other cities around the world, Toronto (Ontario, Canada), Milan (Italy), etc. (Calori & Magarini, 2015);
- the design of educational and awareness-raising activities on the food topic;
- the pursuit of projects related to the Food Atlas of Metropolitan Turin (Atlante del Cibo, nd; Calori et al, 2017);
- the development of concrete actions on the Food Hub concept, thus on the recovery, management and redistribution of food surpluses to the most vulnerable segments of the Turin population.

Specifically, the University of Gastronomic Sciences of Pollenzo, in collaboration with the above-mentioned partners, is acting concretely within the Circular Economy for Food dimension. It has worked on the design of a circular restaurant and a circular bar, an integral part of the Food Living Lab (at the Locanda nel Parco social restaurant and at the Orti Generali kiosk, respectively). These concepts may be able to reduce and prevent the generation of food waste, creating community co-evolution processes and preserving the natural and cultural capital.

2. Methodology

2.1 Approach and Design Phases

In order to design the circular restaurant and circular bar, belonging to a broader Circular Business Model project applied to the Food Living Lab in Mirafiori Sud, the typical methodology of systemic design was adopted (according to the Italian view of the Politecnico di Torino). By definition, systemic design is a design approach, adapted to the design of products, services, processes, strategies, experiences, and in particular, production chains and complex systems, aimed at connecting economies, people, territories and resources, with a view to environmental, social and economic sustainability (Celaschi et al., 2016, Jones, 2014; Bistagnino, 2011). Moreover, it can be defined as a suitable tool to define and implement circular economy projects in different scenarios, such as agrifood, urban or industrial waste, social, etc. However, before being defined as such, it is a tool for decoding complexity to design flexible, virtuous and sustainable strategies and action plans. Adopting the Systemic Design approach not only attempts to reduce the ecological footprint and social repercussions of a project. In fact, it also lends itself to finding creative and coherent methods to enhance local culture, strengthening the identity of communities and territories (Barbero et al, 2022; Parente

& Sedini, 2019). The development of systemic business models thus makes it possible to generate sustainable economic flows, avoiding situations of imbalance, in terms of impacts and benefits, among the actors involved.

Following this methodology (Figure 2), the first step was the realization of a holistic diagnosis (Tamborrini & Stabellini, 2018) of Locanda nel Parco and Orti Generali, i.e. a capillary survey of the case studies that would respectively host the future circular

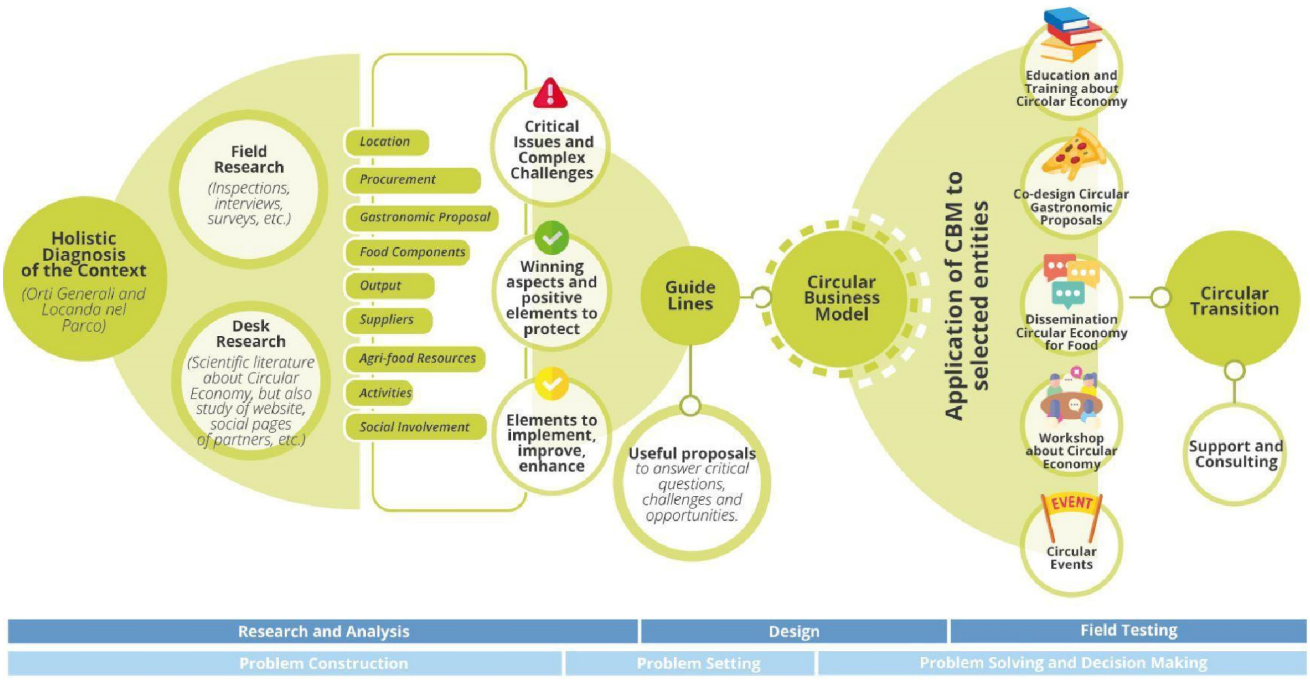

Figure 2. The systemic methodology adopted within the design path undertaken in the H2020 FUSILLI European Project by the University of Gastronomic Sciences of Pollenzo

restaurant and circular bar. This step was carried out starting from the analysis of the territorial context of the urban district of Mirafiori Sud, in which, as already mentioned, different migratory flows have stratified over the years, bringing to the Piedmontese city, the most diversified cultures from the regions of Southern Italy and those from the Middle-East. Through an initial field research, several visits were carried out through which it was possible to interview the actors active in these places, very often represented by citizens belonging to the local community.

Subsequently, the analysis was extended to the food dimension of these locations. The type of food supply, the gastronomic offer, the typology and materials of the components used for the consumption of food, the partnerships with suppliers and their location, as well as that of the resources used, the output produced in terms of waste and by-products in the food processing and consumption phases, and finally, the activities of social involvement of the most marginalized segments of the population, such as families with insufficient income

to lead a decent life, people with motor or cognitive disabilities, people who have come out of crime, etc., through collaboration with non-profit organizations and associations, were all investigated. through cooperation with non-profit organizations and associations.
Considering the purpose of the project, this field research phase was supported by a desk research phase, in which the scientific literature relating to the Circular Economy for Food was analysed, in which other national and international circular food case studies were traced and explored in depth (from which to take inspiration). The product of the holistic diagnosis finally allowed the design of a systemic graphic map for each place analyzed which linked suppliers, food resources, the type of output produced, and the consequent management and disposal (Figure 3). This first methodological phase allowed a simpler identification of the critical aspects to work on, the most complex challenges to address, as well as, the dormant assets and, equally, the winning sides to protect, emphasize, or implement. Therefore, some useful guidelines for the design process were drawn up.

In order to respond to the critical elements, as well as to the need to implement the intrinsic opportunities of such contexts, approximately 100 students from the Gastronomic Design Course (Bachelor's Degree in Gastronomic Sciences and Cultures, UNISG, Pollenzo, Italy) were involved, who developed a panel of circular proposals applicable within the scenario of the future Turin Living Lab 2030. They acted within four specific themes:

- the development of partially or totally circular menus (circular and symbiotic gastronomic proposals such as genuine local products, or alternative formats such as circular picnics and aperitifs);
- the definition of systems for the valorisation of food and inorganic outputs currently not re-inserted into the system;
- the design of laboratories, events, cooking courses and workshops related to the Circular Economy for Food theme;
- the experimentation of tools for the widespread dissemination of circularity.

The best proposals were presented to the managers of Orti Generali and Locanda nel Parco to adapt them appropriately to their needs and begin the first design steps towards a sustainable circular transition of the food system they support. In this process, the transdisciplinary approach of Systemic Design was fundamental. In fact, a close collaboration between eco-designers, gastronomes, food geographers and, more generally, catering professionals was activated. In particular, the support of the Pollenzo FoodLab (UNISG, n.d), an experimentation and training laboratory for innovation in the kitchen, run by chefs and gastronomes specialized in circular agrifood processes, was essential.

In general, the role of the gastronome is to spread the culture and good practices of food sustainability and sovereignty, to develop and share new perspectives on the agri-food

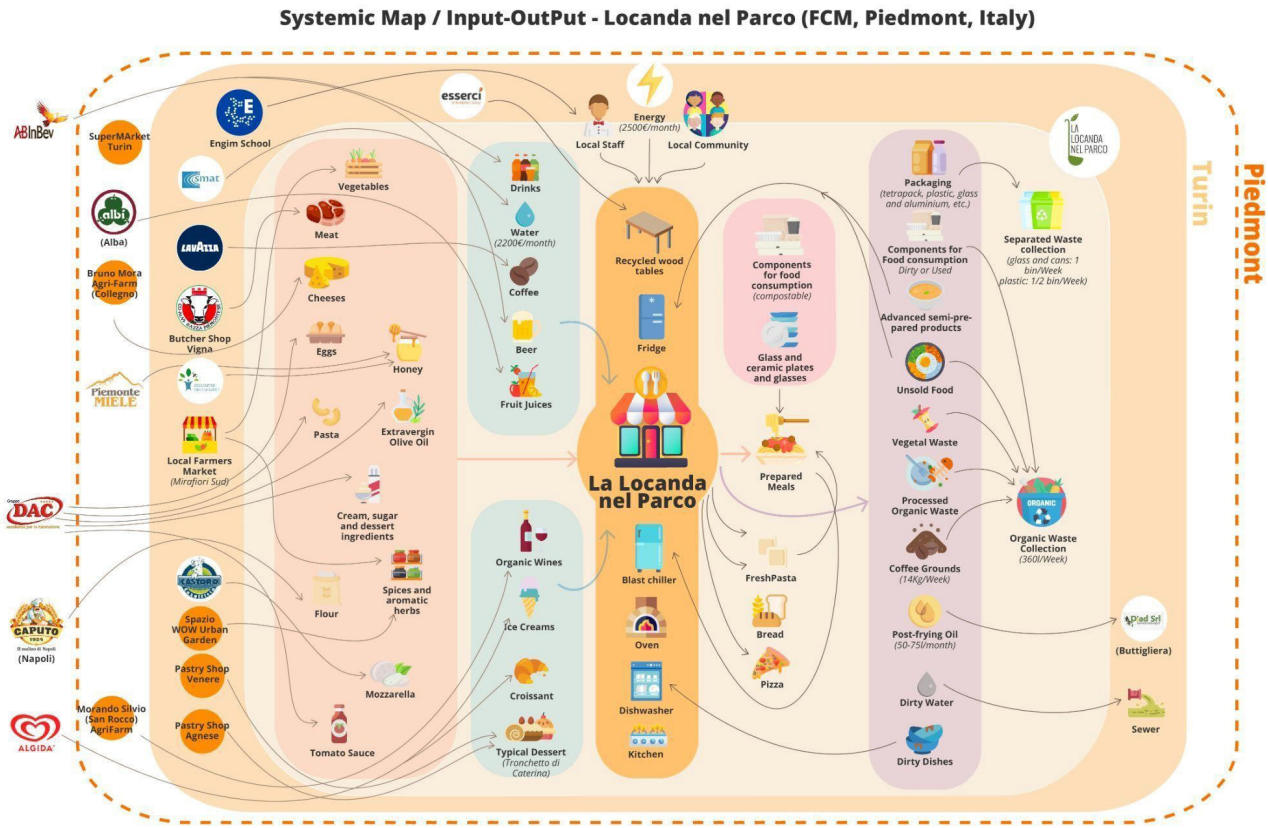

Figure 3. An example of a Systemic Map designed for the Holistic Diagnosis of the Locanda nel Parco Social Restaurant. In particular, graphical representation of the input and output analysis.

system with a holistic view of food production, processing and consumption, and finally, to design possible future food scenarios. In this framework, systemic designers guided and supported co-creation processes, but above all, worked as mediators of different backgrounds, minimizing conceptual and communicative obstacles and working out compromises between different visions. In this sense, they facilitated dialogue between different disciplines and professions in order to achieve high project standards. This specific role of creative connector is extremely favorable to co-design processes with different communities and teams (Celaschi, 2008, Savina & Peruccio, 2020).

3. Discussion and Results

3.1 The Circular Valorisation of the Less Noble Parts of Food

On the basis of the methodology described in the previous section, through the collaboration of the actors introduced, symbiotic circular menus were designed that could be included in the circular restaurant and circular kiosk's agri-food offer.The holistic analysis undertaken has thus allowed the coherent and virtuous planning of the agri-food proposals. These menus were developed following the cycles of the Circular Economy (Ellen MacArthur Foundation, 2012)

and the fundamental principles of Systemic Design, based primarily on the valorisation of outputs, the creation of relationships between the parties, local action, with a strong focus to the protection of the environment and communities (Barbero & Tamborrini, 2015). However, the key principle that guided the development of the menus is not only an integral part of the systemic approach, but is also a key rule of ecology, according to which all waste matter can become a form of nourishment for other systems (Commoner, 1971).

Each circular agri-food proposal has been designed, experimented and preliminarily tested within the Pollenzo FoodLab, under the guidance of cooks, chefs and researchers.



Figure 4. Local citizens involved in the circular gastronomic events organized in the Mirafiori Sud district (Turin, Italy)

The citizens of Mirafiori Sud, already actively involved in Orti Generali and Locanda nel Parco, took part in the co-creation process, which was able to enhance ancient knowledge and traditions of cultures and peoples even far from the Piedmontese territory (Figure 4). In this, the value of the elderly emerged, i.e. citizens of senile age (from 65 years onwards) who in most cases preserve food and agricultural rituals and traditions, to be handed down to younger generations. Citizens from Southern Italy, although grafted into Piedmont for social and work related reasons, have in fact often shown themselves to be very close to the riches of rural settings, often forgotten in more developed urban areas.

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Among the activities designed and implemented in the Food Living Lab it is possible to mention the Circular Cooking Course, (from which the Participated Circular Aperitif format originated) and the Symbiotic Circular Pizza. In both cases, the direction was to valorise the less noble parts of the agri-food products used and that of the by-products of the food transformation processes.

Generally, food waste is that food, or those parts of food, which in the common perception are not useful for human consumption or which, more simply, were not valorised before they became inedible (e.g. food defined as not suitable for consumption , spoiled, expired, advanced, manipulated food, etc.). Changing terminology, however, the perception of food waste changes. In fact, talking about "less noble parts of food", rather than food waste, has made it possible to refer to those parts/ elements of agri-food products that are usually discarded, which however are still perfectly useful for human consumption and, on the contrary, still have good organoleptic/sensorial properties, so much so that they can be fully exploited in the kitchen, following appropriate gastronomic transformations. These are edible components of food, such as fruit peels and leaves, greens, basal/apical parts, seeds and, again, food processing by-products, such as the cooking water of a product. In circular menus, the potential of all the parts of an ingredient are studied and analyzed (Whole Ingredient concept), so that they can be enhanced in the different agri-food courses and in some cases, increase the nutritional intake of a meal.

The target of the circular actions undertaken is primarily the citizens of the Mirafiori district of the city of Turin. However, it extends to all urban citizens, as well as to all urban gastronomic scenarios, as one of the objectives of the project is precisely to increase food awareness at a territorial level. In order to reach such a wide audience, for each of the gastronomic experiences, and specifically, for each menu designed, simplified systemic maps were created (Figure 5 - Figure 8), which, through the use of visual communication, represented a useful tool for communicating the effective circularity of food proposals to an average user, therefore to a mixed audience, characterised by different cultural levels, as well as different disciplinary languages. In some cases, these easy-to-use maps were printed on the placemats inserted inside the aperitif boxes or for the administering of the Circular Pizza during the dissemination events of the project and the official launch of the proposals. This graphic-visual tool generally allows for an easier metabolization of concepts aimed at changing the user's behavioral habits.

3.2 The Circular Cooking Course and the Participatory Circular Aperitif

Within the evocative natural spaces of Orti Generali, which host 178 urban gardens, a synergistic vegetable garden and an didactic farm with animals such as chickens, bees, hares and Irish cows, a participatory, zero-waste circular aperitif format open to all local citizens has been designed every year, since 2022, in the summer season.
This format included a preliminary circular cooking course, through which to collectively cook the agri-food proposals, under the expert guidance of the pollentine chefs. Around 20 chefs from the Turin restaurant sector were involved annually, mostly belonging to Turin's neighborhood houses, and around 100 citizens, reaching a broader social dimension. The objective of the event was to spread the principles of the Circular Economy for Food in the restaurant sector and among local citizens, so that the urban food transition could take place both in restaurant and domestic environments, involving the dimension of daily life. The course led cooks and chefs to experiment with the preparation of vegetable and circular proposals based on the integral use of seasonal and local vegetables (such as tomatoes and courgettes, wild vegetables and legumes), creating a concrete menu of sustainable circular proposals, in mutual symbiotic connection, through the complete valorization of the less noble parts of the ingredients and preparation waste. The citizens who attended the circular agri-food training actively contributed to the cooking course, while the other citizens were the users of a broader dissemination process, which concluded with the tasting of the circular aperitif (Figure 5).

Considering the multiple geographical identities of the local community involved, the menus were designed by revisiting international gastronomic elements. In the systemic map representing the circular menu of the participatory aperitif designed in 2023 (Figure 6), it is possible to see how, starting from the integral valorisation of three ingredients (beetroot, radish, red onion), some typical recipes of Argentina, Greece, America, but in particular the Middle East (as well as those of other regions of Italy) have been revisited. These recipes belonging to different geographical contexts (such as chimichurri sauce, tzatziki sauce, hummus, ketchup) have been re-designed following the concept of mutualistic symbiosis (Bronstein, 2001). In the preparation of each of them the process output of further gastronomic preparations is present. The format of this circular aperitif demonstrates how the concept of Circular Cuisine, already partially anticipated by the Italian chef Massimo Bottura (Italia Circolare, 2020), does not undertake to exclusively valorise what is commonly treated as waste, but also the resources and the communities of a specific territory.

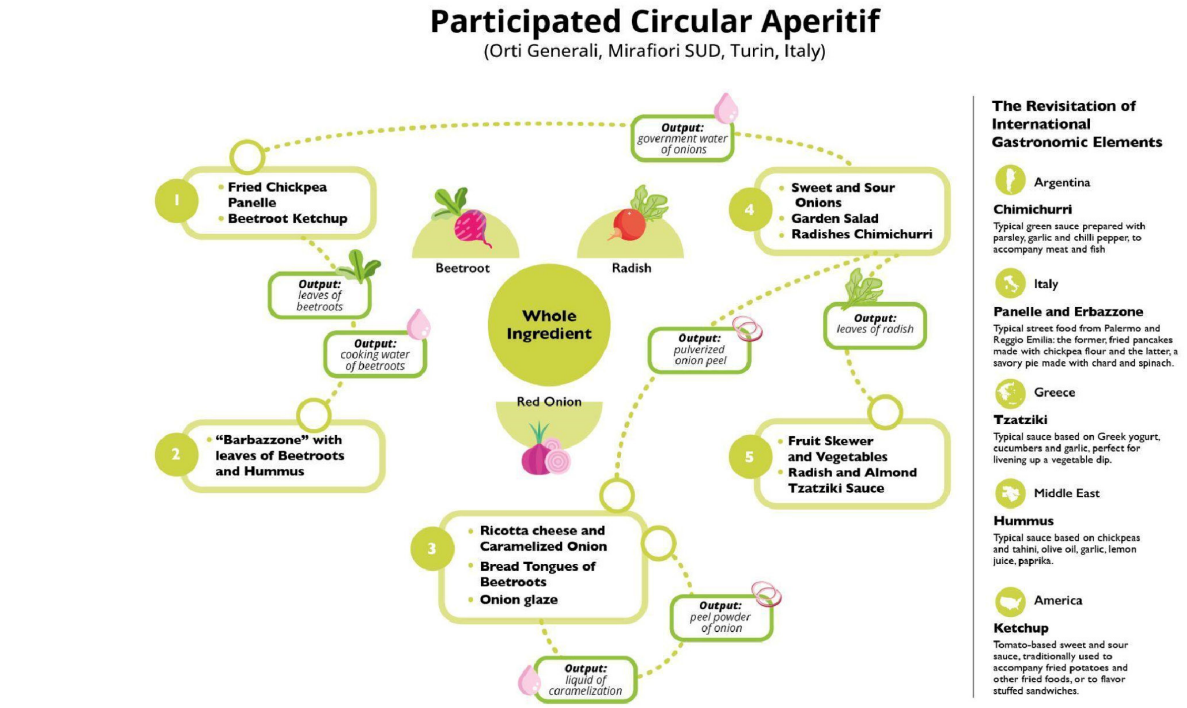

Figure 5. The Systemic Map of the gastronomic proposals of the Participated Circular Aperitif (Orti Generali, 2022)



Figure 6. The Participated Circular Aperitif, with the Preliminary Circular Cooking Course (Orti Generali

3.3 The Symbiotic Circular Pizza

Following the same methodological process, the Symbiotic Circular Pizza was designed at the Locanda nel Parco social restaurant (Figure 7). This is not a static recipe, but an iconic Italian product, which, following the 3Cs of the Circular Economy for Food (synthesized as Capital, Cyclicality, and Coevolution) (Fassio et al., 2020), enhances the ingredients in their wholeness, avoiding the generation of waste, enhancing the natural and cultural biodiversity typical of the territory and involving the local community with a nutritious and healthy product.
Its recipe, extremely versatile depending on the annual periods and geographical areas, proposes the use of vegetables that are a seasonal expression of the Piedmontese territory and that of typical local products, coming from sustainable production processes. The broader ambition was to circularly revisit some great classics of Italian cuisine. In the circular restaurant project, the Circular Pizza changes seasonally. Furthermore, it was designed in a symbiotic relationship with a circular starter. In the following image (Figure 8) it is possible to analyze, as in the same way as the circular aperitif, also in the case of this food combo, the elements of products and preparations that are not enhanced within the pizza, with appropriate transformations, represent the main ingredients of the appetizer and vice versa.



Figure 7. The Circular Combo (Circular Aperitif and Circular Pizza) of the Locanda nel Parco social restaurant (FCM, 2023)

Although these projects are located in a micro-local dimension (in this case purely urban), the strategic choice of some agri-food products, such as pizza, known internationally, has made it possible to make the new agri-food proposals vehicles of circular innovation and information

in different international contexts, not just Italian ones, overcoming every cultural and geographical barrier[4]. In this sense, the objective of contributing to the sustainability of the food sector has been achieved in a much broader way. In fact, these are Italian food rituals that lend themselves well to adoption by other territories and cultures, albeit with appropriate variations. The prevention of food waste and the valorisation of the less noble parts of food are in fact activities and values that can be communicated and learned in any kitchen in the world, where the Circular Economy is often already intrinsically present.

It is important to point out that the development of circular menus is not enough for the design and subsequent construction of a circular restaurant and a circular kiosk. In order to complete these concepts, further fundamental points have been adopted, such as:

- the use of energy-saving technologies, such as ovens made of refractory materials to maintain temperature and reduce consumption;
- the use of renewable energy, through the installation of solar panels;
- self-production, where possible, of vegetables, fruits, herbs and other food products, in compliance with current Italian food safety regulations;
- the use of agro-ecological cultivation practices, without the use of chemical herbicides, within urban agriculture activities;
- the facilitation of on-site separate waste collection by all the actors involved,
- the supply of drinkable water in pitcher, to avoid the over-production of plastic waste;
- the production of common goods useful to the community starting from food waste that cannot be exploited in the kitchen, such as the artisanal production of soaps starting from the used oil resulting from the frying process;
- the supply of doggy bags to avoid wasting leftover food, encouraging the domestic consumption of what is not consumed in the catering sector.

The development of the aforementioned activities, connected to the designed circular gastronomic experiences, adapt well to the concept of Food Living Lab, already widely rooted in the Mirafiori Sud district of the City of Turin. The local community welcomed the initiatives undertaken, demonstrating a growing interest which allowed the rapid

[4] In 2023, the Circular Pizza concept was presented at the Karlín Forum in Prague, Czech Republic,during the international catering event organized by Fany, major food retailer, and at the World Pizza Championship 2023 (Parma Exhibition Centre, Italy).

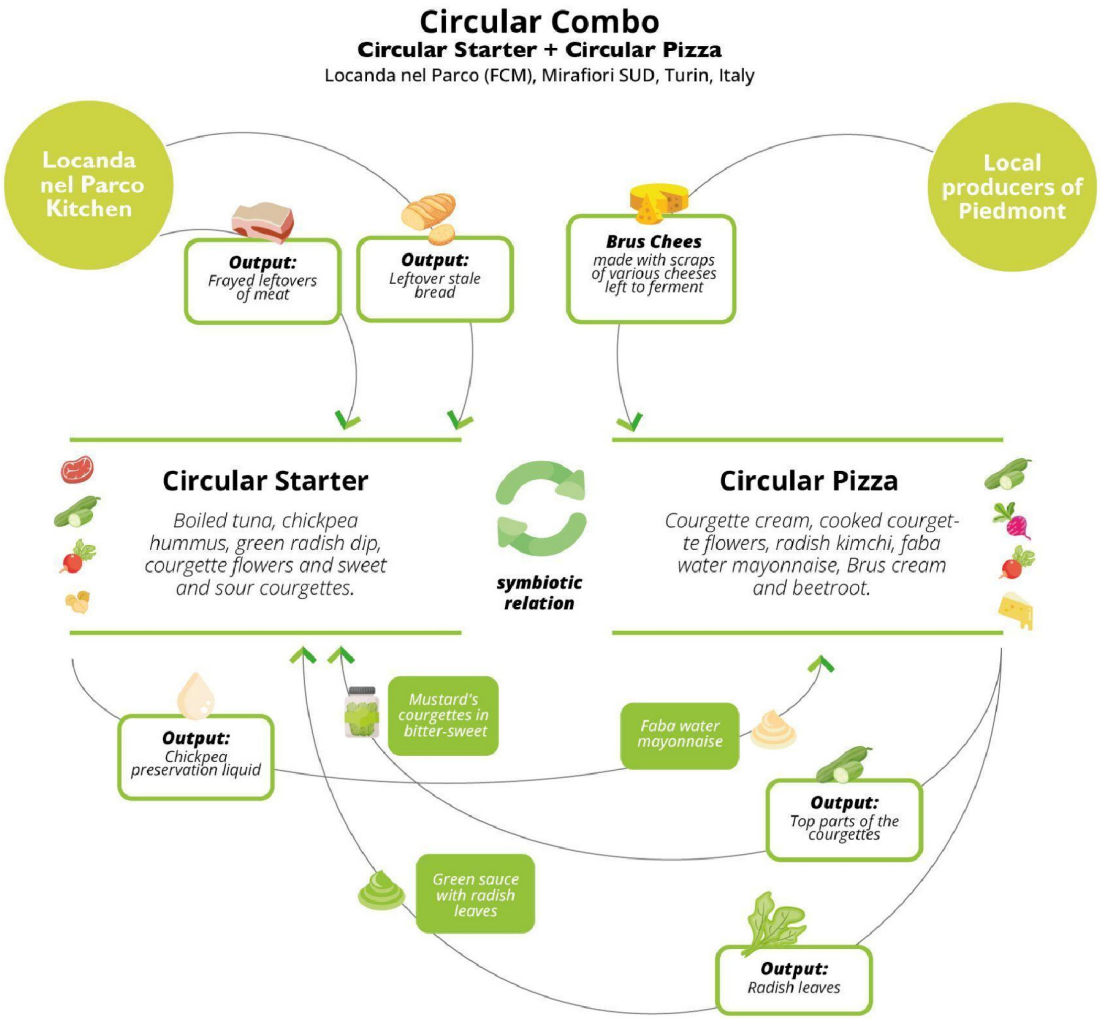

Figure 8. The Systemic Map of the Circular Combo (Circular Aperitif and Circular Pizza) designed for the Locanda nel Parco social restaurant (FCM, 2023)

metabolization of the circular experiments and effective autonomy in the reproduction of the developed model.

Furthermore, the project demonstrated how design is an effective tool in supporting "wicked interactions" (Buchanan, 1992; Granovetter, 1973), and in creating local informal networks, contributing to territorial social capital. In this sense, design manifests itself as a discipline extremely suitable for the coordination of multidisciplinary groups and the management of 'community-centered' projects (Manzini and Meroni, 2014), i.e. initiatives in which local communities (stakeholders and citizens) actively participate in the design path, leading to the achievement of a holistic result and a collective virtuous behavioral change (Wendel, 2013). In many cases, such as the one presented in this article, such projects can become versatile models that can be replicated in different territories.

4. Conclusion

Through the circular agri-food experiments launched through the European H2020 FUSILLI project within the city of Turin, it was possible to act on several elements of the urban food system. Although the starting point was, for obvious reasons, a supply of seasonal local resources, favoring sustainable production processes, the main focus was directed more concretely on the food handling and transformation phases, in particular to prevent the generation of waste in the pre-consumption phase. Working with food catering, in fact, allows us to act in the phase preceding the meeting with the final consumer. Working with food catering makes it possible to take action in the phase before meeting the end consumer. In addition, applying circularity in the kitchen for the elaboration of gastronomic catering proposals makes it possible to indirectly contribute to increasing the food awareness of the public reached, initiating processes of ecological literacy (Sterling, 2012), which facilitate the arrival of the Circular Economy also in the domestic sphere, triggering a change in people's daily habits. In this sense, food, and more specifically, design for gastronomic sciences, becomes a vehicle for sustainable virtuous principles.

Although local citizens were defined as the primary target of the project, the activities carried out also significantly involved several catering professionals. In turn, they will be able to replicate the good practices learned within their food business, also adopting a sustainable change in the systemic design of menus, with a broader vision of the different food formats, which, on the contrary, often embody formulas that involve massive consumption at low cost, to the detriment of the quality and sustainability of the products and working conditions. In this sense, the ecological transition path initiated wants and must also consider the social dimension of the designed system.

Currently, the FUSILLI project is still ongoing at European and Italian level and it will end in December 2024. The real challenge will be to preserve the results achieved at the Food Living Lab in Mirafiori Sud, progressively expanding them and maintaining the active participation of the community and stakeholders involved. The limits of the project are in fact in some cases to be found in the lack of continuity, which is predominantly the most critical element, not only in associationism, but also in forms of citizen self-organization. European projects make it possible to direct substantial funding towards the exploration of specific topics and the development of joint activities related to them, which can lead to tangible impacts on territories and communities in different European nations. This allows the realization of individual local programmes characterized by concreteness, capable of generating employment over time, also thanks to the structuring of expected periodic results, verified by international managers. Nevertheless, it is not uncommon

that there are inconsistencies between the peculiarities of each territory and the standard requirements dictated by specific KPIs (key performance indicators), the same for all cities in their diversity, Political involvement supports and nurtures the life of such projects, and vice versa, such projects help political administrators in the development of targeted innovative activities. One of the most decisive strengths has been the structuring of a heterogeneous local partnership of which the research organizations are part, which has made it possible to combine different competences and approaches to achieve extensive results in terms of food awareness and new sustainable good practices.

The downside, however, is the risk that the activities undertaken will be suspended at the end of the funding period, not allowing the final achievement of results or their maintenance over time. This means that in the event that the project has not generated structured activities on the ground capable of self-management and self-financing, the impact on communities risks fading over time, unless the arrival of new funding allows for investment in the continuation of the results achieved.

As regards the fruits of the FUSILLI project in the city of Turin, the greatest legacy is undoubtedly the development of an Interdepartmental Group of Food Policies (GIPA), capable of making departments and local authorities discuss the topic of food, with a shared effort and with different points of view. This discussion will establish a real Food Council, which can develop healthy and sustainable food policies for all citizens and the environment, educating on more virtuous food consumption and production behaviors, in line with the Sustainable Development Goals of Agenda 2030. To conclude, in 2024, through the activities developed in Turin, the University of Gastronomic Sciences of Pollenzo won the prestigious CEFoodCycle AWARD (Lamoro, 2024) which recognized the most innovative circular economy initiatives in the food sector, and identifying some circular pioneers on the European scenario.

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AN ANALYSIS OF INCLUSIVE DESIGN INTEGRATION AND INTERSECTIONALITY IN DESIGN EDUCATION CURRICULA.

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ABSTRACT | This paper investigates the integration of inclusive design principles and intersectionality within design education by analyzing curricula from top-ranking international design programs. The study employs an interpretative approach to examine 23 undergraduate and postgraduate courses from the top 10 universities in the QS World University Rankings (2023). A research protocol features a comprehensive analysis grid focusing on five main clusters: 1) General Information, 2) Inclusive Approach, which evaluates how each course addresses inclusive design both explicitly and implicitly, 3) Mapping of Course Aims and Approaches, 4) Levels of Design, and 5) Integration of 13 individual identities in diversity. Data were collected from university websites and databases, with fifteen literature-derived terms used to guide the search within course descriptions. The findings reveal current practices incorporating inclusive design principles across leading design programs. The research underscores the necessity of embedding inclusive design principles into design education, advocating for both practical applications and a holistic approach to address complex societal challenges. The paper concludes with potential future research, emphasizing the value of the analytical protocol developed. In fact, this protocol could serve as an example for similar studies or as a tool for educators to assess and enhance their courses. By providing an initial overview of this educational area, the paper aims to stimulate reflection, foster meaningful engagement, and guide the evolution of design education to integrate inclusive design principles better.

KEYWORDS | INCLUSIVE DESIGN, DESIGN EDUCATION, INTERSECTIONALITY, DESIGN CURRICULUM ANALYSIS

1. Introduction

The landscape of inclusive design is evolving, driven by two key factors: an increasing recognition that "good intentions cannot be enough" (Del Gaudio et al., 2020; D'Ignazio & Klein, 2020) and a shift from physical exclusion to more complex forms (Donahue & Gheerawo, 2021). Inclusive design, traditionally focused on integrating disabled and elderly groups into mainstream society, has expanded its scope beyond traditional accessibility concerns (Clarkson & Coleman, 2015; Lillegård et al., 2021; Szlavi & Guedes, 2023). There is a growing imperative to address diverse issues such as race, gender, social status, and sexual orientation, acknowledging intersectionality, as introduced by Kimberlé Crenshaw (1989). Intersectionality and the matrix of domination (Collins, 1990) shed light on how privilege and oppression intersect. Despite the momentum of intersectionality, a gap exists in design education, necessitating comprehensive studies on how students approach and address intersectional biases (Berry et al., 2022). This paper aims to analyze the educational landscape of design and answer the research question: **How are inclusive design principles and intersectionality addressed in different design curricula?**

Drawing inspiration from Das et al.'s (2023) methodology for ethics, equity, and justice audits of design pedagogy, this paper analyzes the course programs of top-ranking international design universities and colleges. A literature review informs a protocol for analyzing existing design education programs. The research protocol includes an analysis grid to map the courses and compare the results. Initially, the results are analyzed quantitatively, followed by a qualitative examination to highlight the primary considerations that emerged from the inquiry. The research, restricted to the top 10 universities in the 2023 QS World University Rankings by subject: Art and Design, examines programs and course descriptions of 23 undergraduate and postgraduate courses. Second-hand data from university websites and databases were analyzed, with fifteen terms derived from the literature as search criteria within course descriptions. The

analysis provides insights into the current state of design education programs and their incorporation of inclusive design principles. Overall, this research highlights the importance of integrating inclusive design principles into design education, emphasizing practical applications and holistic perspectives to address complex societal challenges effectively. The paper concludes with discussions and reflections on potential future avenues for similar studies, aiming to contribute to ongoing discourse and advancements in design education. The primary goal of this paper is not to provide exhaustive research but to lay the foundation for further investigation and to share tools for analyzing and reflecting on design courses.

This brief research is part of a PhD research focused on prioritizing inclusive design within design education, particularly in the methodological learning approach aimed at redefining design briefs (problem-framing). Research on problem-framing, which influences decisionmaking, can be significantly biased, resulting in superficial efforts to promote inclusive actions (Holmes, 2020). This study is based on the principle that addressing awareness, power dynamics, and biases at the beginning of the design process is crucial to prevent these biases from affecting the proposed solutions (Costanza-Chock, 2020).

2. Theoretical background

This section offers general reflections on the future of design education by identifying fundamental changes underway to address the urgent needs of global development. It explores the dimensions of these changes and how scholars are intervening to implement them. Additionally, it analyzes the literature on inclusive design, attempts to define the term, and outlines how current research approaches this subject.

2.1 Exploring the Changing of Design Education

The field of design education is undergoing substantial changes, necessitating the development of new courses, curricula, and teaching methods (Mercer & Terresa, 2019). Two interrelated factors primarily drive this transformation. Firstly, ongoing global and local challenges of unprecedented scope and intricacy highlight the limitations of traditional, discipline-specific design education in preparing students for emerging contexts (Pontis & Van der Waarde, 2020). Consequently, there is a pressing need to reconsider the future direction of design education (Jones et al., 2022). Designers today face increasingly complex and impactful challenges, necessitating reevaluating educational methodologies to effectively address contemporary issues (Pei & Colombo, 2023). Simultaneously, there is a growing recognition of design's role in influencing societal structures. This shift in perspective

demands a critical reassessment of current practices and calls for an expanded definition of innovation that encompasses socially inclusive outcomes (Noel et al., 2023; Monteiro, 2019). Monteiro (2019) claims, "The world is not broken but works exactly as it was designed to work, and we are the ones who designed it", underscoring the importance of transformative processes within the design discipline. In its various manifestations, design is increasingly viewed as a catalyst for social change, capable of empowering marginalized communities and promoting innovative behavioral patterns (Avelino, 2021; Meyer & Norman, 2020). This comprehensive reform requires interventions at various scales, driven by the increasing emphasis on diversity, inclusion, and equity. Researchers are reevaluating macro and micro scales to foster genuine change within the education system.

Three dimensions are identified here:

1. **Rethinking the pedagogical model**
   At the macro level, there is a need to rethink the entire pedagogical model. One prominent theme in this discourse is transdisciplinarity. As design education expands to incorporate critical, inclusive, and systemic tools, its potential as a discipline and a mode of teaching and learning becomes more evident (Jones et al., 2022). This shift acknowledges that traditional disciplinary boundaries are less beneficial for higher education graduates compared to more active and constructivist learning opportunities. In this dimension, while strong and widely theorized ideas remain relevant, there is a challenge to the traditional "banking mode" of education, where educators are viewed as experts depositing knowledge into students. According to hooks (1994), the primary goal of education is to cultivate critical thinking skills in both teachers and students. This approach, known as critical pedagogy, involves educators posing thought-provoking questions, fostering collective critical awareness, formulating action plans, and helping students become more autonomous. Fundamental principles of this pedagogy necessitate that all participants are capable of thinking, questioning, and acting on issues that matter to them (Tang et al., 2020). Furthermore, recognizing the incomplete nature of individual knowledge, collaboration and active listening among participants is crucial. New and more disruptive ideas are also emerging, built on similar foundations. For instance, the Matriarchal Design Futures framework rejects capitalistic and hierarchical structures, instead focusing on caregiving and nurturing for all identities. It emphasizes values of collectivism, cooperation, inclusivity, and human rights, challenging the priorities set by white supremacy and capitalism (Place, 2022). This approach avoids using metrics to measure success and seeks to highlight and discuss issues rather than provide definitive answers. The goal is to spark public conversation and collaborative imagination.

2. **Rethinking Design Curricula**

The effects of dominant design education curricula are now recognized in both practice and educational research (Jones et al., 2022). From the broader reconsideration of pedagogical models, a need arises to revise the educational offerings of design universities. Rethinking design curricula opens new research frontiers that follow the trend of inclusion more comprehensively and systemically (Noel, 2022). A significant example is the focus on decolonizing design curricula, a topic debated for decades, with much work still needed to represent a plurality of design practices, cultures, and approaches. Design education has historically played a role in global projects aimed at universalizing design principles, both in subject matter (e.g., modernism and internationalism) and curriculum (e.g., the dominance of the Western "Bauhaus model") (Kambunga et al., 2023). Escobar (2019) highlights that concepts like universalism, impersonality, and standardization are often considered virtues in modern society. However, this emphasis on universalist methodologies in design pedagogy can lead to homogenization, reducing diversity, perpetuating social inequalities, and favoring a dominant narrative (Noel et al., 2023). Dominant narratives are deeply embedded in mainstream design forms, potentially leading designers to employ discriminatory practices (Prendeville & Koria, 2022). Noel (2023) argues for questioning the global uniformity of curricula and recognizing what is lost when the richness of specific and local design cultures is marginalized (Berry et al., 2022; Noel, 2022). With its Bauhausian and Ulmian roots, the education system risks uniformity that erases cultural specificity, which could otherwise enrich student design education (Noel, 2022). Moving away from modernist and Eurocentric approaches to design history involves adopting a global perspective that includes design practices from Latin America, Africa, and Asia— adding "non-Western" design objects to an existing Eurocentric curriculum and rethinking historical narratives to center previously marginalized or erased design practices (Charlotte Smith et al., 2020; Jae & Kevin, 2023). The pluriversal approach in design education, as advocated by Mignolo (2020) and Noel et al. (2023), values a range of locally rooted perspectives, acknowledging that design shapes different ways of existence despite contextual contradictions and conflicts (Bianchin & Heylighen, 2018). Pluriversal thinking encourages diverse viewpoints, addresses power imbalances, and avoids extractive practices (Rodriguez Schon & Celi, 2023). It promotes teaching design from local contexts and actively involves those most affected by the design process. This shift challenges the conventional transactional view of design, emphasizing relationality instead.

3. **Reforming Courses Structures and Methods**

At the micro level, researchers are challenging the structure of design courses and proposing new solutions for teaching methods and application contexts. Emerging work is rethinking when, where, and how design education occurs, shifting the focus from what and how to why and from things and processes to intentions such as improving, facilitating, provoking, and conserving (Davis & Dubberly, 2023). This systemic thinking implies that interventions in university organizations must be holistic. Just as a company must ensure that its internal operations and external results align with its values, universities must address change comprehensively. For example, using recycled materials is mere greenwashing without a genuine commitment to energy-saving production and sustainable product end-of-life strategies (Davis & Dubberly, 2023). Thinking about systemic change is necessary but can be problematic since it is often only a trivial exercise of speculation (Jones et al., 2022), and, critically, it avoids questioning how a change to design education takes place (Noel, 2020). Furthermore, there is the potential to trigger broader transformations through local course interventions. Starting at the departmental level and gradually expanding to the international level can foster meaningful reflections and actions. Scaling efforts from local to global can spread insights and practices, initiating broader discussions and collaborations.

2.2 Inclusive design as a mindset

Inclusive design has become a focal point within design education since design schools have become where social impact, engagement and innovation can be developed, analyzed, and sustained. Design schools now play a critical role in equipping educators with the necessary tools to promote diversity, inclusion, and equity (Noel, 2022). Inclusive design is becoming more than a method to apply and persuade; it is a mindset that should change from the beginning of the approach to the project.

Traditionally, inclusive design focused on disabled and elderly individuals, known globally as “Design for All” in Europe and “Universal Design” in the US, originating in the 1950s (Clarkson & Coleman, 2015). However, two critical conditions are transforming inclusive design: the realisation that good intentions are insufficient (Del Gaudio et al., 2020; D’Ignazio & Klein, 2020) and a shift from physical exclusion to more complex forms (Donahue & Gheerawo, 2021).

These two critical conditions are briefly summarized as follows:

- Designers play a crucial role in shaping our world, as their decisions can have global consequences (Norman, 2023). It is easy to cause harm with good intentions (Costanza-Chock, 2020; D’Ignazio & Klein, 2020). Prejudices, norms, and stereotypes are embedded in many artefacts, and design has the potential to strengthen

them (Prochner & Marchand, 2018). There is a growing awareness in the design process that recognizes the responsibility of design and how unconscious biases can influence and impact decisions (Costanza-Chock, 2020; Wachter-Boettcher, 2018). Unconscious biases are learned, natural, instinctive, unintentional preconceptions so deeply rooted that they quickly affect a person's behavior (Canlı, 2018; Lillegård et al., 2021). "Exclusion happens when we solve problems using our biases" (Holmes, 2020). Designers must recognize their biases and be open to questioning their perspectives to avoid tokenistic attempts at inclusivity and shifting to community-driven approaches instead of the traditional power dynamic (Place, 2022).

· The literature highlights the need to expand the definition of exclusion, moving beyond traditional accessibility concerns (Lillegård et al., 2021; Szlavi & Guedes, 2023). While issues like ageing have received attention, there is a growing imperative to address other critical issues and steer research towards a more holistic direction (Donahue & Gheerawo, 2021). Inclusive design should consider characteristics like race, gender, social status, sexual orientation, and others, embracing the theory acknowledging intersectionality. This concept was introduced by Kimberlé Crenshaw (1989), a Black feminist legal scholar, in 1989. Crenshaw (1989) has highlighted how race and gender intersect, particularly the experiences of racism and sexism endured by black women. The concept of intersectionality was developed within a legal framework to show how a "single axis framework" often failed to protect Black women workers (Crenshaw, cited in Costanza-Chock, 2018). The predominance of what Crenshaw calls "single-axis analysis", in which race, class, or gender is considered an independent construct, continually undermines the intentions of well-meaning designers who hope to challenge bias through the objects, systems, or environments they design. Intersectionality reveals that forms of oppression are interconnected. Another concept related to Intersectionality is the representation of the "matrix of domination" (Collins, 1990). Intersectionality and the "matrix of domination" help us understand how privilege and oppression are interconnected. A privileged view will also likely inform beliefs, assumptions, and norms that shape many design decisions made throughout design projects. If designers become more aware of and sensitive to how privilege and oppression (including their own) function in the contexts they are designing, they can make decisions to challenge status quo inequities and patterns of oppression produced (Goodwill et al., 2021).

This increased awareness has prompted scholars to strive for equity and justice in their practice. New frameworks actively pursuing this goal are emerging from the literature,

such as Design Justice (Costanza-Chock, 2020), Liberatory Design (Anaissie et al., 2021), and Design for Belonging (Anaissie et al., 2022).

Design Justice, developed in 2018, aims to ensure the equitable distribution of design benefits and limitations, meaningful participation in design decisions, and recognition of communitybased design traditions (Costanza-Chock, 2018). Liberatory Design, first introduced in 2016 and reviewed in 2021, encourages self-awareness and reshapes power dynamics in design processes for collective liberation (Anaissie et al., 2021). Design for Belonging supports designers in fostering community belonging and reducing othering through diversity-driven design choices (Anaissie et al., 2022). In this research, "inclusive design" encompasses these emerging frameworks, particularly the principles of design justice influenced by intersectionality theory. The concept of intersectionality has initiated a slow but ongoing shift in the social sciences, legal studies, and various research and practice fields (Crenshaw, 1989; CostanzaChock, 2018; Gianfrate et al., 2024). This shift, linking intersectionality with accessibility and empowerment, fosters a more integrated understanding of discrimination, social exclusion, and stigma. It is also beginning to influence the design industry by promoting comprehensive approaches that enhance collective efficacy, recognize marginalized individuals and their autonomy, and build community solidarity and tacit knowledge (Gianfrate et al., 2024).

Despite the growing acknowledgement of intersectionality, design education still faces challenges. There is a need for further research on how students engage with intersectional biases (Berry et al., 2022) and for practical guidelines to help educators teach these concepts effectively beyond theoretical discussions (Costanza-Chock, 2020).

A research question emerged from these reflections: How are inclusive design principles and intersectionality addressed across various design curricula? This question aims first to analyze the current state of the art and then explore potential ways to address gaps.

3. Research Methodology

The literature review facilitated the identification of key parameters necessary to assess the presence of inclusive design within design universities.

To effectively operate within societal contexts, designers must be trained to incorporate ethics, equity, and justice into their practice. With this premise, an analysis of design curricula was conducted, drawing inspiration from the work of Das et al. (2023), who developed a methodology based on the Design Justice framework for auditing ethics, equity, and justice in design pedagogy. In their research, Das et al. (2023) analyzed course syllabi from various departments at the Massachusetts Institute of Technology (MIT) from Fall 2019 to Fall 2020. While their work inspires this paper, it employs a different methodology. The main

distinction lies in the data sources; Das et al. (2023) analyzed a substantial amount of first-hand information from their university, making their research more reliable.

In contrast, this study analyses second-hand data gathered from publicly available sources on the internet. Similar to Das et al. (2023), this research underscores the importance of reflecting on university offerings and informs the research question. It also seeks to determine whether the racial, social, and environmental justice movements of 2020 have had any significant impact on design pedagogy. The hypothesis posits that, due to the COVID-19 pandemic, courses may now incorporate more socially conscious practices, but these changes may not profoundly influence pedagogy. A review protocol was developed based on the literature review to analyze the curricula. This protocol investigates 1) the presence and extent of inclusive design in design curricula, 2) the overlap with other terms and approaches, 3) whether intersectionality is addressed, and 4) the most common topics covered in the programs.

3.1 Design the research tool: protocol development

The research protocol consists of an analysis grid summarized in Table 1. The protocol is organized into several columns to capture and analyze course information systematically, as well as to facilitate comparisons among the courses under review:

· General Information: This part includes essential details such as the course name, university, prerequisites or competencies, modality, level of the course, course format, and required outputs.

· Inclusive Approach: This part maps whether the course description mentions accessibility or intersectionality.

· Course Aim and Approaches: details the approaches mentioned, including theoretical aspects, hands-on activities, and outputs required to achieve the course's objectives.

· Levels of Design: categorizes the course content according to Young's (2008) model, designed to capture design tasks' varying scales and complexities. The model distinguishes between three levels of design. The first level is the Product Level, which involves design within a specific context and focuses on tangible, micro-level design outputs. This dimension represents the traditional approach to designing artefacts and objects. The second level, Systems Thinking, addresses design within a broader context. It emphasizes the design of services and systems, incorporating a holistic perspective that considers the interactions and relationships among components within a system. The third level is the Policy Level, which deals with creating meaning and purpose. This dimension involves macro-level design dimensions, including developing policies and ideologies to address large-scale, systemic issues. The idea was to map the outputs required by the course syllabi and understand the main outputs required by future designers.

· The 13 individual identities in diversity, as identified by Wilson (2023), were integrated into the analysis to understand how courses address multiple perspectives of diversity. This includes mapping whether characteristics such as gender, Indigenous status, race/ ethnography, socio-economic status (class), disability, LGBTQI+, religion, age, immigrant status, physical or mental illness, refugee status, veteran status, and neurodiversity are present in the course descriptions.

This structured organization offers a comprehensive mapping tool to understand each course's

Table 1. Parameters used to analyze curricula integrated with the design levels proposed by Young (2008) and the 13 individual identities in diversity introduced by Wilson (2023).

General Information	**Inclusive approach**	**Course aim and approaches**	**Levels of design (Young, 2008)**	**The 13 individual identities in diversity (Wilson, 2023)**
Course name	Design with community	Approaches mentioned	D1: Product level	Gender
University	Accessibility	Prerequisites/ Competencies	D2: System level	Indigenous
Modality	Intersectionality	Theoretical aspects	D3: Policy level	Race/ Ethnography
Couse Level	Reflection practice	hands-on activities		Socioeconomic status (Class)
Course Format		Outputs Required		Disability
				LGBTQI+
				Religion
				Age
				Immigrant
				Illness (Physical or Mental)
				Refugee
				Veteran
				Neurodiversity

framework and approach to inclusive design education. An Excel file was used for the analysis to speed up the process and provide a visual comparison of all the courses analyzed. Figure 1 illustrates the Excel file's structure and the courses' final compilation.

Course Code	Modality	Level	Type of course	Co-design in practice	Hand-on Activities	Theoretical	Accessibility	Intersectionality	Reflection Thinking	Approaches mentioned	Prerequisite/ competences	Type of Output	Individual identities	Levels of design
C1	Online	Extracurricular Course	Elective	✗	✗	✓	✗	✓	✓	equity, inclusion, and social justice (EISJ)	Non Designer	n/a	Socio-economic status (Class) Gender	D2, D3
C2	In-Person	Undergraduate	Elective	✗	✗	✓	✗	✗	✓		Designer	n/a	Gender Disability LGBTQI+	D2, D3
C3	In-Person	Undergraduate	Elective	✗	✗	✓	✗	✗	✓	Equity, justice intersectionality	Designer	n/a	Socio-economic status (Class) Gender	D2
C4	In-Person	Undergraduate	Elective	✗	✗	✓	✗	✓	✓	design activism	Non Designer	Research/ speech	Gender Indigenous Race/ Etnigraphy Socio-economic status (Class)	D1,D2
C5	In-Person	Extracurricular Course	Elective	✗	✓	✓	✓	✗	✗	emphaty	Designer and non	a tool to evaluate good and bad design	Age Disability Illness (Physical or Mental)	D1,D2
C6	Hybrid	Extracurricular Course	Elective	✗	✓	✓	✓	✗	✓	Human- centerd design	Designer and non	mobility innovation processes	Age Disability Illness (Physical or Mental)	D1,D2
C7	online	Short Course	On Demand	✗	✓	✓	✓	✗	✗	Participatory design Design and climate change	No prerequisite	n/a	Age Disability Illness (Physical or Mental)	D1,D2
C8	online	Short Course	On Demand	✓	✓	✓	✗	✓	✓	Critical Research	No prerequisite	n/a	Gender Indigenous Race/ Etnigraphy Socio-economic status (Class) Refugee Veteran	n/a
C9	In-Person	Postgraduate	Dregree	✓	✓	✓	✗	✗	✓	Design in action, Sustainability	BA Degree	Thesis	Socio-economic status (Class) Immigrant	D1,D2,D3
C10	In-Person	Postgraduate	Dregree	✓	✓	✓	✗	✗	✓	Making and design	BA Degree	Thesis	Indigenous Race/ Etnigraphy Immigrant Refugee Veteran	D3
C11	In-Person	Postgraduate	Dregree	✓	✓	✓	✓	✗	✗	Business Design	BA Degree	Thesis/ project	Socio-economic status (Class)	D3
C12	In-Person	Undergraduate+ Postgraduate	Elective	n/a	n/a	✓	✓	✓	✓	Human sciences	Enroll in a program	n/a	Gender Indigenous Race/ Etnigraphy Socio-economic status (Class) Disability LGBTQI+ Religion Age Immigrant Illness (Physical or Mental) Refugee Veteran Neurodiversity	n/a
C13	In-Person	Postgraduate	Dregree	✗	✓	✓	✗	✗	✗	Technology	BA Degree	Thesis/ project	Socio-economic status (Class) Immigrant Refugee Veteran	D2
C14	In-Person	Undergraduate+ Postgraduate	Elective	n/a	n/a	✓	✓	✗	n/a	User Experience	n/a	n/a	Disability Age Illness (Physical or Mental) Neurodiversity	
C15	n/a	Undergraduate+ Postgraduate	Elective	n/a	✓	✓	✓	✗	✓	pedagogical knowledge; evidence-based strategies	n/a	Reflection and discussion	n/a	D3
C16	In-Person	Undergraduate+ Postgraduate	Elective	n/a	✗	✓	✗	✓	✓	case studies, Examine trend	n/a	examine trends	Indigenous Race/ Etnigraphy Socio-economic status (Class) Religion Immigrant Refugee Veteran	D1
C17	In-Person	Undergraduate+ Postgraduate	Elective	n/a	✓	✓	✗	✓	✓	social activists, policy maker	n/a	analyze and synthesize evidence	Indigenous Race/ Etnigraphy Socio-economic status (Class) Age Immigrant Refugee Veteran	D1,D2
C18	In-Person	Undergraduate+ Postgraduate	Elective	✓	✓	✓	✓	✗	✓	community based, social health	n/a	hands-on exploration of urban art and design	Race/ Etnigraphy Socio-economic status (Class) Age Immigrant Refugee	D1, D2, D3
C19	In-Person	Undergraduate+ Postgraduate	Elective	✓	✗	✓	✗	✓	✓	cultural landscape theory, historic preservation	n/a	n/a	Indigenous Race/ Etnigraphy Socio-economic status (Class) Immigrant Refugee	n/a
C20	In-Person	Undergraduate+ Postgraduate	Elective	✗	✓	✓	✓	✗	✗	Technology driven	Enrolled for a degree programme of faculty Industrial Design	project	Disability Illness (Physical or Mental) Neurodiversity	D1,D2
C21	In-Person	Undergraduate+ Postgraduate	Elective	✓	✓	✓	✓	✗	✗	Technology driven	Enrolled for a degree programme of faculty Industrial Design	project	Disability Illness (Physical or Mental) Neurodiversity	D1
C22	In-Person	Undergraduate	Elective	✓	✓	✓	✓	✗	✓	service design, systemic change	Enrolled for a degree programme of faculty Industrial Design	project	Race/ Etnigraphy Socio-economic status (Class)	D1
C23	In-Person	Undergraduate	Dregree	✓	✓	✓	✗	✗	✓	post capitalism	n/a	Prototype and realise design solutions for sustainable and positive social change	Race/ Etnigraphy Socio-economic status (Class)	D1, D2

Figure 1. The Excel file was used to analyze the courses, showing how the protocol was structured and how the tool was used. The screenshot shows both the tool and the appearance of the final compilation with the course information entered.

3.2 Sample selection and data collection

The research focused on the top 10 universities in 2023 according to the QS World University Ranking by Subject: Art and Design (Table 2). Data were collected second-hand by analyzing the program syllabi and main descriptions from university website databases. Based on the literature, a list of 15 terms referring to design justice and inclusive design was searched within the course descriptions (Figure 2).

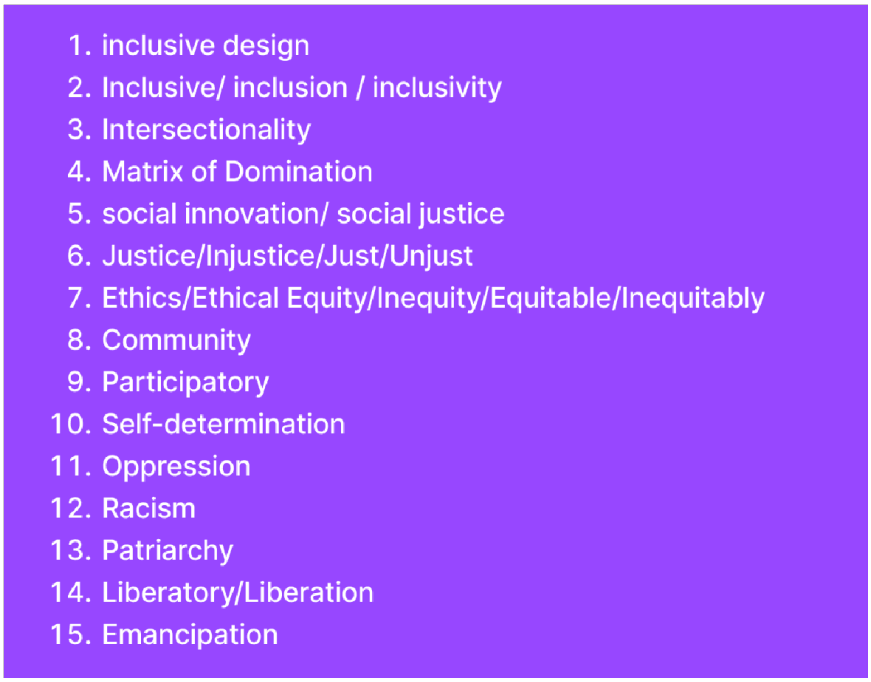

Figure 2. List of the15 terms used to perform the design curricula analysis

This list of terms helped the selection process, as the first screening was conducted to identify relevant courses. The study is based on the available information: not all universities describe the courses in detail. Courses that did not provide enough information to understand the course requirements and goals were excluded. Additionally, courses that seemed out of scope based on their descriptions were eliminated, allowing for a final filtering. A total of 23 courses, both undergraduate and postgraduate programs, were analyzed.

Table 2. Top 10 universities analyzed in the QS World University Rankings by Subject 2023 in the session Art & Design

Position	University	Country
1	Royal College of Art United Kingdom	United Kingdom
2	University of the Arts London	United Kingdom
3	Rhode Island School of Design (RISD)	United States
4	Parsons School of Design at The New School	United States
5	Massachusetts Institute of Technology (MIT)	United States
6	Aalto University	Finland
6	Pratt University	United States
8	Politecnico di Milano	Italy
9	Design Academy Eindhoven	Netherlands
10	Tongji University	China (Mainland)

4. Analysis results

The analysis of inclusive design courses across university programs provides several key insights, summarized in Table 3 and detailed in the following text.

Out of the 23 courses examined, 18 are integrated into degree programs. Of these, 9 are available to both postgraduate and undergraduate students, 4 are exclusively for postgraduates, and 5 are exclusively for undergraduates. Additionally, 5 courses are offered ondemand or as extracurricular options, indicating their presence beyond formal degree programs. Regarding the mandatory nature of these courses, only 5 out of the 18 integrated courses are compulsory, while the remaining 13 are elective. This trend suggests that inclusive design education is often treated as an optional rather than a required part of the curriculum.

The analysis also highlights the inclusion of intersectional and related topics such as antioppression, power dynamics, inequity, and positionality. These topics are explicitly covered in 6 of the 23 courses: 5 are elective, and 1 is an on-demand extracurricular course. However, practical activities related to intersectionality are less prevalent, with only 2 courses explicitly mentioning to incorporate hands-on activities. These practical elements are linked to ongoing projects or supported by teaching labs focused on social innovation.

Regarding addressing critical social issues, 4 out of the 10 universities reviewed offer master's programs focusing on significant challenges such as climate change, racial inequality, and poverty. This reflects a solid commitment to tackling pressing societal issues through advanced educational programs.

The presence of inclusive terminology in course descriptions is noteworthy. Terms such as "inclusive", "inclusivity" and "inclusion" appear in 10 of the 23 courses. Additionally, "ethics" is mentioned in 4 courses, "equity" in 6 courses, and "social innovation" in 16 courses, highlighting the emphasis on ethical considerations and social impact within the curriculum.

Examining the design dimensions covered in these courses revealed that obtaining clear and consistent information was challenging, as course descriptions often did not specify the outputs. Only 3 out of the 23 courses address the product dimension of design, and the same number address the policy dimension. Furthermore, 7 courses address a second design dimension, with 4 offering a hybrid approach that integrates product or service skills and policy considerations.

Finally, the analysis of individual identities addressed in these courses reveals a diverse range of focus areas. Gender and LGBTQI+ identities are covered in 6 courses, socio-economic status in 14 courses, age and disability in 10 courses, and religion in 2 courses. This distribution suggests a varied emphasis on different topics, with some identities receiving more attention than others. Notably, the courses that address individual identities do so in a manner consistent with an intersectional approach. However, further investigation is needed to explore how these focus areas intersect and to understand why some identities, such as religion, are less frequently considered than others.

Table 3. Summary of data analyzed derived from the grid and the comparison of the courses

Analysis factor	Numbers	Comments and considerations
Included Courses on inclusive design within their degree programs as elective courses	18/23 (courses analyzed)	Of the 18 courses integrated into the design curricula, 9 were accessible to postgraduate and undergraduate students, 4 were exclusively for postgraduates, and 5 were exclusively for undergraduates.
Coursers on inclusive design offered by the university on-demand or extracurricular	7/23 (courses analyzed)	This category covers on-demand and extracurricular courses that have been mapped because they are present in the university's offerings but not strictly related to design programs such as bachelor's or master's degrees.
Included Courses on inclusive design within their degree programs as mandatory	5/18 (not considering the course on-demand or extracurricular)	13 courses are elective, only 5 mandatory.
Courses explicitly mention concepts related to intersectionality or connected topics (such as anti-oppression, power dynamics, inequity, and positionality)	6/23 5 elective courses 1 on-demand	Of these 6 courses, 5 are elective 1 on-demand, an extracurricular course organized periodically and open to other participants, not only enrolled students.
Courses explicitly mention concepts related to intersectionality with hands-on activities.	2/25 (courses analyzed)	The courses proposed are predominantly theoretical, and only 2 offer hands-on activities. In this case, they either offer the course by linking it to an ongoing project or have a teaching lab dedicated to social innovation that supports students.
Universities offer master's degree programs centered on addressing critical social issues	4/10 (universities under analysis)	Programs centered on addressing critical social issues, including climate change, racial inequality, and poverty.
Presence of the terms "inclusive", “inclusivity”, “inclusion” in courses	10/23	Number of the courses that are mentioned these terms in the course title or description
Presence of the term "equity" in courses	6/23	
Presence of the term "social innovation" in courses	16/23	
Presence of the term "ethics" in courses	4/25	
Individual identities working on gender and LGBTQI+	6/23	Individual identities mentioned (directly or indirectly) in the course description
Individual identities working on socio- economic status	14/23	
Individual identities working on Age + Disability	10/23	
Individual Identities Working on Religion	2/23	

5. Discussion and consideration

5.1 Emerged consideration

From this analysis, three primary considerations emerged:

1. **Positioning of inclusive design in design curricula**: In all the universities considered in the sample, at least one course related to inclusive design was identified. However, the predominance of elective courses poses a challenge in fully integrating inclusive design into the curricula, necessitating further consideration. While standalone courses risk limiting its perception as a peripheral subject, seamlessly incorporating its principles into existing syllabi is complex. Although relevant theories and principles can be introduced through lectures on inclusive design, it is crucial to incorporate practical applications into education, ensuring students have opportunities to apply these principles (Dong, 2010). It is well recognized that inclusive design addresses specific issues but follows a general design process, emphasizing user involvement to create solutions accessible to a broad audience (Dong, 2010).

2. **Integration of Accessibility and Social Inclusion in Design Education:** The curriculum often treats accessibility and social inclusion as separate topics, with only six courses explicitly addressing concepts related to intersectionality, such as anti-oppression, power dynamics, inequity, and positionality. While these courses focus on social inclusion, they frequently overlook accessibility, and vice versa. This separation highlights a significant gap in the curriculum, underscoring the need for a more integrated approach that encompasses both accessibility and social inclusion through the lens of intersectionality. Some courses address inclusion by linking it to equity and social change. For instance, these courses may be associated with ongoing projects or feature dedicated educational labs focused on social innovation that support student engagement. These approaches enable co-design with communities and emphasize the importance of community engagement and equity. One of the primary challenges in implementing inclusive design in an educational context is the difficulty of applying projects to real-world situations, compounded by ethical considerations. Although these courses may effectively address the concept of intersectionality, they often fail to incorporate accessibility, indicating a lack of a comprehensive, holistic perspective in the curriculum.

3. **Linking with Environmental Sustainability and Social Innovation**: It emerged that universities often offer master's degree programs targeting critical social issues like climate change, racial inequality, and poverty. While these programs align with intersectionality, they often neglect identity-related aspects. Nevertheless, they stress the link between social innovation and environmental sustainability, echoing the objectives of the 2030 Agenda.

This alignment advocates for a holistic approach that challenges traditional power dynamics and consumption patterns, promoting economic and environmental sustainability while addressing human factors like poverty reduction and community needs. Indeed, sustainability and inclusion are intertwined; by questioning consumerist and Western economic paradigms, these programs endorse a comprehensive approach considering power dynamics and striving to foster sustainable attitudes benefiting communities. However, it is essential to note that sustainability cannot replace justice (Das et al., 2023), and often, this correlation is absent in program descriptions.

5.2 Limitations

This analysis is primarily interpretative and relies on secondary research data, which introduces several limitations typical of qualitative research. As detailed in the methodology section, the study faces constraints related to the availability of information and the challenges associated with conducting a thorough exploration of each design education program and its related courses. Consequently, this paper represents an initial effort to observe and examine this specific area of education, aiming to stimulate reflection and promote meaningful participation in understanding, initiating, and implementing solutions.

A notable limitation of this research is the relatively small sample size of the courses analyzed, which may offer a partial view. This suggests that a larger sample size could provide more robust insights. Additionally, the reliance on programs and course descriptions to assess the integration of inclusive design content is constrained by the limited access to materials and the incomplete nature of publicly available information. More than Syllabi is required to fully capture a course's pedagogical approach and learning experiences, highlighting the need for more detailed and varied data sources.

5.3 Conclusion and Future Works

Beyond the data presented, what could be particularly valuable for future research is the analytical protocol itself. This protocol could serve as a model for conducting similar studies or as a guide for educators to understand the trajectory of their courses. Additionally, the data provide a partial yet significant overview of the current state of design education at leading universities.

To build on this research, several actions could be taken:

- Update the Analysis: Repeat the analysis using the latest rankings, such as those from 2024, to determine if other universities now address inclusive design differently or more effectively.
- Expand the Scope: Examine additional universities beyond the top-ranked institutions, possibly selecting them based on literature where authors have highlighted relevant teaching practices.
- Conduct In-Depth Interviews: Conducting in-depth, semi-structured interviews with educators and scholars would be beneficial. These interviews aim to explore how experts implement inclusive design, manage biases within the design process, and interpret key research terms related to inclusive design. Such qualitative insights could illuminate behavioral models and practices in greater detail.
- Obtain First-Hand Data: Conduct detailed investigations of syllabi and entire course programs to better understand the educational landscape.

These steps provide a more comprehensive view of how inclusive design is taught and applied across different institutions and contribute to a more robust analysis of the current educational practices. Integrating inclusive design into design education is an ongoing process requiring substantial effort and commitment from educational institutions. By embedding inclusive design principles into the core curriculum, fostering practical applications, and adopting a holistic approach that merges social inclusion with environmental sustainability, design education can better prepare students to address the complex and impactful challenges of today's world. This comprehensive reform is essential for nurturing a new generation of designers equipped to create innovative, equitable, and sustainable solutions for the future.

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A CONTRASTIVE STUDY OF SERVICE DESIGN IN PUBLIC TRANSPORTATION SYSTEM IN SHANGHAI AND TURIN

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ABSTRACT | As urban populations continue to rise, the efficiency and effectiveness of public transportation systems have become pivotal in urban livability and environmental sustainability. This paper, with an integration of service design principles into public transit systems, focuses on the deployment of service design tools including service blueprints, real-time monitoring systems and passenger flow analytics aims to innovate and refine the delivery of public transportation services with higher operational efficiency and better passenger experiences . Service design offers a systematic approach to understanding and catering to users' needs, facilitating collaboration across various stakeholders in the public transit ecosystem. With the help of service blueprints, transportation agencies can visualize the entire journey of a passenger and then identify critical touchpoints where improvements are needed. This visualization helps in pinpointing inefficiencies and designing targeted interventions that can significantly reduce wait times and improve service reliability. Furthermore, the adoption of real-time monitoring systems enables transit operators to respond dynamically to on-the-ground conditions. These systems use GPS and other sensor-based technologies to track vehicles, allowing for adjustments in service frequency and routes in response to real-time traffic or passenger loads. This responsiveness not only enhances operational efficiency but also reduces overall travel time and make public transit more popular as a viable alternative to private vehicles. Passenger flow analytics play a crucial role in understanding patterns of use across different times and routes. Based on these data, transit agencies can optimize resource allocation and thereby improve service capacity and reduce overcrowding. This strategic approach not only improves passenger comfort but also makes full use of assets, which is conducive to the economic sustainability of the transit system.
The challenges and opportunities of integrating service design herein involve diverse cultural

and geographical contexts. It is proposed that local cultural dimensions should be taken into consideration in service design to ensure that solutions are appropriately adapted to meet the specific needs of different populations. This is crucial for inclusive design practices that accommodate and respect the diversity of users in global cities.

In conclusion, service design, as a powerful tool for transforming public transit systems, not only contributes to the efficiency and effectiveness of these systems but also plays a vital role in making them more user-friendly and environmentally sustainable. The findings of this study underscore the potential of service design to act as a catalyst for innovation in public transportation in a more connected and accessible way. In this sense, public transit, as the backbone of urban mobility, is conducive to the shift towards more sustainable and equitable urban environments.

KEYWORDS | SERVICE DESIGN, PUBLIC TRANSPORTATION, SERVICE BLUEPRINTS, REAL-TIME MONITORING, PASSENGER FLOW ANALYTICS, CULTURAL ADAPTATION

1. Introduction

As urban populations continue to grow, the importance of efficient public transportation systems has become increasingly evident. Urban centers around the world face significant challenges in managing traffic congestion, reducing environmental pollution, and ensuring equitable access to transportation (Cervero, 2013). Efficient public transportation is not only pivotal for urban livability but also for environmental sustainability by reducing the reliance on private vehicles, thereby lowering greenhouse gas emissions and improving air quality (Litman, 2021). An effective public transportation system supports economic productivity by facilitating the smooth movement of people and goods, which is essential for the economic vitality of cities (UITP, 2019).

Service design is an interdisciplinary approach that focuses on the planning and organizing of a service's components to improve its quality and the interaction between the service provider and its users. It encompasses a wide range of tools and methods, such as service blueprints, customer journey mapping, and real-time monitoring systems, to visualize and optimize service delivery processes (Stickdorn & Schneider, 2011). Service design principles emphasize understanding user needs, co-creation with stakeholders, and iterative testing and refinement of service components. In the light of these principles, public transportation systems can be made more efficient, user-friendly, and responsive to the needs of diverse populations (Moritz, 2005).

This study, with an integration of service design principles, aims to enhance public transportation systems with higher operational efficiency and better passenger experiences. The scope of the research includes the deployment of various service design tool including service blueprints, realtime monitoring systems, and passenger flow analytics to innovate and refine the delivery of public transportation services. By examining these tools in different urban contexts, the study seeks to provide a comprehensive understanding of how service design can transform public transit systems into more efficient and user-centric services.

The primary research questions of this study include: How can service design principles be integrated into public transportation systems to enhance operational efficiency? What are the specific tools and methods of service design that can be deployed to improve passenger experiences in public transit? How do real-time monitoring systems and passenger flow analytics contribute to optimizing resource allocation and service delivery in public transportation? What are the possible challenges and opportunities of the service design in diverse cultural and geographical contexts?

2. Literature Review

Service design has become a key aspect of public transportation systems with an aim to enhance user experience and at the same time improve efficiency and accessibility. Scholarly attention has already been on the service design in public transportation mainly in terms of strategies and practices to meet the diverse needs of urban populations. Historically, public transportation systems were designed with a focus on operational efficiency rather than user experience. According to McKinsey (2020), many cities' public transportation systems initially prioritized speed and reliability to ensure quick and predictable transportation for passengers.

However, it is gradually realized that human-centered design can not only enhance user experience, but also improve the efficiency of public transportation systems. This shift stems from understanding user needs and behaviors so that these needs can be better met during the design process, thereby achieving higher operational efficiency and user satisfaction. For example, the application of design thinking methods in public transportation has achieved remarkable results in many places. Singapore's Land Transport Authority (LTA) has improved the public transportation user experience through design thinking, including redesigning station layouts, improving signage systems, and enhancing digital tools. As a result, passenger satisfaction and usage rates have increased significantly (Design Thinking Association, 2023). Similarly, in Minneapolis, design thinking methods were used to transform bus stops to make them more responsive to residents' needs, significantly improving the user-friendliness of the bus system (Design Thinking Association, 2023).

In addition, studies have shown that human-centered design plays an increasingly important role in improving the efficiency of public transportation systems. For example, a case study in Istanbul showed that improving public transportation comfort through human-centered design methods not only improved user experience but also optimized overall system efficiency (Deb et al., 2019). This approach continuously iterates and improves transportation facilities and services through in-depth understanding of user needs and prototype design, thereby improving user satisfaction and the overall efficiency of the transportation system.

Previous studies also cover service design applications in various urban settings. Service design in public transportation aims to enhance user experience and operational efficiency. It encompasses the planning and organizing of transportation services to meet the needs of urban residents. In metropolitan areas, service design often focuses on integrating multiple modes of transport, such as buses, trains, and bicycles, to provide seamless mobility. For instance, cities like New York and London have implemented integrated ticketing systems that allow passengers to switch between different modes of transport with ease, enhancing the overall travel experience (Smith & Clark, 2020). In smaller urban settings, the focus shifts to optimizing routes and schedules to match the specific demands of the population. For example, in cities like Portland, Oregon, the emphasis is on creating sustainable and user-friendly public transportation systems that encourage the use of public transport over private cars. This includes the development of dedicated bus lanes and real-time tracking systems that inform passengers of arrival times, thus reducing waiting times and improving reliability (Jones et al., 2019).

The role of cultural adaptation in service design is another perspective. Cultural adaptation plays a crucial role in the successful implementation of service design in public transportation. Understanding and addressing the cultural preferences and behaviors of local populations can significantly enhance the usability and acceptance of public transportation services. For example, in cities with a high reliance on bicycles, such as Amsterdam and Copenhagen, service design incorporates extensive cycling infrastructure and bike-sharing programs to complement public transit options (Cultural Adaptation and Service Design, 2020). Cultural adaptation also involves accommodating local social norms and practices. In many Asian cities, where punctuality and cleanliness are highly valued, public transportation systems emphasize timely services and stringent maintenance standards. Additionally, in regions with diverse linguistic populations, providing multilingual information and customer support is essential for ensuring accessibility and user satisfaction (Polaine, Løvlie, & Reason, 2013). Technological advancements are undoubtedly important in service design. Technological advancements have revolutionized service design in public transportation, making systems more efficient, reliable, and user-friendly. Real-time monitoring and data analytics are at the forefront of these innovations, providing valuable insights into passenger flow, system performance, and operational efficiency. For instance, real-time tracking of buses and trains allows for dynamic scheduling adjustments and accurate arrival predictions, reducing wait times and enhancing the overall user experience (Berger, 2016). Mobile applications and digital platforms have also transformed how users interact with public transportation services. Features such as route planning, real-time updates, and mobile ticketing streamline the travel experience, providing users with greater control and convenience. Additionally, the integration of IoT devices and sensors facilitates predictive maintenance,

ensuring that vehicles and infrastructure remain in optimal condition, thus minimizing disruptions and improving reliability (Trischler & Scott, 2016). Moreover, advancements in AI and machine learning are driving the development of intelligent transportation systems. These systems can analyze vast amounts of data to optimize routes, predict demand, and identify potential issues before they arise. Autonomous vehicles and electric buses are also emerging as sustainable solutions that further enhance the efficiency and environmental performance of public transportation systems (Ma, 2020).

In summary, the evolution of service design in public transportation has shifted from operational efficiency to a user-centric approach, influenced by various urban settings and cultural contexts. Technological advances have played a key role in supporting these developments, making work more manageable for workers and more efficient and reliable for users.

However, despite these advancements, research gaps remain. First, there is a lack of comparative studies on the impact of service design in public transportation systems across different urban settings. Existing research primarily focuses on single cities or specific regions without systematic comparisons across multiple cities. Second, there is also a need for more research on how service design can be effectively implemented in local public transportation systems. While some studies have explored the theoretical frameworks and general principles of service design, further empirical research and case studies are needed to understand how to tailor and implement these designs according to local needs, cultures, and environments. By addressing these research gaps, we can better guide the practice of public transportation service design, ensuring its effectiveness and sustainability across different urban and cultural contexts. This will not only enhance user experience and efficiency in public transportation systems but also promote broader social and environmental benefits.

3. Case Studies: Service design of Bus Transportation in Shanghai and Turin

Public transportation is a vital aspect of urban life, offering travel solutions that support economic activity, reduce traffic congestion, and promote sustainable development. Selecting Shanghai and Turin as case studies for analyzing public transportation service design allows us to explore how distinct urban environments shape and are shaped by innovative design strategies. These cities represent two contrasting contexts—Shanghai's rapid urban growth and Turin's balance of modernization and heritage—which offer valuable insights into the effectiveness of service design in addressing diverse urban challenges. Shanghai, as one of the largest and fastest-growing megacities globally, serves as a model for understanding the challenges and innovations required to manage high-volume public transportation systems in a dynamic and rapidly evolving urban context. In contrast, Turin, with its rich

industrial heritage, represents a European city navigating the complexities of modernization and sustainability. This juxtaposition provides a unique opportunity to examine how service design principles can be adapted to different scales, cultural contexts, and developmental stages. Several aspects of public transportation service design in these two cities are to be explored, specifically including their service blueprinting, real-time monitoring, passenger flow analysis, touchpoints, and cross-cultural characteristics.

Shanghai's public transportation system is highly developed with an extensive network of buses, subways, and ferries that serve over 24 million residents. The bus network is crucial for connecting the surrounding areas with the city center. It operates approximately 1,000 routes with over 17,000 buses (Shanghai Public Transport Group, 2020). This network complements the integrated subway system and helps to reduce road congestion. In contrast, Turin, with a population of about 900,000, has a much smaller but well-structured public transportation system. The city's bus network comprises around 100 routes and, though smaller in scale compared to Shanghai, it integrates fully with the tram and subway lines. This system emphasizes reliability and accessibility, striving to modernize public transportation to make it more appealing to residents (GTT - Gruppo Torinese Trasporti, 2019).

Aspect	Shanghai	Turin
City Population	Over 24 million residents	Approximately 900,000 residents
Public Transportation Modes	Buses, subways, ferries	Buses, trams, subways
Bus Network Size	Approximately 1,000 routes	Approximately 100 routes
Number of Buses	Over 17,000 buses	Around 1,000 buses
Integration with Other Systems	Complements integrated subway system, reduces congestion	Fully integrates with tram and subway lines

Figure1. Comparison of public transportation in Shanghai and Turin

3.1 Passenger Flow Analytics of Bus Transportation in Shanghai and Turin

Shanghai's public transportation system employs advanced passenger flow analytics to optimize bus operations. The city leverages a variety of data sources, including smart card transactions, GPS data, and passenger counting systems, to monitor and analyze passenger flow patterns. This data is integrated into the Suishenxing platform, which provides real-time information and supports dynamic scheduling and route adjustments. The platform aids in managing passenger loads and minimizing delays, thereby enhancing the efficiency and reliability of bus services (Shanghai.gov.cn, 2023). The analytics system in Shanghai is designed to capture the spatiotemporal dependencies of passenger flows across different bus lines. By using advanced models such as the Diffusion Convolution Recurrent Neural Network (DCRNN), the system can predict short-term passenger flow with high accuracy. This enables better resource allocation and service planning, ensuring that buses are dispatched based on real-time demand (Zhai & Shen, 2023).

Turin's public transportation system also utilizes sophisticated passenger flow analytics to enhance service design. The Gruppo Torinese Trasporti (GTT) integrates data from electronic ticketing systems, passenger surveys, and GPS tracking to analyze and predict passenger flow. This data-driven approach helps in optimizing bus frequencies, adjusting routes, and improving overall service reliability (Muoversi a Torino, 2023). Turin employs machine learning algorithms, including Extreme Gradient Boosting (XGBoost), to forecast passenger demand and adjust bus schedules accordingly. This approach not only improves the accuracy of predictions but also allows for more efficient use of resources by ensuring that buses are available where and when they are needed most (Lv et al., 2022).

In Shanghai, the implementation of passenger flow analysis has significantly improved the city's public transportation service design. With accurate forecasts of passenger demand, the system enables dynamic scheduling and route optimization, which reduces congestion and minimizes waiting times. This data-driven approach ensures efficient bus dispatching, thereby enhancing overall user experience and operational efficiency (Shanghai.gov.cn, 2023; Yin et al., 2022). The analysis system also supports strategic planning and policy-making by offering insights into travel patterns and passenger behavior. This helps urban planners and transportation management make informed decisions regarding infrastructure development and service improvements, ultimately creating a more resilient and adaptable public transportation system (Zhai & Shen, 2023).

In Turin, passenger flow analysis plays a crucial role in enhancing the efficiency and reliability of bus services. Predictive models enable GTT to adjust bus schedules in real-time, ensuring that services align with actual passenger demand. This reduces the

likelihood of overcrowding and increases service reliability, which is vital for maintaining high levels of passenger satisfaction (Muoversi a Torino, 2023). Turin's analysis system also promotes better resource management by optimizing bus frequency and routes based on demand patterns. This ensures that buses are deployed where they are most needed, improving the overall efficiency of the public transportation network. Additionally, insights gained from passenger flow data aid in the long-term planning and development of the transportation system, making it more responsive to the needs of the city's residents (Lv et al., 2022).

A comparative analysis of the passenger flow analysis systems in Shanghai and Turin reveals significant differences and similarities in how these cities leverage data to optimize public transportation services. Both cities employ advanced analytical technologies to monitor and predict passenger flow, which is vital for enhancing the efficiency, reliability, and user experience of their respective transportation systems. Shanghai's strategy is characterized by comprehensive integration and the use of advanced predictive models. The Suishenxing platform provides a holistic solution that encompasses various modes of transport and offers real-time updates, facilitating a seamless travel experience for users. The DCRNN model used in Shanghai enhances the accuracy of passenger flow predictions, which is crucial for managing the city's high commuter volumes. This data-driven approach enables dynamic scheduling and route optimization, reducing congestion and wait times, thereby improving overall operational efficiency and user satisfaction. Turin focuses on operational flexibility and efficient resource management. The city's real-time monitoring system allows for quick adjustments to bus schedules and routes based on real-time data, ensuring that services align with actual passenger demand. This flexibility helps maintain high levels of service reliability and passenger satisfaction, even with varying demand patterns. The use of predictive models like XGBoost, while slightly less accurate than Shanghai's DCRNN, still provides valuable insights that support effective resource allocation and service planning.

The comparison between Shanghai and Turin's passenger flow analysis systems highlights each city's unique challenges and priorities. Shanghai's approach is distinguished by its comprehensive integration and advanced predictive modeling, addressing the needs of a densely populated city with high passenger volumes. In contrast, Turin emphasizes operational flexibility and efficient resource management, catering to a city with diverse and fluctuating demand patterns. Both cities demonstrate how advanced analytical technologies can significantly enhance public transportation systems, improving efficiency, reliability, and overall user experience.

3.2 User Journey Map of Bus Transportation in Shanghai and Turin

In Shanghai, a passenger's bus journey begins by using mobile applications like "Shanghai Bus" to check bus routes and schedules. These digital touchpoints provide real-time bus locations, estimated arrival times, and traffic conditions. Although these apps are convenient and easy to use, passengers often face issues with inaccurate real-time information, leading to concerns about missing the bus. As passengers walk to the bus stop, they encounter physical touchpoints such as bus stop signs, which provide important information about routes and schedules. While waiting at the bus stop, passengers rely on electronic display screens to know the bus arrival times. Long waiting periods and sometimes unclear signage can cause anxiety during this stage. When boarding the bus, passengers interact with physical touchpoints like the bus front door and footboard. Passengers must swipe their bus cards on a card reader, but this process can sometimes fail, causing frustration. Once on board, passengers look for seats or handrails to ensure a comfortable journey. Overcrowding on buses can reduce comfort, highlighting the need for improved space management. During the ride, passengers use onboard displays and audio announcements to check station information. Ensuring they get off at the correct stop requires careful attention, and any malfunction in the display system can cause anxiety. After disembarking, passengers often use mobile applications or social media to review bus services and provide feedback for continuous improvement. However, inefficient feedback channels can lead to dissatisfaction. When planning their next trip, passengers need to check updated routes and schedules, hoping for more accurate real-time information.

stages	Pre-Trip			On-Board			Alighting		Post-Trip	
Timeline / features	Finding information	Walking to the bus stop	Waiting at the bus stop	Boarding	Tapping card	finding a seat or standing	checking information	Preparing to alight	Rating the bus service	preparing for the next trip
Behavior	Checking bus routes and schedules	Walking to the bus stop	Waiting at the bus stop	Boarding at the front door	Tapping card to purchase ticket	finding a seat or standing	checking the station	Preparing to alight	Participate in pilot runs and feedback sessions	Provide recommendations for continuous improvement
Touchpoints	Mobile apps (e.g., "Shanghai Bus" App)	bus stop signs	Bus stop signs, electronic displays	Bus front doors, step-on ramp	Bus card/phone, card reader	seats, handrails	bus road map, information notice	Bus back doors, bus stop	Mobile apps, social media	Mobile apps
Thoughts	Finding the quickest route	Ensuring arrival at the stop on time	Hoping the bus arrives soon	Getting on the bus safely	Ensuring payment	finding a comfortable place	ensuring alight at the right station	Smooth exit	Improving bus services	getting to the next destination
Emotions	Nervous	Anxious	Anxious	Careful	Relaxed or tense	Relaxed	Careful	Relaxed or hurried	Satisfied or dissatisfied	Careful
Pain Points	Inaccurate real-time bus information	the bus just left while waiting to cross the road	Long wait times, unclear sign information	High steps, crowded doorways	Unable to successfully pay or validate transit card through machine	Crowded bus with no seat	miss the station that plan to alight	far from the back door to alight, crowded doors	Inefficient feedback channels	In-time application is not accurate

Figure2. User journey map of passengers taking bus in Shanghai

In Turin, a passenger's journey on a bus typically begins with checking routes and schedules via the "GTT" app. This application, along with others like Moovit, provides highly accurate real-time information, alleviating the anxiety about bus arrival times. An additional step for passengers is purchasing tickets before their trip. Tickets can be bought through various means, including mobile apps and physical kiosks. Ensuring they have the correct ticket type and remembering to

carry it can cause confusion and anxiety. As passengers walk to the bus stop, they interact with bus stop signs similar to those in Shanghai. While waiting, they scan QR codes to receive real-time bus information and confirm arrival times. This digital interaction helps reduce anxiety but relies on the availability of smartphones and internet connectivity. In Turin, boarding may require extra interaction, such as signaling the driver if the bus does not stop automatically. Physical touchpoints like bus doors and ramps facilitate boarding. Once on board, passengers use ticket validators and look for seats or handrails. The well-maintained facilities usually ensure a comfortable ride. Passengers in Turin can also use stop request buttons to signal the driver when they wish to disembark. This interaction ensures timely stops but can occasionally malfunction or be misused. During the journey, passengers use onboard displays and audio announcements to monitor their trip and ensure they are alight at the correct stop. After disembarking, passengers often provide feedback on bus services through mobile apps and social media, similar to practices in Shanghai. Although these feedback channels can be inefficient, they are crucial for service improvements. Before planning the next trip, passengers recheck schedules and routes to ensure timely arrival.

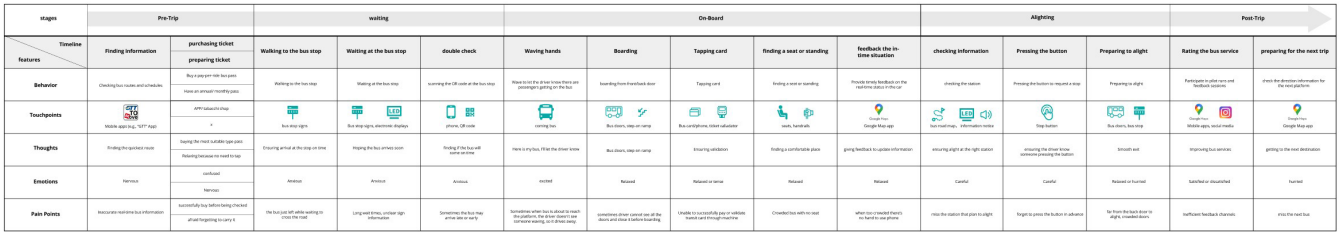

Figure 3. User journey map of passengers taking the bus in Turin

Similar to public transportation in other Europe cities, Turin's service design interventions focus on enhancing user experience through better route planning and real-time information systems. With the help of software to convey information more promptly and accurately to passengers and connect with instant public transportation information apps such as Google Maps, Turin provides accurate travel route planning and scheduling. Additionally, public transportation hardware facilities enable passengers to communicate stop information to drivers and other staff, reducing unnecessary stops and improving overall service efficiency.

Compared to Shanghai's fixed routes, Turin has introduced more flexible bus route schemes, such as setting AB routes in the same direction and differentiating stops for weekdays and weekends to meet varying passenger needs, especially during off-peak hours (Bartolini et al., 2017). These flexible route and schedule settings enhance service reliability and increase passenger satisfaction.

The comparison between the bus systems in Shanghai and Turin reveals different strategies in service design and user experience. Despite issues with accuracy, Shanghai passengers rely on digital

touchpoints for real-time information. On the other hand, Turin has invested significantly in technology to provide high-quality, modern facilities and ensure real-time information updates.

3.3 Real-time Monitoring of Bus Transportation in Shanghai and Turin

Shanghai employs a sophisticated real-time monitoring system integrated with its extensive public transportation network, which includes buses, metros, ferries, and bike-sharing services. The core of this system is the Suishenxing app, developed by the Shanghai Mobility Service Technology Company. This app provides comprehensive real-time updates and services, such as public transportation schedules, taxi hailing, smart parking, and payment options through Alipay or WeChat Pay (Shanghai.gov.cn, 2023). Supporting over 1,560 bus lines and 20 metro lines, the app offers a seamless travel experience by consolidating various transportation modes into a single platform (Shanghai Municipal Transportation Commission, 2022). The real-time monitoring system in Shanghai is designed to enhance operational efficiency and passenger convenience. It provides realtime data on bus and metro locations, arrival times, and service updates through electronic displays at stations and within vehicles, as well as through the Suishenxing app. This system helps manage the city's vast transportation network by enabling dynamic scheduling and rapid response to service disruptions (Shanghai.gov.cn, 2023).

Turin's public transportation system also features a robust real-time monitoring system that utilizes GPS technology to track buses and trams. Managed by Gruppo Torinese Trasporti (GTT), this system provides real-time updates through mobile applications and digital displays at bus and tram stops. Passengers can scan QR codes at bus stops to access real-time arrival information, facilitating journey planning without relying solely on mobile apps (Muoversi a Torino, 2023). The real-time monitoring system in Turin enhances the passenger experience by ensuring accurate and timely information on bus and tram arrivals. It helps reduce waiting times and improves overall service reliability. Additionally, onboard electronic displays provide real-time updates on current and next stops, including whether the bus or tram will stop, which is particularly useful for passengers unfamiliar with the route (Muoversi a Torino, 2023).

In Shanghai, the real-time monitoring system plays a crucial role in optimizing the public transportation network. By providing real-time data, the system can better manage passenger flow and minimize delays. This results in more reliable and efficient services, which is essential for a city with such a high daily commuting volume. The integration of various transportation modes into a single platform via the Suishenxing app offers a unified solution for all public transportation needs, enhancing the user experience (Shanghai.gov.cn, 2023; Xu & Zhao, 2020). The system also supports data-driven decision-making in urban

transportation planning. By analyzing travel patterns and passenger behavior, the city can make informed adjustments to routes and schedules, improving service coverage and efficiency (Shanghai Municipal Transportation Commission, 2022).

Turin's real-time monitoring system improves public transportation service design by enhancing transparency and communication with passengers. Accessing real-time information through QR codes and mobile applications ensures that passengers can make informed travel decisions, reducing uncertainty and waiting times. This contributes to a more user-friendly and reliable public transportation system (Muoversi a Torino, 2023). Additionally, the real-time monitoring system allows for dynamic adjustments to bus and tram schedules based on real-time data, increasing operational efficiency. This flexibility helps address service disruptions promptly and maintain high service reliability. Detailed onboard displays further assist passengers by providing clear and timely information about their journey, enhancing overall satisfaction (Muoversi a Torino, 2023).

3.4 Touchpoints of Bus Transportation in Shanghai and Turin

Shanghai and Turin's public transportation systems exhibit significant differences in touchpoints, reflecting their unique approaches to addressing city-specific challenges. A comprehensive touchpoint analysis reveals these differences, focusing on passengers' digital and physical interactions throughout their journey from platform to onboard experience and back to platform.

In Shanghai, digital touchpoints like mobile applications and real-time information systems are crucial. Major applications such as "Shanghai Bus" App, Gaode Map, and Baidu Map provide route maps, real-time bus locations, estimated arrival times, and traffic conditions. These applications are widely accessible, catering to the high smartphone penetration among Shanghai residents. However, the accuracy of the provided information can sometimes be lacking, with occasional delays in data updates reducing user trust. Electronic display screens at bus stops complement these digital systems by providing real-time updates on upcoming buses and expected arrival times. While these screens are common in major areas, they are less prevalent in remote regions, limiting their utility for all passengers. In contrast, Turin's digital touchpoints are characterized by high accuracy and user trust. Primary applications, such as the "GTT" app, supported by auxiliary apps like Moovit, offer highly accurate real-time bus locations, route maps, and arrival times. These systems are known for frequent updates, providing reliable information that enhances user experience. Additionally, Turin has implemented QR codes at bus stops, allowing passengers to quickly scan for real-time information and records of this bus station. This innovative approach ensures passengers can instantly access essential information, though it requires a smartphone and internet connection.

Shanghai's physical touchpoints include well-distributed bus stops equipped with shelters, seating, and electronic display screens. These stops provide essential information such as bus arrival times, route maps, and public announcements. Despite the extensive network, some remote stops have outdated facilities that need better maintenance. Shanghai buses are equipped with well-arranged seating, handrails, onboard display screens, and audio broadcast systems that effectively convey route information and the next stop.

However, during peak hours, buses can become overly crowded, reducing passenger comfort. Turin's physical touchpoints are marked by modern, well-maintained facilities. Bus stops are equipped with comfortable seating, high-quality shelters, and electronic display screens that provide detailed bus information and public notices. The high standards of these facilities significantly enhance passenger comfort and satisfaction. Turin buses feature seats in different orientations and sizes and clear display screens that provide timely updates on routes and the next stop. Additionally, buses are equipped with multiple stop buttons for passengers to request stops conveniently. While this system is efficient, it requires ongoing maintenance to prevent malfunctions or accidental activations.



Bus stop | Bus stop sign | QR code | Stop request button

Figure 4. Touchpoints in the process of taking bus in Turin

This comparative touchpoint analysis highlights the distinct strategies employed by Shanghai and Turin in designing and managing their public transportation systems, tailored to meet the specific needs and challenges of their urban environments.

3.5 Differences in Service Design Interventions

The comparative analysis of bus transportation service design in Shanghai and Turin highlights significant differences in how each city addresses its unique public transportation challenges through innovative service design interventions. The study identifies several key aspects:

1. Stop Request Systems: Turin's buses are equipped with stop request buttons that allow buses to bypass stops if no passengers need to disembark, which saves time and improves efficiency. In contrast, Shanghai's buses stop at every designated stop, potentially leading to longer travel times and reduced operational efficiency (GTT, 2023; Shanghai Municipal Transportation Commission, 2022).

2. Bus Configuration and Accessibility: Turin's buses feature multiple-door entry and exit options, which reduces the walking distance within the bus and enhances passenger convenience. Shanghai's buses typically require passengers to board through the front door and exit through the rear door, which can increase walking distance and inconvenience passengers (GTT, 2023; Shanghai Public Transportation Group, 2020).

3. Real-Time Information Accessibility: Turin provides real-time bus arrival information through QR codes at bus stops, which is particularly useful for passengers without access to mobile applications. Shanghai also offers real-time updates via mobile apps and electronic displays, but the addition of QR codes could further enhance accessibility (GTT, 2023; Shanghai Municipal Transportation Commission, 2022).

4. Onboard Displays: Turin's buses feature electronic displays that provide real-time updates on the current and next stops, including whether the bus will stop. This helps passengers unfamiliar with the route to stay informed. Shanghai's buses also have electronic displays, but Turin's system offers more detailed and user-friendly information (GTT, 2023; Shanghai Public Transportation Group, 2020).

As is discussed, the case studies of Shanghai and Turin illustrate how different service design interventions can significantly impact public transport systems. These insights highlight the importance of tailoring service design to local conditions and needs. However, we need to more systematically study how successful interventions in one city can be adapted and applied to another, as understanding and discovering cross-cultural applicability can help establish broader application scenarios, thereby leading to more effective and sustainable public transport systems around the world.

4. Discussions

Based on the differentiated perspectives of these two cities, the following discussion will delve into the specific impacts of these service design strategies, structured around four key criteria: operational efficiency,

user satisfaction and engagement, cultural adaptation, and the challenges and opportunities within diverse city contexts.

4.1 Impact of service design on operational efficiency.

The implementation of service design methodologies has significantly affected the operational efficiency of public transportation systems in both Shanghai and Turin. In Shanghai, the integration of real-time monitoring and passenger flow analytics through the Suishenxing platform has optimized bus operations by enabling dynamic scheduling and reducing idle times. The use of advanced predictive models like the Diffusion Convolution Recurrent Neural Network (DCRNN) has enhanced the accuracy of passenger demand forecasts, leading to more efficient bus dispatching and resource allocation (Zhai & Shen, 2023).

In Turin, the use of stop request buttons and multiple entry/exit doors has streamlined bus operations, reduced unnecessary stops and improved passenger flow within the vehicles. This has led to shorter travel times and increased operational efficiency. Additionally, the implementation of real-time information systems, including QR codes and onboard displays, has enabled more flexible and responsive service adjustments, further enhancing operational performance (Muoversi a Torino, 2023).

Overall, both cities have demonstrated that thoughtful service design can lead to significant improvements in the efficiency of public transportation systems by optimizing resource use and reducing operational delays.

4.2 Impact on user satisfaction and engagement

User satisfaction and engagement have also been positively impacted by the service design interventions in both cities. In Shanghai, the Suishenxing platform provides comprehensive real-time updates and multiple payment options, which have enhanced the convenience and reliability of the public transportation system. The integration of different modes of transport into a single platform has simplified the user experience, leading to higher levels of satisfaction and increased usage (Shanghai.gov.cn, 2023).
Turin's focus on user-friendly features, such as multiple door access and real-time information through QR codes and displays, has similarly improved passenger satisfaction. These features make the system more accessible and reduce the physical and informational barriers to using public transportation. The positive feedback from users indicates that these design elements have successfully increased engagement and loyalty to the public transit system (Muoversi a Torino, 2023).
By addressing the specific needs and preferences of users through targeted service design interventions, both cities have managed to create a more user-centric public transportation system that encourages greater use and satisfaction.

4.3 Cross-cultural features and service Adaptation of Bus transportation in Shanghai and Turin

Shanghai is a rapidly developing megacity with a public transportation system designed to handle a large number of passengers efficiently. This system prioritizes extensive coverage and frequent service to meet the diverse needs of its users (Shanghai Municipal Transportation Commission, 2022). Reflecting the city's swift modernization and technological advancements, Shanghai's public transportation system places a high value on efficiency and scale. In contrast, Turin's public transportation system balances modern demands with the city's historical context. The overall aim is to integrate public transportation into the urban structure sustainably and conveniently, emphasizing quality of life and user experience (GTT - Gruppo Torinese Trasporti, 2019).

In Shanghai, the public transportation system enhances efficiency by integrating technology, such as applications providing comprehensive traffic information and payment options in multiple languages to cater to both local and international users (Shanghai Government Website, 2023). Interventions include multilingual information systems and services tailored to the needs of international tourists and expatriates. These measures make the bus system more accessible to non-Chinese speakers, enhancing overall service inclusivity (Xu et al., 2020).

Turin's service system focuses more on passenger convenience, including multiple entrances and features like QR codes for real-time information. These adjustments consider local passengers' cultural and behavioral patterns, thereby improving the overall user experience (Muoversi a Torino, 2023). Turin has also implemented cross-cultural features similar to those in Shanghai, such as multilingual information and training staff to assist foreign passengers. These efforts ensure the public transportation system is welcoming and user-friendly for all passengers, including tourists and international residents (Bartolini et al., 2017).

Cultural differences play a significant role in shaping the service design strategies of Shanghai and Turin. Shanghai, as a rapidly growing megacity, prioritizes efficiency and technological integration to manage its large and diverse population. The use of advanced technology and comprehensive data analytics reflects the city's focus on innovation and high-capacity solutions (Shanghai Municipal Transportation Commission, 2022). In contrast, Turin's service design is influenced by its historical and cultural context, which emphasizes accessibility, user-friendliness, and flexibility. The city's approach to service design includes features that cater to the specific needs of its residents, such as stop request buttons and multiple entry/exit doors, which enhance the overall user experience in a culturally appropriate manner (Muoversi a Torino, 2023). Both cities have successfully adapted their service design strategies to align with their unique cultural and urban contexts,

demonstrating the importance of cultural adaptation in the implementation of effective public transportation solutions.

In summary, the comparative analysis of bus service design in Shanghai and Turin reveals how local contexts and cultural differences influence public transportation systems. Both cities have implemented service design interventions tailored to their unique needs and challenges. Shanghai's approach focuses on managing its vast, densely populated urban environment through advanced technological solutions and extensive real-time monitoring. Conversely, Turin emphasizes accessibility, reliability, and cultural integration, reflecting its smaller size and historical context.

4.4 Challenges and opportunities of service design in diverse urban contexts

Implementing service design in diverse urban contexts presents both challenges and opportunities. In Shanghai, the main challenges include managing the sheer volume of passengers and the complexity of integrating multiple transportation modes. However, these challenges also present opportunities to leverage advanced technologies and data analytics to create innovative solutions that can be scaled to other megacities facing similar issues (Yin et al., 2022). Turin faces challenges related to balancing modern service design with its historical infrastructure and catering to a smaller, yet diverse, population. Opportunities here lie in the potential to innovate within a more flexible framework, allowing for the testing and refinement of user-centric design features that can enhance the overall public transportation experience (Lv et al., 2022). Both cities illustrate that while the specific challenges of service design may vary, the fundamental principles of user-centric and datadriven approaches remain crucial for developing effective and sustainable public transportation systems.

The case studies of Shanghai and Turin provide valuable insights into the role of service design in enhancing public transportation systems. These findings have several implications for public transportation policy and practice. First of all, integration of advanced technologies such as leveraging real-time monitoring and predictive analytics can significantly improve operational efficiency and user satisfaction. Secondly, user-centered Design to meet the specific needs and preferences of local populations is vital to enhance user engagement and satisfaction. Thirdly, successful service design requires understanding and integrating cultural differences to create solutions that are both effective and acceptable to the local context. Moreover, developing scalable solutions that can be adapted to different urban contexts is crucial for addressing the diverse challenges faced by global cities.

5. Conclusion

This study highlights the significant impact of service design on the operational efficiency and user satisfaction of public transportation systems in Shanghai and Turin. By integrating advanced technologies and adopting user-centric design principles, both cities have managed to produce more efficient and reliable public transportation networks. The findings are expected to contribute to transportation system with an analysis of the importance of cultural adaptation and the potential of data-driven approaches in service design.

Service design has the potential to transform urban public transportation systems with more efficient, user-friendly, and adaptable transit networks. The experiences of Shanghai and Turin illustrate that thoughtful design interventions can address specific urban challenges and enhance overall service quality. Future research should focus on the scalability of these solutions to other urban contexts and the possible long-term impacts of service design on public transportation patterns. By means of constantly innovative and adaptive service designs, cities around the world can draw on each other and develop public transportation systems to not only meet the current needs of the residents but also to anticipate and respond to future challenges.

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COLLABORATIVE DESIGN EXPLORATIONS WITH AUGMENTED REALITY

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ABSTRACT | Immersive technologies for augmented reality allow interaction with virtual or digital objects, which appear in the operator's vision, and with which they interact through electronic equipment that can be controlled both gesturally and vocally by the user; This capacity for interaction makes it suitable for the practice of formal and functional design of models at any scale. This work explored the use of augmented reality in collaborative design exercises, starting with ideation until reaching the physical and digital prototyping of the model. Exploratory in nature, with contemporary design, the work was developed with the participation of students from the schools of Architecture and Habitat Sciences, and Art and Design, at the University of Monterrey, in Mexico. It was carried out in two phases: a first stage of exploration of collaborative design mediated with augmented reality, in the Experimental Study course, for the formal creation of a three-dimensional object with use and feasibility of seating, designed in an interdisciplinary manner, applying the Bottom-up methodology, using the Rhinoceros software with the Fologram plugins; In the second stage, alternatives were studied for the physical materialization of the object, through digital printing and the development of proposals, with the premises being: detailing the modeled three-dimensional explorations; evaluate and select the proposal to be physically developed; adapt the geometries of the chosen object to improve its formal characteristics, dimensions, and ergonomic stability; as well as carrying out 3D printing tests on a scale of the model to contrast the digital model with the physical one. The entire process concluded with proposing a prototyping system for constructing the object. The results demonstrate that augmented immersive technologies motivate the involvement of students in the creative process, due to their innovative nature, in addition to allowing them to organize their participation and performance in the design phases. The immersion in mixed scenarios made it possible to align the exercise with the interdisciplinary approach and explore new frontiers of digital design for its conceptualization, and modeling.

KEYWORDS | AUGMENTED REALITY, COLLABORATIVE DESIGN, DIGITAL MANUFACTURING, DIGITAL MODEL, PROTOTYPING.

1. Introduction

The study of function and space, just like its representation, is one of the purposes of design, which, as a discipline, allows students to develop spatial-logic skills through technical expression, with which they can observe, comprehend, and communicate figures in the geometric space, through concepts, abstractions, and approximations.

However, said observation or study requires practice and training, mostly in the early stages of any undergraduate-level professional career in technical and creative design, for which it is necessary to be able to comprehend and imagine objects in two and three dimensions, which after a tedious process transforms into the fabrication of products, tangible volumes, materialized through inventiveness and creativity.

The technical study of design therefore adds to the creative process with the conditions necessary for the representation and the visualization of the figures, relying on different projection systems, which, as methods, provide a standardization of steps to reach the result or product.

In the specific case of creative careers, the subject of design becomes even more relevant, since each construction process goes through representation and visualization, through flat and orthogonal forms, to generate views that constitute the communication of essential parts of the object to be built.

Moreover, as a professional discipline, design relies on geometry for the technical study of form and space, which is applied not only to the structure but also to the calculation of materials, the estimate of the area, and the physical volume of what is built, as well as to the development of graphic thinking, as a professional competence.

However, according to the works of Mataix et al. (2015), Gómez (2019), and Suter (2020), one of the greatest weaknesses of students the moment they begin their professional studies on design is precisely the lack of spatial practice on shapes, to the learning of their articulation or variation, to which is also related to underdevelopment in other areas such as mathematics, physics, and drawing.

It is therefore necessary to strengthen the study of design during the first semesters of professional study, since, as a creative exercise, it allows students to acquire and train spatial-logic skills on which the career is based as a technical and constructive practice of form and space and its habitable and functional elements. In addition, it allows the development of visual graphic understanding, through which design ideas are communicated, and systematized in a project.

For this reason, the design technique is constituted as the starting point for the development of the student's visual and graphic thinking during their first semester of a creative career, because through analogical practices of representation and visualization, they understand and apply concepts of the discipline, such as form, space, volume, scale, and proportion, to mention a few.

The design student is generally introduced gradually to digital tools for visualization, representation, and project management after having previously developed logical-spatial skills that allow them to understand the architectural object in its primary dimensions of form, space, and function.

Therefore, three-dimensional design is the basis on which the application of technology is based during the practical learning process, thus completing the range of possibilities to be used in professional design work, a process generally achieved through vectorized drawings, renders, digital modeling, and simulation exercises among others, which are means or channels of communication used to design, manage, and make functional objects.

Doing, and much more, learning design as a professional craft in all its areas, goes through the practice of modeling and the application of digital software, which according to the authors Jin-Kook et al. (2023) not only permeates the projective work but more so influences the designer's thinking itself.

Therefore, this research focused on the incorporation of immersive technologies into the study of creative design, since this is the appropriate scenario to develop visual graphic thinking and spatiallogic skills in first-year students in the career of professional studies, through practical exercises that introduce them to the subject of planes and volumes as spatial elements.

Adding on, the technological component as a pedagogical tool, valid for the introduction to the processes of digitalization and modeling that arise from the study of forms in space, as a documented design craft, and communicated in physical and digital pieces such as plans, digital models, renders, and simulations.

Digital design, therefore, as a technical area of professionalization reinforces graphic thinking, strengthens, and trains the development of spatial skills, and constitutes a transversal component in design courses and workshops, where the students form criteria and foundations to propose feasible solutions.

Although the concept of digital design is broad, this study explores it with two emphases, the first from the immersive through simulation technologies of mixed and combined realities, and the second from the digital modeling as an object of study, which evolves and is transformed into an image with operational feasibility of the design.

1.1 Augmented reality applied to design.

Immersive technologies are becoming a real instrumental challenge for the development of design, not only because of the procedural processes of creation or rendering of images or videos but also because they lead the professional discipline to unexplored frontiers. This is one of the motivations of the work presented by Bernasconi et al. (2023), which is a literature review of the scientific production on the subject because of the post-COVID-19 scenarios.

In the paper, the authors state that virtual, augmented, mixed, and augmented realities are an effective opportunity for architectural design since they allow overcoming physical spatial barriers, bringing experimentation into simulated scenarios, generated by the ubiquity in the use of the immersion of these tools. However, they point out that in this process the human experience must prevail, that is, the consideration of the user as the recipient of the design and the creative effort.

An example of such practice is the design proposal applied by Jin-Kook et al. (2023) using immersive technologies, including augmented reality, for 360° interactive experiences. The work consisted of the interior design of the hall of an existing library, which was adapted and renovated, to be toured and digitally validated by users. The conclusions allowed us to verify the effective use of these technologies, especially in the visualization approach, ensuring a high sense of realism and immersion using lights, shadows, textures, and materials in the design of the simulated reality.

Dan et al. (2021) will also test augmented and mixed realities for design, doing an in situ practice, where the user is placed in the real context and through immersive technologies tests the various design options; their work stands out not only for considering such technology as a useful tool but for associating it with the operational and participatory design of the user as the recipient, who finds in the immersive experience the opportunity to become more actively involved in the design and the solution.

A particular feature of the use of these technologies in creative processes is that they are not applied alone but are generally accompanied by other visualization processes related to modeling and rendering, which turns the experience into a true ecosystem of digital tools and techniques at the service of design.

1.2 . Collaborative design mediated by immersive technologies.

Collaborative design is the process characterized by the participation of various agents who contribute their points of view, criteria, and options on the design solution generated. It is based on teamwork, synergy and communication of all the members involved that guarantee the collegial experience of integrating the opinions of many in a single proposal.

As a projective strategy, collaborative design is often associated with participatory design, as the idea of consulting and integrating the creative process, the generation of ideas and the technical solution, the inclusion of various actors ranging from users, recipients, interdisciplinary technicians, and design professionals in a positive environment for the creation of an orchestrated solution. As mentioned above, the key points of the process are integration, good team communication, active participation of all members, and the organization of the work by stages to make the process more efficient. That is why the collaborative design process is associated with the Bottom-up design methodology, which consists of an emergent solution based on a reaction, where the key is in the integration proposal.

Collaborative design is also associated with interdisciplinarity because if what is addressed is the complexity of design as a solution to an emerging event, the participation and involvement of the participants are an essential task to detect the causes and consequences that have generated such a situation that must be responded from the technical and professional design.

An example of this is the work developed by Belaroussi et al. (2023) on participatory and collaborative design with a focus on urban issues, where virtual reality technologies were used to consult experts and residents on neighborhood design, through the modeling of emblematic places in the neighborhood, which could be toured and evaluated based on the design solutions applied in each of them. The experience is interesting because it considers as a key element of the design process, the active participation of various members who were involved in the design process through virtuality.

In the same way, the work of Han et al. (2023) applied immersive technologies as a mediator of collaborative experiences for design, by experimenting with an algorithmic design that relates the interactivity of the person with the computer, reacting to visual stimuli related to cultural design in urban and architectural spaces. Although their proposal is entirely technical, they apply virtual reality focusing on the possibilities of integration that this allows in a modeled and simulated scenario, which can be accessed through input and output devices, sensitive to movement and sound.

Although the work focuses on explaining the algorithmic design of the platform in which the layout of the simulation experience has been designed, its direct users used immersive Ness to validate its operation

It can be understood that the application of immersive technologies in the collaborative design process is useful because it ensures effective understanding and therefore, the successful participation and integration of members with the same purpose of validating and providing timely design solutions and consequently close to the sensitivities of users who in most cases, are the recipients of the same creative effort.

1.3 . Augmented reality in learning design.

The use of new digital design tools has given rise to an enthusiastic impulse in the application of emerging technologies in teaching and collaborative learning processes, which has led to immediate references when it comes to courses related to the operative practice of design; such is the case of augmented reality, a technology characterized by relating virtualization with the physical environment, through the use of electronic instruments that generate a relative immersion of the operator.

Collaborative design learning is understood as when the emerging solution does not come from the inventiveness of a single person but from the synergy and communication of the team working on the same model, which, in the specific context of augmented reality, allows the visualization of several participants in a synchronous and real way simultaneously.

Augmented reality is a digital immersion alternative, which combines “digital information and physical information in real-time through different devices” (Cabrero et al., p. 10, 2022) these react to the user’s indications that operate them through gestures, movements, and sounds, with which it is possible to experience and interact with physical and digital elements at the same time, finding in it, the main difference in regards to virtual reality, which generates the total isolation of the subject in a digitally simulated world.

It is also worth noting that both technologies share three fundamental aspects: immersion, navigation, and interaction. Fernández & Ampuero (2020) define augmented reality as a “media scenography that combines physical and digital information in real-time, through the use of different technological devices... such as computers with webcams, tablets, video cameras, smartphones, video game consoles with cameras”, among others (p. 30).

Therefore, the diversity of its use and application is not only referred to the image or the development of immersive content, but rather to the equipment that is used for the experience (Navarro et al., 2018), this becomes by the user’s indication activators, to see and do, transform, and compose, physical and digital realities in the same plane of vision.

Augmented reality, although it maintains the potentiality of the subject in a visible physical place, involves all the senses in

the experience, as it considers sight for interaction with digital forms, sound for navigation and control of the equipment, as well as touch for immersion in digital reality and kinesthetic movements for the activation of commands.

However, the referred works emphasize the use of immersive tools as a proposal for design validation and even as a strategy for user participation, so for this research, we began with the following question: How does one start a design exercise from the immersion of augmented reality?

Can the design go through the path of immersion and then move on to the technical specificity of the object to be manufactured?

This work validated the hypothesis of using augmented reality as a starting point for the design of a three-dimensional object as a conceptual reference to be developed in a more specific phase, applying the bottom-up methodology and collaborative design, as an academic experience.

2. Methodology

The exploratory research was based on the general objective of exploring the use of augmented reality in collaborative design exercises, starting with the ideation until reaching the physical and digital prototype of the model. The specific objectives were to test the use of augmented reality for three-dimensional design through the bottom-up methodology. Systematize the design process from the digital immersion to the use approach of the designed object. Establish the design stages of an object created digitally its prototype as a model for its implementation.

The work was carried out in two stages: a first phase during the first half of 2023, applying an open and self-directed collection instrument, which gathered the opinions of the informants in terms of strengths, opportunities, weaknesses, and threats (SWOT) considered in the first stage of the process to adapt this technology to the design.

The second stage dealt with the indicative and characteristic design and the testing of the digital and physical object, carried out in the first half of 2024. It is worth adding that the work is part of a research project still under development, to deepen the study and application of immersive technologies in design.

The designers who served as informants in the first stage were 16 students from the schools of Architecture and Habitat Sciences (EACH) and Art and Design (EAD), of the University of Monterrey (UDEM), who took the subject Experimental Study, Common Core for the eight careers of the schools: Architecture, Interior Design, Industrial Design, Energy and Sustainable Innovation, Graphic Design, Arts, Fashion and Textile Design, and Digital Animation. Hence, the interdisciplinary nature of the exercise approached the implementation; the sample is classified as non-probabilistic, self-directed, with mixed and homogeneous characteristics.

For the second stage, a design team composed of two students from the same School of Architecture oversaw materializing and operationalizing the selected proposals. This second team also has expertise in digital fabrication, parametric and digital design.

The analysis of the qualitative information from both stages was done through the design of matrices, which organized the comments by categories that were then coded and grouped, adding a description, and the frequency of repetition of the theme, for a more detailed explanation according to the findings.

3. Procedure

The first phase of ideation and design was applied in two three-hour sessions, with the basic goal of organizing four interdisciplinary teams, who, collaboratively, had to design an object with eight volumes (holograms), previously configured. Although they shared the same virtual model, each participant visualized the shapes in their environment, being able to observe in real-time the changes suggested by the other participants and verify the work during the grouping of the holograms.

The glasses used were the HoloLens 2, which has a resolution of 2k 3:2, a density of more than 2.5k radians, 4 visible 1080p cameras, and a microphone with built-in speakers, sensitive to human vocalization. The software applied for the modeling and grouping of the shapes was Rhinoceros 7.0 with the Fologram plugin, accessed by scanning a QR code.

At the end of the exercise, the instrument was applied to the participants for feedback and reflection. The starting point was to identify the categories of the four aspects of SWOT to evaluate the instructional design of the augmented reality sessions. Thus, the comments were grouped to obtain the highest frequency of thematic repetition and, therefore, like each other.

The second stage started with the review of the models made, to evaluate the proposal that was best adapted to 3D printing and digital fabrication, ensuring its design quality in terms of construction and ergonomics, since the proposals dealt with the design of a functional seat for two or three people.

This phase took approximately 4 months, which not only represented the study of the form but also the due bibliographic review, the establishment of the design criteria, the evaluation and selection of the proposal, as well as the development of the creative operability of the design in terms of its approach, to move from the digital model or mock-up to an understandable object with a defined use, concerning the human scale and some daily activity.

The entire work process can be summarized in the following steps:

Stage 1. Conceptualization and invention.

1. Initiation phase, selection of volumes: In which 6 volumes characterized by their transformations and extrusions were identified as solids that could be added to assemble a free composition, without any indication of their own, only the proximity between their contours, edges, and profiles.

2. Instructions on exercises and technology: design teams were configured, and instructions and training were given on the use of augmented reality technology, HoloLens handling, and Rhino-accessible commands from Fologram. This stage was of utmost importance since in many cases it was the students' first approach to immersive technologies.

3. Three-dimensional explorations: The four three-dimensional approximations were carried out using the bottom-up methodology, whereby aggregation of components, and parts were incorporated into the model, following the coordination and communication of the team members in real-time. The typology to be designed and the use to be made of it were decided synchronously, having only the premise of grouping components in the digital scenario with the mediation of augmented reality and the physical context.

Stage 2. Design and operationalization.

4. Proposal selection: The 4 proposals generated in stage one was studied to find the most appropriate model to continue development. In which the adaptations would be minor, the morphological proposals of the object could be maintained, and the design proposal initiated would be operationalized. The purpose of the evaluation was not to reject any of the proposals, but to select the most appropriate one to continue the process. For this purpose, a matrix of criteria with three values was established: 1 for the highest, 0 for neutral, and -1 for the lowest.

5. Adequacy of the geometries of the selected proposal: Having selected the model with the highest valuation, the geometries of the model were adapted. This work was performed with the Rhinoceros 7.0 desktop application. Various commands were applied. In addition, the Grasshopper algorithm described in the tutorial 'Parametric Bench' (Rhino Grasshopper, 2020) was used.

6. Digital model proposals: At the center of the whole process is the digital model, since it is the effective means that translates the designed object, this, although initiated from augmented reality, is reinterpreted to convert into a three-dimensional object that can approach a suitable effective use.

The diagram below will serve as a map to indicate the stages and steps of each of the design stages, and the most important aspects or criteria to be considered at each of the moments described in the process are also indicated.

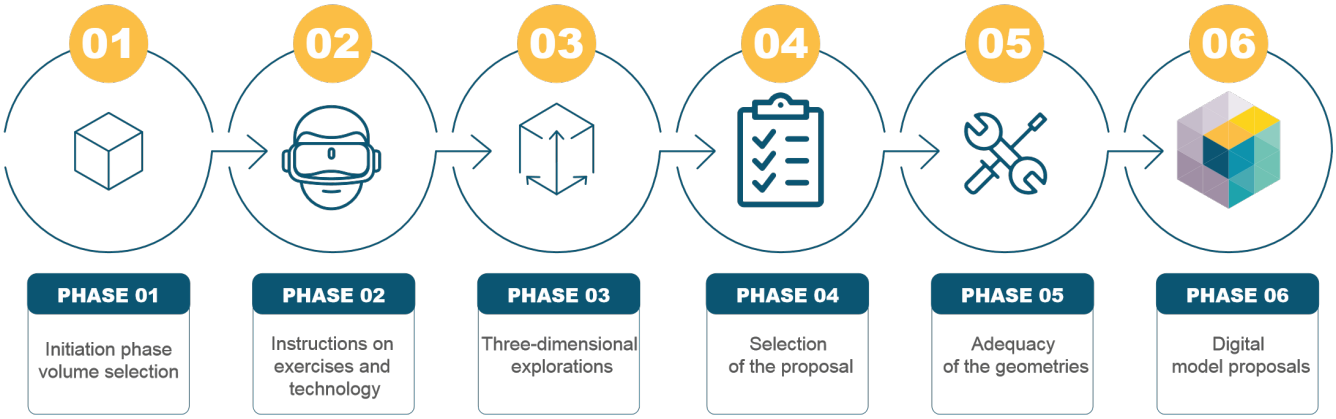

Figure 1. Stages of the design process. The process establishes the phases of exercise preparation, technological training, and experimentation in the modeling process. The sequence generated was not determined until after the experience so in a way it also reflects the bottom-up methodology applied.

4. RESULTS AND DISCUSSION

To better organize the results, they are organized following the same sequence of activities described in the previous section, because, although the process was carried out comprehensively and uninterruptedly, the proposed classification and organization emerged after the practical study and applicability of these technologies.

4.1 . Stage 1. About augmented realities in the design process.

The possibility of teamwork in real time was one of the strengths pointed out in the first stage, highlighting the interdisciplinary sense, since the augmented reality tool used allowed group work on the same model. The model can be modified and revised immediately by all members, thus requiring coordination, communication, and collaborative work skills. The value of the tool also appears in this section due to its innovative nature in the teaching and learning process, since in most cases, it was the first time that they faced the use of augmented reality with a pedagogical sense for design.

Regarding the weaknesses, the informants pointed out the need to have previous practices or training to become familiar with the software and the handling of the commands, because, although the temporality of the exercise was positively valued, minimum training is required to adapt to the equipment and to adapt to the gestures that allow the relationship with the holograms in the physical world. Linked to the issue of temporality, the need for intermediate breaks during the development of the sessions was identified.

On the other hand, the opportunities focused on the usability of the software and the technical failures of the equipment to calibrate concerning the eyesight of each user, since, in some cases, it required constant verification by the operator; this suggests reviewing the possibility of using other applications that allow precision commands and greater versatility for the movement of the holograms. Concerning threats, the informants referred to the generation of discomfort and dizziness after several hours of use with the equipment, for which reason they pointed out the need to incorporate intermediate breaks.

4.2 . Stage 2. Operational design process considerations.

Among the weaknesses of the first stage in terms of design, was the limitation of the software used for precision scale commands or grouping of components, as the relationships of faces between volumes were not neat and, in many cases, clumsy or inaccurate.

It must be considered that in the work plane of augmented reality and possibly due to the same relative immersion of the technology, the relationship with the design object is merely visual, the scale and approach that the designer has with the volumes is through holograms and hence the difficulty of their grouping or coupling, since no physical or digital reference was used in this regard.

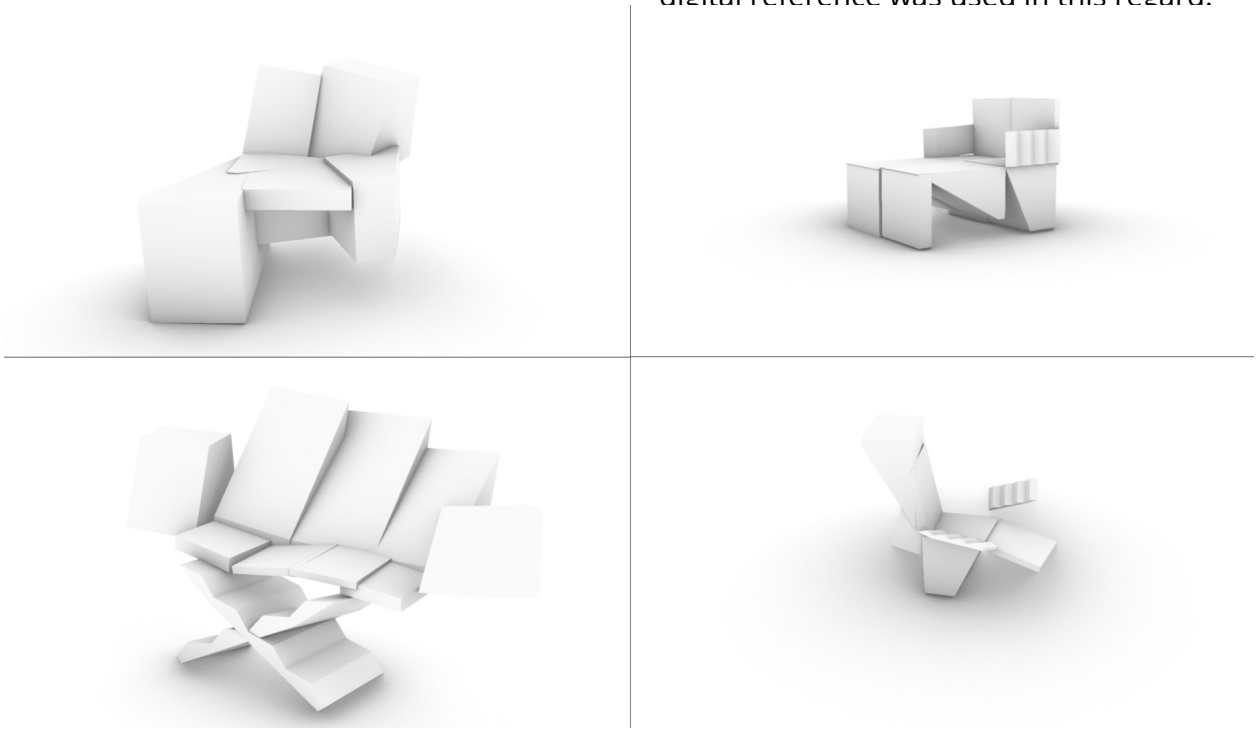

Figure 2. Models generated in augmented reality. The graph reflects the experimentation by the team, the association of shapes, and the design solutions generated, which in this case were associated with using a chair or seat for several people. Again, the theme was deliberate and was only determined by the grouping of components, a determining aspect of the bottom-up methodology.

So, looking at the result, it is natural that the next design stage of shape adaptation consisted precisely of simplifying the morphology, adapting the contours, and scaling the elements to be sure which would be the elements to be considered in the next phase of design and prototyping of the object.

The next step consisted of rethinking the object by interpreting the design criteria proposed in the original model based on the following considerations:

· Maintain the style of the morphology considering the inclinations or angles of the break of the forms.

· Adjust the proposal while maintaining the capacity of the scale according to the ergonomics of the number of people to be served with the designed bench object. In this aspect it was very important to understand the programmatic comfort proposal of the measures in the design, having as key points the minimums provided by Neufert (2013).

· Differentiate between two bodies or elements of the composition: the first supporting elements that will serve as the base or support or structure of the object, and the supported elements that are composed of seats, railings, and backrest of the bench. This classification of differentiation also allows us to make material associations, not only in terms of the logic of the design but also in terms of its actual approach as an object of operational use.

· To achieve a better and more orderly staggering of the proposed forms, it was decided to apply an algorithmic code that would give more order to the proposal. This was a deliberate decision and, although not raised at the beginning, the parametric allows to establish a better systematization of the exploded view, to then develop the proposal for the materialization or manufacture of the object.

· One of the fundamental premises of the whole design process was to maintain the digital character, that is, all approaches should be mediated with digital technologies, although starting with augmented reality, the experience proved that the complementarity of desktop design applications was necessary for the modeling of the forms. Because of the immersion, it was almost impossible to correct the imprecision of contours and couplings of the composition.

Therefore, a series of steps were established to work directly in the design software, to reinterpret the digital model according to the indicated criteria:

· Studies of the shapes of the selected proposal, for the interpretation of these using lines that can be drawn and expanded.

· Simplification of the curves of the model involved adapting the geometries, adapting the joints and the relationship

of the components, and establishing radii, diameters, and sections by the correct proportion and the mathematical relationship between them.

· Working with the modeling from contours, the subject of edges, and the profile, was fundamental for the understanding of the parts and the possible rhythms of variation to be considered.

· From the curves and lines, generate surfaces, and operating planes that configure the components or parts of the bench.

· The extrusion of parts or surfaces, as volumes, considering the thickness associated with the materiality to the physical proposal that later would be worked from the render as a possibility of expression and communication of the modeled object.

· Subdivision of the module, or surface.

· Inclusion of parametric algorithmic code for the subdivision of the parts or components.

· Solution of fixation or union of the parts or components, using the proposal of a tubular linear element that unites, supports, and articulates all the pieces, grouped integrally, and that, in some way, would give body to the volumetric composition.

· Solution of the base using the handling of lines or extrusion, repeating the previous points.

· Generation of the final digital model.

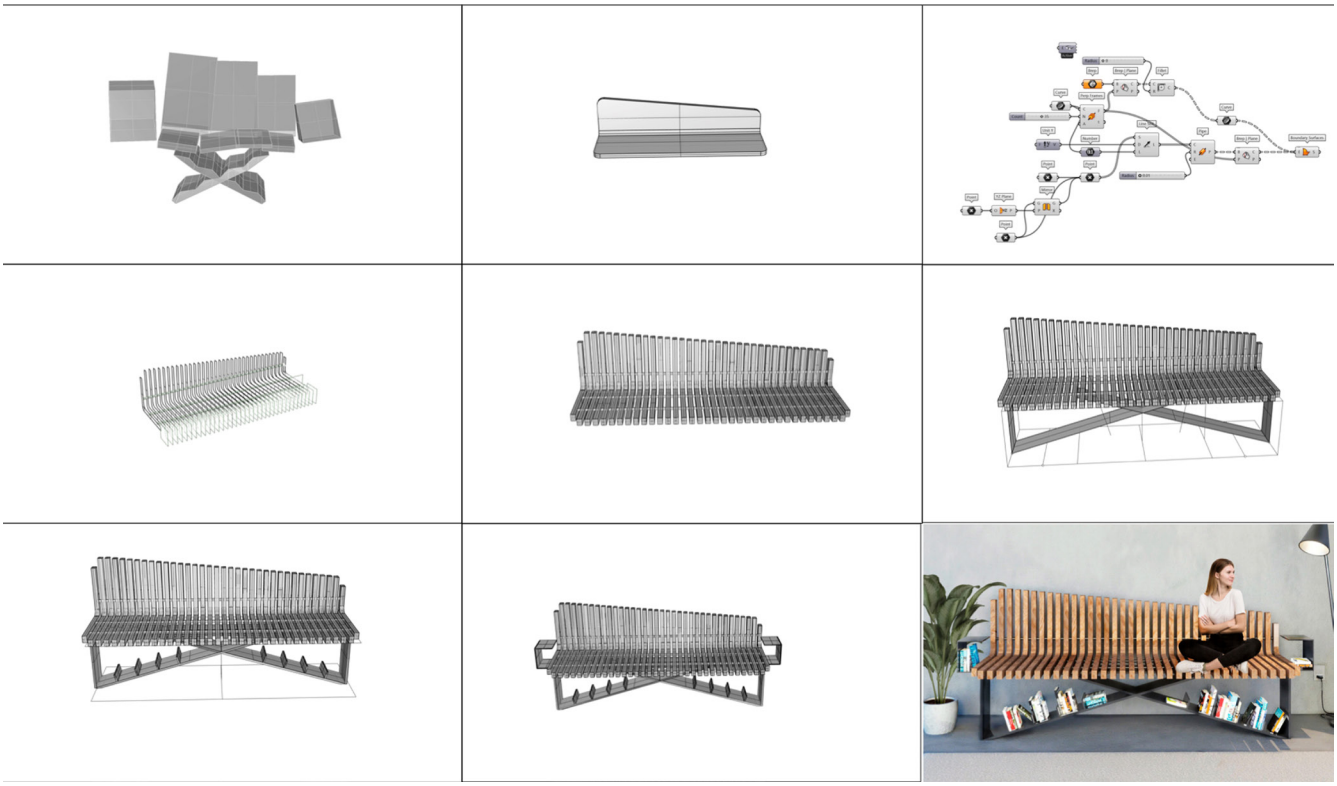

Figure 3. Modeling process. The process of moving from the original model modeled using augmented reality to the final object required adapting the geometries and applying various processes in the software used, as shown in the graphic.

As the process included the modeling and rendering part, as continuous stages of the

Finally, the proposal was modeled by making design approximations using rendering, assigning textures, lights, and materials, and recreating a scene of its use to determine the efficiency of the design, so that an accurate path can be established from the generation of ideas to the concentration of a three-dimensional object of use, based on the applicability of technology and the exploration of various design criteria.

same integrated activity synthesized in the modeling, other software for image management was incorporated to generate maps, textures, colors, materials, lights, and shadows to give realism to the achieved proposal.

For image processing, commands associated with the Twinmotion, and Photoshop software were included, especially for scene editing, the study of lights and shadows, the generation of a realistic illustration of the context of use, and the typology of the designed object, about the human scale.

Conclusions

Based on these results, two priority actions are established for the use of augmented reality in interdisciplinary exercises; the first one refers to correcting weaknesses in terms of opportunities, or in other words, to study the possibility of alternating software and/or applications, as well as technological equipment that allows a more efficient training in terms of the best, establishing stages in the instructional design, before, during and after each session.

The second action to be developed aims at correcting the weaknesses to face the threats, oriented along the same lines as the previous one, since the instructional design should consider breaks and times of appropriation of the user's technology, ensuring their comfort to avoid fatigue and discomfort, which undermines the creative process.

It is also necessary to consider the relevance of the selection of the software to be used, since the versatility and usability of these conditions limit the expected scope, especially considering that any design must address the operability of its execution or manufacture, whether analog or digital, because that is where the greatest challenge for future experiences lies.

Although the multidisciplinary character was due more to the nature of the participants than to the product resulting from the process, it is of utmost importance to find spaces to work with the transversality and interdisciplinarity of design, this not only enriches the creative process but also develops and expands the practice of design beyond disciplines, to emerging solutions, where themes such as place, form, space, clear, empty, full, scales and proportions, are converging points of learning inclusion and not barriers of separation.

Regarding the model because of the project or as a product of the academic exercise developed from beginning to end in digital environments, and therefore new for those involved, some of them, it was the first time they approached such technologies, and in some cases, that they applied them for pedagogical purposes concerning design,

which was worth as a point of honor and distinction of the exercise itself.

Although the work presents the process in an almost linear schematic manner, the process was certainly much more complex and required constant revision of the models for their interpretation and adaptation. Design decisions were based on the proactivity allowed by the technologies and modeling, rather than on the ergonomics of the object for use and relationship with the person, which after all should be the immediate reference to serve. In this case, it only became part of the final phase of adaptation of scales, sizes, and proportions.

This first exploration of design with augmented reality also shows that the key to the process lies in the relationship of various technologies around the digital model, which from the ideation became the protagonist of the process, the central axis on which commands and approximations were operated. Hence the prominence of this as a product and tangible digital object, a mediator between ideas and design.

It is also necessary to consider the relevance of the use of these technologies in academic environments since the study proved that immersive technologies and digitalization practices in design motivate the involvement of students, encourage them to explore new creative frontiers and encourage them to develop critical thinking about design mediated by technology.

The practical study of design as an exercise mediated by digitalization and specifically augmented reality as a scenario for the ideation and creation of digital forms and objects that can be associated with real uses validates the hypothesis put forward in the exploratory study because although the proposed objective was indeed achieved, it is necessary to go deeper into the use of technologies and design, especially to establish key and replicable methodologies that can be adapted by design teams at the professional level.

Therefore, the characteristic of experimenting with academic exercises, which although limited, brings students closer to new work methodologies, synchronous, virtual but with morpho-spatial aspects, is a challenge, not only because of the access or training necessary for the use of such technologies, but also because the idea of associating the exploration of virtuality to gamification or playful learning must be overcome, but rather, to digital design as a necessary and outstanding technical competence of the professional profile of the contemporary designer.

So, the path traced, starting with augmented reality, passing through digital modeling, and landing in a three-dimensional object with apparently real characteristics simulated with rendering, is an ideal example of how to incorporate technology in various moments of learning design, especially as a practical task and trade, which requires from the creative and instrumental point of view of various options to generate the best possible results.

Due to the nature of the bottom-up methodology, selected for academic purposes,

the digital model ended up opting for a three-dimensional object that could well be applied to the disciplines of industrial, interior, or architectural design, however, this is not a limitation, since other disciplines of the arts and design may well apply similar processes in their creative exercises to explore the use of such tools in the practice of design.

It is also worth adding the usefulness of immersive technologies as design tools for collaborative processes, since by their digital nature, the teams allow immediate interconnection for teamwork, the synchronization of modeling in real-time, and the intervention of the participating members on the object instantly so that what any member does on the model is instantly observed by the rest of the colleagues, which opens new possibilities of digital design, usually explored through the computer, but in this case, with augmented reality lenses a more decisive component is added.

This is one of the most decisive points of this work because participatory design was applied not from the user, but applied through augmented reality, for integrated processes of modeling and generation of formal design ideas instantly. Breaking with the linear or sequential inertia that characterizes collaborative processes, but rather experiencing instant integration for action, participation, modeling, and solution.

In addition, it is significant to associate the design methodology proposed through bottom-up, which although it is true is not exclusive or definitive concerning others, nevertheless, it worked satisfactorily in the exploratory exercise with students, considering their experience in digital design issues, and the little or no practice of using immersive technological equipment for learning design.

So, it is right to relate immersive technologies with design methodologies for the experimentation of forms since there are multiple options such as virtual, augmented, and mixed realities that allow such activity, and although this work was conducted for academic purposes of teaching and learning, students from various areas of professionalization gathered precisely to propose an integrated solution, they can well be applied in any design studio for the practicality of their results.

As lines or recommendations for future work are pending the exploration of manufacturing or fabrication for the materialization of objects, either with digital, analog, or hybrid procedures. Although the rendering offered an accurate approach in terms of materiality and scale, it will be necessary to develop a further stage of the process for the actual manufacture of the object and study aspects such as assemblies, supports, and finishes.

In addition, the augmented reality experience was limited to the visualization of objects for docking, but other strategies could be integrated to enrich the immersive experience, such as the use of sounds, smells, textures, or

light and shadow effects on the operator. This is a very interesting area to explore from a design and learning point of view.

Although, in this case, the digital premise supports the entire creative process, through the bottom-up methodology, the experience also showed that any digitization process must involve the real proximity of the manufacture of objects, and their physical materialization as a solution, so that the valuation of augmented reality, immersion, and digital models, go beyond the simple technological appreciation, as they are means and tools that should approach the operational reality of design. And it is at this point where the greatest frontier to be explored lies.

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BIOMATERIALS AND BIODESIGN TRANSFERRING KNOWLEDGE FROM ACADEMIA TO SECONDARY SCHOOLS

Susana Leonor, Carla Paoliello, Derya Irkdas Dogu, Onur Mengi, Américo Mateus, Anil Dinc Demirbilek, Gulizar Caliskan, David Palma and Deniz Deniz

ABSTRACT | Climate change poses a significant existential threat, challenging humanity and future generations. To address this, the EU aims to become the first climate-neutral continent (EU Green Deal), necessitating changes in both industry and education. Reskilling the workforce to build green skills is crucial, particularly in education, where integrating multidisciplinary knowledge and actionable skills is key to tackling climate change. This requires cross-sectional upskilling pathways in bio-based solutions.

This study focuses on transferring knowledge between Biomaterials and Biodesign Research Institutes and Design Educational Institutions. It emphasizes the need for practical and creative skills in addressing climate challenges, using microorganisms, bacteria, and fungi in material production as potential green solutions. The BiomaterialKIT project serves as a practical and pedagogical experiment aimed at promoting sustainable consumption. It explores various scholarly contexts and seeks to [1] improve consumer decision-making behaviors, [2] increase awareness of environmental impact and responsibility, and [3] foster innovation through better use of Biomaterials and their reintegration into the circular economy to mitigate climate change effects.

Employing participatory action research (PAR), participatory design, and co-creation processes, the project engages young citizens and their communities in sustainability practices. By integrating innovative methods and tools into school curricula, the project empowers students to become change agents within their families and communities. Conducted in Izmir and Portimão, this pilot study involved 200 K-12 to K-16 students, implementing sustainability principles and preparing them to influence future environmental practices.

KEYWORDS | BIOMATERIALS AND BIODESIGN LEARNING, SUSTAINABLE CONSUMPTION BEHAVIOR, PARTICIPATORY DESIGN, CO-DESIGN

1. Introduction

Climate change is one of the greatest existential threats to life on earth; this presents a considerable challenge to humanity and generations to come. Under this global threat, the EU aims to be the first climate-neutral continent on Earth (EU Green Deal). To achieve this goal, changes in industry and education need to transpire. To reach our climate targets, we must further educate, reskill the workforce, and build green skills, especially in education. We must address climate change as a complex societal challenge intertwining multidisciplinary knowledge and actionable skills.

The green transition is not just an option but a necessary response to an existential threat. The primary question is how to achieve it effectively. As climate change continues to accelerate, the urgency to adopt sustainable practices becomes more pronounced. This involves a comprehensive approach that integrates policy, technology, education, and community engagement. The design and implementation of education, in particular, can play a crucial role in shaping our capacity to tackle the social and economic challenges that will inevitably arise from this transition. By embedding sustainability into educational curricula, we can equip future generations with the knowledge and skills needed to drive and sustain green initiatives. The motivation for green action is also closely linked with the skills to implement changes, the tools to enable those actions, and, most importantly, creativity. Green solutions in Biomaterials and Biodesign are at the forefront of innovative responses to environmental challenges. These solutions involve creating materials that are not only sustainable but also biodegradable, reducing reliance on traditional, polluting materials like plastics. Harnessing living systems - such as microorganisms, bacteria, and fungi- for material production and design also hold significant potential such as mycelium based materials, which utilize the root structure of fungi, offer sustainable alternatives for packaging, building materials, textiles and even meat substitutes.

Green solutions also need to play a more prominent role in the European education system. This requires cross-sectional upskilling pathways towards the field of bio-based solutions. However, the green solutions in Biomaterials and Biodesign currently confined to university labs should be made accessible to a wider audience. This requires cross-sectional upskilling pathways towards the field of bio-based solutions to

bridge the gap between advanced research and everyday application. By enabling access to these practices, The BiomaterialKIT aims to contribute to the broader objectives of the EU Green Deal, thereby accelerating the adoption of sustainable behavior and awareness. Additionally, it provides training for innovation by encouraging the better use of Biomaterials and their reintegration into the circular economic cycle.

This comprehensive approach not only enhances understanding but also helps mitigate the effects of climate change by fostering sustainable practices and slowing down environmental degradation. For this reason, the project focuses on the transfer of knowledge between Biomaterials and Biodesign research institutes and design education institutions; and on the creation of innovation methods and tools to create awareness and support for schools, students and families to experiment using and creating with Biomaterials in their learning pathways.

1.1 Biodesign Learning: An Innovative Educational Approach

Biodesign learning integrates principles of biology with engineering and design, enabling students to create sustainable solutions. This educational approach is mainly rooted in interdisciplinary learning, where students are encouraged to explore the intersections between science, technology, engineering, art and mathematics (STEAM). Transferring knowledge between Biomaterials and Biodesign Research Institutes and Educational Institutions catalyzes innovation and value creation centered around sustainability to foster increased engagement particularly around younger generations. This involves creating educational programs that integrate biology, chemistry, enginering and design principles to equip sdents and professionals with the necessary knowledge and skills.

Considering the literature, Biodesign Learning (BDL) represents a new approach to education combining the principles of design thinking and bioscience to encourage innovation for the existing problems (Vygotsky,1978). To do that, Biodesign Learning aims to understand the problems by focusing on the biomimetic solutions inspired from nature and applying them for creative design processes via knowledge through experience for sustainable education (Benyus,1997). In addition, Biodesign learning mainly focuses on users' needs and expectations (Brown,2008) and aims to create a correlation between nature and design thinking for innovative solutions to the possible problems (Chappell, et.al.,2023). In this respect, Gopnik et al. (1999) demonstrates how Biodesign principles can create learning environments and encourage students to focus on real-world problems through biological point of views.

Biodesign Learning not only creates a new way of understanding for students, but also reveals benefits for improving students' creativity (Asghar, et al.,2012). Although Biodesign Learning is crucial for developing an environmental point of view for the existing problems, there are some obstacles which need to be considered. There is an urgent need for educators who are both capable in

biology as well as design principles and able to implement those changes into education (Myers et al.,2014). To fill this vital gap and beat these obstacles, BDL practices must be adapted to traditional educational settings urgently.

In this context, the importance and components of Biodesign Education can mainly be divided into subcategories, such as “Enhanced Problem-Solving and Collaborative Skills, Sustainability Awareness, and Interdisciplinary Learning”. BDE is crucial for integrating biological insights and design processes to encourage students to tackle everyday problems. This approach helps to enhance students’ ability to think wider and solve problems innovatively. Developing collaborative skills for better results also help students to learn how to work effectively in teams. This integration improves students’ understanding among various fields and applies them to real-world challenges (Pieters, et.al.,2019).

Educational innovations in Biodesign are crucial to transform the way students engage with biological and design principles. Improving sustainability awareness helps to focus on ‘Biomimicry’ and sustainable design which allow students to develop environmentally friendly design solutions (Benyus, 2002). Design thinking educators can create dynamic and interdisciplinary learning experiences by integrating biomimicry into their creative problemsolving processes.

Biodesign Education presents a forward-thinking approach to learn from the interaction of biological insights and design thinking to develop problem-solving skills through
interdisciplinary learning and awareness for sustainability. In this respect, integrating Biodesign into Science, Technology, Engineering, Arts, and Mathematics (STEAM) to combine biology with design thinking to create interdisciplinary learning experiences is inevitable to tackle with the obstacles in Biodesign Education (Bergmann & Sams, 2012). Developing online platforms as well as virtual labs to facilitate collaboration among students and educators are also crucial for enabling students to work together on innovative solutions (Välk et al., 2022). In this case, finding well-trained educators to deliver Biodesign effectively and integrating the changes to the current curriculum are the main problems (Biomimicry Institute, 2021) as implementing innovations requires significant resources (Ferruzca et al., 2022). Consequently, scaling Biodesign education to a wider range of educational institutions is inevitable for sustainable solutions.

1.2 BiomaterialKIT approach

The BiomaterialKIT – is a practical and pedagogical experiment for more sustainable consumption, fostering collaboration between universities, K-12 to K-16 schools and communities through training modules, workshops and hands-on projects that emphasize Biodesign practices. It aims to explore different scholarly contexts and introduce:

- better behaviors in consumer decision-making;

- awareness of individual and collective responsibility in the environmental impact,
- training for innovation through better use of Biomaterials and their reintegration into the circular economic cycle, to enhance and slow down the climate change effects.

Co-creation, Co-design and Co-innovation

The project focused on Biomaterials and Biodesign education, aiming to engage young citizens and the broader community in a participatory process to co-create improved physical, social, and economic solutions. Through the use of Biomaterials, this project sought to foster greater consumer awareness and enrich community life. Co-creation, in this context, involved cultivating a participatory, open-minded, and collaborative culture, which formed the foundation of co-innovation. These co-innovation layers were crucial to the success of co-design and community practice approaches.

Integrating a profound co-design culture into education (Scornavacco et al., 2021) was central to this project, addressing critical issues for comprehensive community development towards sustainability. This grounded culture of co-creation (Adamson & Davis, 2017) and co-design (Antonini, 2021) inherently encompassed ethics, shared experiences, human relationships, and the ways in which individuals interacted within a creative environment. It involved processes, codes, symbols, behavioral patterns, language, and customs, ultimately reflecting the BiomaterialKIT project's values, visions, environments, beliefs, and habits.

Education, families, and public spaces were emphasized as essential mediating environments for co-creation, fostering the convergence of experiences that could drive transformative changes in sustainable consumption and behavior within the community, families, and schools in the short to medium term.

Cultural drivers

The BiomaterialKIT project engaged with the societal, cultural, and economic differences between Portugal and Turkey, particularly through the lenses of co-creation and participatory culture. By recognizing and addressing these differences, the project aimed to foster a more inclusive and collaborative environment. The project's focus on Biomaterials and Biodesign education served as a medium to bridge the diverse cultural contexts of both countries, promoting an exchange of ideas and practices that enriched the learning and development processes. The participatory approach was crucial in ensuring that the project's initiatives were relevant and beneficial to both Portuguese and Turkish communities.

The Biomaterialkit research project focuses on the development of four primary tangible products:

- the BiomaterialKIT Manual, a pedagogical resource designed to support secondary school educators in introducing Biomaterials and Biodesign projects into their curricula;
- the MobileLAB, a mobile unit equipped with tools and equipment necessary for the inclass preparation of Biomaterials;
- the Community Building Intervention,

which involves the participatory co-creation of an urban Biomaterials-based sculpture;

· the BiomaterialKIT manuals for Families, a comprehensive guide offering recipes and instructions for conducting Biomaterials experiments at home.

2. Methodology

The research promotes awareness and support for schools to use innovative methods and tools to experience Biomaterials in their learning pathways. Introducing new competencies to the youngsters.

The methodological approach settles on participatory action research (PAR), participatory design, and co-creation processes to generate a commitment to the young citizens are the main actors of change with a higher impact on their communities and the future.

2.1 Overall Biomaterialkit process framework for green skills development

Reskilling for green skills and the potential of bio-based solutions.
The research promotes awareness and support for schools to use innovative methods and tools to experience Biomaterials in their learning pathways. Introducing new competencies to the youngsters makes them the influencers of change in their families and friends and acts as a culture of change agents. The Biomaterialkit process flowchart delineates a systematic approach for the development and deployment of Biomaterials through a structured fourphase methodology, based on Divergence, Convergence and Action from the Design Thinking processes (Mateus et al, 2016) see Figure 1.

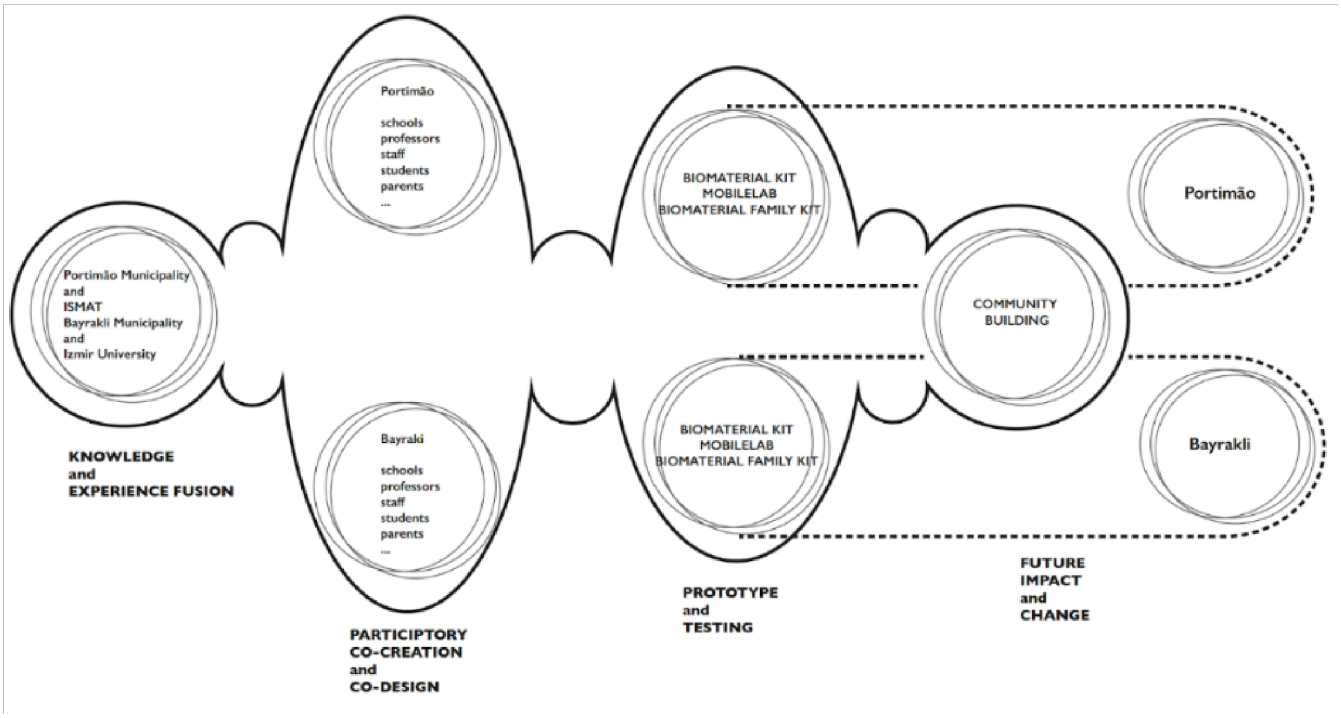


Figure 1. Knowledge flow chart of BiomaterialKIT framework.

Phase 1: Converge

The Knowledge and Experience Fusion framework, conceived by university researchers of the project, underpins the development of tools specifically designed for participatory processes within the BiomaterialKit initiative. These tools were designed to collect and facilitate insights from both the student and teaching communities regarding the development of the BiomaterialKit Manual and MobileLAB. Additionally, they were intended to coordinate community-building events aimed at promoting transformative change. Prior to the development of these tools, a sustainable awareness survey was administered to over 200 students to gauge their consumption habits and their understanding of sustainability and Biodesign. The findings from this survey were instrumental in informing the creation of targeted tools and activities for the subsequent bootcamp sessions, ensuring that the interventions were grounded in empirical data and aligned with the participants' needs and knowledge base.

Phase 2: Diverge - Converge

The participatory co-creation and co-design process encompassed a series of week-long boot camps held with secondary schools in Portimão (PT) and Bayrakli (TR). These multi-stakeholder sessions focused on the introduction of core concepts related to sustainable consumption through co-design methodologies and scenario development. The bootcamps began with an overview of these concepts, underscoring their relevance within sustainable frameworks (Diverge). Following this, students participated in group activities aimed at assessing their current understanding and assumptions about sustainable practices, and at developing actionable strategies for their practical implementation (Converge).

Phase 3: Diverge - Converge

Building upon the findings from the previous phase and the established framework for change, participants engaged in co-design activities to generate a range of potential solutions (Diverge) aimed at addressing the identified needs and innovation opportunities. This phase involved the development of design templates and content for the pedagogical school manual, the familybased recipes manual, and the school's forthcoming MobileLAB. Subsequently, stakeholders were responsible for prototyping the most promising ideas within their groups and presenting these prototypes to one another for evaluation (Converge). The most viable ideas were selected through a voting process involving students and teachers. These selected concepts were then utilized by the final design team, which comprised Biomaterialkit researchers, students from the Design degree at ISMAT, and Master's students from Izmir University.

Phase 4: Action

This phase aims to foster community awareness and drive impactful change among the project's target groups—students, teachers, families, and the broader community. In October 2024, all stakeholders will collaborate to co-create, co-design, and co-implement a communitybuilding sculpture and an urban public space in Portimão and Bayrakli. The sculpture will be constructed using Biomaterials produced in the Schools' MobileLAB and recipes from the families' home manuals. Each municipality has selected a public space for intervention, where a basic structure designed by the Biomaterials research team will be implemented, incorporating the Biomaterials created by the educational community and families. This initiative seeks to promote the project's values and objectives, highlighting it as a transformative community event aimed at encouraging better consumption behaviors and fostering more circular use of organic waste, which are foundational principles of the Biomaterialkit project.

In summary, the process methodology is designed to enhance the skills of the educational community—including students, teachers, staff, families, and friends—in developing green skills. This approach is grounded in an innovative adaptation of Design Thinking processes and methods, which are presented in detail subsequently.

2.2 Participatory Action Research (PAR) & Bootcamp Roadmap

Participatory Action Research (PAR) is a collaborative research approach that involves researchers and participants working together to identify a problem, collect and analyze data, and take action to address the problem (Chevalier & Buckles, 2019). PAR emphasizes the active involvement of community members by decentralizing the professionalized university-based knower in the research process (Fine & Torre, 2021), ensuring that their perspectives and experiences shape the research questions, methods, and outcomes. This approach is often used in social sciences, education, public health, and community development to empower participants, promote social change, and produce actionable knowledge. It also helps create an opportunity to create alternatives to education (Levin & Greenwood, 2008) by experimenting with pedagogy (Freire, 1970; Hooks, 1994).

Since the main aim of PAR is to transform society to be more democratic, equitable and just (Torre, Stoudt & Fox, 2012), the pilot study conducted for the BiomaterialKIT project encompasses over 200 K-12 to K16 students from educational institutions in two distinct cities: Izmir, Turkey, and Portimão, Portugal. This approach ensures that the target groups, embedded within their respective communities, have the potential to make substantial contributions to the project's objectives.

The project is designed to achieve six specific objectives:

- It aims to facilitate dialogue and the exchange of experiences between local stakeholders and between the two countries through the implementation of initiatives centered on Biomaterials and Biodesign.
- The project seeks to identify local natural resources to develop three deliverables for the Biomaterials KIT: a mobile school laboratory, a home toolkit experience manual for families, and a small-scale Biodesign project for the community.
- It will enhance educational skills and competencies by co-creating learning scenarios and experience manuals.
- The project will provide training for teachers, students, families, and the community on Biomaterials techniques and tools, promoting sustainable consumption practices.
- It aims to bridge the gap between schools and homes, fostering a deeper understanding of their roles in altering consumer behavior patterns, with an emphasis on the reuse of natural materials.
- The project intends to increase awareness and visibility of Biomaterials and Biodesign through community interventions and develop an action plan to integrate the Biomaterials KIT approach into the K12-K16 educational system.

Roadmap for Bootcamps

The roadmap for implementing Participatory Action Research (PAR) in the BiomaterialKIT project commences with the establishment of the project's objectives, which focus on advancing secondary education through the integration of cutting-edge knowledge in Biomaterials and Biodesign.

This roadmap spans a five-day period, with each day dedicated to specific thematic stages designed to promote sustainable practices, foster innovative learning, and facilitate hands-on experimentation among students. Each day is connected to a key research question:

- Day 1: Focuses on sustainable consumption habits, aiming to encourage students to recognize and adopt eco-friendly practices. Research question: "How to be Conscious?"
- Day 2: Examines the impact of ideas on behavioral changes. Research question: "How to Change?"
- Day 3: Introduces innovative learning scenarios to stimulate understanding and creativity. Research question: "How to Learn?"
- Day 4: Involves students in the development of Biomaterials manuals, applying theoretical knowledge to practical tasks. Research question: "How to Do?"

· Day 5: Centers on the conceptualization of a MobileLAB, where students experiment with and co-create tangible outputs. Research question: “How to Experiment?”

According to Bradley & et al (2023), the Design Thinking (DT) process must account for two distinct dimensions (see Figure 2):

· Horizontal Axis - Macro View: This dimension outlines the major sequential stages of the process that are anticipated to lead to the desired final outcome. It emphasizes the continuous and active involvement of students and all stakeholders throughout each phase.

· Vertical Axis - Micro View: This dimension details the various layers within each stage of the process, from Divergence to Convergence, to achieve consensus within each phase.

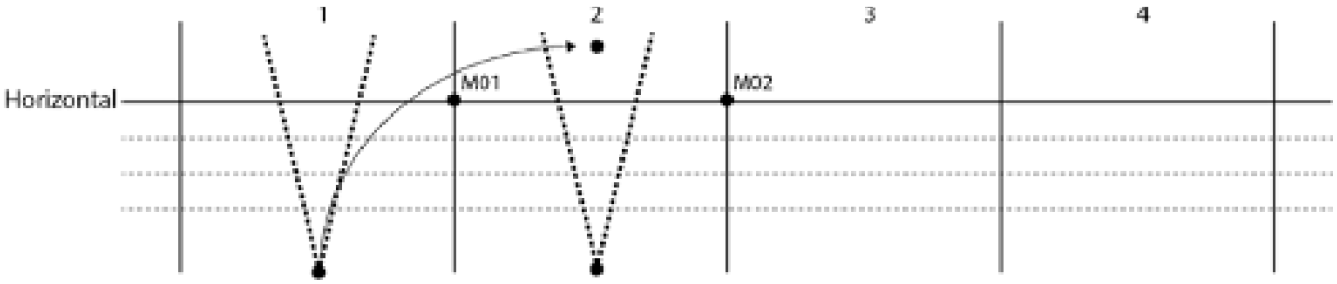


Figure 2. DT Process Macro & Micro Views, Bradley & et al (2023)

Based on the model outlined by Mateus (2016), the BiomaterialKIT program roadmap utilizes a variety of interactive and collaborative tools grounded in Design Thinking (DT) principles. These tools include mapping, ideation, co-creation and three-dimensional modeling, aimed at immersing students in experiential learning. The program incorporates dynamic group exercises, sensory experiences, and hands-on construction tasks, all designed to integrate academic knowledge with creative, real-world applications. The roadmap culminates in cross-fertilization sessions, during which groups consolidate and refine their ideas, present their outcomes, and link them to subsequent exercises to support continuous learning (see figure 3).

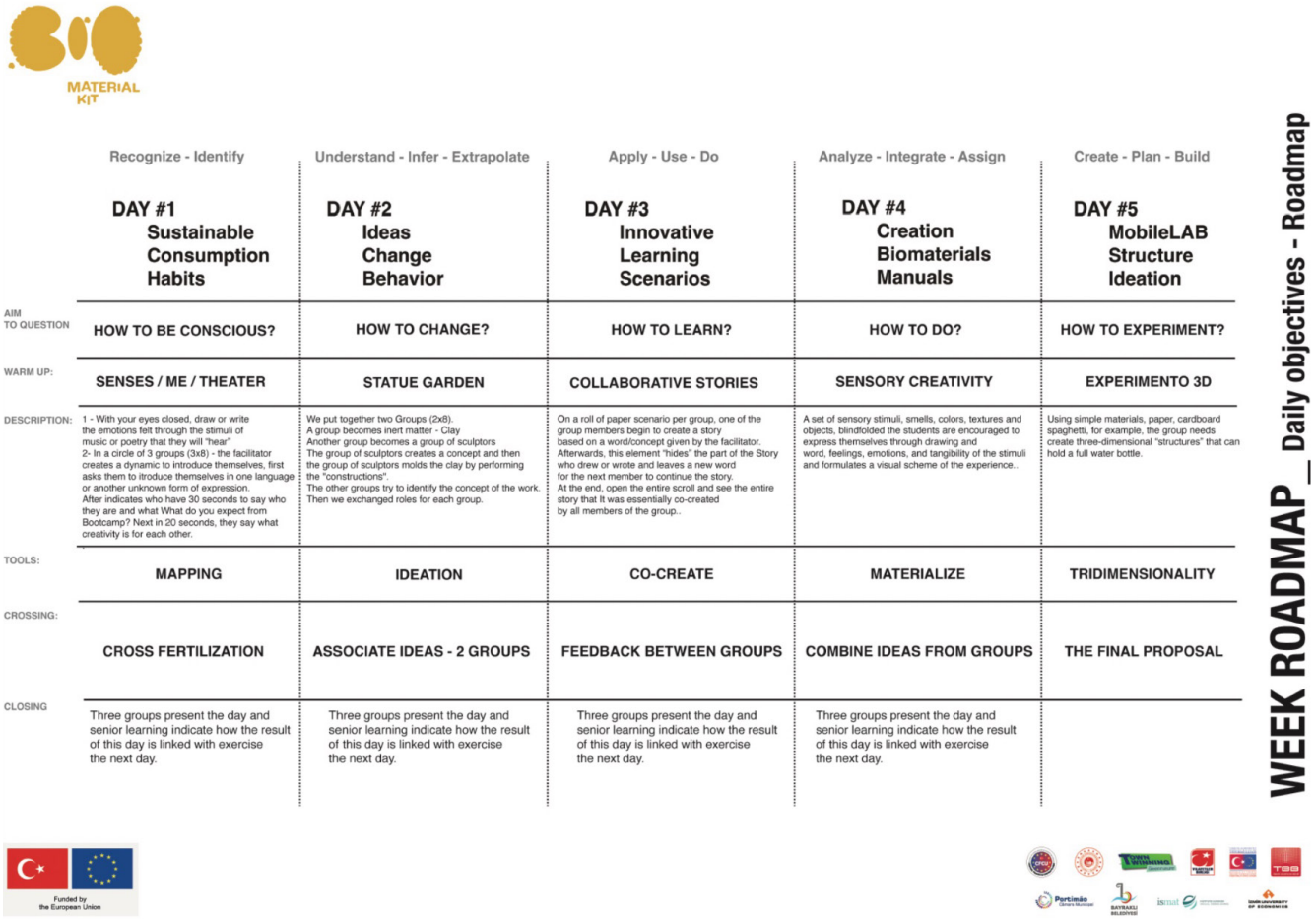


Figure 3. Road Map, the authors (2024)

Within the framework of the Roadmap, the Bootcamp workshop series employs four methodological tool canvases (see figure 4), developed in collaboration with universities and K12 to K16 students from Portimão and Bayrakli. The primary aim is to foster sustainable consumption behaviors among students through interactive and structured activities grounded in co-creation and co-design approaches.

The workshop begins with an introductory presentation that provides an overview of sustainable consumption and presents results from a prior survey. Following this introduction, the sequence of tools initiates group dynamics. Participants are organized into sub-groups of up to eight individuals each. Participants engage with the canvases to examine their knowledge, perceptions, and actions related to sustainability.

Inspirational letters, prepared by the research team, were placed on each work table. These letters presented content in a concise and highly visual manner, addressing the key issues that motivated each stage of the Design Thinking (DT) process. The content was curated to include best pedagogical practices, relevant case studies, exemplary consumption practices, and information on sustainable and circular products (see figure 5).

The workshop is structured around four comprehensive canvases that facilitate selfassessment, brainstorming, and scenario development:

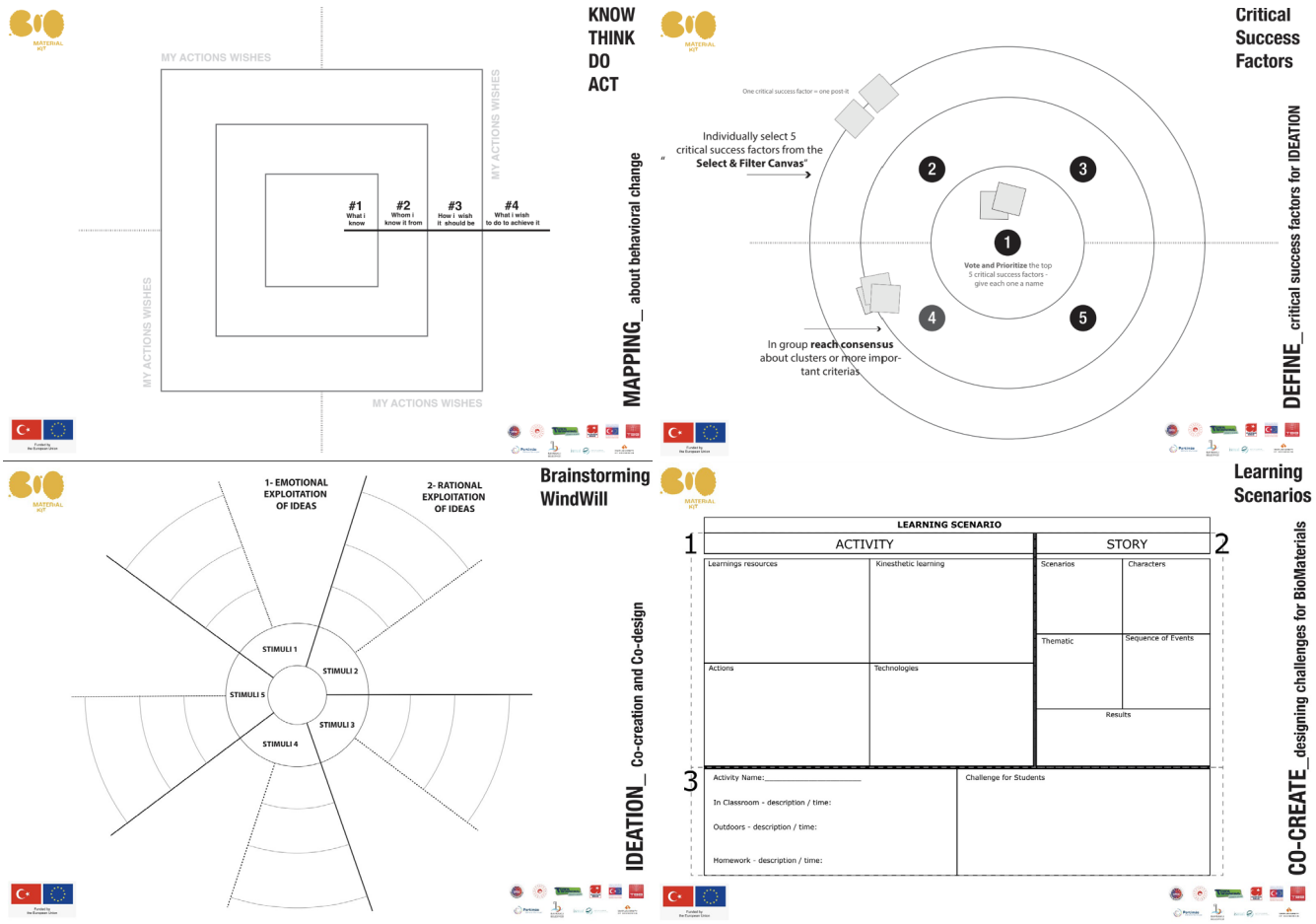
· Tool 01 - “I Know, I Think, I Do, I Act” canvas - encourages students to reflect on their understanding and practices concerning sustainability. Participants document their existing knowledge, identify their sources, describe their current actions, envision ideal scenarios, and brainstorm strategies to achieve these ideals.

· Tool 02 - “Key Success Factors for ‘Act’” canvas - extends the “Act” component of the first canvas. In this phase, students individually identify critical success factors necessary for achieving their sustainability goals and subsequently categorize these factors into thematic groups during a collaborative session. The group then prioritizes the top five critical success factors through a consensus-building process.

· Tool 03 - “Brainstorming Windmill” canvas - focuses on collaborative ideation. Students individually propose ideas to achieve the critical success factors identified in the second canvas. The group then selects and refines the best ideas into actionable steps through collective brainstorming.

· Tool 04 - “Learning Scenario I” canvas - involves creating a detailed learning scenario using the top ideas from the brainstorming session. Participants develop a narrative that includes characters, themes, and a sequence of events. They outline expected learning outcomes and describe activities for classroom, outdoor, and home settings, anticipating potential challenges and proposing solutions.

Figure 4. Methodological Canvases for Mapping tools (upper left), Definition (upper right), Brainstorming



Windmill (lower left) and Learning Scenario, the Authors (2024)

Figure 5. Inspirational Cards, Left side Bootcamp Portimão, Right side Bootcamp Izmir (2024)



2.3 Creativity: Bootcamp Co-design process

As previously mentioned, the co-design aspect aims to collaboratively develop three tangible deliverables for the BiomaterialKIT project: a pedagogical manual, a home manual for families, and a MobileLAB to equip schools. The creative process commenced in alignment with the Design Thinking (DT) approach described earlier, building on the results from prior stages, specifically addressing what needs to be changed, how it should be changed, and how students expressed a desire to learn about and utilize Biomaterials. This activity builds on the concept of design-build-test, a common paradigm for students to design an experiment (Pham et. al. 2017). It is important to note that the project design incorporated preparatory activities, wherein the project research teams visited schools in advance to introduce the project, discuss concepts of sustainability, circularity, and Biodesign, and conduct Biomaterials experiments.

Initially, students were tasked with divergent thinking, where each member of the subgroup sketched individual ideas to address the questions, problems, and innovation opportunities identified earlier. Following this individual phase, students presented their ideas to one another and engaged in a dialogue about the ideas, discussing their complementarities and evaluating their creative potential. Through this discussion, each group starts to converge by identifying two combined ideas to explore further as a team. These ideas were then prototyped and prepared for presentation to the larger group at the end of the session

The constraints and objectives for each creative challenge were outlined, with particular emphasis on the MobileLAB. This modular educational laboratory kit is designed to facilitate biomaterial explorations using basic lab tools and equipment. It is intended to be paired with food and domestic waste, as well as low-cost laboratory chemicals, to provide a comprehensive and accessible learning experience.

To address the challenges involved in co-designing the BiomaterialKIT manuals for both school and home environments, and to deepen students' understanding of the context, setting, and pedagogical models associated with Biomaterials and Biodesign, the co-design session began with a demonstration of Biomaterials. This interactive session enabled both students and teachers to engage directly with the process. A series of demonstrations was developed to facilitate creative learning activities, aimed at increasing student engagement and promoting independent, student-driven projects (see figure 6).

Co-design is a collaborative design thinking process that transcends one-directional

feedback, fostering active participation from all stakeholder groups to achieve mutual understanding and shared creativity (Eckhardt, 2021). In the BiomaterialKIT Bootcamp, the co-design process was focused on the students rather than the project itself. The research team acted primarily as facilitators, allowing shared creativity to develop organically among interdisciplinary student groups from diverse schools, age ranges, and areas of expertise. This approach was designed to enhance the creative experience and complementarity among participants, yielding outstanding results that are detailed in the following section.

Figure 6. Biomaterial explorations with paper waste (left & middle) and domestic waste (right).

Figure 7. MobileLAB Ideas from Bootcamp (left) and Biomaterials demonstration





3. Findings & Discussion

The BiomaterialKIT aligns with the goals of the European Union Green Deal, which seeks to make Europe the first climate-neutral continent by 2050. By educating and equipping the younger generation with the skills and knowledge needed for sustainable living, the BiomaterialKIT contributes to the broader objectives of the Green Deal. It empowers individuals and communities to participate actively in the green transition, thereby accelerating the adoption of sustainable solutions and fostering a more resilient and environmentally conscious society.

3.1 Bootcamp outcomes:

The training activities to introduce the pilot program for K-12 to K-16 students reached over 200 students, 50 teachers, more than 600 parents, NGOs, local associations, and municipality representatives. These training activities, along with the co-creation process, led to outcomes that ensure K-12 to K-16 students have the necessary information and awareness for sustainable development and lifestyles in harmony with nature. Through detailed coaching led by professional designers, academics, and school professors, students were introduced to the bio-design thinking process. This initiative also aimed to develop a framework for similar projects at both national and international levels.

The co-creation process further empowered student groups to refine their ideas into the most promising strategies. During this phase, students developed detailed learning scenarios based on these strategies, identifying both opportunities and challenges in achieving sustainable consumption objectives. These learning scenarios were subsequently utilized to develop the MobileLAB (see figure 8) and the BiomaterialKIT pedagogical exploration at the secondary school level. Incorporating the students' co-designed final ideas, these scenarios were transformed into Biomaterial Recipe Cards (see Figure 9).



Figure 8. Bootcamp ideas for the MobileLAN (left) Final design MobileLAB (right)



Figure 9. Bootcamp Ideas for the School manual (left) and the final Biomaterials Cards (right)

3.2 Impact & Opportunities:

The impact of the project was based on the knowledge transferred from students to their wider circles and the integration of bio-based solutions to everyday life problems within educational curricula. This approach ensured that individuals had the relevant information and awareness for sustainable development and lifestyles in harmony with nature. The primary assumption was that visibility of these impacts, through learning about and understanding the use of Biomaterials and the power of bio-design as a powerful tool, would last a lifetime and provide students with skills they could leverage for personal use and future careers. The impact also aimed to enhance policy coherence for sustainable development.

The initial evaluation conducted with the participating school teachers was highly positive. In June 2024, students independently operated a biomaterial lab during their school's open days for the community. Additionally, the main topics learned from the research projects were applied by students at Bemposta School in Portimão to their real-life project, OUSAR, which focused on sustainability and innovative green development in urban areas.

We assume that through this experience, K-12 to K-16 students would continue to be motivated by the BiomaterialKIT and MobileLAB experiences, eventually joining societies, communities, and professional careers worldwide that seek equitable solutions through environmental consciousness. It is expected that the impact of the outcomes would have a lasting imprint on young people, helping them tackle social and environmental issues. Our broader aim was to create an international opportunity and expand the beneficiaries of the project beyond designers and professionals from two different countries, turning it into a compelling encounter and cross-cultural exchange, which was achieved.

4. Conclusion

The BiomaterialKIT project posited that implementing Biomaterials and the BiomaterialKIT would significantly reduce waste generation through prevention, reduction, recycling, and reuse, adhering to the principles of bio-design. The outcomes aimed to achieve environmentally sound management of knowledge regarding Biomaterials and their life cycles, in line with BiomaterialKIT's methodological frameworks, thereby contributing significantly to human health and environmental sustainability.

Additionally, the project sought to foster global partnerships for sustainable development by engaging multiple actors to mobilize and share knowledge, expertise, technology, and financial resources in support of sustainable development goals in both countries. The outcomes encouraged and promoted effective public and societal partnerships, leveraging the experiences and resource strategies of stakeholders.

The co-creation culture encountered differing contexts in Portugal and Turkey. In Portugal, the project benefited from a society with a long-standing tradition of community engagement and a well-established educational framework that supports participatory learning. This context facilitated smoother integration of co-creation practices within educational institutions and public spaces. Conversely, in Turkey, the project navigated a dynamic socio-cultural landscape characterized by rapid economic development and varying degrees of openness to participatory methodologies. The initiatives in Turkey focused on adapting co-creation principles to resonate with local customs and societal norms, ensuring effective implementation of the participatory culture in diverse educational and communal settings.

Despite these challenges, the BiomaterialKIT project successfully cultivated a shared understanding of sustainability and innovation across both countries, highlighting the transformative potential of co-creation and participatory culture in addressing global educational and societal challenges.

Future research should focus on further developing the BiomaterialKIT Education Model to meet the demands of the EU. Establishing contact with other research partners developing projects in this area is essential for structuring a vision that aligns with the new guidelines for the educational system and building a new proposal that can extend this pilot to a broader audience. This expansion is vital for enhancing the impact and reach of the project, ultimately contributing to more sustainable and innovative educational practices globally.

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“THE ‘MARAÑA’ AS A DYSPHORIC NOTION FOR STAYING WITH THE TROUBLES OF REVOLTS”.

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ABSTRACT | Drawing on Donna Haraway’s ‘Staying with the Trouble: Making Kin in the Chthulucene’ (2020), Silvia Rivera Cusicanqui’s ‘Ch’ixinakax utxiwa: A Reflection on Practices and Discourses of Decolonization’ (2010), and Paul B. Preciado’s ‘Dysphoria Mundi’ (2022), this paper aims to develop the notion of the ‘Maraña’ as both a theoretical-methodological and political tool. Through design research, this concept helps to address the complexities of a world that has entered a state of global tumult. The ‘Maraña’ is understood as a way to view socioecological phenomena as dense entanglements of forms, materialities, and intersubjective expressions that cannot be approached fragmentarily without losing their vitality and potential for becoming. Given its inherently intertwined nature, it is not apparent where each enmeshed component begins and ends. The ‘Maraña’ challenges the classic scientific rationality of modern epistemology, which tends to reduce phenomena to the mere sum of their parts, objectifying and sanitizing each phenomenon, thereby creating the illusion of understanding that would allow for control and prediction of its future. Following the etymologist Yakov Malkiel (1948) and his work on the concept, the word ‘Maraña’ has a polysemic and evocative character that allows for situated interpretations according to each object and context to which it may be referred. Consistent with its own logic, the word is tangled. It evokes everything from weeds and brush in Botany, a tangled mass of chords in music, to a difficult issue to resolve, thus precluding any univocal meaning. This paper aims to propose a critical and transdisciplinary elaboration of the notion of the ‘Maraña’, outlining its epistemological foundations and its theoretical-methodological potentials for design research, exemplified in relation to certain aspects and moments of the 2019-2020 revolt in Chile.

KEYWORDS | MARAÑA, DYSPHORIA, REVOLTS, CRITICAL DESIGN RESEARCH

1. Introduction

On Friday, October 18, 2019, a cycle of protests began in Chile, spreading across the country until mid-March 2020, when Covid-19 containment measures were implemented (Aguilera & Espinoza, 2022; Fernández Droguett, 2022). This cycle of protest, referred to as the social outbreak or uprising (Cuevas Valenzuela & Budrovich Sáez, 2020), commenced after two weeks of high school students' demonstrations in the capital's metro stations against fare increases. Within days, these protests extended throughout Chile, marking the largest demonstrations since the return to democracy in 1990 (Aguilera & Espinoza, 2022). Beyond the various labels for this cycle, what is significant is that it reflects

"a crisis of the commitments and organizational principles underpinning the regime of 'neoliberal capitalist democracy' of the post-dictatorship era, as well as the discourses, social grammars, practices, and institutions that sustained them. Indeed, during the events that began in October 2019, outside the party system and democratic institutions, society experienced an acute process of re-politicization in a series of unconventional formats"

(CUEVAS VALENZUELA & BUDROVICH SÁEZ, 2020, P. 178).

While the uprising encompasses multiple dimensions, including the protagonism of young people (GANTER SOLÍS & ZARZURI CORTÉS, 2020; Infante Aravena & Cárdenas Castro, 2022; Paredes & Valenzuela, 2021; Rivera-Aguilera et al., 2021), the management and distortions of the phenomenon's communications (Basulto Gallegos et al., 2023; Herrera et al., 2022; Riffo-Pavón et al., 2021), and the hypotheses on the reasons behind the revolt (Aguilera & Espinoza, 2022; Akram, 2021; Artaza, 2019; Matus, 2019; Morales Quiroga, 2020; Urzúa-Martínez & González Franzani, 2022), the occupation and appropriation of public space by mobilized citizens stands as a central aspect of the event. Various authors (Campos Medina & Bernasconi Ramírez, 2021; Fernández Droguett, 2022; Márquez, 2020; Orellana Águila, 2022; Paredes P., 2021; Pinochet Cobos, 2021) highlight that public space

became the principal stage of the revolt, not only through its intensive occupation over months via demonstrations in the streets and squares of different cities in Chile but also through the material and symbolic interventions that radically transformed the infrastructures and everyday imaginaries of public space. This transformation included graffiti, posters, murals, signs, and other visual interventions, which Campos Medina & Bernasconi Ramírez (2021) referred to as "graphic explosion."

"The writings of the uprising expressed the set of citizen demands, the variety of requests made by inhabitants to their authorities. They captured the progressive definition process of the demands, showed the commonality of needs, contributed to profiling the actors of the conflict, and formulating the antagonisms. They recorded the violence in its various forms and bore witness to the risks and dangers of the protest, but they did all this materially: there were mural writings, constant text replacement, overlapping layers, and collage, different messages coexisting on the same wall and dialoguing among themselves, in a variety of techniques and supports. All this accounts for the polyphony of writings, but it is also a material record of the protest and leads to thinking of the urban space as a kind of archive of the present"

(CAMPOS MEDINA & BERNASCONI RAMÍREZ, 2021, P. 117).

In a previous work, we conceptualized these forms of occupation and appropriation of public space as insurgent co-design (Fernández Droguett et al., 2023). Relatively spontaneously and emergently, the mobilized citizenry intervenes and transforms public space based on the needs of the uprising, ranging from political expression through various visual interventions to the destruction of streets and urban furniture to erect barricades and thus protect themselves from police repression (Fernández, 2021; Orellana Águila, 2022). It should be noted that these transformations of the neoliberal city (Pinochet Cobos, 2021) not only operate on the infrastructures and flows of the capitalist logic of the prevailing social order but also on material and symbolic layers that transcend the present and immediate past.

In this vein, Silvia Rivera Cusicanqui's notion of Ch'ixinakax utxiwa (2010) prompts bodies and collectives to consciously act against injustices, based on reflection on their own experiences and those of others to develop actions of resistance. Rivera Cusicanqui emphasizes that this is not just a theory but a living practice, involving a continuous process of struggle, self-affirmation, and self-criticism. In Ch'ixi practices, the incorporation of modern elements within traditional Andean ways does not show a process of hybridization but a complex and intertwined way of inhabiting that *enmaraña* the component identities, keeping them active and productive, allowing new cultural forms and practices to emerge that are simultaneously traditional and modern, political and transcendent. Resistance arises from collaboration and the ability to maintain and adapt practices that imbricate

collectives and worlds, in response to modern and neoliberal pressures and influences.

In accordance with this perspective, we consider that the notion of *maraña* allows us to approach the set of elements, relationships, and contexts that comprise the uprising as a complex and dynamic whole. As we will explain in more detail later, we understand *maraña* as a way of viewing social phenomena as an entanglement of forms, materialities, and intersubjective expressions that cannot be approached in a fragmented manner without losing their emergent configuration and the vitality they perform.

The present work aims to address some aspects of the occupation and appropriation of public space during the uprising and how these aspects transformed its morphology, aesthetics, uses, and meanings, constituting a *maraña* that should be analyzed by identifying its complexly articulated components. This approach aims to advance the understanding and account of the vitality and potency of the phenomenon. By approaching from a vision situated within the *maraña*, we align ourselves with a series of conceptual, epistemological, empirical, and political efforts that seek to move away from positivist pretensions of understanding social phenomena as merely the sum of variables susceptible to being addressed in fragmentary and reductionist ways. These positivist approaches not only reduce the comprehension of the uprising but also, by transforming its isolated parts into "objects" of study, often omit or reduce its vitality and the potency of its *enmarañada* coexistence.

The research methodology is qualitative in nature (Duarte, 2023; Sisto, 2008; Vasilachis, 2006), as it seeks to understand phenomena by integrating their subjective, intersubjective, relational, material, aesthetic, symbolic, contextual, and historical dimensions. Specifically, a photoethnography (Hermansen & Fernández, 2018, 2020) was conducted on the protests of the uprising between October 2019 and March 2020, in the area of Plaza Baquedano—renamed Plaza Dignidad—and Plaza Ñuñoa. During this period, participant observations and written and photographic records of the political uses of public space by protesters occupying these places were made.

2. Theoretical Perspectives: Analyzing how the theories of Haraway, Preciado, and Rivera Cusicanqui can inform and enrich resistance practices in the Maraña.

2.1 The Notion of Maraña

The etymological work of epistemologist Yakov Malkiel (1948) on the word *maraña* evidences its polysemic and suggestive nature, which invites situated interpretations corresponding to what it refers to or the context in which it is used. According to its own logic, the word is *enmarañada*. Its rich etymology is as diverse and promiscuously intricate as it is fertile in definitions and connotations. We stubbornly use it in Spanish because, as Yakov Malkiel (1948) described,

it is in this language where this difficult-to-translate word unfolds its richest range of meanings. It can denote a set of threads, hairs, or similar things tangled in such a way that they cannot be separated; in botany, it refers to a "weed, shrub, bush"; in music, to a "tangled mass of chords"; in logic, to a "difficult issue to resolve"; morally, to a "deception, trick or hoax" either human or demonic (Malkiel, 1948). Each *maraña* is unique, intertwining elements intricately that are incomprehensible to those not situated in the respective *enmarañamiento*. However, we can recognize that its different meanings and uses underlie a certain continuity. We will use the notion of *maraña* to indicate an entanglement of human and non-human entities, material and symbolic, that cannot be understood separately without stifling the vitality of the environment that intertwines them and whose metabolism exceeds (de la Cadena, 2015) the explanatory capacity of modern epistemology (Hermansen & Fernández, 2024; Hermansen & Guerra, 2023).

2.2 "Staying with the Trouble" to Coexist in the Maraña

In her theory of knowledge, Haraway develops the notion of situated knowledges in which she establishes the centrality of the gaze. However, following Borotto (2019), this notion of the gaze is not reduced to the mere processing of visual stimuli but is always laden with socio-historical significance that simultaneously constitutes both what is seen and who is seeing. For Borotto (2019), these processes of signification unfold through metaphors, using a language evocative of images, multiple and complex readings, distancing itself from the literal and reductionist language of classical science. As Borotto points out, this language

"pretending to offer a faithful description of the world, imprisons our perceptual capacity in rigid modes of visualization that induce us to think that the described world is the only possible one. It would be the normative effect of a language with claims of literalness. Against this, figurative language can bring to our visual field what has been arbitrarily excluded under the pretext of objectivity, rationality, and neutrality. Thus, the use of metaphors in Haraway becomes a subversive gesture"

(BOROTTO, 2019, P. 273).

For Caeymaex (2019), Haraway's (2016) writing deploys a technique and a pragmatics of meaning production where words and images train our sensitivity and invite us to conceive more-than-human modes of coexistence.

While a series of concepts have been proposed to address these imbrications – complexity, assemblages, hybridity, rhizome – we consider that these do not fully account for the qualities of coexistence in the current global upheaval, nor for the emerging modes of epistemic pain (Preciado, 2022) or correspondence (Ingold, 2017) between socio-environmental reality and the embodied ways of knowing and inhabiting it.

2.3 "Dysphoria Mundi" and Epistemic

Pain in the Maraña

Paul B. Preciado (2022) introduces the notion of "Dysphoria Mundi" to describe a global condition of profound discontent with the state of the world. This condition responds to the ecological crisis, structural inequalities, and the imposition of norms on bodies to restrict the free flow of identities and their potential for enjoyment. Preciado advocates for reconfiguring power relations and breaking with the normative systems that govern bodies and relationships, systems, and environments. They describes Dysphoria Mundi as "the resistance of a large part of the planet's living bodies to being subordinated within a petro-sex-racial knowledge and power regime; the resistance of the living planet to being commodified as capitalist merchandise" (Preciado, 2022, p. 22).

Preciado does not understand the body as an anatomical entity nor dysphoria as a psychiatric concept referring to a gender identity disorder. Instead, they conceives the body as a "somatotheque," a site of political action where technologies and power relations are instituted and dismantled. The body as a somatotheque is a battlefield where forms of identity, sexuality, and gender are negotiated and contested, containing the potential to dismantle racial, sexual, cultural, economic, and ecological inequalities and violences. The somatotheque, as a body *enmarañado* whitin the world, is a collective site from which to initiate and sustain the revolution against the petro-sex-racial order – of decarbonization, depatriarchalization, and decolonization. From this perspective, dysphoria is not a pathological alteration of the anatomical body with consequences on the sense of sexual identity, but a way of life in response to a new regime of knowledge-power through experimental life practices, which allow for understanding what Preciado calls "epistemic pain."

The "epistemic pain," as described by Preciado (2008) in "Testo Yonqui," is both personal and collective and arises from the experiments of hacking their somatotheque to resist the prevailing social order. Hacking their own body is not limited to its physical transformation but also implies a profound identity reconfiguration and a corporeal confrontation with the power structures that regulate and control bodies. Epistemic pain is, therefore, a constitutive part of the revolutionary process. It is the pain of dismantling and restructuring the frameworks of knowledge and the identity categories that have been internalized in bodies throughout life.

"It is necessary to understand dysphoria mundi as a general somatopolitical condition, the pain produced by the necropolitical management of subjectivity, while at the same time pointing to the potential (not the power) of the planet's living bodies (including the planet itself as a living body) to extract themselves from the capitalist, patriarchal, and colonial genealogy through practices of inadequacy, dissidence, and disidentification."

(PRECIADO, 2022, P. 27)

Recognizing ourselves as densely

enmarañados means experiencing epistemic pain while we try to hack ourselves to hack the categories and structures that the machines of capital, desire, and discourse production impose, describing them as sources of security and pleasure. Epistemic pain is inherent in the process of resistance and personal and social transformation, emerging from abandoning established certainties and identities to embrace new forms of relationship and existence.

In its constant reconfiguration, the Maraña demands a permanent adaptation of our coexistence, confronting us with renewed epistemic pains that derive from the struggles to reconfigure the frameworks of reference and life practices imposed by the neoliberal city. This painful confrontation is necessary to resist in a dysphoric and crisis-ridden world. Living enmarañados requires both an ethics of care and responsibility – the capacity to respond – shared by interconnected entities, as well as dysphoric policies and confrontational struggle. This implies constant intersubjective attention and consideration, along with the disposition for struggle and self-defense. By confronting and undermining oppressive embodied structures, the potential for building more just and equitable relationships opens up. The ethics of care, dysphoria as a will to resist, and responsibility in the Maraña are, inevitably, sources of epistemic pain, as they modify our bodies, demanding a constant revaluation of our actions, positions, and their affective and practical impacts on the interconnected fabric of dense coexistence.

2.4 “Ch’ixi” as Enmarañada

Coexistence

Following the reflections of Silvia Rivera Cusicanqui, we consider that both Latin America and marginalized territories by the Modern Capitalist World System (Bautista, 2015) have myriad histories of particular resistances. These need to be understood, shared, and incorporated to establish new ways of recognizing, transforming, and making worlds. When describing the notion of *Ch’ixinakax utxiwa*, Rivera Cusicanqui (2010) emphasizes that this is not merely a theory but a living practice that involves a constant process of struggle, self-organization, and self-critique, during which mobilized bodies and collectives consciously act against their colonization, exploitation, and marginalization.

We propose that the notion of Ch’ixi can be revisited as a situated manifestation of the *Maraña* in the Andean cultural context. In Ch’ixi practices, the imbrication of modern elements within traditional Andean modes should not be seen as a process of hybridization but as a form of coexistence that demonstrates the *Maraña* as an existential condition: complex, intertwined, and without a clear or final resolution among the entities and identities that compose it and give it vitality.

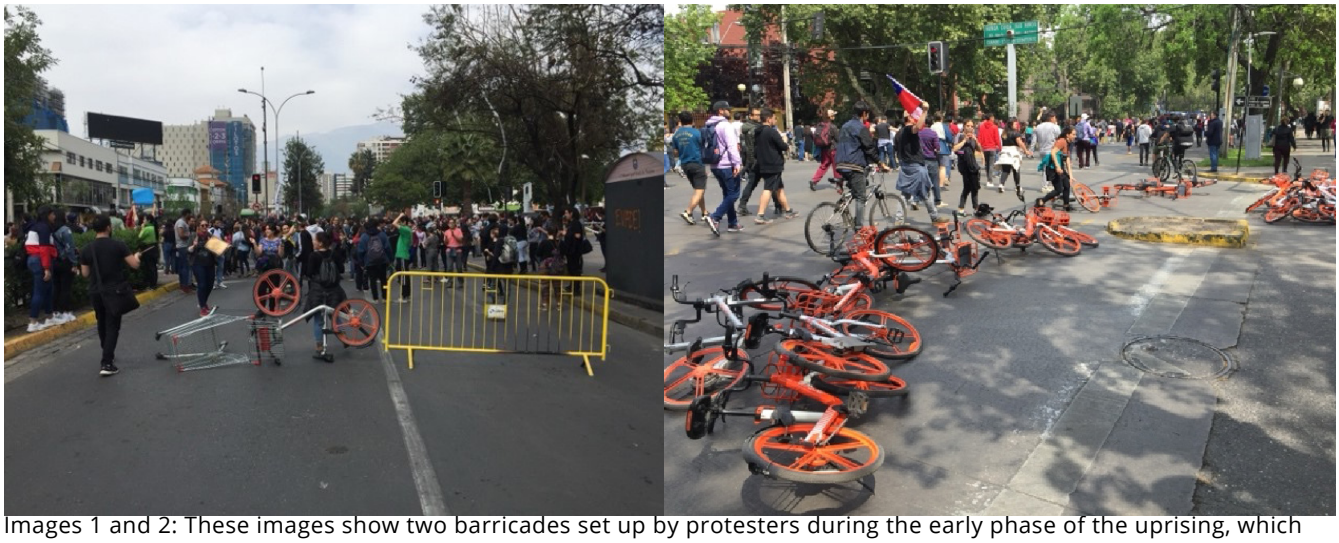
We embrace for the *Maraña* the quality of Ch’ixi that does not seek to homogenize differences but rather to keep their constitutive tensions active and productive, thus favoring the emergence of new modes and cultural practices that are simultaneously situated

and modern, political and transcendent. In Ch'ixi, the relationships between traditional and modern modes of coexistence, spiritual and economic, sustain their *enmarañada* vitality and suggest forms of resistance and adaptation. In the *Maraña* as in Ch'ixi, resistance arises from collaboration, friction, and the ability to apprehend (Butler, 2009) and adapt practices among subjects and worlds, in response to modern and neoliberal homogenizing pressures and influences. Bringing these concepts together offers an interpretative perspective that allows us to delve into understanding how collectives and environments can be seen as places of constant transformation. We believe this intersection is crucial for thinking about the decolonization of our ways of life, to recognize ourselves as bodies coexisting in *enmarañados* contexts.

3. ANALYSIS

On Friday, October 18, 2019, after two weeks of protests in metro stations by high school students against the fare hike, authorities decided to close most of the stations in the metropolitan network to avoid new demonstrations. However, this led to the protests shifting to public spaces, with increased intensity in the late afternoon outside the stations and then in emblematic places in the city. Thus, from 7:00 p.m. onwards, people began to gather in the main squares of the city to continue protesting. Over the days, the protests grew, and the mobilized citizenries became *enmarañada*, managing to resist police repression and settle in key urban areas. Just as had happened with the protests in the metro stations in the first weeks, the authorities criminalized the protest and deployed unprecedented repression since the return to democracy in 1990, resulting in the death of about 30 people and thousands of injured and detained. The protests continued until mid-March 2020, when they were interrupted by the lockdown measures to combat the Covid-19 pandemic.

As we pointed out in the introduction, the political occupation and appropriation of public space was a central axis of the uprising, which involved, as we can see in images 1 and 2, not only the occupation of squares and streets but also their blockade. Since the first day, the security forces developed a strong repression, consisting of the disproportionate use of water cannons and tear gas, as well as the shooting of tear gas bombs and rubber bullets. The protesters' street blockades began to be complemented with the use of urban furniture, such as fences and construction materials, as well as objects like shopping carts and rental bicycles. However, as the weeks went by and the repression increased, the street blockades became increasingly complex, systematic, and organized. This transformation, which involved a growing *enmarañamiento* of the protesters with the environments where they were located and their infrastructures, is evident in the comparison of photos 1 and 2, taken in the first days of the uprising, with photos 3 and 4, taken in December and January.



Images 1 and 2: These images show two barricades set up by protesters during the early phase of the uprising, which can be dated until November 2019.

Images 3 and 4: These images show two barricades constructed by protesters to defend the boundaries of the



occupied territory. By December 2019, the structures of these defenses reflect the emergence of an increasing level of organization and settlement in the areas occupied by the mobilized citizenry.

While during the first days of the uprising, citizen protests took place almost throughout the

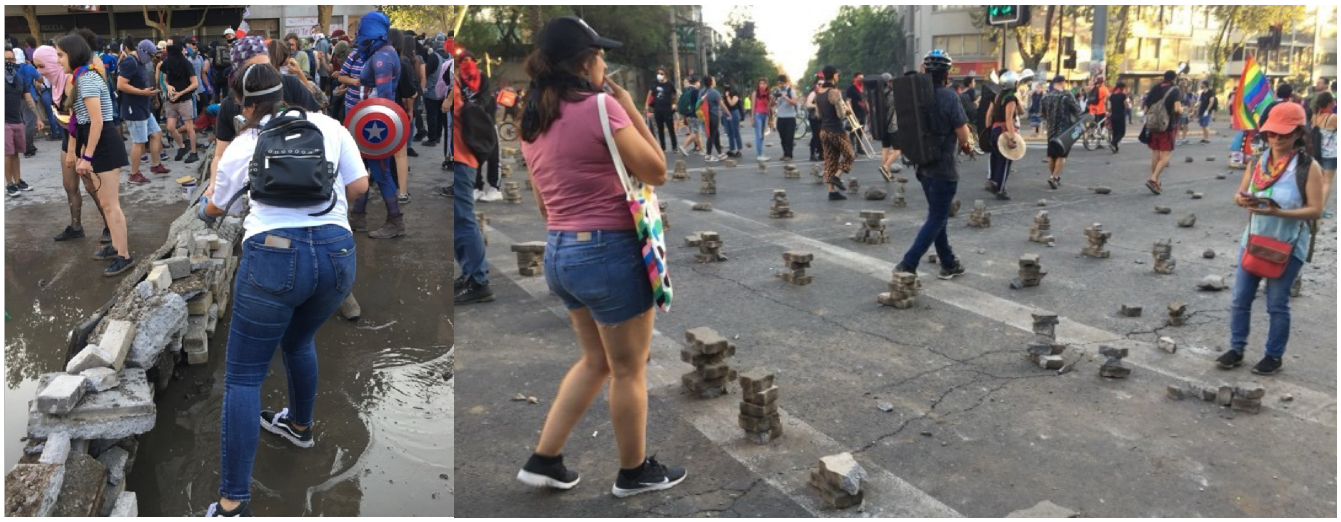
city, after a couple of weeks, they began to concentrate in strategic locations. Simultaneously, Plaza Italia, renamed by the mobilized citizenry as Plaza Dignidad, established itself as the symbolic center and main gathering place. This plaza, which has been a meeting point for citizens since the late 19th century, was occupied almost daily by the protests, with the largest and most violently repressed demonstrations occurring on Fridays. In this context, and as weeks passed, a growing organic citizen mobilization emerged, whose complexity is expressed in a spontaneous diversification of roles and specialization of respective tasks. One of the most emblematic groups was the *Primera Línea* (First Line), a sector of protesters who systematically confronted law enforcement to prevent their advance towards the center of the Plaza, where the majority of the demonstrators gathered peacefully. Along with throwing stones and other blunt objects, the *Primera Línea* erected barricades constructed with urban furniture, construction materials, and later also, in coordination with other mobilized sectors, began breaking sidewalks and pavements to obtain stones for use as projectiles and defensive barriers against repression.

As seen in images 5, 6, 7, and 8, individuals from various collectives participated in these activities collaboratively, constituting an emergent and certainly spontaneous organization – in the sense that throughout the uprising, there was no leadership from political parties or social organizations. This independence from organizations that have traditionally channeled citizens' political demands allowed for the emergence of original ethics and aesthetics of the uprising, whose modes of expression and action are possible only from a spontaneous and unprecedented entanglement of diverse subjectivities that coordinate and gather to protest. The uprising operated under a "self-convened" logic, whose organicity was undoubtedly greatly favored by the use of social media. Along with sustaining autonomous coordination, social media allowed for challenging the narratives that mass media tried to impose, in alliance with political and economic powers, to criminalize the citizen uprising. Images like these practically demonstrate the alliance between different sectors converging in Plaza Dignidad, discrediting the version that mass media attempted to impose, namely that there were violent groups acting independently of those protesting peacefully.



a quarry, and image 6 shows a line transporting the stones to be used as projectiles, in barricades, or for demarcating the territory.

Images 7 and 8: Show different but complementary uses of stones from the quarries. In image 7, stones are used to build a defensive wall against police attacks, while in image 8, they are stacked as boundary markers for a



cultural event.

Drawing on Rivera Cusicanqui's notion of Ch'ixi (2010), images 5, 6, 7, and 8 particularly

highlight the entanglement of aesthetics and discourses in political, practical, and affective alliances. We observe the coexistence of leftist discourses and pop graffiti, Mapuche emblems, and sexual diversity symbols, Tinku collectives with Captain America. By associating their agencies in a complementary manner, they entangle politically and affectively, exceeding the classical limits of the subject, thus challenging the traditional classifications used to comprehend and interpret this manifestation of civic discontent.

Images 9 and 10: We observe scenes of the constructive and destructive agency of the uprising. In image 9, we see one of the entrances to the Baquedano metro station





blocked by a barricade intended to hinder the repressive assaults of the police forces. In image 10, we observe the transformation and reinterpretation of the center of Plaza Dignidad through the entangled superimposition of expressions from the multiple and diverse identities and sentiments that gathered and interwove there.

The barricades erected at various points in the area serve as material evidence that these places have been transformed into borders of the occupied territory and scenes of intense confrontations. As we see in image 9, one of the most heated locations is the main exit of the Baquedano metro station, which faces directly towards the plaza. This station hosted the main demonstrations before October 18th, gaining particular importance due to the high level of repression towards the students, with several of them being detained and illegally confined within the station's premises. Later, although the station was closed, the police forces stationed inside would often emerge to throw tear gas and shoot rubber bullets at the demonstrators outside. These covert repression practices demanded the constant vigilance of the demonstrators, who would frequently throw stones inside and build barricades to try to block police actions, as seen in image 9.

The analysis of images 9 and 10 highlights the constructive and destructive dimensions of insurgent co-design actions, revealing an entangled continuum. The destruction of urban furniture to build barricades is combined with the creation of new forms of community

organization and resistance, evidencing the vitality and complexity of the phenomenon. While image 9 shows the destruction and disabling of one of the entrances to the Baquedano metro station through a barricade, image 10 presents a constructive intervention, transforming and reinterpreting the existing infrastructure through the entangled superimposition of the multiple and diverse identities and sentiments that converged and intertwined there. This original landscape of the uprising in Plaza Dignidad, filled with vitality, constitutes a milestone of our memory, of an experienced event that, as such, has the potential to be present over and over again.

4. CONCLUSIONS

The collective action in Plaza Dignidad was not just the result of individuals acting together, but of the convergence of identities, wills, and experiences that deeply intertwined, creating a robust and resilient social fabric that allows us to invoke the notion of Ch'ixi (Rivera Cusicanqui, 2010) as a precedent. This interconnection reinforces the idea of *enmarañamiento* as a cocreative process that is not only physical but also social, political, and affective. Through the resistance and reinvention of the places they cohabited, the demonstrators challenged official narratives and established powers, proposing new ways of understanding citizenship, politics, and community, essentially what we hold in common. As we have conceptualized in previous works, these entangled forms of occupation and appropriation of public space can be understood as insurgent co-design (Fernández Droguett et al., 2023), as they emerge from the same political manifestation practices, forming a complex and vital collective metabolism (Haraway, 2016), which reconfigures urban infrastructures, their uses, and meanings in a consistent and consonant manner with the course of the uprising, while embracing and not homogenizing the identities that constitute it.

This can be seen as an *enmarañamiento* between ethics, politics, power, and resistance, where each action in the Plaza redefined the balance of forces in the city and the country. Based on what has been observed, we consider that the notion of *Maraña* allows us to address the complexity of current social phenomena in a situated and pertinent manner, with a broad and dysphoric theoretical-methodological approach (Preciado, 2022) that approaches phenomena without simplifying, homogenizing, or stifling their vitality.

The social uprising in Chile represents a decolonizing gesture against the neoliberal city, demonstrating how the mobilized citizenry reappropriates urban infrastructures and transforms them into raw materials—stone and metal—to build and defend their own world. This transformation challenges the materialities and meanings imposed by colonialism and neoliberalism, turning them into devices of struggle and resistance. In turn, the citizenry, through mobilization, digests and reappropriates urban structures, contesting their original meanings and utilizing them

for their own purposes. This Ch'ixi process transforms the city through an insurgent and vital co-design of its space, where temporal and symbolic layers overlap and intertwine, resisting the logic of invisibility and erasure present since the disruption in the pre-Hispanic past, the imposition of the modern State, and currently, the logics and infrastructures of neoliberalism (Bautista, 2015).

The mutations of the Plaza Dignidad sector can be traced back to the early 20th century, showing how the plaza has been reconfigured as a space of capital and human resource flows, attempting to negate its character as a place of citizen gathering and political expression. The recurring appropriations of the place, such as football celebrations and political demonstrations, emerge as practices and knowledge available in the collective memory of this urban sector, challenging the transactional logic and capital multiplication that the neoliberal city seeks to impose.

The emergence of Plaza Dignidad, as a territory, is the result of self-organization. Its construction, configuration, and defense were emerging and collective practices of insurgent co-design (Fernández Droguett et al., 2023) through which various groups materialized, if only for a moment, another world, one that had previously only been imagined, transforming the city into original stone and tools of struggle. Barricades and other interventions not only serve as physical defenses but also organize and structure new practices of culture, health, and commerce in the occupied and re-signified public space.

These practices challenge and transgress, both materially and symbolically, the neoliberal urban planning of the city (Pinochet Cobos, 2021). These practices challenge the institutional logics with which cities have traditionally been designed and offer us 'new alternatives for a common future' (Pinochet Cobos, 2021, p. 2). These insurgent co-designs deploy practices of urban appropriation and transformation that have the potential to inform and inspire new ways of designing and constructing urban environments and public spaces that are more democratic, interpretable, transformable, and relevant to contemporary modes of inhabitation and the demands of modern citizenship.

Living *enmarañados* demands an ethic of care and shared responsibility, where the actions of some affect all. This ethic, combined with struggle and self-defense, allows for confronting and dismantling oppressive structures, opening the possibility of constructing more just, plural, and equitable relationships. Finally, we emphasize again the notion of *Maraña* as a useful tool to situate ourselves and understand the complexity of current social phenomena, allowing us to approach the uprising from a perspective that integrates ethical, political, and epistemic dimensions without reducing its vitality or homogenizing what it comprises.

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RESEARCH ON FASHION CLOTHING DESIGN STRATEGIES FOR THE YOUNG ELDERLY FROM AN INCLUSIVE PERSPECTIVE

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ABSTRACT |

As the global population ages, the consumption power and social activity participation of the young elderly have significantly increased. Inclusive design, a wellestablished design approach, is redefining many industries, including fashion. The young elderly are gradually becoming an indispensable consumer force in fashion design, necessitating a reevaluation of their composition and boundaries. This research employs methods such as literature review, case studies, and focus group interviews to focus on the redefinition and new characteristics of fashion design for the young elderly from an inclusive perspective. The study adopts an adaptive design paradigm to comprehensively optimize the economic and environmental benefits throughout the fashion design product lifecycle. It then analyzes the value and necessity of fashion design for the young elderly from three dimensions: user, function, and value. This research proposes fashion design principles (design relevance principle, social coherence principle), methods (inclusive design method, experience design method, etc.), and development processes based on inclusive design for the young elderly. Finally, these principles and methods are validated and optimized through design practice. This study aims to provide theoretical support and practical references for the fashion design industry in addressing the needs of the young elderly amid global population aging, further promoting high-quality development in the fashion design industry.

KEYWORDS | INCLUSIVE DESIGN, YOUNG ELDERLY, FASHION DESIGN, DESIGN METHODOLOGY, FASHION INDUSTRY

1. Introduction

Population is the cornerstone of social development. However, population aging has become a global trend(Bai, C et al., 2020). According to the "World Population Prospects 2024: Summary of Results" report released by the United Nations, by the end of the 2070s, the global population aged 65 and above is expected to reach 2.2 billion, surpassing the population under 18 years old(Wang, H et al., 2024). In the mid-19th century, France became the first country to enter an aging society, followed by several developed countries such as Sweden, the United Kingdom, the United States, and Japan. Mildly aging countries are mostly distributed in Asia and South America, moderately aging economies are mainly found in North America and other regions, and heavily aging countries are concentrated in Europe (Lutz W et al., 2008). Japan has become one of the most severely aging countries in the world (Coulmas F, 2007). Currently, the elderly population over 60 in China has exceeded 260 million, accounting for 18.7% of the total population (Zhang, M et al., 2024). China entered a deep aging phase in 2021, with the proportion of the population aged 65 and above rising to 15.4% in 2023. According to the latest data from the National Bureau of Statistics of China, by the end of 2023, the population aged over 60 had reached 297 million, accounting for 21.1% of the total population, and it is predicted to grow to 500 million by 2050. The increasing trend of population aging in China is gradually putting pressure on the social pension system(Chang, Z. 2024).

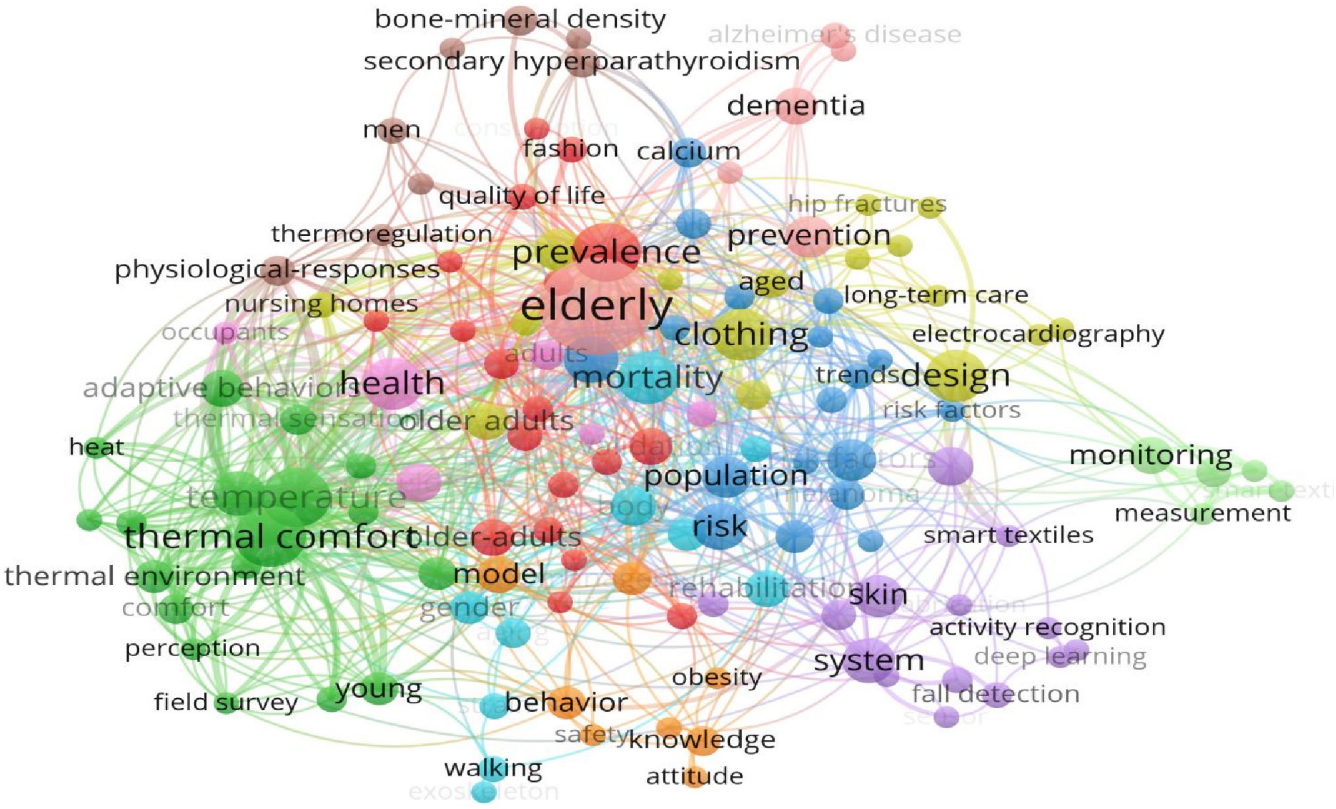
As the elderly population continues to expand and the quality of life and life expectancy of the elderly improves, the global aging industry has vast market potential and promising development prospects, becoming a new growth point for economic development. Karin Schmidt-Ruhland proposed in 2011 that with the changing population structure, the demand for products and assistive tools from the growing target group of the elderly is increasing. The changing demographics present significant challenges for the manufacturing and service industries, as traditional products do not meet the needs of the elderly, and many needs and requirements for this age group are not currently addressed (Schmidt-Ruhland K et al., 2011). Anna pointed out that the young elderly group seems to be gradually forgotten, with few consumer products available to

them (Sell A et al., 2017). Sandrine Dupont Rocher suggested in her 2016 study that the young elderly have specific characteristics, and research results targeting this subgroup should not be generalized to the entire elderly population (Dupont Rocher S et al., 2016). Christer Carlsson in his research highlighted that European policymakers often focus on the elderly population but fail to give targeted attention to the young elderly, an important and unique subgroup (Carlsson C et al., 2023).

As the trend of population aging intensifies, the young elderly are becoming an indispensable consumer force in the fashion market. This group not only has strong purchasing power but also shows a high demand for fashionable and personalized products, seeking not only material satisfaction but also self-expression and social needs. However, current market offerings often fail to meet their complex needs for fashion, comfort, and ease of use, indicating that traditional fashion design concepts and methods require innovation and improvement. Fashion is a term that is difficult to define; it appears to encompass everything yet is not all-encompassing, it is elusive yet not impossible to grasp. Fashion arises with the presence of humans, as it is inherently human(Sharma, A. 2024). Fashion is an external form of life, constantly seeking an appropriate form to express itself. The evolution of life is also a process of discarding old forms and creating new ones. Simmel's theory suggests that life and form are interconnected and mutually influential. He advocates respecting life and allowing it to continuously develop through changing forms (Zimmer, A. L. 2021).

Inclusive design, as an emerging design concept, emphasizes considering the needs of all potential users, especially those who may require special consideration due to age, ability, or other factors. Applied to elderly fashion design, inclusive design not only focuses on the functionality of products but also emphasizes the aesthetic and emotional value of clothing, ensuring that the elderly can enjoy fashion while feeling dignity and comfort. The British Design Council defines inclusive design as "a general design approach where designers ensure their products and services meet the needs of as many customers as possible, regardless of age or ability" (Clarkson P J et al., 2015). Currently, some scholars have conducted in-depth academic explorations on the lifestyles and health behaviors of the young elderly from disciplines such as sociology and psychology. However, there is a lack of in-depth research on fashion design for the young elderly. Using the Web of Science core database as the data source, I conducted a literature search using keyword combinations. By searching with keywords "elderly" and "fashion design" for all English literature included before July 20, 2024, I obtained a total of 371 results after manual sorting and screening. Knowledge mapping visualization analysis shows that keywords such as smart textiles, thermal comfort, physiological response, quality of life, and trend design are hot research directions in inclusive design for the elderly. This article will focus on researching fashion design strategies for the young elderly in China from an inclusive perspective.

Figure 1. Visualization Analysis of Fashion Knowledge for



Young Elderly Clothing

2. Current Status of Young Elderly Population in China Against the Background of Aging Population

2.1 Definition and Current Status of Young Elderly Population

According to the universal standards set by the World Bank and UNESCO, the young elderly are defined as individuals aged 60-698 (Forman, D. E et al., 1992). In China, both aging policy formulation and related research typically adopt this age range to classify young elderly individuals. As the global trend of population aging intensifies, the living needs and market potential of the elderly population are increasing, particularly in the realm of fashion consumption(Schiaroli, V et al., 2024). However, the current market often overlooks the specific needs of this group, leading to a mismatch between supply and demand.

Currently, the majority of young elderly individuals in China were born in the 1950s and 1960s. They grew up during the early years of the People's Republic of China and, compared to other middle-aged and older elderly populations, are characterized by greater willingness and ability to work, more robust physical health, higher cultural levels, more complete family structures, and stronger economic capabilities. Research indicates that before 2035, China will experience

the fastest growth and highest fluctuation in its aging population, with a relatively low social dependency ratio and the youngest elderly population structure, representing the period of highest proportion of young elderly individuals. Strategic and tactical preparations to address an aging society should be completed during this period(Kulik, C. T et al., 2014).

2.2 Clothing Needs of Young Elderly Individuals

Against the backdrop of escalating global population aging, the consumption capacity and social activity engagement of the young elderly demographic have significantly increased (Engelhardt, H et al., 2010). The clothing industry, a critical sector within the global economy, not only plays a pivotal role in consumption and exports but also provides a substantial number of employment opportunities. As societal aging trends intensify, the young elderly group has emerged as a significant consumer force within the apparel market (Sharma, A. 2024). However, the clothing needs of this demographic have become increasingly complex and uncertain.

This consumer group not only possesses substantial purchasing power but also demonstrates a high demand for fashionable and personalized products, seeking not only material satisfaction but also self-expression and social interaction on a psychological level(Li, G et al., 2012). Health and comfort are crucial factors in their clothing choices, with fabric softness, breathability, moisture absorption, and overall wear comfort being particularly important. Furthermore, functionality and practicality cannot be overlooked, with features such as ease of dressing, multifunctional garments, and materials that are easy to clean and maintain being essential to meet their daily needs. At the same time, the young elderly's pursuit of fashion has made personalized design a market hotspot, necessitating that designers incorporate modern trends to create clothing that aligns with age characteristics while retaining a sense of style.

However, current apparel products for young elderly individuals in the Chinese market often fail to adequately address their complex needs for fashion, comfort, and usability. As times change, this demographic is increasingly rejecting age-defined constraints and pursuing personalized fashion tastes. Statistics show that in 2023, the "silver economy" market in China reached 5.4 trillion yuan, with an annual growth rate of 25.6%, significantly outpacing the growth rate of the younger consumer demographic. This indicates the enormous consumption potential of the elderly, who are becoming an important driving force for economic growth.

Despite the growing consumption capacity and willingness of the elderly, the fashion industry has not yet sufficiently addressed the needs of young elderly individuals. Traditional and singular aesthetic orientations such as fashion, elegance, youthfulness, or national styles with bright colors and patterns

are increasingly being discarded in favor of diverse and individualized aesthetic choices. More and more young elderly individuals are choosing clothing based on their personal preferences rather than conforming to the conventional notion of what "elderly people should wear."

2.3 Young elderly individuals have become a significant sub-segment within the apparel industry

Young elderly individuals, as the youngest and most active subgroup within the elderly population, have now entered the retired demographic under current Chinese policies. This group of young elderly individuals is characterized by a significant population size and is expected to have a high level of remaining life expectancy, health, and educational attainment. Most young elderly people, due to their stable economic foundation and substantial purchasing power, exhibit a clear demand for high-quality and comfortable fashion products. Concurrently, modern society's perception of the elderly is evolving, with more elderly individuals willing to explore and showcase personalized fashion choices. They express their personal life attitudes and styles through clothing, pursuing fashion that transcends age.

This stage is closely linked to the transitional needs between middle-aged and older elderly populations. Understanding their fashion preferences and guiding their behavioral habits is crucial for future middle-aged and older elderly cohorts.

In the current Chinese fashion apparel market, there are notable deficiencies in the design of fashion clothing for young elderly individuals. Most apparel for this demographic lacks innovation and modernity, often relying on outdated color schemes and conservative cuts that fail to meet the young elderly's desires for fashion and personalization. Such clothing frequently overlooks the dual needs for aesthetics and comfort, instead opting for monotonous and uninspired patterns and materials, resulting in designs that appear outdated and rigid. This outdated design approach not only fails to reflect the vitality and individual characteristics of young elderly people but also does not engage their purchasing interest, thereby diminishing the vitality and appeal of the elderly apparel market. This phenomenon highlights the insufficient understanding of elderly needs within the current fashion design industry, underscoring the importance of more in-depth market research and innovative design methods.

3. Incorporating Inclusive Design into the Fashion Apparel Industry

3.1 Empowering the Elderly Apparel Market through Inclusive Design

As young elderly individuals become significant consumers in the fashion market, traditional fashion design methods face challenges, as they often fail to fully consider the specific needs of this demographic. The particular needs of this group reflect the dual pursuit of personalization and functionality in apparel design for elderly

consumers, especially given their growing market influence (Park, J et al., 2014). However, traditional fashion design frequently overlooks these needs. Currently, the development level of China's fashion industry lags far behind the pace of aging, placing greater demands on elderly consumption patterns and social service systems. China is one of the fastest-aging countries, and the rapid pace of this transition has left society with insufficient time to adapt and understand the shift, leading to a lack of comprehensive understanding. Many enterprises in the silver economy still have a superficial grasp of elderly people and their living contexts, lacking in-depth research and exploration of their needs.

Inclusive design is a method that leverages and realizes human diversity, focusing not only on the usability and safety of products but also on the emotional and social needs of the elderly, enhancing their quality of life through design (Steinfeld, E., & Maisel, J. 2012). Inclusive design can improve elderly individuals' ability and willingness to consume and engage in social activities by providing products that are easier to use and suited to their physical conditions. Additionally, as healthy young elderly individuals seek personalized and high-quality living experiences, inclusive design should also emphasize product personalization to meet their diverse needs.

3.2 Inclusive Design Drives the Development of the Fashion Industry

The role of inclusive design in the fashion apparel industry is crucial. By comprehensively considering the needs of diverse user groups during the design process, this concept drives the fashion industry to better meet the varied demands of consumers, particularly the young elderly population. Inclusive design integrates functionality, aesthetics, and emotional value, making apparel both practical and comfortable while fulfilling consumers' desires for fashion and personalization. Additionally, this design approach stimulates designers' creativity and encourages the use of new materials and technologies, thereby advancing overall industry innovation and progress.

For the young elderly demographic, inclusive design effectively addresses their complex clothing preferences, allowing them to enjoy stylish apparel while experiencing comfort and dignity. This not only enhances the brand's market competitiveness and social responsibility but also increases consumer loyalty and satisfaction. The application of inclusive design further broadens market reach, attracting a wider range of consumer groups and contributing to economic growth (Persson, H et al., 2015). Moreover, it fosters social inclusivity and harmony, advancing societal progress as a whole.

3.3 Challenges Facing the Development of Fashion Apparel Industry for Young Elderly

Despite the significant potential of inclusive design in advancing the fashion apparel industry, the sector focused on young elderly individuals faces numerous challenges. Designers often lack a deep understanding and research into the needs of the young elderly demographic, resulting in products that fail to fully address their physiological and psychological requirements. The current apparel design education system and training mechanisms have not kept pace with evolving trends, leading to insufficient emphasis and promotion of inclusive design principles, and failing to adequately prepare designers to meet market demands.

Moreover, the diversity and individual needs within the young elderly population add complexity to design processes. Designers must balance functionality, comfort, and fashion while also considering the impact of different cultural backgrounds and lifestyles on apparel design. However, the fashion apparel products available for this demographic often suffer from design homogenization, lacking innovation and differentiation, and failing to effectively attract and meet the diverse needs of young elderly consumers. Additionally, apparel brands frequently overlook the aesthetic preferences and consumer psychology of the young elderly when conducting market promotion and marketing, leading to imprecise market positioning that affects sales performance and brand recognition.

Furthermore, the consumption habits and purchasing behaviors of the young elderly differ from other age groups, rendering traditional sales channels and models insufficient. There is a need to explore new marketing strategies and channels to enhance user experience and satisfaction. Addressing the development of the young elderly fashion apparel industry requires overcoming challenges related to design principles, education and training, market demands, product innovation, and marketing strategies, necessitating collaborative efforts from all stakeholders to achieve a more inclusive and sustainable growth.

4. Building System Elements for Fashion Apparel Design for Young Elderly from an Inclusive Perspective

4.1 Building Design Elements for Fashion Apparel Targeted at Young Elderly

Experts in the relevant field were invited to form a panel and participate in an open interview concerning product requirements. Prior to the interview, the Vosview knowledge graph evaluation results were presented to the expert panel as foundational material to enhance the comprehensiveness of the interview information. During the interview, the author attended in the roles of interview facilitator and recorder, and added discussions at the end of each segment. This method of participation helps facilitate communication and understanding between both parties and allows for a deeper insight

into the interviewees' situations and needs.When selecting interviewees, the author required that they possess a certain level of understanding and theoretical foundation in the study's field. Therefore, we chose 3 senior university professors specializing in fashion design, 3 senior fashion designers, and 3 experts in inclusive design theory, making a total of 9 interviewees. The open interview lasted for 80 minutes. Basic information about the interviewees is shown in Table 1. In this study, we summarized the basic information of the interviewees and conducted preliminary organization of the interview audio data.

Next, we applied grounded theory research methods to encode and quantitatively analyze the data, obtaining the specific results shown in Table 2. Through the analysis of the interview data, we can gain a deeper understanding of the interviewees' views and needs, and also uncover some valuable information and insights. The application of grounded theory research methods enabled us to abstract core views and themes from a large amount of data and establish relationships and connections between them. This provides strong support and assistance for subsequent data analysis and decision-making.To ensure the effectiveness of the requirement elements, keywords mentioned 6 times or more were retained (6-9 times as sub-core codes, 10 times or more as core codes), while those mentioned fewer times were deleted. The frequency of each requirement keyword as a proportion of the total frequency was recorded as the requirement importance score.

Table 1. Basic information on the Panel of Experts

	classifications	quorum	percentage
genders	male	5	55.6%
	female	4	44.4%
educational background	Bachelor's degree	1	11.1%
	Master's degree	3	33.3%
	Doctoral degree	5	55.6%
age	18–30	4	44.4%
	31–45	3	33.3%
	45–60	2	22.2%

Table 2. Research Methods for Rooted Theory Specific Results Information

Primary elements	Word frequency /time	Number	Secondary elements	Word frequency/ time	Enter or not	Weighted percentage (%)
Diverse Demand	62	A1	Functional design	12	Yes	19.35
		A2	Comfort Optimisation	13	Yes	20.97
		A3	Fashion taste	11	Yes	17.74
		A4	Personalisation	5	No	8.06
		A5	Cultural adaptation	4	No	6.45
		A6	Lifestyle Matching	3	No	4.84
		A7	Health Aids	7	Yes	11.29
		A8	Psychological needs fulfilment	4	No	6.45
		A9	Scene Adaptation	3	No	4.84
Market segmentation	87	B1	Target Audience Identification	8	Yes	9.20
		B2	Consumer Behavior Analysis	11	Yes	12.64
		B3	Demand Characteristics	13	Yes	14.94
		B4	Psychographic Segmentation	5	No	5.75
		B5	Purchasing Power Assessment	4	No	4.60
		B6	Market Positioning	12	Yes	13.79
		B7	Product Line Refinement	3	No	3.45
		B8	Brand Perception Analysis	9	Yes	10.34
		B9	Social Media Influence	7	Yes	8.05
		B10	Marketing Channels	12	Yes	13.79
		B11	Regional Culture	3	No	3.45
Design Innovation	108	C1	Technological Innovation	10	Yes	9.26
		C2	Material Innovation	7	Yes	6.48
		C3	Sustainable Design	11	Yes	10.19
		C4	Functional Integration	13	Yes	12.04
		C5	User Experience Design	3	No	2.78
		C6	Smart Wearable Design	9	Yes	8.33
		C7	Cultivation of Innovative Design	2	No	1.85
		C8	Fashion Aesthetics	4	No	3.70
		C9	Optimization of Design	5	No	4.63
		C10	User-Centered Design	14	Yes	12.96
		C11	Customized Pattern Design	13	Yes	12.04
		C12	Garment Structure Design	9	Yes	8.33
		C13	Color Coordination	8	Yes	7.41

As seen in Table 2, we extracted a total of 20 core and sub-core codes related to fashion clothing design elements for younger seniors that were mentioned 6 times or more. We had 9 experts rate the selected codes, with a total possible score of 100 points (as shown in Table 3). After the expert panel completed their scoring, we used the information weight method in SPSS to analyze the scoring weights of the 9 experts (as shown in Table 4). By calculating the CV coefficient and the weight coefficient, we ultimately obtained the final comprehensive evaluation scores for the 20 word frequencies.

Table 3. Expert scoring and composite scores

No.	Expert1	Expert2	Exper3	Exper4	Exper5	Exper6	Exper7	Exper8	Exper9	score
A1	89	92	78	90	88	85	89	93	90	88.295
A2	92	89	88	84	80	89	93	94	91	88.658
A3	81	78	84	82	80	75	71	73	80	77.971
A7	86	70	89	72	71	75	78	88	86	78.804
B1	85	87	77	75	89	91	94	75	71	82.865
B2	80	91	78	83	86	81	77	73	79	81.061
B3	90	76	92	84	75	71	87	89	91	83.242
B6	88	92	84	86	93	95	84	80	90	88.189
B8	87	76	79	83	89	85	71	91	93	83.653
B9	78	81	70	73	72	75	89	84	80	78.069
B10	85	86	88	82	91	94	85	81	80	85.928
C1	90	93	88	95	93	96	89	90	86	91.264
C2	85	96	91	88	80	94	91	81	86	88.123
C3	85	82	85	91	94	86	82	80	85	85.673
C4	87	79	84	81	77	89	93	91	70	83.242
C6	87	82	89	77	93	85	81	80	90	84.819
C10	90	94	92	95	94	92	89	90	97	92.696
C11	89	91	77	89	90	93	78	90	85	86.963
C12	78	89	90	90	88	92	95	87	92	89.585
C13	85	88	83	93	94	91	89	93	87	89.569

Table 4. Calculation of the weighting of expert scoring information

	average	Standard	CV coefficient	Weights
Expert 1	85.85	3.99	4.65%	6.55%
Expert 2	85.6	7.185	8.39%	11.83%
Expert 3	84.3	6.079	7.21%	10.17%
Expert 4	84.65	6.862	8.11%	11.43%
Expert 5	85.85	7.734	9.01%	12.70%
Expert 6	86.7	7.623	8.79%	12.40%
Expert 7	85.25	7.283	8.54%	12.04%
Expert 8	85.15	6.808	7.99%	11.27%
Expert 9	85.45	7.03	8.23%	11.60%

4.2 Element Data Analysis

We obtained the final evaluation scores from nine experts on term frequency using the information content weighting method. As shown in Table 2, we selected and recorded a total of 20 core and secondary core terms, which are functional design, comfort optimization, fashion taste, health assistance function, target group identification, consumer behavior analysis, demand characteristic classification, market positioning, brand recognition analysis, social media influence, marketing channels, technological innovation, material innovation, sustainable design, functional integration, smart wearable design, user participation design, personalized pattern customization, clothing structure design, and color matching. We extracted the secondary element terms that met the inclusion criteria and integrated them. The experts then re-evaluated these secondary element terms, and the weighting of the evaluation results was calculated. The weighted ranking of the scores given by the nine experts was as follows: Expert 5, Expert 6, Expert 7, Expert 2, Expert 9, Expert 4, Expert 8, Expert 3, and Expert 1. Terms with a comprehensive evaluation score above 85.433 were classified as core high-frequency terms, while those below 85.433 were classified as secondary core high-frequency terms. There were 11 core high-frequency terms and 9 secondary core high-frequency terms. In the design of fashion apparel for the young elderly, we need to focus on the functionality and comfort of the clothing, creating a new fashion ecosystem that fosters a symbiotic relationship between consumers and designers. By analyzing the high-frequency terms under the primary elements of design innovation and demand diversity, we aim to develop more universal solutions for the advancement of fashion apparel design for the young elderly from an inclusive design perspective.

5. Transformation and Upgrading Pathways for the Young Elderly Fashion Apparel Industry from an Inclusive Perspective

5.1 Increasing the Diversity of Fashion Apparel Choices for the Young Elderly

The diversity of fashion apparel choices for the young elderly is fundamental to meeting their complex needs. First, functional design is the cornerstone of young elderly fashion apparel, and should fully consider the physiological changes and daily requirements of the elderly. Designers must take into account the physiological changes and health needs of the young elderly, creating clothing that is easy to wear and remove, and offers supportive and auxiliary functions. For instance, using easily operable fastenings such as zippers and Velcro increases the convenience of putting on and taking off clothing. Designing waist and back structures with supportive effects can reduce the fatigue experienced by the elderly when wearing these clothes. Utilizing breathable, moisture-wicking, and sweat-absorbing functional fabrics can enhance the comfort and practicality of the apparel. Additionally, designers can develop specialized clothing with rehabilitation and auxiliary functions to cater to specific health needs, such as those of arthritis patients or individuals with mobility issues.

Secondly, optimizing comfort is a crucial aspect of clothing design for the young elderly. By selecting soft, breathable, and moisture-absorbing natural fibers such as cotton, linen, and silk, the close-fitting comfort of the clothing is enhanced. Attention to fine tailoring and sewing techniques can reduce friction and pressure, improving the wearing experience and ensuring the clothing's comfort and adaptability for extended wear. Considering the body shape changes in the young elderly, designers should use moderately loose fits that provide greater room for movement and flexibility.

Additionally, fashion appeal and personalized design are key factors in enhancing the attractiveness of clothing for the young elderly. Designers should integrate modern fashion elements with the aesthetic preferences of the young elderly, offering a wide variety of styles to satisfy their desires for fashion and self-expression. By introducing popular color combinations, pattern designs, and decorative details, the fashion appeal of the clothing can be increased. Adopting a design style that combines classic and trendy elements can meet the aesthetic needs of the young elderly while also leading fashion trends. Moreover, designers can draw inspiration from traditional cultural elements and craftsmanship to create fashion apparel with cultural depth and artistic value, thereby fulfilling the cultural identity and aesthetic needs of the young elderly.

5.2 Precise Segmentation of the Fashion Apparel Market for the Young Elderly

In the process of precisely segmenting the fashion apparel market for the young elderly, adopting diversified market segmentation standards and inclusive design strategies is crucial. First, the market should be segmented based on the physiological and psychological characteristics of the young elderly. Designers need to consider their changes in body shape, deterioration in vision and hearing, and psychological needs, such as self-esteem and social requirements. It is also essential to differentiate between young elderly and older elderly individuals, providing targeted designs for different consumer groups. For example, designers can create slim-fit styles for those with well-maintained physiques, while designing easy-towear clothing for those with mobility issues.

Additionally, it is necessary to incorporate the young elderly's lifestyle and interests, such as travel, sports, gardening, or dancing, by developing fashion apparel suitable for different scenarios. This approach not only meets their practical needs but also enhances their sense of belonging, happiness, and social attributes. Regional and cultural backgrounds are also important dimensions for market segmentation. By integrating local cultural elements, designers can cater to the aesthetic preferences and functional needs of elderly individuals from different regions.

Accurate market positioning is central to effective marketing. Through market research and data analysis, the target customer group for young elderly fashion apparel can be clearly identified, including their age range, income level, and consumption habits. This allows for more precise decisions in product development, pricing, and marketing strategies. Differentiated competition strategies should be developed based on market segmentation results. For instance, innovative and stylish products can be introduced for elderly individuals who follow fashion trends, while focusing on comfort and functionality for those who prioritize practicality.

The diversification and inclusiveness of marketing channels play a crucial role in market segmentation. An integrated online and offline marketing channel system can leverage the experiential advantages of physical stores, combined with the extensive reach of e-commerce platforms and social media, to improve market penetration and brand influence. Providing customized services is also a key means of meeting the personalized needs of the young elderly. By collecting customer data and information through online platforms, one-on-one personalized design and production can be achieved, enhancing customer satisfaction and brand competitiveness. Community and group marketing are equally important. By organizing interest groups and fashion salons for the elderly, the interaction and connection between the brand and consumers can be strengthened. Social media platforms can be used to establish fashion communities for the elderly, where they can share dressing tips

and fashion information, further increasing brand awareness and influence.

Therefore, by precisely segmenting the fashion apparel market for the young elderly through diversified market segmentation standards and inclusive design strategies, it is possible not only to better meet the diverse needs of the young elderly but also to effectively promote the transformation and upgrading of the fashion apparel industry, achieving more inclusive and sustainable development.

5.3 Design Innovation Drives the Transformation and Upgrading of the Young Elderly Market

Design innovation plays a crucial role in driving the transformation and upgrading of the young elderly fashion apparel market. By comprehensively applying technological innovation, material innovation, sustainable design, user participation design, personalized pattern design, clothing structure design, and color matching, the transformation and upgrading of the industry from an inclusive perspective can be effectively achieved.

Technological innovation in young elderly fashion apparel design brings unprecedented opportunities to the market. The integration of smart wearable technologies, such as health monitoring and emergency call functions, not only enhances the intelligence and practicality of clothing but also improves the safety and convenience of elderly people's lives. Additionally, using digital tools like 3D printing and virtual reality for fashion design and fitting improves design efficiency and significantly enhances user experience. The application of digital tools provides designers with more flexible and efficient tools, making personalized and customized designs possible, thus better meeting the unique needs of the young elderly.

Material innovation fundamentally enhances the quality and environmental friendliness of young elderly fashion apparel. Prioritizing the use of environmentally friendly, biodegradable, or recyclable materials, such as organic cotton and recycled polyester fibers, reflects respect for the environment and addresses the health needs of the elderly. Developing functional fabrics with antibacterial, deodorant, thermal insulation, and breathability properties better meets the physiological needs of the elderly, enhancing their comfort and health protection. Designers should consider the entire lifecycle of fashion products, including production, use, and recycling, to ensure sustainability. Adopting low-carbon production processes reduces energy consumption and environmental pollution, promoting green production and reflecting the design's responsibility to the environment and society. The lifecycle design concept and material innovation help reduce environmental burdens and meet modern society's demands for green consumption, actively responding to sustainable development.

User participation design, personalized pattern design, clothing structure design, and color matching are essential in promoting

the adaptability and innovation of the young elderly fashion apparel market. Through surveys and interviews, designers can deeply understand the needs and preferences of the elderly, ensuring that the design closely aligns with actual user requirements. Involving the elderly in the design process, such as by hosting design workshops and online voting, ensures their opinions and suggestions are incorporated into the products. This approach not only enhances the practicality and market acceptance of the products but also increases the elderly's recognition and satisfaction with the products.

In terms of personalized pattern design and clothing structure design, designs should integrate the cultural background and lifestyle of the young elderly, introducing diversity and inclusivity by combining traditional ethnic patterns with modern artistic elements to meet the aesthetic preferences of different elderly individuals. Personalized pattern customization services allow the elderly to design unique clothing based on their preferences and stories. Clothing structure design should be based on ergonomic principles to ensure a good fit and comfort, especially optimizing for common body changes in the elderly, and focusing on ease of wear, such as using large openings and elastic bands to facilitate independent dressing.Color matching is equally important in young elderly fashion apparel design. Using color psychology principles to create positive atmospheres, and considering the visual characteristics of the elderly by employing high-contrast colors to improve visibility, enhances the overall appeal. Combining fashion elements with classic colors to create designs that cater to the elderly's aesthetic while leading fashion trends boosts the visual appeal of the clothing, enhancing the confidence and style of the elderly.

5.4 Building a Sustainable Ecosystem for the Inclusive Fashion Design Apparel Industry

Building a sustainable ecosystem for the inclusive fashion design apparel industry is key to the transformation and upgrading of the young elderly fashion apparel sector. Policy guidance and industrial planning play critical roles in this endeavor. The government should implement policies such as tax reductions and financial subsidies to support the young elderly fashion apparel industry, encouraging enterprises to increase R&D investments and promote industrial upgrading. Developing a scientifically sound industrial plan that clearly defines the development direction and goals of the young elderly fashion apparel industry can guide orderly enterprise development, preventing disorderly competition and resource wastage. These policy measures not only provide robust support for the industry but also create a favorable external environment for enterprise development.

Secondly, technological innovation and talent cultivation are essential drivers of sustainable industrial development. Building a technology innovation system that integrates enterprises, market orientation, and deep

collaboration among academia, research, and industry can facilitate the application of new technologies, materials, and processes in fashion design. Enhancing talent cultivation in fashion design and related fields, especially through specialized training for young elderly fashion apparel design, improves the professional skills and innovative capacities of the workforce. Coordinating the industrial chain and integrating resources are also crucial for boosting overall industry competitiveness. Strengthening collaboration and coordination among upstream and downstream enterprises to form a complete industrial chain system enhances industry competitiveness. Optimizing the supply chain reduces production costs, improves product quality, and increases response speed. Promoting the sharing of design, technical, and market resources helps build an open and cooperative industrial ecosystem. Encouraging enterprises to engage in technical exchanges, collaborative R&D, and market expansion activities can achieve mutual benefits and win-win outcomes.

Simultaneously, market demand and consumer guidance, sustainable development and environmental protection concepts, and cultural integration with inclusive design are equally important in building a sustainable ecosystem for the inclusive fashion design apparel industry. Conducting in-depth research on the consumption needs and habits of the young elderly helps understand their actual and potential needs, providing a basis for product design and market positioning. Media promotion and fashion events can guide the elderly to establish correct consumption concepts, enhancing their awareness and acceptance of fashion apparel. Moreover, transitioning the young elderly fashion apparel industry towards green production by adopting eco-friendly materials and energy-saving, emission-reducing production processes and equipment can minimize environmental impact. Building a circular economy system to promote the recycling and resource utilization of used clothing reduces resource consumption and waste generation. Combining traditional cultural elements with modern fashion design concepts creates culturally rich and contemporary young elderly fashion apparel, fulfilling the cultural needs of the elderly and promoting cultural heritage and development. Adhering to inclusive design principles by respecting the individual differences and diverse needs of the elderly ensures they feel warmth and care from fashion apparel through humane design and accessible wearing experiences.

6. Conclusion

The transformation and upgrading pathway of the young elderly fashion apparel industry, centered on the core concept of inclusive design, seamlessly integrates functionality, comfort, and personalization in fashion design. From the drive of technological innovation and the selection of environmentally friendly materials and processes to the deep practice of user participation in design personalization and cultural integration, these core strategies provide new insights and solutions for the sustainable development of the fashion industry. However, achieving this pathway requires the collective efforts of designers, enterprises, governments, and consumers. Through this inclusive design-driven sustainable transformation pathway, the young elderly fashion apparel industry will embrace a more innovative, eco-friendly, and sustainable future. Inclusive design is becoming the new engine of fashion design, injecting fresh vitality into the sustainable transformation of the fashion industry. Simultaneously, we must cautiously address the challenges posed by new technologies and design methods, such as social equity, cultural differences, and ethical considerations, to ensure that design practices align with ethical and social values.

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BEYOND BOUNDARIES: ENHANCING HUMAN EXPERIENCE THROUGH INCLUSIVE DESIGN

Sooshin Choi
Savannah College of Art and Design

ABSTRACT | In our quest to enhance humanity, inclusive design stands out as a transformative force, breaking barriers and promoting diversity. This paper explores the profound impact of inclusive design, intertwining accessibility, empathy, and social equity to foster a richer human experience.

At its core, inclusive design goes beyond functionality, embracing the full spectrum of human diversity—from physical abilities to cultural backgrounds, socioeconomic status to cognitive differences. By acknowledging and accommodating this diversity, inclusive design ensures equitable access and celebrates the worth and dignity of every individual.

Through real-world examples and student projects, this paper showcases how inclusive design fosters belonging and empowerment. From a device improving ambulatory function and muscle performance to a haven for hyper-sensitive individuals at theme parks, each case study highlights the transformative power of inclusive design.

Inclusive design is a holistic approach, beginning with empathy and ending with empowerment. It requires a shift in mindset—from viewing diversity as a challenge to embracing it as a source of creativity and innovation. By co-creating with diverse stakeholders, designers can create solutions that are accessible, meaningful, and culturally resonant.

In our interconnected world, the importance of inclusive design is paramount. It is a moral imperative, a social responsibility, and a catalyst for positive change. By centering inclusivity in design practices, we can create equitable, accessible products and environments, and foster a more inclusive society. This paper calls for embracing inclusive design principles to move humanity beyond borders, creating a world where everyone can fully participate, contribute, and thrive.

KEYWORDS | DESIGN FOR HUMANITY, INCLUSIVE DESIGN, HOLISTIC DESIGN APPROACH, EMPOWERMENT BY DESIGN, SOCIAL EQUIT

1. Introduction

Inclusive design represents a shift in the design paradigm, moving from a one-size-fits-all approach to one that embraces human diversity in its many forms. This transformative design philosophy goes beyond creating accessible products; it seeks to enhance the overall human experience by fostering empathy, social equity, and a sense of belonging. This paper delves into the theoretical foundations of inclusive design, showcases real-world applications through case studies, and provides practical guidelines for educators to instill these principles in future designers.

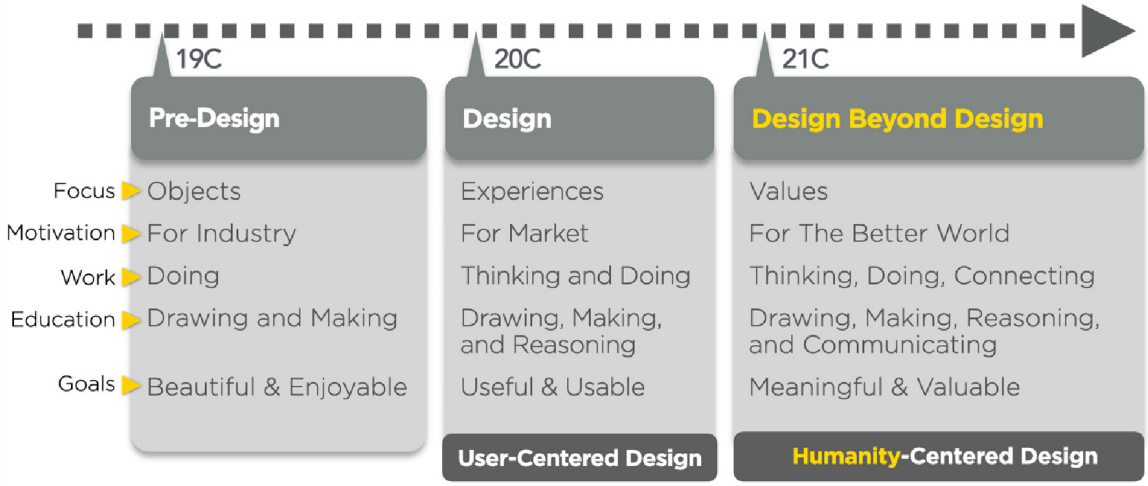
2. Historical Review of Inclusive Design

Emergent of inclusive design is a result of the evident need of equal opportunity, which had been overlooked in all industry and social sectors. As the focus is given to those who do not have access to products and environments. Also, with the development of assistive technology and growth of social awareness of DEI (diversity, equity, and inclusion, the importance of inclusive design has grown within the field of design.

Victor Papanek's vision of designing for all people, including those with disabilities and in developing countries, laid the foundation for inclusive design. His emphasis on ethical, usercentered, and socially responsible design practices in "Design for the Real World" has significantly influenced modern approaches to creating accessible and inclusive products and environments.[1]

It was a natural evolution from focus on object and product to people, not only as users, but holistic human being as the owner of the product and experiences.

[2] Sooshin Choi, Leveraging AI to Infuse Humanity in Industrial Design Education (WDO Education Forum Publication, 2023)



[1] Victor Papanek, Design for the Real World: Human Ecology and Social Change (New York: Pantheon Books, 1971)
Figure 1. Evolution of Industrial Design and Emanating of Humanity-Centered Design. By author.[2]

Inclusive design is one of the two major branches of socially responsible design, alongside sustainable design. Sustainable design has evolved from eco-friendly design, which focused on materials and the physicality of products and the environment, to sustainable design, which addresses products and businesses, and finally to circular design, which encompasses all aspects of products, the environment, and the economy. Similarly, inclusive design has progressed from barrier-free design, which focused on accessibility, to transgenerational design, which considered the elderly, user-centered design, which emphasized ergonomics, universal design, which aimed for the universality of design and the environment, and ultimately to inclusive design.

While sustainable design has been widely accepted and practiced across various fields such as design, business, economics, and environmental studies, inclusive design has seen limited application, primarily within design and architecture. One main reason for this disparity is that sustainable design has demonstrated its impact on the environment, particularly with the growing concern about global warming, as well as on business, thereby gaining national and global attention. It has even become a popular marketing rhetoric, sometimes used by businesses that do not fully practice sustainable design. In contrast, inclusive design has struggled to attract interest from a broad range of stakeholders. It is often perceived as prioritizing people's rights at the expense of business interests. Therefore, it is crucial to teach, practice, and promote inclusive design not only as a philanthropic approach but also

3. Shortfall and Opportunity of Inclusive Design

as a route to innovation and business success. Some design schools have sustainable design programs globally, while there is no design program specialized in inclusive design. Additionally, products in inclusive or universal design are often stereotyped as boring and mundane, making it challenging to capture market attention.

4. Theoretical Foundations of Inclusive Design

Inclusive design is built on several core principles that guide the creation of products, services, and environments that are usable and meaningful to a diverse range of people. These principles include:

4.1. Empathy

Empathy should be the first step in any design process as it helps to understand and share the feelings of others. While most design projects aim at the 'target users,' inclusive design looks at those who are often ignored and excluded in typical design approaches. In the context of design, empathy involves understanding the unique needs, challenges, and experiences of diverse user groups. Empathy-driven design seeks to create solutions that resonate with users on a deep emotional level, fostering a sense of connection and understanding.
Building empathy in design is crucial in any design process and achieved by:

- Contextual User Research: Conducting interviews, surveys, and observations to gain insights into the lived experiences of different user groups.
- Personas and Scenarios: Creating detailed profiles of potential users and their typical use cases to guide the design process.
- Empathy Mapping: Visualizing what users think, feel, see, and do to gain a deeper understanding of their needs and motivations.

4.2. Social Equity

Social equity in design involves recognizing and addressing the diverse socioeconomic and cultural backgrounds of users. Inclusive design promotes fairness and inclusion by ensuring that products and environments are accessible and meaningful to people from all walks of life. This principle emphasizes the importance of designing for marginalized and underserved communities, ensuring that everyone has the opportunity to participate fully in society.
Promotion of social equity can be achieved by:

- Inclusive Participation: Involving diverse stakeholders in the design process to ensure that multiple perspectives are considered.
- Culturally Responsive Design: Creating products and environments that respect and reflect the cultural values and practices

of different communities.

· Equitable Access: Ensuring that all individuals, regardless of their socioeconomic status, have access to the benefits of design.

4.3. Accessibility

Accessibility is a cornerstone of inclusive design, ensuring that products and environments are usable by individuals with varying physical, sensory, and cognitive abilities. Accessibility involves designing for a wide range of abilities, including mobility, vision, hearing, and cognitive function. This principle not only enhances usability for people with disabilities but also improves the overall user experience for everyone.

5. Real-world Examples of Inclusive Design

Successful inclusive design not only helps people who are otherwise excluded but also opens new opportunities for product innovation. There are numerous examples of designs focused on assisting neglected users becoming mainstream in the market. Two examples here demonstrate excellent design solutions that benefit everyone, regardless of their limitations, while achieving significant business success and impact.

5.1. Oxo Good Grips Potato Peeler

The OXO Good Grips Potato Peeler was initially designed to be usable by people with arthritis, but its ergonomic design proved beneficial for all users. Key features include a thick, soft handle for easy gripping and a sharp, swiveling blade for efficient peeling.

This product demonstrates how designing for users with specific needs can result in a product that's better for everyone. It embodies the principle of "universal design" - creating products that are accessible to as many people as possible without the need for adaptation.

Figure 2. Development of Oxo Good Grips potato peeler. Image courtesy Oxo.[2]



Impact of Good Grips product on business and innovation are:

1. Market success: The peeler's inclusive design led to widespread consumer appeal, driving significant sales and establishing OXO as a leader in kitchen tools.
2. Brand reputation: OXO became known for user-centered design, enhancing its brand value.
3. Industry influence: The success of the Good Grips line inspired other companies to adopt inclusive design principles.
4. Innovation driver: It showed that considering diverse user needs can lead to innovative solutions and market opportunities.
5. Shift in design thinking: The peeler's success helped popularize the idea that good design should be accessible to all, influencing design education and practice.

[3] https://www.oxo.com/blog/behind-the-scenes/behind-design-oxos-iconic-good-grips-handles

This example illustrates how inclusive design can lead to better products, business success, and positive social impact, encouraging a more inclusive approach to innovation across industries.

6. Successful Examples of Inclusive Design as Student Work

Most designers applying inclusive design focus on usability, but some expand the definition to include human dignity and product innovation. While the former approach is somewhat passive, solving existing problems, the latter is active, visualizing how designers can improve the quality of life and impact the market.

When products no longer work for them, it's not just the products that are deemed useless; often, the aged consumers themselves feel they have become useless. This leads to a profound and humiliating self-judgment.

6.1. IncludeHealth Access Strength fitness machine

The Access Strength machine, designed as a capstone project by Ryan Eder, a senior industrial design student in 2006, is designed to be universally accessible, allowing people with various abilities, including wheelchair users, to exercise using the same equipment as able-bodied individuals. Its key features include:

1. Adjustable components that accommodate users of different heights and abilities
2. A digital interface for easy program selection and tracking
3. Wheelchair-accessible design that doesn't require transfer

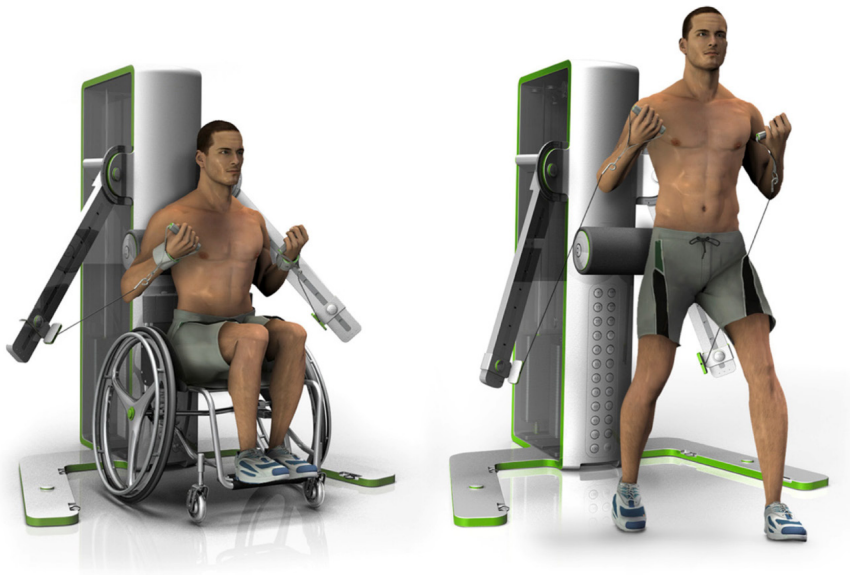
This design showcases inclusive innovation by:

1. Eliminating stigma: It allows people with disabilities to use the same equipment as others, promoting inclusion in fitness spaces.
2. Versatility: The machine serves a wide range of users without the need for specialized equipment for different abilities.
3. Digital integration: The use of technology enhances usability and allows for personalized workout experiences.

Figure 3. Inclusive fitness machine as a capstone project. Image courtesy of IncludeHealth[4]

[4] IncludeHealth Access Strength (source: www.prioritydesigns.com/content/include-health-access-strength)

[5] IncludeHealth Access Strength (source: www.prioritydesigns.com/content/include-health-access-



strength)

broader population.

The project was developed by the students as a capstone project. After earning lots of major design award, he was able to secure fund enough to establish a business to develop this student project into a reality. The images below show the product as a student project and the final product which took ten years in development.

This example underscores how designing for inclusivity from the outset can result in products that are not just accessible, but also technologically advanced and appealing to a wide market leading to new innovative product opportunities.

Figure 4. Fully developed IncludeHealth fitness machine. Image courtesy of IncludeHealth. [5]

6.2. Alle Bathroom Cleaning Tools



The Access Strength machine illustrates how inclusive design can lead to innovation that expand access to fitness, promote equality in public spaces, and potentially improved health for a

The challenge posed by the growing population of aging consumers involves more than just their disadvantages from aging and diminishing physical abilities. It also encompasses the gap between their desire to maintain dignity and their need for assistance. Additionally, many seniors live alone, separated from their families.

This leaves aging consumers with the challenge of maintaining cleanliness in their homes, particularly in the bathroom, without relying heavily on others. The bathroom, being a highly private space, adds another layer of reluctance for many to invite strangers for assistance. This can result in a feeling of helplessness and loss of dignity.

[6] Alle cleaning tools (source: https://www.rcjobe.com/alle)

Figure 5. Alle cleaning tools for senior users. Images courtesy of Cooper Jobe. [6]



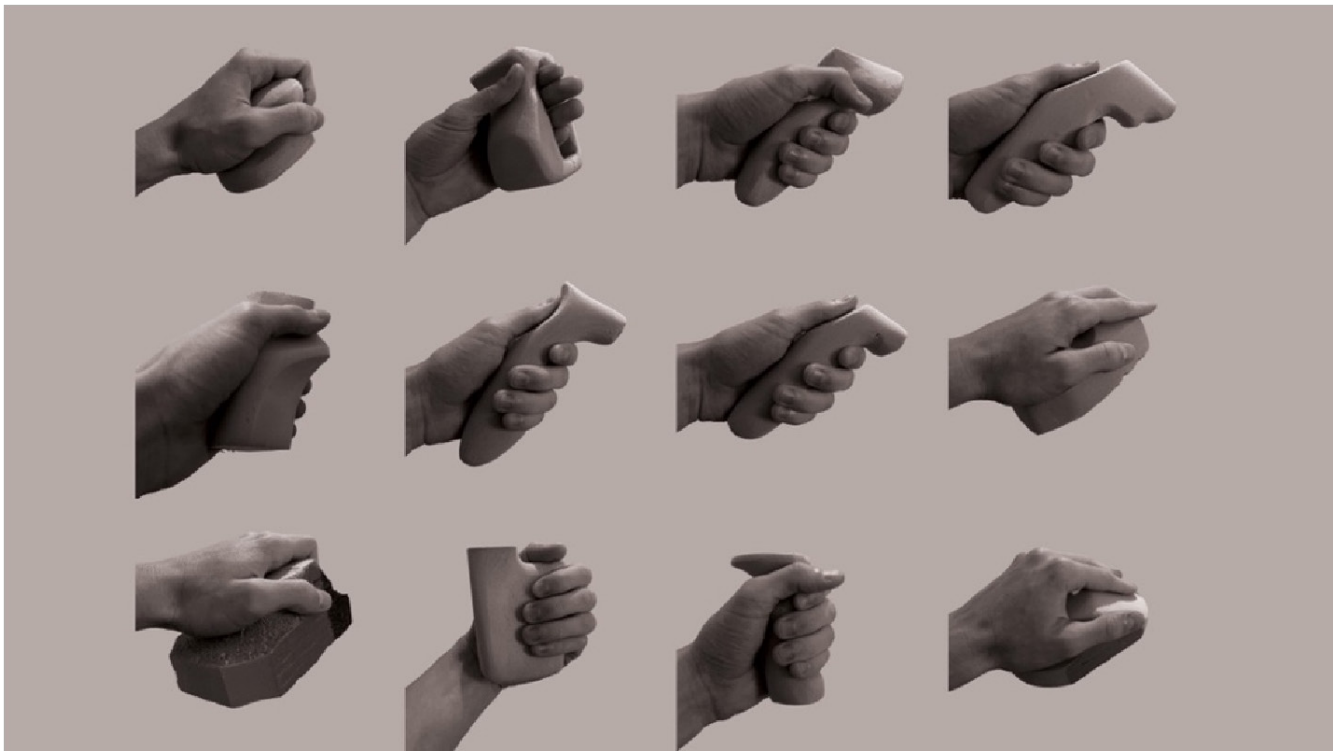
in 2023, is a series of bathroom cleaning tools specifically designed to address these issues, making the cleaning process more manageable and less strenuous for aging consumers. The development of Alle involved extensive consultation and concept validation stages. This ensured that the tools were not only ergonomic and easy to use but also genuinely met the needs of the target users. The name “Alle,” meaning “all” in German, signifies the inclusive intent behind the product. These tools are designed not just for aging consumers but for everyone, highlighting the universal design principle.

Alle, developed by Cooper Jobe, a senior industrial designer at Savannah College of Art and Design

This approach mirrors the success of OXO's Good Grips tools, which were initially designed for people with arthritis but became popular among all users due to their superior ergonomic design. This inclusive strategy not only helps aging individuals maintain their independence and dignity but also presents a compelling business opportunity by tapping into a broader market.

Figure 6. Concept validation of Alle cleaning tools. Images courtesy of Cooper Jobe.[7]

7. Practical Guidelines for Educators





Educators play a crucial role in fostering the principles of inclusive design among future

designers. This section provides practical guidelines for educators to help students develop more valuable designs that address the needs of marginalized groups.

7.1. Incorporating Inclusive Design Principles into Curricula

Ensuring that design education includes a strong emphasis on accessibility, empathy, and social equity is essential to preparing students for inclusive design practices. It has become more crucial than before as the focus on market success, technology, and even artificial intelligence redirects designers from developing designs for all. Educators can incorporate these principles into their curricula through various strategies including philosophical and practical aspects. The image below shows two pillars of an ideal industrial design curriculum that can prepare designers for the future.

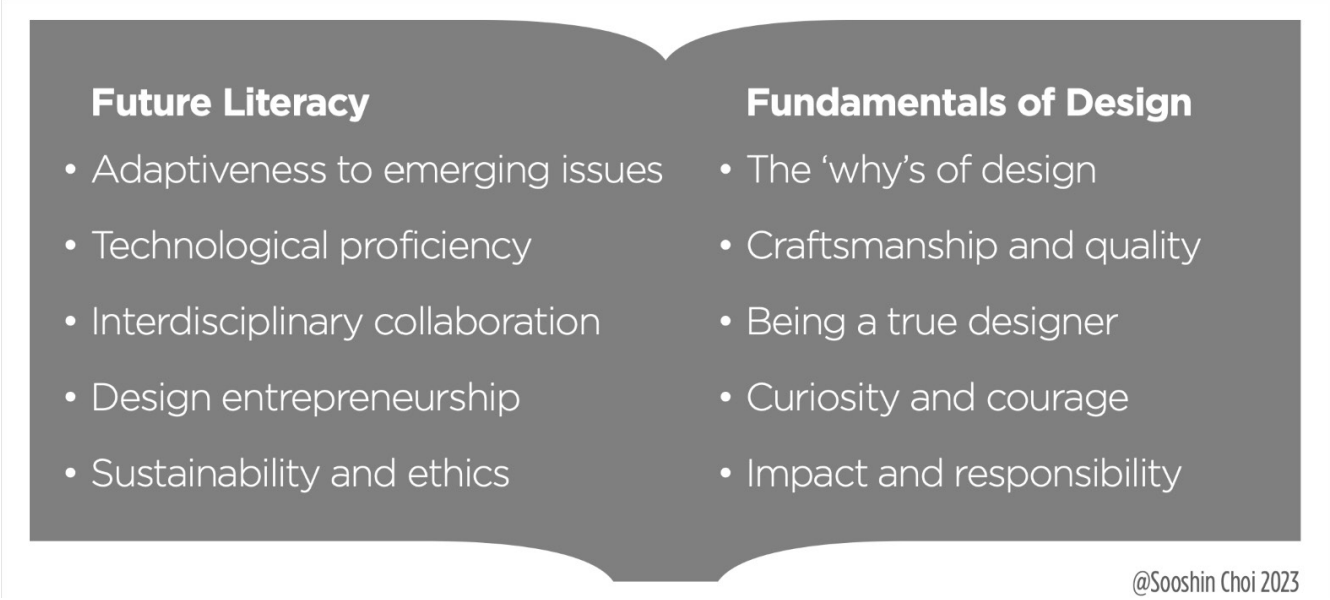
The Future Literacy pillar of the curriculum covers practical aspects of design that will be useful for designers as professionals. It is important to ensure that students learn to handle the topics that are relevant for the future environments.

The Fundamentals of Design pillar of incorporates philosophical aspects of design that are the timeless virtue for designers. Without these values, they will become just design technicians.

Figure 7. Two pillars of Design Education. By author.[8]

[8] Sooshin Choi, Leveraging AI to Infuse Humanity in Industrial Design Education (WDO Education Forum Publication, 2023)

- Philosophical curricular courses:



Students to gain understanding of the virtue of designing for all in classes such as Design

Theory, Design for Society, and Design Colloquium.

· Practical curricular aspects: Students can learn applicable knowledge and experience of how to develop designs for all in classes such as Contextual Design Research, Ergonomics for Industrial Design, Design Studios.

7.2. Strategies for Incorporating Inclusive Design

· Course Content: Integrating topics related to inclusive design, such as accessibility, empathy, and social equity, into existing courses.

· Guest Lectures and Workshops: Inviting experts in inclusive design to give lectures and conduct workshops for students.

· Case Studies and Projects: Assigning case studies and projects that require students to apply inclusive design principles to real-world challenges.

7.3. Interdisciplinary Effort for Inclusive Design

In the "real-world' context, interdisciplinary effort is the key. So, encouraging students to work with peers from diverse disciplines and backgrounds helps them gain a more holistic understanding of user needs. Interdisciplinary collaboration fosters creativity and innovation by bringing together different perspectives and expertise.
Providing opportunities for students to engage in projects involving real users and real-world challenges is crucial for developing their ability to create inclusive designs. Real-world projects allow students to apply their knowledge and skills to practical problems, gaining valuable experience in the process.

Most design schools have partnerships with industry for collaborative projects. While these are primarily aimed at developing market-applicable concepts, schools can take the lead by introducing inclusive design as a motivation for innovation.

· Team Projects: Assigning group projects that require students from different disciplines to work together on a common design challenge.

· Collaborative Studios: Creating studio environments where students from various disciplines can collaborate and share ideas.

· Cross-Disciplinary Courses: Offering courses that bring together students from different disciplines to learn about and practice inclusive design.

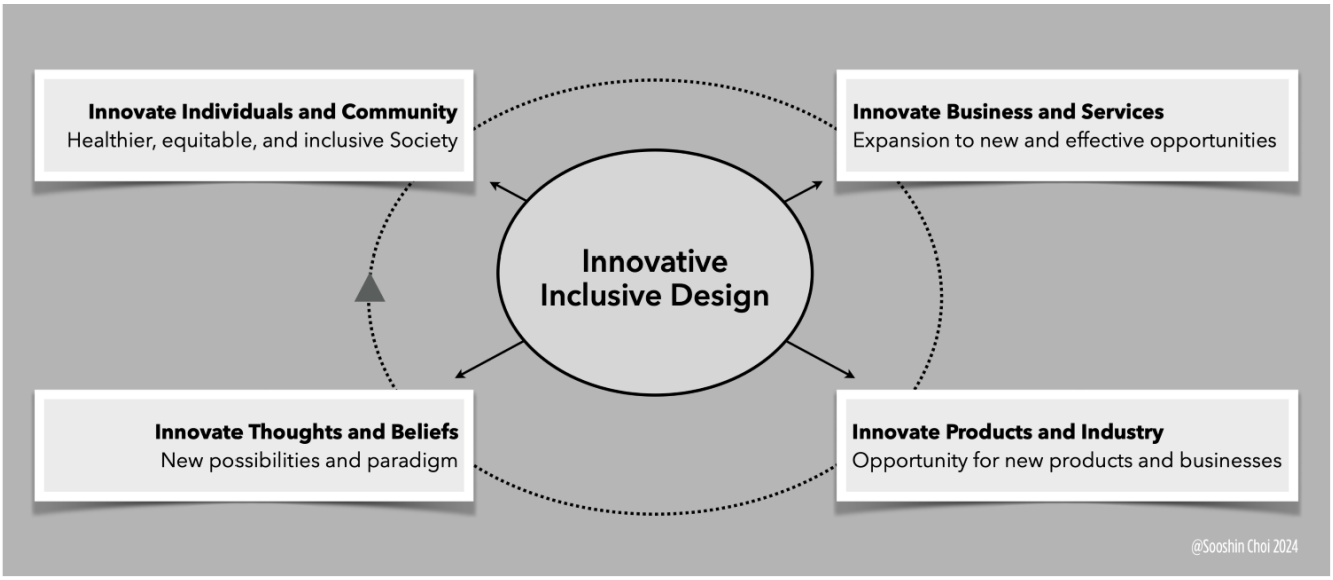
Conclusion

Inclusive design is a powerful tool for enhancing the human experience and

promoting social equity. By centering inclusivity in our design practices, we can create a world where everyone, regardless of their differences, can fully participate, contribute, and thrive.

Figure 8. The Impact of Innovation and Inclusion. By author.

This paper calls on designers, educators, and stakeholders to embrace the principles of inclusive design and harness its transformative potential to move humanity beyond boundaries. Through a commitment to inclusivity, we can cultivate a more empathetic, innovative, and equitable society.



Compared to sustainable design, which often appeals primarily to eco-conscious consumers willing to pay more for conservation efforts, inclusive design can attract a wider range of consumers and benefit individuals, communities, and industries alike.

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THE DEVELOPMENT AND LOGIC OF DIGITAL FASHION FROM THE PERSPECTIVE OF THE DESIGN

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ABSTRACT | As society and the economy transition to different organizational paradigms deeply influenced by digital technologies, the current education system, scientific research, and talent cultivation face elevated demands. Digital fashion, as a frontrunner in this transformative development, is continually pushing the boundaries of traditional fashion, redefining numerous aspects of the industry. In this process, design as a comprehensive and forward-looking discipline, plays a crucial role in understanding and shaping the development of digital fashion. This study addresses the critical issue of the unclear path for the transformation and upgrading of traditional fashion to digital fashion from the perspective of the design discipline. Utilizing theoretical research and case study methods, this research delves deeply into various aspects of the development status, forms of expression, and practical applications of digital fashion in luxury fashion companies and brands. In addition, this study summarizes specific practical approaches in five dimensions: social and spatial integration, deep technological integration, new paradigms of human-machine co-creation, virtual and real fusion, and transaction and circulation. The research demonstrates that the continuous convergence and integration of the design discipline not only drives innovation of digital fashion but also serves as a crucial link bridging technology and creativity, virtual and reality, commerce and art. The findings provide theoretical and methodological references for research on digital fashion from the perspective of design discipline, contributing to the positive development of a design-driven innovative fashion industry.

KEYWORDS | DESIGN SCIENCE, DIGITAL FASHION, FASHION DESIGN, DIGITAL TECHNOLOGY, DIGITAL DESIGN

1. Introduction

Nowadays, digital technology is everywhere. The constantly improving digital technology makes it possible for the process of digitalization in various industries. Digitalization refers to “the transformation of the socioeconomic environment through processes of digital artifact adoption, application and utilization” (Gradillas & Thomas, 2023). The transformation is happening in the fashion industry. The digitalization of the fashion industry also leads to a trend of digital fashion. Digital fashion refers to the application with the use of digital technologies in the fashion industry (Muhammad Sayem et al., 2023). Digital fashion involves digital human and metaverse, digital design and e-prototyping, digital apparel and smart e-technology and digital business and promotion (Sayem, 2022). The digital transformation in fashion has not only affected the creative processes of fashion designers and the production and sales of fashion products but also reshaped the media through which fashion symbols such as trends, styles, and aesthetics are expressed and disseminated (Cantamessa et al., 2020).

Research on the topic of digital fashion has been conducted through the perspectives of different disciplines. Baek et al. did a systematic review of the research on digital fashion. The result shows that the six research topics most closely related to digital fashion are design, virtual, printing, supply, body, and consumer (Baek et al., 2022). Although the topic of design seems to be a common interest of researchers, it is primarily limited to manufacturing and production (Baek et al., 2022). It’s clear that design nowadays, both as an academic discipline and a professional practice, encompasses more than just products and the means of manufacturing and production (Cross, 2018). It includes the design of symbols and signs, material objects, actions and services, as well as systems and environments (Buchanan, 1992). Holding this view, the design of digital fashion should expand to a broader field beyond the manufacturing and production of fashion products.

This paper analyzes the essence and forms of fashion design. By organizing relevant digital technologies and applications, we discuss

how digital fashion functions as the bridge between reality fashion and virtual fashion. To present the development and logic of digital fashion, we use the "four orders of design" as the theoretical framework to conduct a case study of luxury fashion companies Louis Vuitton-Moët-Hennessy (LVMH) and Kering, along with their two most prominent luxury fashion brands: Louis Vuitton (LV) and Gucci. We examine the digital technologies and applications utilized by these two companies and their brands in the design of graphics, objects, activities, and systems in recent years. Through the case study, we identify the status quo and logic of the digitalization of luxury fashion brands and summarize the challenges and limitations of digital fashion today. Finally, from the five dimensions which are social and spatial integration, deep technological integration, new paradigms of human-machine cocreation, virtual and real fusion, and transaction and circulation, we provide potential pathways for the digitalization of fashion and predict the possible future development of digital fashion from the perspective of the design discipline.

2. The Perspective of the Design

2.1 The expanding scope of design discipline

As Cross said, "Design is developing strongly as an academic discipline, as well as a professional practice"(Cross, 2018). During the development of design as a discipline, it faces increasingly complex and wicked problems, a growing intersection of diverse elements, and an expanding range of applications. In this context, the meaning and scope of design as the fundamental question has once become a central topic in the design discipline. The foundational issue is crucial for understanding and advancing the direction of the design discipline. John Walker notes that design has multiple meanings, which can refer to the process, the outcome of that process, the final product, and the overall pattern of a product (Smal & Lavelle, 2011). Herbert Simon once stated that everyone who devises courses of action aimed at changing existing situations into preferred ones is engaged in design (Simon, 1988). Richard Buchanan views design as the capability inherent in human beings to serve personal or collective purposes through the conception, planning, and creation of artifacts (Buchanan, 1992). These varied interpretations of design by different scholars highlight the expanding scope of design.

As a professional practice, the objects that can be designed have continuously expanded. The scope of design has extended beyond traditional artifacts such as graphics and products to include intangible entities such as relationships and environments (Buchanan, 1992). The theory of "Four Orders of Design" put forward by Richard Buchanan provides a framework for clarifying the potential objects and orders encompassed in design activities.

2.2 The theory of “four orders of design”

The theory of “four orders of design” divides design activities into four distinct yet interconnected domains: signs, things, actions, and thoughts (Buchanan, 1992). The first order of design focuses on the design of graphics, which contains the creation and interpretation of symbols and images. The goal of design on this level is to solve communication problems. The second order shifts towards the material objects and products. Here, designers must consider aspects such as functionality and form of artifacts. The demand for graphic design and industrial design comes after the First Industrial Revolution. With the digital transformation of various industries, the demand for design goes to the third order, which extends to interaction, service, and experience. The user experience becomes crucial. In the fourth order, designers need to consider systematically. The system of business, organization, and government is involved in design activities. Design in the order emphasizes the integration of the resources in complex systems, to demand different stakeholders. Strategies become the form of design output. This theory has been applied in design research across various fields, such as interior design (Buchanan, 2019), digital media stage (Liu & Chen, 2020), organizational management (Buchanan, 2015), hybrid collaborative work environments (Meluso et al., 2022), digital publishing (Nylén et al., 2014), design education (Duman & TiMur, 2020), and policy-making (GovLab, 2018).

3. Digital Fashion: from Reality to Virtual

3.1 Connotation of fashion

Fashion exists in various aspects of social life and is continually negotiated within society (Loschek, 2009). It can be treated as a material object, a lifestyle, an abstract idea, a belief system, a social phenomenon, or a cultural value that is adopted by a significant segment of society (Crane, 2000). On one hand, Fashion refers to the idea of what is popular or on trend in a particular time and place (Reddy-Best, 2020). This idea can refer not only to tangible material entities (e.g., clothes and accessories) but also to abstract ideological and cultural currents. It needs to be stressed that material entities themselves cannot simply equal fashion unless they have been embraced by a significant segment of society, i.e., embedded in a broader belief system (Smal & Lavelle, 2011). On the other hand, fashion can also be understood as a social process: a particular behavior or style is possessed and propelled by a small group of pioneers, and then sought after by the public for a period of time and situation (Reddy-Best, 2020). This process represents the inherent scarcity value and flux of fashion.

Georg Simmel remarked that fashion is rational and possesses objective characteristics (Clarke et al., 2003). Different academic disciplines take on different meanings of fashion and conduct research from different perspectives. In a systematic

sense, the object of fashion research can be divided into four aspects. The first one is the symbol system of fashion, trends, fads, and styles; the second one is clothing, accessories, appearance, and other material culture related to lifestyles; the third one is the commercial system for the production and sale of material goods; the last one is the sociocultural forces closely linked to modern and postmodern societies (Kawamura, 2005).

3.2 Design of Fashion

Fashion design refers to a practical activity (Smal & Lavelle, 2011). In lots of contexts, fashion design is merely connected to the creation of objects in trends such as clothing and accessories, i.e., fashion product design. However, that is only a segment of the broader fashion ecosystem. In a broader context, fashion is a complex social phenomenon that encompasses not only material culture but also the commercial systems involved in the production and sale of goods, as well as the symbolic systems and social cultures intertwined with it. Fashion and design are inherently interdisciplinary fields, and their intersection stems from their shared existence within a network of interconnected activities (Smal & Lavelle, 2011). From the broader perspective of the design discipline, the definition of fashion design should not only be limited to the creation and production of merchandise. The interaction between consumers and fashion brands, shopping experiences provided by fashion retailers, and the environment of the fashion shops and shows can all be included in the design of fashion. In addition, the visible or invisible systems such as fashion supply chains, fashion company structures, and strategies, can also be designed. The theory of "four orders of design" provides a broad perspective to scan the fashion industry beyond the motifs and styles of images and products. Thus the definition of a fashion designer can be expanded.

Traditionally, undergraduate fashion design education has focused on developing practical skills, including technical expertise, specialized knowledge, and industry-related competencies. However, with the rise of digital technologies in creative industries like art and fashion, educational institutions are now exploring new approaches to train the next generation of digital fashion designers(Smal & Lavelle, 2011). With the process of digitization, every segment of the fashion industry from the raw material, design, manufacturing, distribution, and retail is experiencing the process of digitalization. Digitalization may provide a new approach to the innovation and reform of the fashion industry and provide more chances and challenges for fashion designers.

3.3 Digitalization of fashion

Digitalization in different industries demands scientific research and response of educational systems within the design discipline. On the one hand, digitalization has expanded the objects of design from traditional tangible products to include virtual products and experiences (Ramaswamy

& Ozcan, 2018). On the other hand, it has profoundly influenced the design processes and design tools across different design activities (Marion & Fixson, 2021). Additionally, The relationship between digital technology and design education has become increasingly intertwined. Digital technology offers design education opportunities to transcend geographical boundaries, allowing students to access knowledge on a global scale. This not only broadens the scope of education but also provides various online resources and tools, enabling students to stay abreast of the latest trends in digital design technology. Moreover, digital education fosters innovation by utilizing virtual laboratories and collaborative platforms, where students can share ideas, collaborate to solve problems, and apply design thinking within a global network, collectively advancing the field of design discipline.

Similar to the impact of digital technology on design, digitalization is continuously merging with the fashion industry. Digital fashion represents the intersection of fashion and digital technology, primarily focusing on the aesthetics and collection of clothing, accessories, and other material culture in the digital world (Bertola & Teunissen, 2018, p. 4). By leveraging technological means, digital fashion transcends the limitations of color, material, and craftsmanship in the real world, enabling the design, exhibition, and sale of virtual fashion products. The transition from traditional fashion to digital fashion has revolutionized the fashion industry, allowing consumers to immersively experience interaction with fashion material and culture through digital media and platforms.

In the early 21st century, with the rise of e-commerce, the term “digital fashion” was first introduced to the fashion industry. Marketers used this term to refer to e-commerce platforms that sold fashion products (Baek et al., 2022). At that time, digital fashion products were referred to as portable hardware devices (Baek et al., 2022). However, with the advancement of digital technology, the definition of digital fashion products has expanded from wearable computing devices to virtual goods within blockchain and metaverse spaces. In recent years, fashion brands have ventured into the metaverse and begun experimenting with digital collectibles, gaming, artificial intelligence (AI), and extended reality (XR) (Noris et al., 2021). As a result, the definition of digital fashion has continually evolved and become more complex. Digital fashion now encompasses any concept combined with digital experimental technologies with fashion. This includes real or virtual clothing and accessories produced using technologies like body scanning and 3D printing, as well as digital media for showcasing and disseminating these products and services, such as virtual avatars and online fashion shows.(Baek et al., 2022) through a systematic literature review of digital fashion-related research, define digital fashion as “the virtual creation, production, and representation of one’s identity via computergenerated design” (2022).

The digitalization of fashion signifies a comprehensive transformation, as depicted in Figure 1. Reality fashion serves as the foundation for the existence of digital fashion. The term “fashion” here is used in a broad academic context. It refers to both a type of material culture (such as clothing and textiles, jewelry and accessories, and consumer services) and a system of symbols (Kawamura, 2005). Fashion functions as a commercial system that produces and sells products (including brands, systems, and intermediary media) and also as a socio-cultural force closely linked to modernity and postmodernity (Rocamora & Smelik, 2015). Thus, objects and symbols together construct fashion and, through practices of production, consumption, distribution, and representation, connect countless individuals and collectives (Elliott, 2004).

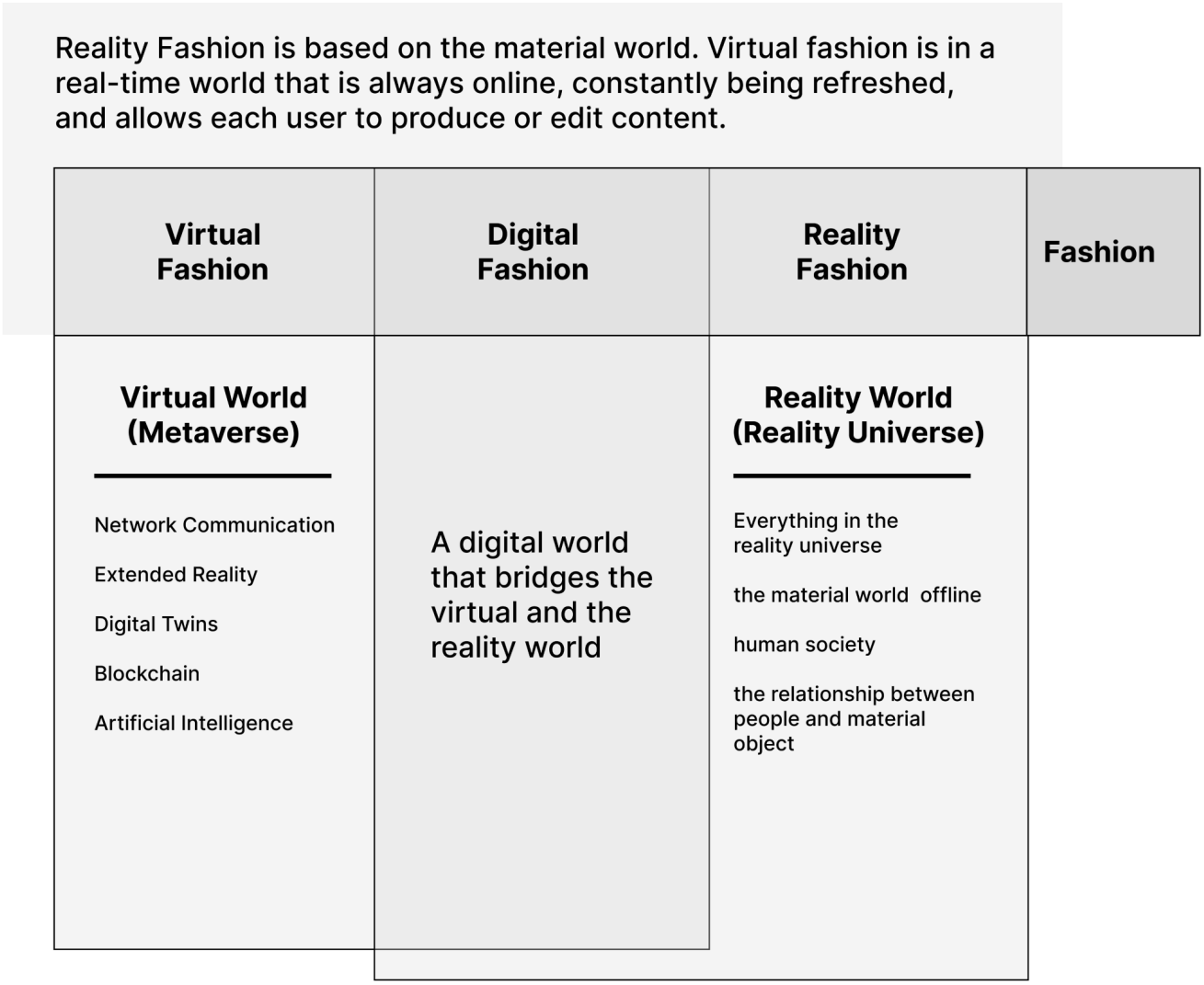


Figure1. Elements of development in digital fashion.

Since the onset of COVID-19, the development of digital fashion has led the traditional fashion industry to move beyond its reliance on physical materials. In this context, virtual fashion, based on digital technologies, has emerged (Fu & Liang, 2022). Virtual fashion represents an extension of reality fashion into the metaverse, a new hybrid form of internet application and social structure that integrates network communication, extended reality, digital twins, blockchain, artificial intelligence, and other emerging technologies (Huynh-The et al., 2022). The metaverse features a complete economic system, encompassing data, objects, content, and intellectual property, and functions as a perpetually online, continuously evolving real-time digital world (Lee et al., 2021). It allows users to create content and edit the world. Digital fashion blurs the lines between the real world and virtual spaces, with the metaverse providing a broader space for its development. Virtual and reality fashion are not separate entities but are interconnected, complementary, and enriched through digital technologies. Fashion consumers are now living in a fully digitalized dimension, where self-expression and identity exploration are not limited to various hardware and software applications. Instead, they are engaged in multimedia, crossmedia, and even virtual reality environments, showcasing and defining themselves in diverse ways. Through fashion media, individuals can express themselves and explore their identities beyond tangible material boundaries, pushing the pursuit of fashion beyond the constraints of the real world and into the expansive realm of digital fashion. In this digital environment, individuals are empowered to present diverse forms of self-expression, thereby opening up new avenues for constructing multiple self-identities. This evolution allows for a more profound exploration of identity and self-representation, transcending the limitations of the physical world and venturing into the boundless possibilities of digital fashion.

3.4 Digital technologies and applications in fashion

Digitalization is a key driver of transformation in the contemporary fashion industry, with the core of digital fashion development centered on the integration of various technological fields. Emerging digital technologies are reshaping traditional fashion design, production processes, and consumer behavior (Bertola & Teunissen, 2018). These shifts have profound implications for the overall ecosystem of the fashion industry.

In the fashion product design process, designers utilize computer-aided (CAD) modeling technologies and platforms (e.g., Rhino) and digital pattern-making software (e.g., CLO3D) to create digital prototypes. Users can enhance garment fit and size prediction by accurately scanning their bodies, thereby optimizing the design and development process of physical clothing. Parametric design techniques allow designers to maximize their creativity by constructing parametric structures. Moreover, virtual fitting, virtual bodies, and virtual fashion shows that use virtual bodies and apparel are also based on

CAD technology. The virtual concept in digital fashion goes beyond the realm of fashion products, introducing a new framework that includes digital platforms and virtual worlds based on real-time rendered simulations.

Additive manufacturing technology disrupts the traditional paradigms of fashion manufacturing and production. 3-Dimension (3D) printing enables designers to materialize complex forms of digital prototypes, facilitating rapid prototyping. Additionally, it offers sustainable production alternatives, allowing for material usage without waste, thus revolutionizing traditional supply chains. Digital accessories (e.g., Arduino) and wearable technology are also employed by designers to create products with fashion functionalities (e.g., smartwatches), or to design fashion pieces that respond to body movements in real-time.

Extended Reality (XR) technologies have transformed traditional tangible fashion into intangible fashion expressed through pixels and digital prints. XR technologies include Augmented Reality (AR) and Virtual Reality (VR). AR enables shoppers to interact with products in real-time within physical retail environments (e.g., digital Gucci shoes). VR aids fashion brands in developing virtual stores and virtual fashion shows, offering new venues for shaping digital fashion. It also allows consumers to develop their digital identities within digital environments like the Metaverse. XR provides consumers with new experiences in shopping, exhibitions, and identity formation.

Blockchain technology provides transparent and trustworthy data throughout the entire supply chain process in the fashion industry. For instance, blockchain technology can reveal the origin and quality of raw materials and ensure the authenticity and reliability of final retail products. Additionally, blockchain allows digital models to be sold as non-fungible tokens (NFT) and distributed to consumers in both virtual and real worlds.

AI and machine learning assist designers in quickly gathering design inspiration and realizing creative ideas. They empower brands to understand fashion trends and respond to consumer and market segment needs. Retailers can use real-time data provided by AI to observe changing trends and inventory performance, thus making informed business decisions. AI and machine learning significantly shorten the fashion creation and dissemination cycle.

Under the influence of emerging technologies, the interplay between visual arts, science and technology, digital information, and artificial intelligence has given rise to a new paradigm of digital fashion. Digital fashion is not merely the combination of art and technology. It represents a significant advancement in the cultural and creative industries, specifically within the fashion sector. This encompasses technological innovations and new models applied across various stages, from design and manufacturing to communication and distribution, thereby enhancing the industry's diversity. The incorporation of digital technologies does not simply alter traditional

fashion imagery but also profoundly transforms consumer perceptions. However, scholars have pointed out certain issues during the process of digitalization. For example, Smal & Lavelle states that "the over-reliance on historical elements in fashion has neglected the technological and global relevance of fashion in the twenty-first century."(2011) To address challenges, the framework from the design discipline can provide a theoretical foundation for exploring the structure and development paths of digital fashion, as shown in Figure 2.

Design Object		Tangible Fashion	Digital Fashion
Signs	Graphic	Brand logo Monogram Pattern Photograph Drawing	Digital brand logo and pattern Digital images Videos
Artifact	Product	Cloth Apparel Accessories	Smart wearables Embedded Electronics Virtual clothing and accessories Virtual avatar
	Tool	Traditional tools	2D/3D CAD AI for design & prototype
Action	Interaction	Offline Retail	Branded websites, applets Virtual platform
	Services	Maison service	Online retail (VR/AR shopping experience) Virtual try-on
	Experience	Offline Fashion Show Exhibition	Virtual fashion show/exhibition Digital and virtual games
Thought	Environment	Physical shops	Social Media Digital/Virtual fashion space Metaverse
	Business	Supply chain Offline Retail	Blockchain E-Commerce E-Promotion
	Strategy		AI for business

Figure2. Key elements of the four orders in the traditional and digital design spaces in the fashion industry.

4. Development and Logic of Digital Fashion

4.1 Research Design

We studied the current state and logic of digital fashion development by conducting a case study of two of the largest luxury fashion companies in the world: LVMH and Kering, along with their two most prominent luxury fashion brands: LV and Gucci. The case study method is effective in analyzing contemporary and unique phenomena that lack extensive theoretical grounding. Studying luxury fashion groups and brands allows us to better understand the practical logic behind digital fashion development, as these companies often leverage cutting-edge digital technologies to lead fashion trends. While fashion cannot be simply equated with clothing, the apparel and accessories industry is one of fashion's main drivers and a key stakeholder in the digital fashion landscape.

The theory of "four orders of design" provides an appropriate framework for our case study. Since these four orders are not isolated from one another, the logic of digital fashion development can be seen in the interactions between them. We organized and analyzed these companies' recent efforts in digital fashion from the perspectives of signs, things, actions, and thoughts, aiming to clarify the current state and underlying logic of digital fashion development.

4.2 Case study on graphic design

Before the rise of digital social platforms, luxury fashion groups primarily focused on promoting their brands through print and television advertisements. With the emergence of social media platforms like Facebook, Instagram, YouTube, and Redbook, luxury brands are no longer confined to the limitations of one-page magazine ads. Today, luxury brands and conglomerates are flocking to these platforms, leveraging a variety of digital media formats (e.g., pictures, videos, games) to reach an increasingly younger luxury audience.

For example, LVMH regularly posts images and videos of contemporary idols and celebrities wearing and showcasing their brands and products on social media. Meanwhile, Kering's brands have achieved high levels of engagement across all the platforms they utilize. Gucci, for instance, launched the online art initiative #GucciGram on social media, encouraging users to creatively reinterpret its iconic patterns like the "geraniums of Blooms" and the "graphic lines of Caleido." These classic brand patterns and products are shared and showcased through photography, painting, and collages on digital visual platforms. Social media platforms have allowed for consumerdriven content to enhance traditional fashion brand marketing, moving beyond the limitations of one-way advertisements.

In the digital era, brand symbols face new design demands. Logos and typography must adapt to various screen sizes on mobile phones, computers, and head-mounted displays to ensure brand recognition across apps, websites, and augmented or virtual reality environments. As a result, brand logos and patterns have gradually shifted from static designs to adaptive, dynamic, and interactive digital forms. For example, in LV's 2021 digital game "Louis: The Game," its iconic floral monogram appears as the protagonist's character element, as scene decorations, and even as a virtual joystick for player control. Moreover, luxury fashion brands are broadening the reach of their brand symbols through collaborations with the gaming industry. In the phenomenon-level game "League of Legends", Louis Vuitton introduced in-game skins featuring its logo, allowing players to express their personality and style through fashionable character customizations.

Beyond product logos and patterns, digital technology is redefining the symbolic forms of fashion brands. In 2022, LVMH introduced "Livi", a 3D-modeled digital figure, as its virtual brand ambassador. This technological advancement has enabled fashion brands to transition from traditional two-dimensional logos and patterns to more immersive, three-dimensional representations.

4.3 Case study on industrial design

Luxury fashion brands like LV and Gucci are renowned for their high-quality materials, exceptional tailoring, and exquisite designs. However, with the widespread adoption of digital technology, the design and production processes of fashion products have undergone a profound digital transformation. Today, designers can replace traditional hand-drawn sketches and manual cutting with digital tools, allowing them to conceptualize and create fashion items through software. AIdriven design tools further assist in generating novel styles. Beyond digital creation, 3D printing technology has revolutionized the manufacturing process of luxury fashion products. For instance, Gucci combined traditional craftsmanship with 3D printing to design its "Cub3D" sneakers, while LV introduced the "Cobra" sneakers using hybrid material 3D printing technology.

Digital technology not only influences the aesthetic of fashion products but also enhances their functionality. Gucci's smart rings and Louis Vuitton's smartwatches exemplify this trend. By integrating advanced sensors and miniaturized electronic devices into wearable fashion products, luxury brands capture physiological data and respond to users' interactions with their environment, achieving a fusion of digital functionality and fashion aesthetics.

Moreover, digital technology has expanded the definition of products from physical entities to virtual ones. On the one hand, by merging digital technology with physical products, luxury fashion brands are breaking down the barriers between the physical and virtual realms. Through digital twin technology, designers can create precise replicas of real fashion items, allowing consumers to preview, personalize, and virtually try on products in fully digital environments. Consumers can view how a product would look on them via 3D virtual models, aiding their purchase decisions. For example, Gucci uses AR technology in its mobile app and on social media platforms like Snapchat to offer virtual try-ons. Through a phone camera, users can "try on" Gucci's shoes, bags, and accessories, providing a new online shopping experience.

On the other hand, digital technology enables luxury brands to create entirely new forms of products. Virtual fashion can transcend physical limitations, offering novel visual experiences. These virtual fashion pieces can exist in games and on social platforms and can also be traded as NFTs on the blockchain, creating a new form of luxury. LV, for instance, launched the "VIA Treasure Trunk" series of digital collectibles in 2023. These NFTs feature iconic travel trunk designs and come with physical replicas. The high-priced NFTs cannot be resold or transferred, maintaining extreme rarity and exclusivity. By transforming virtual fashion products into unique digital assets, luxury brands enable consumers to own and showcase these items in virtual worlds. This virtual fashion trend not only expands the luxury market but also enhances the digital collectible value of brands.

Overall, in the second order of design, luxury fashion brands' digital transformation is characterized by leveraging advanced digital technologies to innovate the entire process, from design and production to sales, creating more novel, interactive, and personalized products and experiences.

4.4 Case study on experience design

Both Kering and LVMH are leveraging innovative digital tools to enhance brand interaction with consumers, optimize fashion experiences, and reshape customer relationships. A key step in LVMH's digital transformation was the launch of its multi-brand eCommerce site, "24 Sèvres", in 2017. This platform offers a wide range of online functions, including product availability checks, online fitting appointments, click-to-order, and in-store pickup services. In addition to a user-friendly interface, luxury brands prioritize providing a high-quality consumer experience. One standout feature of 24 Sèvres is the option for customers to have one-on-one video consultations with brand stylists. LVMH also uses social media platforms to enhance customer engagement.
On Facebook, for example, shoppers can interact with the "24 Sèvres Style Bot" to maximize the platform's shopping capabilities. Similarly, Gucci has strengthened social

engagement through campaigns like #GucciGram on social media, fostering a sense of belonging and brand loyalty among users.

With the development of digital technologies such as AR and XR, consumers can now view and interact with virtual fashion products in real or virtual environments through smart devices. These new interaction modes, enabled by head-mounted displays, introduce new demands for user interface design. In early 2024, Gucci and Balenciaga, both under Kering, launched digital apps on the Apple Vision Pro platform. Through these apps, users can immerse themselves in documentaries, online fashion shows, and interactive styling experiences. VR and AR technologies offer consumers new interactive shopping experiences. AR technology makes personalized services like virtual try-ons and customizations possible. Gucci, for instance, began offering virtual try-on functionality in its app in 2019. This feature allows consumers to preview how clothing looks on them in a digital environment without needing physical products.

Moreover, the application of XR technology has expanded the boundaries of digital fashion displays and experiences. In 2021, Balenciaga partnered with Epic Games to launch the digital game “Afterworld: The Age of Tomorrow”. Within the game’s futuristic virtual world, Balenciaga showcased its 2021 Fall fashion collection. This gamification of luxury fashion brands attracted younger consumers through novel interactive experiences, providing a fresh way to present brand culture. By applying cutting-edge digital technologies, luxury fashion brands aim to enhance the shopping experience and optimize the display and interaction of digital fashion products. This allows consumers to enjoy interactive and service experiences on digital platforms that rival or even surpass those in physical stores, significantly boosting the immersion and interactivity of online shopping.

In the third order, luxury fashion brands’ digital transformation focuses on enhancing user experiences and interactions through technological innovation. Digital technologies offer consumers more convenient, personalized, and immersive service experiences.

4.5 Case study on system design

Luxury brands are utilizing digital technology to create fashion spaces that blend virtual and physical experiences. On one hand, luxury brand offline stores integrate digital technologies to offer personalized and immersive fashion experiences for in-store customers. On the other hand, the design of environments is no longer confined to traditional physical spaces. By leveraging digital technology to build fashion spaces that are either parallel to physical ones, merge virtual and real environments, or are purely virtual, fashion brands can offer their users more diverse experiences across time and space. For example, GUCCI has experimented multiple times with creating virtual spaces

in the metaverse. In 2021, Gucci launched a two-week virtual exhibition called "Gucci Garden" on the Roblox platform, where players could discover and purchase digital Gucci collectibles, such as clothing and accessories. Following the success of "Gucci Garden," in 2022 Gucci introduced "Gucci Town" on Roblox, offering consumers a richer digital fashion experience, including creation, social interaction, customization, and themed games. That same year, Gucci partnered with the digital real estate platform The Sandbox to launch a metaverse hub called "Gucci Vault Land," making it the first fashion brand to own its assets on a metaverse platform. Such innovations not only bring brands closer to younger consumers but also provide fashion brands with a new path for creativity, transactions, and display within virtual spaces.

In addition, luxury fashion groups are driving innovation in supply chain management, brand marketing, and shopping experiences through digital strategies. Kering and LVMH have successfully streamlined the online luxury experience by launching fully functional e-commerce websites and tapping into the power of social media. This direct-to-consumer (DTC) approach allows luxury brands to extend their exclusive experiences from physical stores to digital platforms. In terms of supply chain management, Kering and LVMH have adopted RFID and NFC technologies at every stage of the supply chain, from fabric management and production to warehousing and sales. For instance, consumers can verify the authenticity of their LV purchases by scanning NFC tags. With the rise of blockchain technology and NFT markets, luxury fashion brands have begun engaging with virtual trading platforms. Both LV and Gucci have released several NFT products in recent years. Blockchain technology, with its decentralized, secure, and transparent nature, provides a reliable ownership and authentication database for digital fashion products, ensuring that the originality and ownership of each piece can be permanently recorded and verified.

The digital transformation of luxury fashion companies is also reflected in their holistic yet differentiated innovation strategies. Groups like LVMH have started implementing digital transformation plans across their entire organization. LVMH currently has over 75 brands, each with its own brand image, requiring differentiated digital strategies tailored to their individual characteristics. Since 2018, LVMH has been promoting the "La Maison des Startups" program, which fosters collaboration between startups in the luxury industry and its own brands, exploring the future of digital products and services in the luxury sector. This incubator model not only empowers startups to innovate but also provides LVMH brands with an open space for transformation.

5. Discussion: Challenges, Limitations, Projections and Pathways

5.1 Challenges and limitations of current digital fashion

Digital and virtual fashion presents exciting possibilities but also faces significant challenges. As fashion evolves at an increasingly rapid pace, trends emerge and disappear quickly. The attitudes of luxury fashion brands toward virtual fashion remain speculative. A noticeable fact is that many luxury fashion brands sparked a wave of virtual fashion during the pandemic. However, whether this trend will endure remains uncertain.

From a business perspective, transforming innovative designs into viable commercial products in the realm of digital fashion is challenging. This not only involves creating appealing virtual products and platforms through appropriate design but also exploring new business models suited to digital and virtual fashion. The glamorous future fashion world portrayed by the media is an illusion, representing only one facet of the business. The relationship between decision-making and the impact of luxury fashion brands in virtual spaces like the metaverse remains unclear (Granqvist, n.d.). Key challenges include ensuring the longevity and sustainability of virtual products, maintaining user engagement, and fostering content creation within virtual spaces. Furthermore, the conflict between blockchain-enabled supply chain transparency and the commercial confidentiality of fashion brands is yet to be resolved.

From the perspective of technological development, integrating virtual and real-world design requires substantial resources and technical investment. This may lead to a division of innovation forces within the fashion industry (Strähle & Grünewald, 2017). Additionally, fashion design education has shown a lag in adapting to the rapid growth of digital fashion. Traditional design curricula often fail to fully cover the skills and knowledge required for digital fashion, leaving young designers without the necessary digital competencies and facing the challenge of skill conversion (Chrimes & Boardman, 2023). To keep up with the times, they must learn new tools and technologies, such as 3D modeling and programming, which can result in a steep learning curve, potentially limiting their ability to innovate. For consumers, long-term participation in creating content within virtual environments is likely only if they find the digital components of the metaverse useful and user-friendly. Moreover, interoperability between different virtual environments remains an obstacle. While the exchange of tokenized collectibles in the metaverse is appealing, creating secure and efficient trading platforms for these assets to enable seamless transactions presents a challenge.

From the perspective of social acceptance and ethics, the widespread adoption of digital fashion still has a long way to go. This involves not only the safety and inclusivity of the technology but also how consumers reshape social interaction and personal identity in virtual environments. First, consumers are concerned about the privacy of personal data on digital platforms. For example, creating digital avatars often requires the collection and use of personal data, including facial images, sensory data, and behaviors (Jim et al., 2023). Access to such sensitive information may make users hesitant to enter the metaverse due to fears of personal privacy breaches. As virtual worlds evolve, the way brands collect, use, and apply consumer data remains a gray area, as seen with smart wearable devices. Second, from the standpoint of inclusivity, there are still no effective safeguards to prevent harmful avatar behavior, hate speech, or harassment in virtual spaces. Lastly, societal biases based on gender, race, and culture, which exist in the real world, continue to be present in digital environments. For instance, current avatar presets and digital clothing options are highly binary, limiting gender expression to male or female (Nabbosa & Kaar, 2020). As fashion brands transition into the metaverse, inclusive marketing will remain a critical issue.

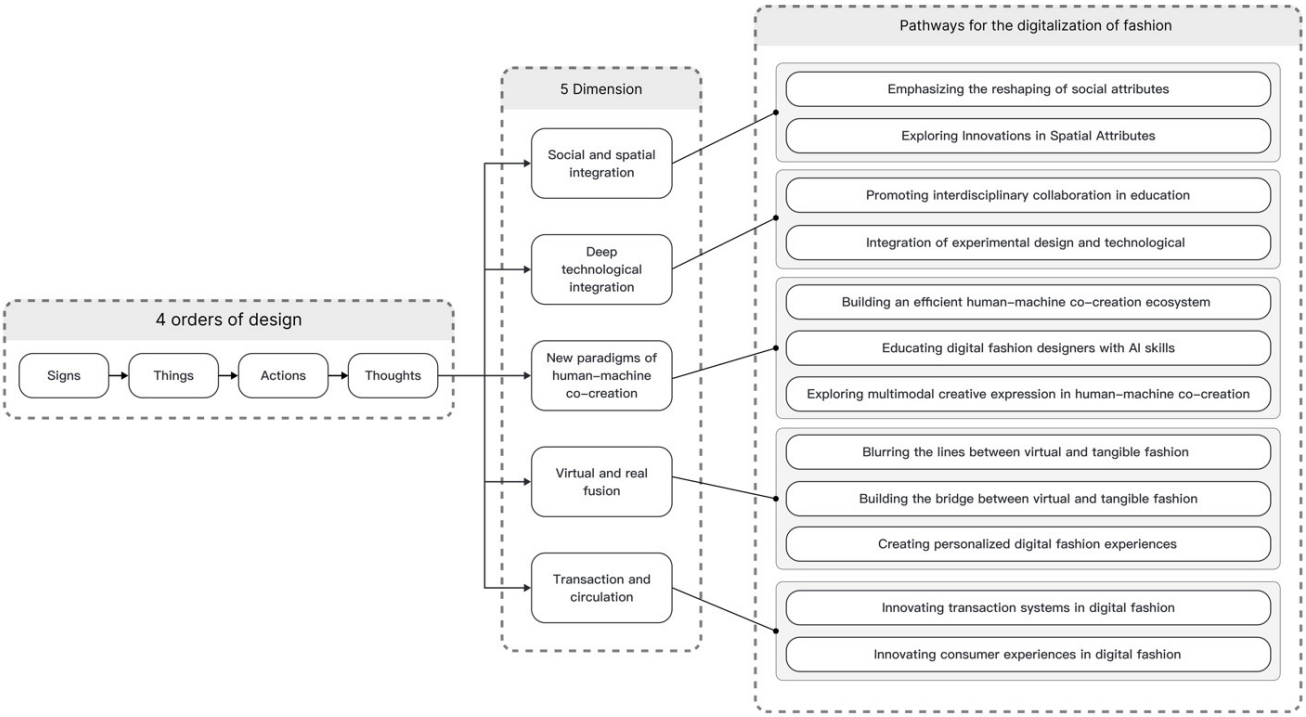
In fact, compared to other industries, the fashion industry has been criticized for its slow adoption of digital technologies. Fashion brands should be more proactive in addressing business and technological challenges. Beyond that, digital fashion still faces significant challenges concerning privacy, cultural diversity, rights balance, and gender issues, all of which touch on broader social and ethical concerns.

5.2 Projections of future digital fashion

With the development of the metaverse, future digital fashion experiences are becoming increasingly immersive, interactive, and personalized. For example, fashion brands will increasingly use NFTs as gateways for digital consumers to enter exclusive, club-like communities. Just as brand trust built on traditional social media platforms can influence brand loyalty, virtual communities in the metaverse will follow a similar pattern. By offering consumers personalized immersive experiences, exclusive privileges, and opportunities to participate in product development, brands can strengthen consumer trust and loyalty. Meanwhile, fashion marketing on social media is gradually shifting from broad-based strategies to building smaller, highly engaged niche communities within the metaverse. These communities will form around shared values, aesthetics, or unique experiences, enabling brands and users to co-create digital fashion. Consumers will no longer be passive buyers but active participants in fashion design and marketing.

Additionally, more fashion brands are adopting blockchain technology to ensure supply chain transparency by openly sharing information about material sources, production facilities,

and environmental impacts. Blockchain can be integrated with digital retail spaces in the metaverse, allowing consumers to explore the manufacturing process, supply chain transparency, and sustainability practices through virtual experiences. By scanning QR codes or NFC tags on products, consumers can access complete production information, thereby enhancing trust in the brand and verifying its environmental commitments. On the other hand, while competition exists between fashion brands, collaboration will become increasingly important for achieving supply chain transparency and fairness. The future of the digital fashion industry may see the emergence of standardized information-sharing systems across the sector. Brands will be able to open up their supply chains in a transparent manner while protecting trade secrets, ultimately improving the industry's sustainability and social responsibility through cooperation.



5.3 Pathways for the digitalization of fashion

Figure3. Five dimensions on digital fashion between "four orders of design" and pathways for the digitalization of fashion.

In the digital age, the rise of digital fashion is driven and constrained by various factors, including design concepts, technological advancements, and market demand. The inherent complexity and challenges in this field present the design discipline with significant opportunities for exploration and innovation. To strike a balance between opportunities and challenges in the transformation

and upgrading of digital fashion, it is essential to adopt a structured approach, applying architectural thinking for top-level planning and holistic layout within the design discipline. We deconstruct the development pathways of digital fashion from five dimensions: social and spatial integration, deep technological integration, new paradigms of human-machine co-creation, virtual and real fusion, and transaction and circulation, as shown in Figure 3. By exploring these dimensions, the aim is to accelerate the digitalization of fashion within the design discipline.

The first pathway is to shape the social and spatial attributes of digital fashion. Emphasizing the reshaping of social attributes. In the transformation and upgrading of digital fashion, reshaping its social attributes has become a key development strategy. This strategy focuses on leveraging the power of design to promote cultural integration and co-creation of values, reflecting and enhancing social diversity and inclusivity. Collaboration between designers and creators from diverse cultural backgrounds, along with the co-creation mechanisms offered by digital platforms, serve as bridges for cross-cultural understanding and communication. Moreover, incorporating sustainable design concepts, such as using eco-friendly materials, implementing recycling strategies, and developing innovative methods to reduce design waste, advocates for a more responsible and sustainable consumption model. Enhancing social engagement and user interaction through design strategies—such as design competitions on social media platforms and personalized services—heightens the appeal of digital fashion products and fosters a sense of belonging and loyalty among users. By reshaping the social attributes of digital fashion from a design perspective, students and designers can recognize that design is not only a form of visual and aesthetic expression but also a medium for social and cultural exchange. This can promote the formation of social values and the enhancement of cultural awareness. The integration of design thinking with social and cultural values plays a crucial role in shaping a more diverse, inclusive, and sustainable digital fashion ecosystem.

Exploring innovations in spatial attributes. Innovations in the spatial attributes of digital fashion are an inevitable trend in response to contemporary technological advancements and changing user needs. These innovations involve the integration of virtual and real worlds, the design innovation of digital exhibition spaces, and the application of intelligent spatial layouts, providing richer and more interactive fashion experiences. By using cutting-edge technologies such as augmented reality (AR) and virtual reality (VR) in design practices, designers can create immersive experience spaces that blur the boundaries between virtual and reality, greatly enriching the sensory experiences and interaction modes for users. Digital display platforms, such as virtual fitting rooms and 3D product displays, optimize the user experience using digital technologies, while also reducing the consumption of physical space and resources, embodying an environmentally friendly and

resourcesaving design philosophy.

The second pathway is to promote interdisciplinary integration of technologies in digital fashion. Promoting interdisciplinary collaboration in education. To foster deeper collaboration and knowledge sharing between the design discipline and fields such as computer science, materials science, and artificial intelligence, it is crucial to build and develop multidisciplinary collaboration platforms and update design education systems. This interdisciplinary cooperation not only broadens the technical horizons of design professionals but also introduces new technological possibilities and innovative thinking into design practices. Innovation in design education also plays a vital role. By integrating the latest technological advancements into design curricula, implementing project-based learning approaches, and offering specialized workshops and training, design education can more effectively cultivate students' abilities in cutting-edge technology application and innovative design thinking. Furthermore, encouraging lifelong learning and continuous professional development ensures that designers remain abreast of technological advancements, thereby reinforcing the central role of the design field in digital transformation.

Integration of experimental design and technology. To drive the cross-disciplinary integration of innovative technologies in digital fashion, it is essential to encourage experimental and exploratory design and to strengthen the dialogue between design and technology. This integration requires a willingness to experiment with new technologies and innovative methods, exploring the potential applications of advanced technologies such as virtual reality, augmented reality, and artificial intelligence in fashion design. Through experimental projects and prototype development, the boundaries of design can be expanded, and new possibilities for technological innovation in the fashion field can be explored. Additionally, establishing a continuous dialogue mechanism between design and technology is critical. Regularly organized seminars, workshops, exhibitions, and public forums provide a platform for designers and technology experts to share the latest research findings, technological advancements, and creative design ideas. This enhances cross-disciplinary understanding and cooperation.

The third pathway is to explore the human-machine co-creation potential in digital fashion. Building an efficient human-machine co-creation ecosystem. In the field of design, it is crucial to continually enhance the potential for human-machine co-creation in digital fashion. A key aspect of this process is optimizing collaborative design platforms. These platforms must provide intuitive tools that facilitate seamless interaction between designers and AI systems, enabling real-time feedback on creative ideas and exploration of AI-generated design solutions. To lower the technical barriers, these platforms should incorporate natural language processing and intuitive graphical user interfaces, allowing designers

to leverage AI capabilities without needing in-depth knowledge of the underlying technology. At the foundational technical level, enhancing the transparency and explainability of AI algorithms is another critical factor in promoting human-machine co-creation. Transparent algorithms enable designers to understand the data or design logic underlying AI-generated suggestions, fostering trust in the machine-generated process. This mutual understanding between human and machine promotes deep collaboration, allowing designers to more effectively guide AI systems and tailor outputs to meet project requirements.

An iterative design process also facilitates effective human-machine co-creation. In this process, designers and AI systems interact through continuous feedback and adjustment cycles, learning and adapting to each other. Designers can evaluate preliminary design solutions proposed by AI, providing specific feedback and new ideas, while AI systems adjust based on this feedback. This iterative process not only accelerates innovation but also enhances the quality and personalization of the final design outcomes.

Educating digital fashion designers with AI skills: as digital fashion undergoes transformation and upgrading, it is crucial to cultivate designers equipped with AI and digital skills, as this is key to unlocking the potential of human-machine co-creation. Design education should focus on a comprehensive curriculum that includes foundational AI, data analysis, machine learning, and human-computer interaction, empowering designers to collaborate effectively with advanced technologies. By adopting an interdisciplinary educational model that combines theoretical learning with practical projects, designers can learn to utilize AI technology in innovative ways. Additionally, specialized workshops and continuing education courses in digital fashion design can help practicing fashion designers update their skills. Enhancing AI proficiency not only strengthens designers' leadership in the co-creation process but also broadens their creative boundaries, making the design process more flexible and faster in iterations, ultimately driving innovation and personalization in digital fashion.

Exploring multimodal creative expression in human-machine co-creation: in the human-machine cocreation process of digital fashion, integrating various sensory dimensions (such as visual, auditory, and tactile) can enrich the interaction and creative process between designers and AI systems. Multimodal design approaches not only expand the boundaries of creativity but also enhance interaction between designers and machines, providing new sources of inspiration and methods of expression for innovative design. By developing AI systems capable of understanding and integrating various inputs—such as text, images, and sounds—designers can communicate with technology in a more intuitive and natural way, stimulating broader creative thinking and exploration. This cross-modal creative process not only fosters deeper understanding and cooperation between humans and machines

but also brings richer and more diverse perspectives to digital fashion design.
The fourth pathway is to surpass the boundaries between virtual and reality in digital fashion. Blurring the lines between virtual and tangible fashion: by integrating AR and VR technologies, along with the application of digital twin technology, the goal is to create immersive experiences that allow users to interact with virtual design elements in real-world settings. This effectively blurs the boundaries between virtual and reality. Digital twin technology offers a transformative approach to fashion design by accelerating the integration of innovative design and sustainability. Through digital twin technology, precise replicas of virtual fashion products can be created, enabling designers and users to preview, test, and modify designs in a fully digital environment. This approach not only enhances the flexibility and interactivity of design but also provides robust support for personalized customization and virtual fitting. The use of digital twin technology elevates the fusion of innovative design and sustainability to a new level. By constructing a fashion design space that parallels physical fashion spaces and merges virtual and real environments, this technology fosters the development of higher-order thinking in the public. It allows fashion design to be more seamlessly integrated into both real and virtual social lives. Digitalization empowers the general public further, making "artistic living" a possibility in everyday life. Through the fusion and application of art and technology, the design field can drive the innovative development of digital fashion, achieving seamless integration of virtual and reality in the fashion domain.
Building the bridge between virtual and tangible fashion: to surpass the boundaries between virtual and reality in digital fashion, continuous innovation in wearable technology is essential. By developing smart wearable fashion products integrated with advanced sensors and microelectronic devices, these products can capture users' physiological data and respond to their interactions with the environment. This results in a perfect blend of digital functionality and fashion aesthetics. Innovations in advanced technology not only enhance the practicality and interactivity of wearable fashion products but also offer highly personalized digital experiences for users. Through these smart wearable products, designers can seamlessly combine physical fashion with digital experiences, further blurring the lines between virtual and reality and promoting higher levels of innovation and personalization in digital fashion.

Creating personalized digital fashion experiences: the interdisciplinary co-creation process not only drives innovation in design and technology but also opens up new markets and user groups, providing broader development opportunities for the digital fashion field. In the process of digital fashion transformation and upgrading, promoting cross-disciplinary collaboration and co-creation, as well as enhancing user engagement and personalized customization, are critical paths to improving the digital fashion experience. Encouraging fashion designers to collaborate with game

developers, digital artists, and technology innovators from various fields helps explore new methods of integrating virtual and reality. By leveraging online platforms, social media, and virtual communities, brands can directly interact with users, gather feedback and personalized needs, and tailor designs and experiences more precisely to meet their pursuit of individuality and differentiation. Active user participation not only provides valuable data to guide product innovation and improvement but also strengthens the sense of belonging and loyalty among users, building a closer brand community. This fusion and creation of personalized digital fashion experiences require designers to possess an open-minded approach to innovation, interdisciplinary collaboration skills, and a deep understanding and respect for user needs and experiences. By putting people at the center, digital fashion can progress towards a more personalized, interactive, and experiential direction.

The fifth pathway is to Explore new models of trading and circulation in digital fashion. Innovating transaction systems in digital fashion: in the pursuit of new models for trading and circulating digital fashion, leveraging blockchain technology to ensure transparency and authenticity, as well as developing the digital fashion NFT (Non-Fungible Token) market, are crucial. Blockchain's decentralized, secure, and transparent nature provides a reliable database for the ownership and certification of digital fashion products, permanently recording and verifying the originality and ownership of each piece. Additionally, integrating digital-physical tools like NFC chips, dynamic QR codes, and blockchain technologies such as smart contracts establishes a new digital asset trading system. This system accurately records NFT transaction information and ownership transfers. Within this framework, the growth of the NFT market offers a unique platform for trading digital fashion products, aligning with the exclusivity and luxury associated with high-end fashion items, thereby attracting consumers and collectors alike. Digital fashion creations, often developed using 3D software and other digital tools, can be displayed within digital metaverses and augmented through virtual reality platforms, AR environments, games, or other digital experiences, providing immersive fashion experiences to users.

Through these multilayered interactions, blockchain and NFTs serve not only as tools for trading and circulation but also as a bridge connecting fashion with the digital world. This new model not only enhances the commercial value and marketability of digital fashion products but also provides designers and brands with innovative platforms for creation and marketing, driving innovation in the digital fashion industry.

Innovating consumer experiences in digital fashion: technological innovation plays a key role in enhancing consumer shopping experiences and optimizing the display and transaction processes of digital fashion products. Virtual try-on technology allows consumers to preview how clothing items

will look and fit on themselves without the need for physical goods, greatly enhancing shopping convenience and efficiency. Additionally, augmented reality (AR) technology expands the boundaries of digital fashion display and experience, allowing consumers to use smart devices like smartphones or AR glasses to view and interact with virtual fashion products in real-time within their physical environments. The integration of these innovative technologies not only improves user shopping experiences and reduces return rates due to size mismatches or style dissatisfaction but also provides designers with a dynamic platform to showcase their work in a more vivid and interactive manner. Through virtual try-on and AR technologies, the design field can explore new forms of design expression and communication, promoting the innovation and personalization of digital fashion products while also reducing logistics costs and environmental impact, aligning with sustainable development principles.

6. Conclusion

The digital transformation of fashion redefines the industry by merging virtual and physical realms, expanding the role of design from product creation to system innovation. Through the “Four Orders of Design,” this paper has explored how luxury brands like Louis Vuitton and Gucci utilize digital technologies to reshape consumer experiences, enhance sustainability, and foster human-machine co-creation. The integration of virtual fashion with emerging technologies like AI, blockchain, and extended reality not only transforms the production process but also reimagines fashion as a dynamic platform for self-expression and social interaction. As digital fashion continues to evolve, the design discipline plays a critical role in driving innovation, offering new opportunities for creativity, personalization, and sustainability in the fashion industry.

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STRATEGIC FORESIGHT AND WORLDBUILDING WITH COMPANIES

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ABSTRACT | 'Tuulilulеima' is an artistic and futuristic protopian film developed using design fiction and art-based methods. Design fiction is a method based on narratives and worldbuilding that unravels unknown, yet possible, futures. Worldbuilding focuses on imaginary realms, cultures, and languages, usually used in literature, film, and gaming industries (Zaidi, 2019). This paper presents a research-through-design process of imagining possible futures aiming to better understand creative methods and the role of artistic expression, which can be further utilised as a means to facilitate companies' foresight and strategy work.

Tuulilulеima followed the core idea of design fiction by creating a physical prototype based on an envisioned future world. The filmmaking process, including costume design and cinematography, had a central role in creating the future world. As part of the speculative design, a futuristic wind chime was created to attract, measure, and deal with wind changes in the future. Tuulilulеima enabled companies to envision possible futures and various personas in future situations. This allowed them to join worldbuilding and apply this in their business strategising process for the future. The strategic foresight design process included the creation and utilisation of several foresight planning tools, such as a foresight matrix for three possible future scenarios (utopian, business as usual, and dystopian) and a canvas for future business model design.

KEYWORDS | STRATEGIC FORESIGHT, WORLDBUILDING, PROTOPIA,

1. Introduction

Tuulilulеima is an artistic and futuristic protopian film developed using design fiction and art-based methods. This paper presents a research-through-design process that imagines possible futures with the aim of understanding better creative ways and the role of artistic expression, which can be further utilised as a method to facilitate companies' foresight and strategy work. Art-based methods have been acknowledged to foster creativity and innovation in businesses (Nissley, 2010). Further, this paper discusses filmmaking—including fashion design, cinematography, and foresight tool development—that is part of the design fiction process. This paper questions whether design fiction can be used to facilitate future-oriented business design.

Tuulilulеima was iteratively developed by relying on intuition, artistic expression, and performative improvisation. It was part of the Empathy Business project (2023–24) funded by Business Finland and focused on researching empathy-driven and digital solutions in business prototyping and service development. The design fiction process included performative notes for a futuristic short film. The notes presented a protopia in which the changes in the main sea streams and wind patterns affected our living conditions and climate. The manuscript relied on embodied performances and reflections of future winds. The breaths of the wind were felt and expressed through the body and voice. Bodily improvisation was undertaken by following the instructions in the performative notes, but room was made for intuition and improvisation.

Futurists and speculative designers such as Kevin Kelly and Monica Bielskyte discuss the protopian future. Kelly (2011, 2022) discusses the importance of optimism when imagining our future. Our world has been designed by optimists with a strong belief in their solutions, such as inventing an airplane. He calls this optimistic future that we can imagine 'protopia'. This is based on trusting each other, gradually solving problems, and creating innovations that will push society forward. The future is not dystopian or

utopian; it is a future in which we are good ancestors and can trust future generations. Bielskyte (2023) highlights protopia as a continuous dialogue that is a process, not a destination—a space that will always iterate, question itself, adjust, and expand. Further, she presents protopian principles as being *'plurality—beyond binaries, community—beyond borders, a celebration of presence; regenerative action & life as technology, symbiotic spirituality, creativity & emergent subcultures and evolution of cultural values'.* Vize (2024, in press) focused on creative practice and, particularly, on utilising transformation design for the worldbuilding of plural futures.

Design fiction is a method based on narratives and *worldbuilding* that unravels unknown yet possible futures. Worldbuilding focuses on imaginary realms, cultures, and languages, usually used in literature, film, and gaming industries (Zaidi, 2019). Tuulilulеima followed the core idea of design fiction by creating a physical prototype based on an envisioned future world. In this future world, nature, particularly winds play an important role. A futuristic wind chime was created to attract, measure, and deal with wind changes in the future. Tuulilulеima was utilised to enable companies to envision the possible futures and personas in future situations where changes in climate conditions and available resources affect our daily lives. This allowed companies to join in the worldbuilding process and apply this in their future business strategising.

An important part of the process was a collaboration with several companies: Content Union, Zone ii Ltd, and Zone2 Pictures Ltd who also participated in the Empathy Business project. Content Union is a design consultancy. Zone ii Ltd is a location scouting company and Zone2 Pictures Ltd is a production company. We have been working with both worldbuilding as well as developing the foresight tools for planning future business models with these companies. Zone ii Ltd and Zone2 Pictures Ltd participated in the filmmaking process by providing cinematography and worldbuilding inputs. Content Union participated in workshops with the companies when testing the first tool and workshop formats. Throughout the development process, there have been several collaborative discussions and planning sessions.

First, the theoretical framework and its main aspects are presented. Thereafter, the research methods and data are discussed, after which the insights from two main parts of the research processes—design fiction by filmmaking and business design for the future—are presented. Then, the findings and conclusions are presented.

2. Theoretical framework

The design fiction process is outlined in this research paper, which deals with creating a representation of the future. Blythe (2014) discussed the uses of prototypes in the research-through-design process. He used design fiction to explore the value of

these prototypes. Blythe suggested that design fiction is used to create meaning. This is also applicable to this research case. Understanding different presentations of the future and discussing them is crucial for creating meaning and relating these meanings with one's business or design. Bosch (2012, p. 1) interviewed award-winning sci-fi writer Bruce Sterling in Slate online magazine regarding design fiction. Sterling made the following comments on design fiction: *'It's the deliberate use of diegetic prototypes to suspend disbelief about change. Diegetic means thinking very seriously about potential objects and services and trying to get people to concentrate on those rather than entire worlds, political trends, or geopolitical strategies. It tells worlds rather than stories'*. In Slate magazine, Blythe (2014), Bosch (2012), and Sterling bring up the role of crafting as an essential aspect of design fiction. Design fiction is a process whereby future representations are concretised as tangible. This process forces one to discuss the future on a rather concrete level, including the physical materials, logistics, and conditions involved therein.

Coulton et al. (2017) proposed that design fiction involves worldbuilding. They argued about the difference between storytelling and worldbuilding. Their preference of building worlds as design fiction can sculpt a plurality of different media forms as well as physical prototypes. They refer to worldbuilding as a process of constructing imaginary realms that can host several media forms and storytelling located within this realm. They make a reference to Bruce Sterling (in Slate magazine) and to Julian Bleecker and his work with the Near Future Laboratory[1] and his essay (2009). In his essay, Bleecker emphasised the role of design as thoughtful exploration, creative materialisation, material crafting, and imagining. Bleecker is pondering the role of design fiction as a combination of science facts and fiction and whether science fiction can have a purpose and be meaningful. Design fiction would be the combination of these two sides—facts and fiction. This combination will likely create a meaningful tool to investigate the future.

Kirby (2023, p. 1) proposes on-screen cinematic space *'whose properties are shaped by relationships between media forms and physical space'*. Kirby refers to the combination of media forms and physical space as a composite layered space. Worldbuilding can utilise such a cinematic space. In particular, the article at hand uses filmmaking and this kind of cinematic space as a platform for design fiction. Boillat (2018) discussed cinema in his book entitled 'Cinema as a Worldbuilding Machine in the Digital Era'. Cinema involves navigating various media enabled by new technologies as well as worldbuilding a multitude of worlds within the metaverse, virtual worlds, artificial worlds, and so on. Filmmaking and cinema are natural means of worldbuilding. Santos et al. (2024) define worldbuilding as a narrative device for describing a world with its geography, interactions, relations, and characters. One could think of the Netflix series 'Bridgerton' as an example of worldbuilding, where a version of London at the beginning of the

nineteenth century is described. In a similar manner, when creating a future scenario, worldbuilding needs to describe a logical story, which includes the plot, setting, characters, point of view(s), style, themes, and possible conflict (Coulton et. al 2017).

Certain philosophical studies recognise the flow of scapes, particularly mediascape. Appadurai (1996) discusses the five dimensions of global cultural flow: mediascapes, ethnoscapes, technoscapes, finanscapes, and ideoscapes. It is essential for these to be considered in worldbuilding, particularly in strategic foresight. Bello (2010) proposed the concept of 'Goodscapes' using theories from the social sciences and design that intersect among globalisation, things, and design processes. Bello placed significance on materiality and the flow of goods in the impact of various scapes, but also mentions future design which involves new physical and virtual environments acknowledging the social, cultural, political, and environmental changes in the society.

One cannot go on without mentioning Dunne and Raby's (2024) classical reading on future studies called 'Speculative Everything' with a new preface. In the book, they remind us about the futuristic nature of design, and that every design process has a certain amount of future thinking embedded in it. In a similar manner to Bleecker (2009), Dunne and Raby also highlighted the role of probabilities, imagining, and crafting concepts and actual designs. Further, in their preface, Dunne and Raby mention the building of parallel worlds rather than futures. This aligns well with the process of worldbuilding. The new preface also recognises Steven Shaviro's study on speculative fiction, speculative philosophy, and speculative finance. Shaviro's (2019) notion of speculative finances is interesting as it looks to the future by pricing potential future events. In our article, we also attempt to take steps in this direction; we attempt to outline future resources for entrepreneurs.

Garcia (2023) is engaged in extremely interesting work with fashion futuring that intertwines speculative design, foresight, and material culture and tweaks them towards sustainable futures. She discusses how designers and futurists are exchanging tools and techniques and, thus, becoming closer to each other. She addresses a critique of speculative design, addressing its elitist positioning as having little application in real life. She proposes that fashion futuring addresses creativity and agency. I see this as an activist action against elitism and pro-relevance. The same positioning is apparent when she places strategic foresight on fashion futuring. This offers tactics to involve decision-makers and gear their effort towards creating desirable futures. In this paper, fashion and costume design plays a central role in design fiction or speculation itself.

When creating design fiction and performing worldbuilding, we discuss different possible futures: dystopias, utopias, and protopias. In the introduction, we have already mentioned a few of the relationships among these concepts. This paper leans

towards protopia, which enables more plural opportunities. Protopia highlights the importance of optimism when imagining the future (Kelly, 2011, 2012) and progressive design movements that believe in human creativity, intuitivity, empathy, and solidarity in designing better futures (Boehnert et al., 2024). Barton (2022) discussed protopia in an exciting manner and proposed that protopian future thinking does not only involve framing futures in a new manner but also utilising technological innovation for proactive future prototyping that focuses on inclusivity, cultural values, and social ethics. Protopian scenarios are experimental platforms for asking complex questions regarding the future. Barton (2022) further reminds us that this is to resist modernist design that focuses only on one thing.

The theoretical framework combines filmmaking, design fiction, worldbuilding, and crafting meaning through creative action. This occurs through speculative design, costume design, fashion futuring, and cinematography. Together, these elements create a cinematic space that enables future prototyping and representing this to a larger audience. With new technologies, such as a virtual production stage, it will likely be possible to enact digitally crafted content and even use AI in prototyping.

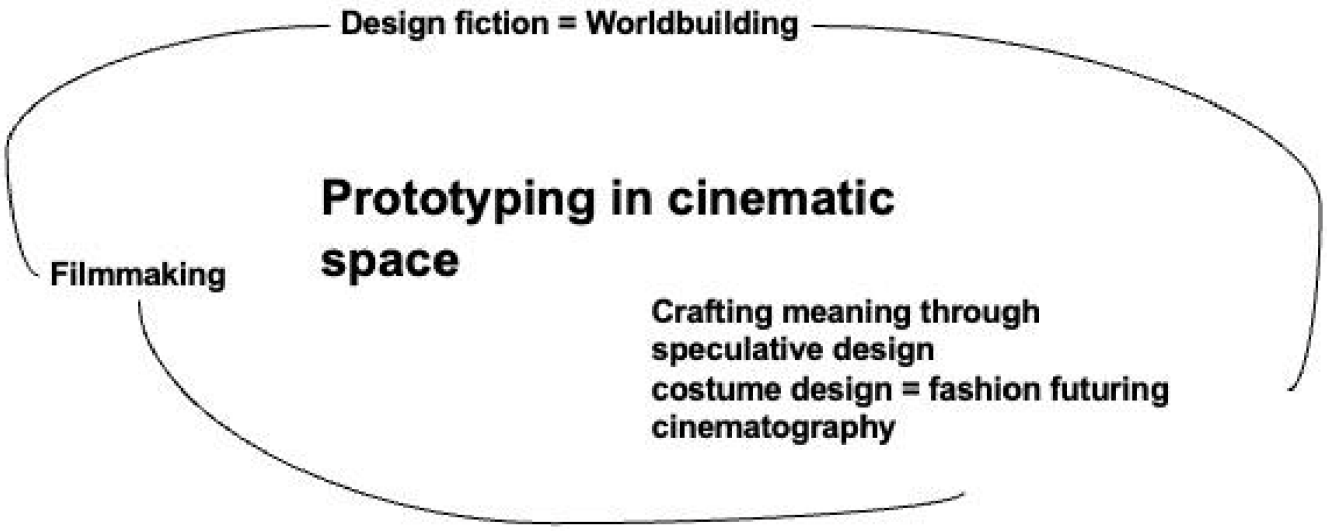


Figure 1 Theoretical framework

The focus of this paper is to consider strategic foresight and how companies can develop their future business. In the context of strategic foresight, methods, experiences gained through methodological implementation, and organisational practices have been discussed in the literature; however, there is limited research on use and motivation, z designers and artists a means to escape cultural traps and possible limitations they may face to explore what ought to be (Slaughter, 1997). It enables escaping realities of the past and the rules laid down by organisations

and those implied in their structures in terms of how processes are supposed to work, thereby emphasising histories and experiences and lessons learned instead of exploring prospective opportunities beyond these realms. Strategic foresight is defined by Slaughter (1997, p. 1) as *'the ability to create and maintain a high-quality, coherent, and functional forward view and to use the insights arising in organisationally useful ways'.*

Strategic foresight can assist designers to come to grip with active transcendence and thought experiments for their visions of the future. However, they can enact their ideas and create actual scenarios using their viewpoints by creating visual resemblances and examples of their visions by using photos, films, scenes, and sets. Designers and artists can build future visions and move into rich and more realistic spaces in which they avoid the 'flatland'. Slaughter (1997) refers to this as 'visions of the future that are 'impoverished, mined-out, polluted, stripped of (non-human) life and overwhelmed by increasingly powerful technologies'. Although his views may be dated, particularly as designers may envision futures with technologies far removed from flatlands and impoverished futures, Slaughter's understanding of how future scenarios may assist in viewing futures differently is relevant as his understanding enables active explorations and curation of methodological complexity to create high-quality insights of meta-level systems change that may be desirable for the future (Slaughter, 1997). As Iden et al. (2017, p. 88) explained, the aim of using strategic foresight and an assortment of good methods is to 'capture and perceive drivers of future change' and convert them into specific strategic responses. One of the challenges of strategic foresight remains the setting of clear objectives and identifying exactly what they seek to achieve (Iden et al., 2017).

3. Research methods

Research design is an iterative research strategy based on learning from the research process and findings (Thomas & Rothman 2013). As an outcome of the research design process, new theories, artefacts, and practices are produced (Barab & Squire, 2004). This strategy serves well in the research-through-design process in which the motivation lies in crafting tangible outcomes (Fryling, 1993). This case study is on an artistic and futuristic protopian film called Tuulilulеima includes styled costumes, speculative objects, an ethnographic documentary film entitled 'The Making of Tuulilulеima', and several business design tools. Research-through-design (Blythe, 2014) focuses on research in real life contexts by systematically working through a series of implementations (Wang & Hannafin, 2005) that are designed and evaluated. The design fiction process that includes both filmmaking and worldbuilding worked as a research context. Similarly, the workshops with companies enabled the business design process.

Blythe (2014) was critical of the limitations of the research-through-design process approach that is not necessarily replicable nor the outcomes always the same, which would

be the requirement for evidence. Of course, research-through-design and qualitative research are utilised more often in explanatory research to investigate phenomena rather than evidence. The background for this is a more general discussion regarding the differences between qualitative and quantitative research. Tracey (2019) summarised the qualitative research approach into three phases: a) collecting evidence; b) crafting analyses, and c) communicating evidence. She also emphasised the role of the researcher and self-reflexivity in comparison to quantitative studies.

The design processes were systematically documented through ethnographic observation, video, and photography as well as field notes. Ethnography as a method focuses on studying real-life settings in which the participants live in personalised, inductive, dialogic, and holistic ways. Biographical ethnographic writing allows for the viewpoint of the author as an active creator or producer of knowledge in social life (Coffey, 1999; Pink, 2015). This perspective is rather essential in the research-through-design process in which reflexive practice plays the central role. Further, several reflective discussions that were recorded, transcribed, and analysed were part of the process. This reflectivity enables learning that is focal to both the research design and research-through-design processes. (Currano & Steinert, 2012)

Further, the research process included an impact assessment of the process. The impact assessment was based on a literature review that particularly focused on both creative evaluation as well as methods of evaluation and reflection in design research. The assessment involved an examination of indicators in areas typical or feasible for a creative process such as engagement, DEI, trans and/or interdisciplinarity (Owen et al., 2022); novelty and creativity (Harvey & Kou, 2013); learning (Rindova et al., 2011); tangible outcomes (Farnese et al., 2019), and systematic reflection (2014). The impact evaluation was conducted in a rather straightforward manner. An impact evaluation form was created and this was filled in by the participating group. The impact evaluation was supported by a survey study (Basballe & Halskov, 2012). The companies participating in the development of the strategic foresight tool completed the survey to assess the workshop's effectiveness.

4. Design fiction through filmmaking

The design fiction process was initiated by creating a manuscript for a futuristic short film called Tuulilulleima. The manuscript was based on a narrative for different futuristic scenes that created a platform for body storming and performative enacting rather than dialogue. Body storming (Broadbent et al., 2023) or enacting (Coenraad, 2019) are familiar methods in design research. In performance art, such a manuscript is called 'the performance notes' (Zeami, 2008). The manuscript relied on futuristic thinking and imagining the future in 2035. The presented image of the future included changes in

inanimate factors such as the main sea streams and wind patterns that have affected our climate and living conditions. Desirable and viable futures require new ways of designing how people live on the planet based on the understanding of the entanglements between humans and the more-than-human in future transitions (Boehnert et al., 2024). Ecological literacy aims to help identify cultural and sociopolitical dynamics that cause or threaten to cause ecological harm and reveals future visions that both work for and against sustainable living on the planet (Boehnert et al., 2024).

Willis and Anderson (2013) discussed how worldbuilding can represent several ideas. It illustrates the process of imagining a unique world for a film set. This world itself can be the genesis for the resulting script. There can be several parameters and visualisations that describe the space as well as a new filmmaking workflow for this world design. This process moves on from the world to the story. Thus, worldbuilding refers to the construction of the visual world of a story prior to writing of the manuscript. Willis and Anderson (2013) refer to the movie Minority Report as an example of such a process. The manuscript worked as a starting point for the worldbuilding process that was initiated by the collaborative reading of the manuscript. The filming team consisted of a director and artist, researchers, and a cinematographer. The daily routine included collaborative discussions and planning, where the team was immersed in worldbuilding. The team needed to plan the logic of the future world. This included discussions of the materials, technology, infrastructure, and climate conditions that the future world would have. In addition, the team needed to think about the personas involved in the future scenario. What were their motivations, feelings, and competence levels to not only survive but also solve problems? The team needed to scout the filming locations and plan each scene as well as its filming. An important aspect of the routine was a daily screening of the materials being shot.

Figures 2 and 3 Images from the set





4.1 Costume design and styling

Fashion and costume are often used to transport actors and viewers alike into specific ephemeral scenarios, thereby enabling them to enact specific characters or be transported by such characters through given themes and enactments (Roubelat et al., 2015). The role of fashion and costume in this context was to function as the 'tool in rethinking fashion futures and testing the plausibility of diverse scenarios' (Burcikova, 2019, p. 328). The costume was reinterpreted to suit future scenarios in which the actors searched for an understanding and reimagining of the climate and living conditions in our speculative futures. The team sourced two fashion collections created by one of the authors called 'Water Wasted' and 'Whom Wore This?'. The Water Wasted collection adapted recycled materials such as the foil lining of water packs and their plastic spouts. The idea of material resourcefulness is well suited to the imagined future world. The other collection utilised a combination of vintage underwear and safety pins, which also conveys the idea of repurposing materials. These two collections provoked a sense of worldbuilding when discussing their materials and repurposing them.

When styling the costumes, design fiction and worldbuilding merged, as proposed by Coulton et al. (2017). The act of styling is a physical process of fitting the costumes in a manner that will suit the performers' bodies and can be utilised in different scenarios when moving around in them. In addition to embodiment, the costumes enable specific viewpoints and mindsets for the performers in a physical and psychological sense by recreating reality into fiction, and weaving materiality into culture (Garcia, 2023). This is called physical crafting through the utilisation of tools and materials. The styling is utilised to create meaning for the costume so it will fit the future world and its storyline. For example, duct tape was utilised to symbolise an interactive digital interface both in clothing and on the skin of the performers. Another example would be the vintage underwear that was repurposed to function as a protective layer over the ears and necks of the performers.

There is a substantial amount of value discussion embedded in costume design and styling. The repurposing and creative resourcing of materials support the more sustainable use of materials in the future world. This resonates well with Caravalho Garcia (2023) who highlights the same values with fashion futuring.

4.2 Speculative design for solving problems

In Tuulilulеima, there are two scenes in which two older women and a younger android—a humanoid robot—are first building a wind chime together and then use it to harvest energy at the wind station. These two scenes resulted from an active process of collaborative worldbuilding. In the manuscript, the performative notes provided an initial narrative for imagining the future world; however, as the design fiction process progressed and the logic for the protopia developed, it became apparent that there is a need for energy that needs to be solved. Here, the role of crafting in design fiction becomes focal as highlighted in Slate magazine by Blythe (2014), Bosch (2012), and Sterling (2012). The team utilised the resources available to build a prototype for both the wind chime and the testing station. The worldbuilding process helped to create these speculative designs.

It must be noted that the idea of protopia was significant during the worldbuilding process. This impacted the team to think about storylines and ideate for solutions. This also embedded a huge number of discussions on ethics and values.

4.3 Cinematography

Filmmaking and cinematography created a cinematic space for design fiction (Kirby, 2023). In our team, the cinematographer played an important role in creating a representation of the future world. He would see what is visible in the shot. He would also see how the performance would look through the lens. In certain scenes, he would be able to provide guidance and direction on how to improve or synchronise actions. For a cinematographer, one of the first decisions affecting the style of a film is the choice of lenses to use. For this work, the modern ultra-sharp lenses did not appear right. The choice of lenses in Tuulilulеima was vintage Nikkor primes from the 1970–80s, with a softer, even ‘spicy’, look. If shot at full aperture, the highlights break up into halos.

The cinematic space for design fiction was created through pre-production, production, and post-production. All these phases contributed to how the future world would be presented in the film. In pre-production, our director/artist created the performance notes. Here, the selected location played a role as wintery scenes replete with snow outline the narrative. In an ongoing production, the cinematographer would need to be able to use his experience to create a prototype and experiment with the team. As worldbuilding is an ongoing process, there is no exact storyboard that would help in planning the process. Moreover, the cinematographer’s ability to shoot supporting material would become handy in the post-production stage in terms of providing more information to the viewer. In post-production, the director/artist would use a variety of digital materials to support the envisioned future world.

The cinematic space where improvisatory performance and enactment take place enables the prototyping of the scenes. In

collaboration with a cinematographer or the director who sees through the lens and the performers, the action is prototyped and finalised. A few of the elements will be only added in the post-production stage. The final step for cinematographers is the colour grading of the film. This is usually done together with the director. Colour grading can be used to adjust mood, character, and period of time. This ensures that the look of the film facilitates the telling of the story in the selected world and not fight against it.

5. Business design for the future

An important part of the process was the goal of developing a tool for strategic foresight with companies. During the filming process, the team discussed the following question on various occasions—how can design fiction be applied in strategic foresight work with companies, particularly SMEs? This was also discussed in the Empathy Business project meetings with all the participating companies. Small and medium-sized companies are important to the European economy through job creation (Palmieri, 2007). It is important to develop tools that are forward-looking and enable companies make decisions that support their future business planning.

Figure 4 Workshop with company representatives

The business design process to develop strategic foresight tools took several phases. First, the project partners immersed themselves in the process of creating a 'three possible futures table' focusing on the Tuulilulelma world. This table discussed the political, economic, social,



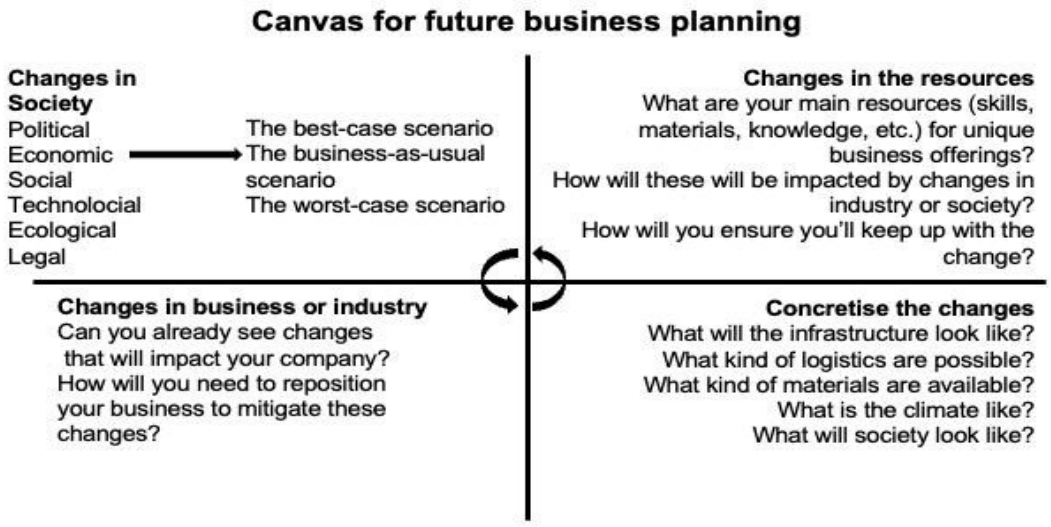
technological, ecological, and legal (PESTEL) aspects of the future from three distinct perspectives:

best possible, business-as-usual, and worst-case scenario perspective (Demneh, 2023). This was a rather analytical and systematic process of outlining the global flow for all these perspectives, which is in keeping with Apparurai's (1996) spirit. This table provided participating companies an understanding of possible futures and the factors impacting it.

After this, a canvas-based tool was developed to help companies study their own businesses and strategise how these would be impacted by global flows, trends, and factors in possible futures. The canvas-based tool focuses on future business planning and how the availability of resources, technologies, and infrastructure as well as the transformation of the business area would impact one's future business model. This is based on Schumpeter's (1934) theory that value is created from a unique combination of resources (Schumpeter & Swedberg, 2021). Further, Canvas as a business planning tool was introduced by Osterwarder and Pigneur (2010).

The third phase consisted of a workshop with companies to immerse them in strategic foresight work. In a collaborative workshop, the participants first saw the Tuulililuleima protopian film. Thereafter, they were introduced to the 'three possible futures table' and they could choose and discuss topics relevant to their business. In the last phase, they worked with a canvas-based tool and focused on their future business planning based on resources available in the future. At the end of the workshop, participants filled in the survey that asked about the relevance of the workshop and the utility of using 'three possible future table' and the 'canvas for the future business planning' (see Figure 5).

Figure 5 The second iteration of Canvas for future business planning



The outcomes of the business planning were interesting. The survey divided participants into half. One half of the participants experienced the benefits of seeing the protopian film and participated in a freer discussion whereas the other half believed that the more structured work, particularly with Canvas, was the most significant aspect of

the process. 'The three possible futures table' was experienced as too dense and having too much information to absorb in a short period. All the participants experienced the workshop as meaningful. Our project team experienced all the distinct phases of the process. The film immersed the participants into future thinking and worldbuilding. The 'three possible futures table' opened up a vast systemic perspective and concretised complexities related to foresight work. Finally, Canvas made participants focus and concretise the topics relevant to their companies. Yet, based on feedback, the next iteration of the workshop will focus on film and a more developed version of Canvas.

6. Findings

This research paper responded to the question of how design fiction could be used in future-oriented business design. This research paper responds to this question in several ways. First, the literature review explains how the crafting of concrete physical or digital designs prompts one to think about future resources, logistics, and infrastructure as well as respond to future needs and challenges with this design. Further, the literature suggests that worldbuilding is design fiction. In this paper, we discuss how filmmaking utilises worldbuilding as a design fiction process. We shared examples of how a protopian future scenario prompted the team to use costume design and styling for design fiction, create a speculative design to address a future problem, and prototype future actions in cinematic space. The overall process of design fiction addresses future challenges and resources that we may or may not have. This has a direct bearing on how to prepare a business design and utilise resources with unique offerings. Skills and capabilities are also part of the resources, and a large part of the future business design is to understand what kind of skillsets can deliver such unique offerings in the future.

The design fiction process helped to understand which kind of tools companies need to design their future business. 'The three possible futures table' offered a systematic view of global trends, flow, and complex systems that interact with each other. The canvas-based tool for future business planning focused on specific businesses and made the companies think of and concretise the trends that transform the business area and directly impact their resources.

This is a process in making so the project team will continue to test and iterate the process and the tools developed until the end of the year 2024. The insights from the first iterations already offer numerous development perspectives. In the next phase, we will test how to utilise a virtual production stage to enact or prototype in an immersive environment with rendered designs. We plan to iterate the future business design workshop with participating companies, and the tools will be further developed for this purpose.

6.1 Discussion and conclusion

In conclusion, we can respond that yes, design

fiction does help companies to concretise the changing future and its impacts on their business. As a novel contribution of this paper, we were able to create a cinematic space for future prototyping by utilising worldbuilding as design fiction and bring together several creative areas—such as costume design and fashion futuring, as well as speculative design and cinematography—to enable this. This created a platform for concretising the changes that will impact the future world. In particular, in resource-based business planning, it is crucial to understand which future resources could impact and how they will impact a business. To facilitate this, we created a canvas-based tool for business design.

There are not too many examples and methods available to prototype, concretise, and craft future scenarios; thus, the use of cinematic space offers new kinds of possibilities for this. Willis (2015) writes about cinematic humanities and the possibility of new kinds of ways of knowing expanding knowledge from written forms to thinking and making through critical visual work that integrates space, time, and the methods of design. We argue that future prototyping in cinematic space can also be utilised for strategic foresight and create new ways of knowing that would not be possible without the elements of creativity.

Bühring and Liedtka (2018) argued that the integration of foresight and design methods can impact strategic decision-making processes. They discuss the timelines or horizons related to product and service development; however, this is focused on short-term market needs. In this paper, we contributed, in particular, to means and methods for more long-term business design.

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A DESIGN-LED SYSTEM TOWARDS CIRCULARITY

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ABSTRACT | Over 400 million metric tons of plastics are produced each year and accordingly increasing plastic waste poses a significant threat to the environment and humanity. Conventional recycling initiatives face challenges due to the low value of recycled plastics and inefficiencies in centralized waste management systems.
To address this crisis, we propose a design-driven, value-oriented circular approach. This involves contextual creation and localized processing, allowing for adaptive distribution beyond the limitations of conventional recycling. Waste materials with little value in the recycling process are sourced locally and transformed into novel composites with unique physical properties and perceived qualities. Parametrically designed objects are then created from these composites, evoking value and emotional durability towards a more sustainable future. Case studies from Samoa and New Zealand demonstrate the transformative power of this circular system. In Samoa, plastic waste is repurposed into composite materials for handheld tools and souvenirs, reflecting the country's cultural heritage. In New Zealand, artifacts with Māori patterns are crafted from novel composites made of soft plastic waste and native plant leftovers. Our approach has also been integrated into design education, resulting in innovative sustainability solutions that transcend geographical, cultural, and technical boundaries.

KEYWORDS | DESIGN, SUSTAINABILITY, CIRCULAR ECONOMY, PLASTIC WASTE, LOCALIZED PROCESSING, DIGITAL CRAFT, TRANSFORMATIVE SYSTEM, VERNACULAR CONTEXT

1. Complex problems of plastic waste

Plastics are an essential ingredient of civilized society. With unparalleled versatility in color, shape, and detail combined with economical and efficient processing techniques, plastics have revolutionized modern life by enabling mass production and global distribution of functional yet affordable products. The unprecedented lightweight, resilient, and accessible material with prolonged shelf life has addictively attracted industries, consumers, and designers, and global production and consumption of plastics is expected to almost double in the next 25 years (Geyer et al, 2017). Strong desires for higher standard of life driven by economic growth around the world increase demands for products and services for convenience, efficiency, and access. Abundant varieties, established manufacturing, and global logistics make plastics the easy and sure material option for the opportunity. The unique, incomparable status that plastics occupy was confirmed again by the rapid response to the surge in need for sterile medical products, personal protective equipment, and hygienic packaging during the global pandemic (Ellis et al, 2014).

Despite the numerous benefits, plastics instigated our excessive reliance and habitual pursuit of low-cost, disposable materials that have consequently caused a global waste crisis, one of the most serious problems that afflict humankind. Since 1950, it is estimated that 8.3 billion metric tons of plastics have been produced and more than 5 billion metric tons of them have been accumulated in the environment. The numbers are expected to exceed 40 billion metric tons and 12 billion metric tons, respectively, by 2050 (Jambeck et al, 2015). Along with the fact that more than half of the plastic produced is intended for single use, mismanaged plastic waste entering waterways each year is projected to sharply increase its amount from 20 million metric tons, exacerbating the situation. Plastics make up 80% of debris that floats on or suspends in the ocean, which break down or degrade to microplastics and nanoplastics, causing a significant, accumulating threat to the marine ecosystem.

As the most common method of waste management, recycling has been in practice in many parts of the world. Sharing many aspects with mass manufacturing, the current recycling scheme adopts the concept of centralized collection and concentrated processing. Collected plastic waste from municipalities, regions, or even an entire country is transported to a small number of large-scale processing centers where the waste is separated, cleaned, and recycled using mechanical and thermal techniques in large quantities (UNEP, 2021). While the scheme has reduced the amount of plastic waste left in the natural environment throughout a few decades' execution, it inherits the major shortcomings that mass manufacturing has, such as capital-intensive infrastructure, large minimum trade quantity for each instance, long turnaround, and long-haul transportation.

In addition, the centralized, concentrated recycling scheme allows recycled plastics limited diversity in material properties and marginal room for application-specific qualities, often causing recycled plastics to demonstrate inferior performance at higher costs compared to new materials. Poor material and monetary value is widely regarded as the key reason for making recycled plastics a significantly less attractive option for adoption and consequently the centralized, concentrated recycling scheme unsustainable without subsidies. The recent findings that only 9% of plastic waste has been recycled and 90% of the amount has never been recycled again show complexity and limitations of the one-size-fits-all approach (UNEP, 2023).

As an alternative approach, chemical recycling has recently been pushed by the plastic industry, including major resin manufacturers. Despite massive investment, there are fundamental questions as to whether the energy-intensive or solvent-based processes provide environmental benefits over the conventional recycling techniques (Korley et al, 2021). While the approach is relatively nascent, recent closedowns of facilities and slowdowns in activities cast doubt on its future.

2. Upcycling over recycling

Upcycling was proposed as an alternative approach to address critical limitations associated with conventional recycling (McDonough & Braungart, 2002) and has gained attention as an essential principle of a circular economy or "cradle to cradle". Upcycling involves repurposing materials by upgrading its value and reshaping the way products are consumed, and therefore is considered a process capable of controlling the entire material lifecycle (McKinsey, 2016). Building on the conceptual foundation, upcycling focuses on reutilizing waste stream materials into products with higher quality or value as opposed to production of items with comparable or inferior quality through conventional recycling.

An emerging element of upcycling is additive manufacturing, often represented by 3D printing (Unruh, 2018). With an unprecedently high level of design freedom and production flexibility compared to conventional methods (Lipton & Kurman, 2013), the technology offers unique benefits towards sustainability,

including minimized material waste, reduced energy consumption, and small-scale, localized production (Anastasiadou & Vettese, 2019).

Recent approaches to upcycling incorporate lifecycle-based practices into additive manufacturing across design creation and optimization using digital tools, 3D printing of products with waste plastic, demonstration or distribution of products, extended use in target context, and upcycling of end-of-life products. In addition, unlike mass production, customization or personalization enabled by such approaches is a crucial element of product longevity through emotional durability or psychological attachment to products (Tateno & Kondoh, 2017). Examples include bespoke products from designer enterprises, such as The New Raw (n.d.), vanPlestick (n.d.), and Dirk van der Kooij (n.d.), which demonstrate contextual configurations and unconventional esthetic achieved by systematic design and production procedures. Philips' fishing net lamps (IF Design, 2022) show that such approaches are adopted by multinational corporations.

3. A design-driven, value-oriented approach

From the findings that the critical issues of the conventional recycling scheme are attributable to the aspects that originated from mass manufacturing, it was hypothesized that an approach that aims to increase the value of recycled materials could address the issues. We correspondingly formulated a design-driven, value-oriented approach for circularity that incorporates decentralized collection, localized processing, and distributed manufacturing. Beginning with exploratory analysis of context, history, and significance through engagement with stakeholders, our approach aimed to amplify the value of plastic waste by formulating materials and artifacts that demonstrate case-specific elements discovered from the analysis.

3.1 Analysis

Following a preliminary study on a specific case associated with plastic waste, details are identified through visits to the location and meetings with stakeholders, including members of the local community, industry, and government impacted by or relevant to the case. The findings are analyzed in relation to historic attempts made to address the issue and their results, explicit and implicit needs of the stakeholders, and social, economic, and cultural significance of the case (Koskinen et al, 2011). Outputs of this engagement-based analysis form the overall direction and guidelines for the subsequent activities. Concurrently, we collect plastic waste materials from the location and analyze them using standard physical and chemical analysis methods to identify their compositions, estimate their value, and explore potential processing conditions. This practice validates viability of decentralized material collection,

which can minimize carbon footprint from long-haul transportation.

3.2 Processing

Selected waste plastics from the analysis are processed at our lab through mechanical, thermal, chemical, and physical techniques. The materials are sorted, cleaned, separated, pulverized, and compressed into a few forms, including powder, granules, slabs, and sheets. We deliberately select easily reproducible processes using standard processing equipment for localized processing to address the limitations of the conventional recycling scheme.

3.3 Material development

A range of material formulations are prepared by blending waste materials and additives using a twin-screw extruder. Each formulation is a permutation of a ratio of the ingredients processed at a particular temperature profile and RPM (revolutions per minute) to augment material value. The formulations are evaluated against a set of criteria across mechanical (strength, elongation, and flexibility), environmental (durability against temperature, UV, and water immersion), visual and tactile (color, shine, and surface) manufacturing (3D printability, shrinkage, representation of horizontal, vertical, and diagonal lines, curves, angles, holes, and overhang) properties and qualities. Promising formulations are identified and used for design development.

3.4 Design development

Informed by the properties and qualities of the promising material formulations, we design artifacts with amplified perceived value and incorporate them into a scenario with a focus on circularity. Building on the material value, cultural, social, and communal attributes discovered in the analysis are interpreted into visual, tactile, geometrical, and configurational elements of the artifacts. According to the scenario, the scope of artifacts spans accessories, lifestyle products, crafts for cultural heritage, exhibits for display, lighting, public furniture, tools for education, sports gear, and outdoor installation. Criteria-based evaluation of the artifacts identifies promising design candidates for prototyping and leads to optimization of the material formulations. Open-source CAD applications and general-purpose 3D printers are used for design development to facilitate data transfer and distributed manufacturing.

3.5 Production

Full scale artifact prototypes are prepared using 3D printing with the optimized material formulations. Production of artifacts ensues from evaluation of the prototypes against perceived and material value in comparison with the estimated value of the waste plastics and the outputs generated by historic attempts, analyzed earlier. Desktop, large-scale, and robotic 3D printers are used to identify the most suitable production method

for scalable implementation.

3.6 Implementation

In relation to the scenario, artifacts are displayed, installed, or circulated in the target context through the established partnership with the stakeholders. For robust implementation of a circular system, we pursue subsequent pathways, including community-based entrepreneurial development, quantity production by local manufacturers, and adaptive introduction to other cases.

We have implemented the approach in various contexts and locations (Ok et al, 2024). While each case has distinct aspects, our approach in general consists of the multidisciplinary activities. We discuss details of three case studies of our implementation across design with traditional attributes for global equity, contemporary reimagination of cultural heritage, and transformative higher education (Yin, 2021).

4. Striving for global equity

The consequences of plastic pollution reach much further than inflicting harm on the natural wildlife and ecosystems. Harsh economic implications by plastic pollution inequitably affect countries that rely heavily on natural environments for their sustenance and income, and the Pacific Islands are particularly vulnerable to plastic pollution. While the Pacific Islands contribute less than 0.1% of global greenhouse gas emissions but bear the brunt of climate change impacts. Similarly, these countries contribute negligible amounts to plastic waste generation but receive a disproportionate share of it (APWC, 2023).

Samoa, an archipelago nation in the Pacific Ocean, earns approximately 25% of its GDP from tourism (World Bank, 2020). The country's reputation for pristine natural beauty and rich cultural heritage has been the cornerstone of its marketing strategy. Tourist attractions like "Swimming with Turtles" are built on the concept of harmonious coexistence and interaction with native species. However, the severe impact of plastic pollution on Samoa's natural habitat and the tourist experience is a significant concern. Plastic waste degrades the beauty of the beaches, threatens marine life, and negatively influences tourists' perceptions of the country. Moreover, the potential consequences for Samoa's economy are alarming, as tourism is the primary source of income (Tofilau, 2024).

From a comprehensive field study through meetings with tourism and government agencies in Samoa, we identified the types and quantities of plastic waste and its sources. Most plastic waste found in Samoa was foreign borne, primarily through imported products and foreign visitors. More than 60% of the plastic waste collected in Samoa originated from outside the country. The tourism sector contributes about 20% of all plastic waste, and tourists generate 40 times more plastic waste per person per day than a Samoan resident does (IUCN, 2021). The

situation is aggravated by lack of separated collection of recyclable materials combined with absence of local plastic recycling, leaving stockpiling of plastics for later overseas processing the only option for plastic waste management in Samoa (SPREP, 2023). In addition, more than 50% of plastic is never collected or landfilled, and a considerable amount of the leaked plastic might have gone astray in the natural environment (IUCN, 2024). A consensus among the local government and international organizations is that the underlying cause of the exacerbating environmental and economic problem includes low market value of plastic waste and insufficient trade volume for local processing (IUCN, 2021).

In addition, we gained a deeper understanding of Samoa's culture and lifestyle from conversations with arts and crafts communities and educational organizations. The Samoan communal way of life (*fa'a Samoa*) is found throughout Samoa. The whole community shares responsibility of living, educating, and helping together as one big extended family, and it is most evident during times of family occasions and traditional events. *Mea alofa* is the term that expresses the gift giving culture in Samoa. Gifts are prepared and presented at any large gatherings even to greet visitors. The culture is associated with rich and longstanding craft traditions in Samoa that spans everyday items, implements, decorative artifacts, and symbolic structures. For example, the asi is a simple handmade tool used to scrape the outer skin off the taro root, the staple of Samoa. The material has changed from coconut shells to the end of a metal can, most commonly mackerel cans, in favor of availability and durability.

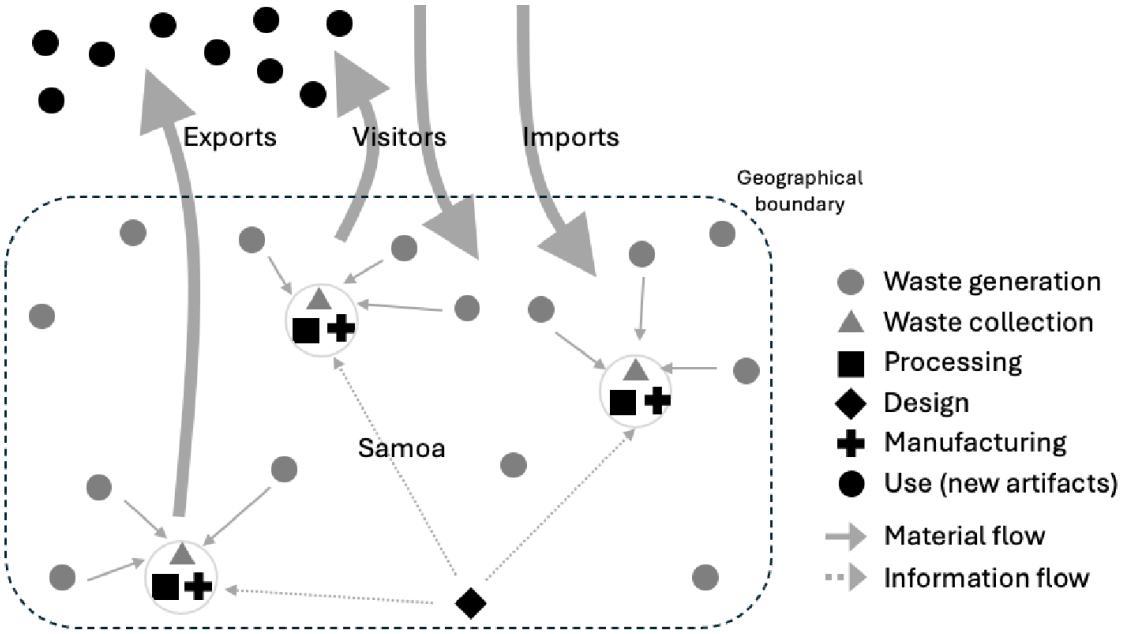

Figure 1. Material flow of plastic waste that enters and exits Samoa.

From the findings, we prepared a scenario-based strategy that aims to reduce the amount of plastic waste left in Samoa by capitalizing on the cultural characteristics. As shown in Figure 1, plastic waste is collected in a decentralized manner across the country. The collected plastic waste is processed locally and used for distributed manufacturing of artifacts at multiple clusters run by local participants (Leavy, 2017). Elevated perceived and material value comes from the artifacts designed to visually and tactilely communicate the essence of the Samoan culture and tradition. The artifacts are given as a souvenir to foreign visitors upon their departures, which serves as a reminder of the grave environmental and economic issue cause by the inflow of plastics from abroad.

To validate the strategy, we collected and processed polyethylene terephthalate (PET) and other types of plastics which together make up the largest proportion of plastic waste found in Samoa, and designed a series of souvenir artifacts, including turtle skull replicas and handgrips for the asi



Figure 2. Turtle skull replicas and handgrips for the asi (photographed by Lionel Taito-Matamua).

The original turtle skull was 3D scanned and 3D printed with our material formulation after digital processing. It embodies a poignantly ironic narrative that the replicas are made from the very material that is threatening the turtle. The vessel that holds the 3D printed skull references the fale, a Samoan house, to endow a ceremonial character to the gift. As a symbolic and tangible reminder of the issue, the gift, at the heart of mea alofa, is designed to entwine the visitor who accepts it with fa'a Samoa, inviting them to play a personal part in disrupting the flow of plastic waste.

The handgrip for the asi represents the Samoan lifestyle and traditional techniques, including dying and lashing that have been used in arts and crafts, celebratory, ornamental, and architectural practices. The handgrip is situated on top of the small stand that also serves as a platform for the taro during scraping. The form references the visual and formal qualities of kava bowls traditionally crafted by carving native hardwood. It is intended to elevate the perceptual status of the artifact beyond disposability to that of a delicate object that will be kept and valued.

Considering that plastic waste issues in many small, isolated areas and countries cannot be effectively addressed by the conventional recycling scheme, our approach can be adaptively applied to other locations, based on this case study (Lupton, 2017).

5. Reimagining cultural heritage

Despite its small size, New Zealand generates large amounts of plastic waste, including more than 700,000 metric tons of packing each year (Recycle New Zealand, n.d.). Although 97% of the population have access to recycling programs, most recyclers only accept PET and high density polyethylene (HDPE) and the majority of other types of plastics, including low density polyethylene (LDPE), polypropylene (PP), and polystyrene (PS) are landfilled (Plastics New Zealand, n.d.). China's strict waste plastic regulations has left fewer options for New Zealand, including exporting the amount to other countries. The problem associated with plastic waste in New Zealand is partly attributed to its relatively low waste disposal levy and low incentives for recycling (Pownall, 2019).

Tourism is an essential part of the New Zealand economy and the largest export industry (NZMBIE, 2022), contributing more than 20% of its total exports of goods and services. The geographical isolation New Zealand allows aviation to be the main means of transportation of tourists. Internally, popular destinations of international visitors include places for natural landscapes, cultural performances, and experience of traditional arts and crafts practices, largely based on Māori culture (Rigby et al, 2011).

The success of the tourism industry in New Zealand is partly the effect of the successful

campaign of “100% Pure” that delivers the image of immaculate nature that coexists with civilization. From our realization of an urgent need for the mounting issues associated with waste plastics in New Zealand, we formed partnerships with an airline and an arts and crafts institute that attracts more than 500,000 visitors annually to natural activity, cultural shows, and experiential classes it features.

Our on-site studies and discussions with the partners identified the types of waste materials generated from their practices. The airline consumes a great number of LDPE bags for in-flight services, including packaging of headphones and blankets. While they are aware of the issue, it is not possible to discontinue the use of plastic bags due to hygienic reasons and requirements. By contrast, the institute mainly produces organic waste, including harakeke (phormium tenax, New Zealand flax) discarded from the weaving classes. In addition to its stiff and strong fibers that put a significant challenge to attempts to repurpose the material, cultural restrictions exclude the option of burning of harakeke waste.



Figure 3. Production and detail of the hybrid material (photographed by Courtney Naismith).

Pursuing an opportunity to combine the two waste streams from the key contributors to the New Zealand tourism industry, we produced hybrid material formulations that demonstrate unique qualities. The harakeke waste collected from the institute was cut into smaller pieces, dried, and pulverized before being blended with the plastic waste processed into flakes. During the blending, the temperature was carefully controlled to process the harakeke waste respectfully according to the recommendations of a Māori advisor from the institute (Chilisa, 2020). Figure 3 shows visual and tactile qualities of the hybrid material across its color, surface, and integrity

produced from the process.

The novel characteristics of the hybrid material strongly informed our design development. The baskets shown in Figure 4 embody New Zealand's identity through multifaceted narratives. The hybrid material's origins track back to the transformation of discarded plastics and harvested harakeke into new, sustainable forms. This narrative captures the significance of the material's past, emphasizing the importance of reducing waste and discovering value from discarded materials in contemporary design; The visual and tactile characteristics of our creation evoke traditional weaving esthetics, yet the manufacturing process is distinctly modern. This narrative highlights the juxtaposition between the old and new, celebrating the rich cultural heritage of New Zealand while embracing innovative techniques and materials; In addition, by incorporating customization into the design, our baskets allow uses to engage with the artifacts and express their unique identities. This narrative emphasizes the importance of creating a strong connection between the user and the artifact, leading to product longevity through emotional durability (Chapman, 2009).



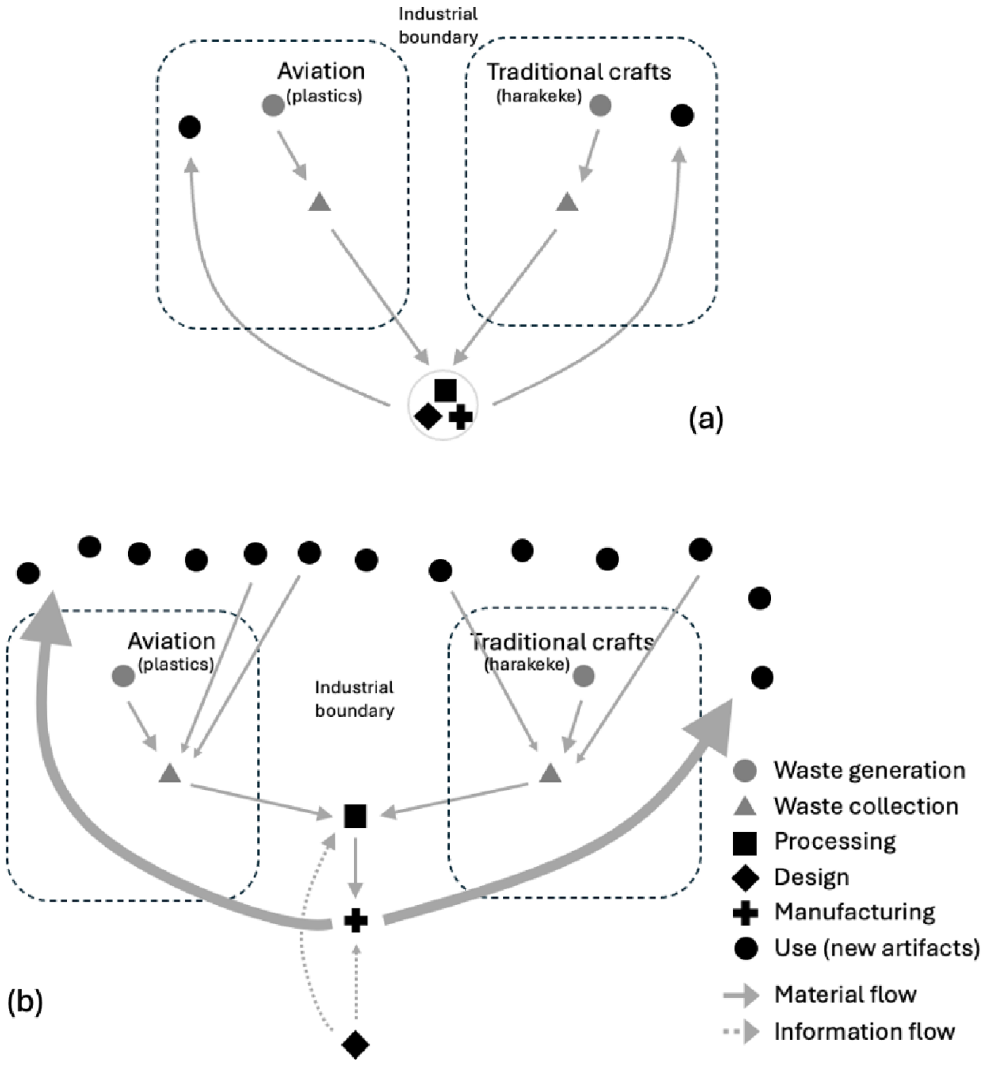

Figure 4. Bask

Figure 5. Material flow of (a) initial implementation, (b) after extension of implementation through contract processing and manufacturing.

Figure 5(a) summarizes the material flow of our implementation. Collected waste materials generated from each partner's practices were processed and produced into artifacts in small quantity mainly for demonstration within the partners. As the artifacts gained attention, a demand for quantity production was identified and our implementation was accordingly extended into contract processing of the waste materials and manufacturing by a startup from entrepreneurial development for commercial distribution. Artifacts that reach end of life are sent back to the partners and merged into the material flow as shown in Figure 5(b).

6. Integrating into education

Recent research emphasizes the role of higher education for successful implementation of sustainability principles such as the United Nations Sustainable Development Goals (UNEP, 2021). Curricular development and interdisciplinary studies are suggested as key agents in the transformation towards sustainability (Bullock & Wilder, 2016). We designed a transdisciplinary study track "Design Mediums" on material literacy, sustainable interventions, and technology competence within our industrial design program, and have integrated our approach into the courses to infuse students with self-motivated design research and practice towards circularity. Within the track, a project titled "the minimum for the maximum" challenges students to propose a real-world design intervention, develop a design solution for circularity, and attempt its implementation through engagement with external partners in five weeks. Additionally, students are required to form an argument that justifies their design intervention in relation to their own definitions of the minimum and the maximum.

Despite positive feedback from students on their practice-based, empirical learning experience within the study track, there was a remaining question how our transformative approach could be applicable to various cultural, economic, and pedagogical settings around the world (Jones et al, 2010). Transformation of higher education into nurturing sustainability-minded future leaders is an imperative regardless of discipline, background, and geographical location, and therefore adaptive application of our approach could accelerate curricular development and implementation in other institutions (Sibbel, 2009).

We discuss a case study of a recent exchange student from Mexico (UDEM) who completed the project with little initial understanding of our curriculum. Facing the design challenge, the student identified an opportunity for design intervention from local cafés near our campus. While the small, independent businesses are an essential element of the prevalent café culture of the city, the student noticed that a significant amount of waste, mostly in the form of coffee grounds after brewing and "compostable" plastic cups, was generated from the locations every day. Although the plastic cups, made from polylactic acid (PLA), are widely advertised as "compostable" containers, composting is only possible under specific temperature and humidity conditions which cannot be achieved in the typical domestic or small business environment. In addition, because PLA is relatively new and its trade volume is not as large as other commodity polymers yet, it belongs to the "7" or "other" category along with a wide variety of plastics that are not suitable for the conventional recycling scheme. Many municipalities around the world therefore do not accept PLA for recycling and instead landfill or incinerate the material.

A few cafés that were aware of the complexity associated with PLA showed interest in collaboration and provided the waste materials. Following our procedure, discarded PLA cups were dried and processed into granules, and coffee grounds were dried and pulverized. The two ingredients were then blended at various ratios, between 3% and 35% of coffee powder in PLA, to produce several material formulations. The processing temperature was maintained below 190 °C to prevent thermal deterioration of PLA that starts to occur at 200 °C (Kervran et al, 2022). The formulations demonstrated light to dark brown colors depending on the type and amount of the coffee included, emitting the coffee aroma (Figure 6).



Figure 6. A material formulation that consists of discarded PLA cups and coffee grounds.

The material flow among the locations is shown on the map (Figure 7). Although the scope was deliberately limited to a few locations close to each other to conclude the project within five weeks, this can easily be extended to include more partners in collection, processing, design, manufacturing, and use.

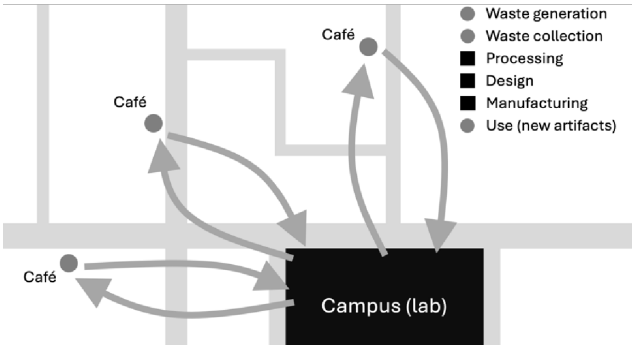

Figure 7. Material flow between campus and nearby cafés shown on a local map.

The design development was effectively informed by the material formulations that represent the main ingredient through multisensory stimulation. On-site observation and discussion discovered most café stores condiments and small utensils in the standard stainless containers on the tables, although café owners, employees, and customers



Figure 8. A multipurpose artifact designed for cafés (photographed by Mariana Avila Amavizca).

7. Building a system towards circularity

Based on our case studies, we propose a conceptual model that consists of three stages as shown in Figure 9.

Analysis is the first stage that decides the scope of an approach through a comprehensive study of the case. Quantitative and qualitative details of the situation, including type and amount of waste stream, impact and severity, stakeholders, relevant precedents, and previous interventions and outputs are investigated. Engagement with potential partners, such as local community members, activists, industry, businesses, and officials, is crucial for focusing on key factors of the issue and setting the overarching goal of the material and design development.

Synthesis is the main part of an approach in which most of the development activities take place. Waste plastics collected from the site or partners are characterized, processed, and turned into initial material formulations that display some useful properties and qualities.

the maximum.

all preferred more unique features.

The café tree is a solution proposed by the student (Figure 8). The artifact, designed to be placed on the tables in local cafés, communicates its origin through its form and materiality. The leaves serve as coasters that gradually spread the scent of coffee and the pot contains condiments such as sugar. The perceived and material value created by the proposed solution is easily recognizable in the context of the minimum for

Informed by the material formulations, design development starts to produce contextual concepts with amplified perceived value, which inform material development back. The two development processes extend each other, progressing through divergence and convergence towards the final solution for the case that demonstrates augmented perceived and material value. Within the boundaries of the intertwined development, permutations are prepared, evaluated using criteria, and refined for prototyping and production. Implementation entails placement of artifacts in target locations, initiation of supply into distribution, or introduction of products into service, through engagement with partners, including those who were identified in the first analysis stage. In addition, potential pathway options are explored in this stage. A sustainable, lasting circular system requires long-term consideration of material flow and subsequent development, such as a plan for collection and processing of designed artifacts when they reach end of life, quantity production of artifacts through contractors, development into a local enterprise, and product diversification.

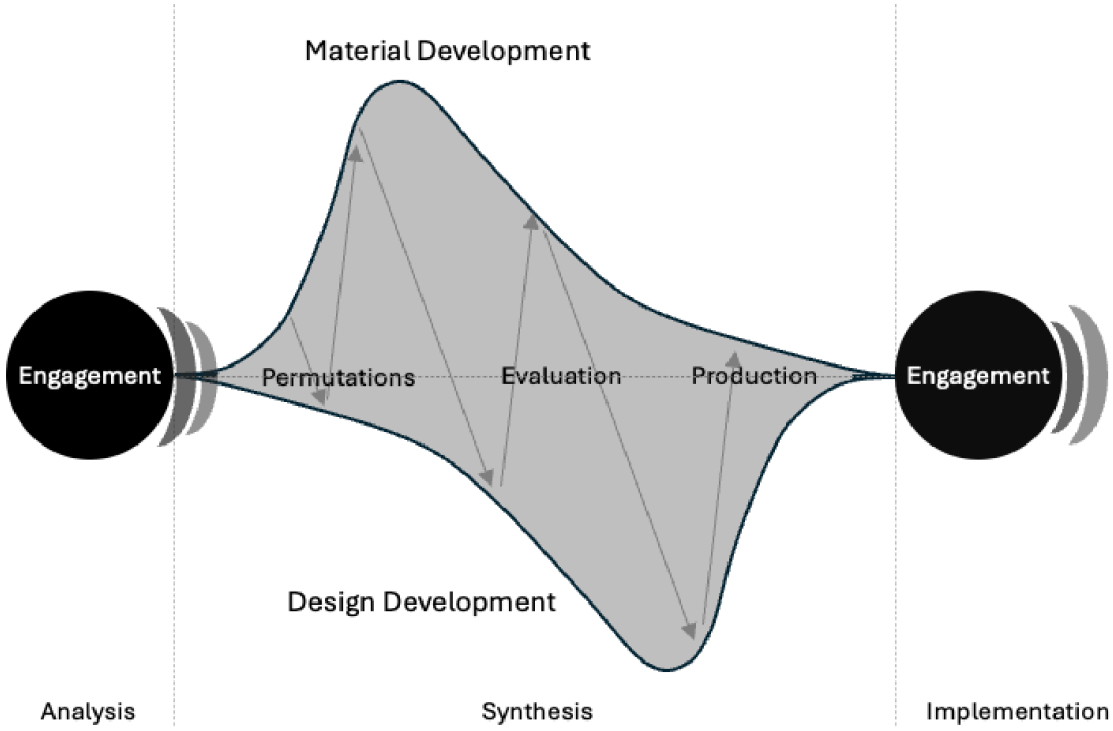

Figure 9. Conceptual model of our design-driven, value-oriented approach for circularity. Note the gray area indicates the extent of the intertwined material and design development processes.

8. Conclusion

The staggering issues associated with plastic waste affect severely the entire Earth system. In response to the limitations that the conventional waste management methods have exposed, we have developed and implemented a transformative approach. Consisting of analysis, processing, material development, design development, production, and implementation, our design-drive, value-oriented approach incorporates decentralized collection, localized processing, and distributed manufacturing towards circularity. The approach has been developed into a conceptual model through implementation in key contexts with stakeholders. The case studies also strengthen the argument that a system-based, multidisciplinary strategy is essential for maximizing effectiveness and longevity of

solutions and minimizing the impacts of plastics (Žalėnienė & Pereira, 2021).

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SPECULATIVE DESIGN EDUCATION: IDENTIFYING AND ANALYZING CRITICAL MOMENTS IN THE PROCESS OF EXTRAPOLATING FUTURE SCENARIOS

Susana Leonor and David Palma.

ABSTRACT | One of the goals of higher education in design is to provide pedagogical practices that promote active learning through exploration and participation in practical projects, where it is possible to introduce and apply methodological and technical skills, such as problem-based learning, which allows through the creative process, to articulate critical and strategic thinking in solving current problems.

However, we are emerging in a global context where it is necessary to encourage future designers to raise systemic and comprehensive issues that require a deeper understanding and an approach that goes beyond immediate solutions and responses, which may obscure or minimize potential future consequences, diverting attention from fundamental issues. Approaches such as speculative and fictional design assume significant relevance in empowering designers to think and extrapolate new solutions and envision beyond the expected. They allow the exploration of solutions capable of generating new concepts and disruptive strategies, potential social and economic changes, and the positive reconfiguration of individual and collective habits and social practices. This also reinforces awareness of the designer's role as an agent of change in society.

Thinking about the environment, society, and political systems in the next fifty or eighty years, imagining utopian and dystopian scenarios, especially with positive propositions for the present, becomes a complex task for students.

This article aims to mitigate this question and identify and analyze recurring patterns of critical moments in elaborating future scenarios. The research is conducted by a bibliographical review of practices in similar contexts and monitoring projects undertaken by final-year students in the Bachelor's degree program in Communication Design.

KEYWORDS | SPECULATIVE DESIGN, CRITICAL DESIGN, SPECULATIVE DESIGN EDUCATION, SPECULATIVE DESIGN PROCESS

1. Introduction

Higher education aims to provide pedagogical practices that promote students' preparation for future challenges and uncertainties (Király & Géring, 2019). In design education, students are frequently introduced to methods and challenges that encourage them to explore diverse pathways and achieve tangible results. This process familiarizes them with rapidly materializing their ideas experimentally and concretely. While design encompasses commercial aspects, leveraging fields such as graphic design and industrial design, it also functions as an evolving discipline aimed at resolving complex, ill-defined problems as well as broader systemic issues in business, society, and the public sphere. In this context, methodologies such as design thinking are employed to devise solutions for "wicked problems" (Buchanan, 1992).

Moreover, other approaches within design diverge from commercial interests and focus on areas beyond the commercial spectrum, such as speculative design and fictional design (Dunne & Raby, 2013). Constant social and economic transformations have led society to adopt unsustainable habits, lifestyles, and social practices. These practices necessitate a new orientation and the adoption of methods that promote disruptive change (Angheloiu et al., 2020), including approaches like speculative and fictional design, which challenge students to navigate uncertainty and new challenges. Through these approaches, students can acquire skills and the capacity to analyze and develop a reflective and critical attitude to help them thrive in a specific (future) context (Barendregt et al., 2024).

This article presents a framework applied to communication design students since the 2020/21 academic year. This framework introduces and explores future scenarios that offer new perspectives on addressing wicked problems. However, extrapolating future scenarios is a complex process with critical moments, during which we identify gaps and patterns among students who struggle to disconnect from the present and from projects that can be tangibly realized. Consequently, we will analyze and discuss the most critical moments for final-year communication design students.

2. Framing Speculative and

Fictional Design

Speculative design, like design fiction, aims at exploring and extrapolating alternative future scenarios, making it difficult to differentiate between the two and leading to a standard interchange of the terms. The term design fiction was coined by science fiction writer Bruce Sterling (2005), when he felt the need to reflect on and differentiate between science fiction and design fiction. Later, David Kirby (2009) defined design fiction as a 'diegetic prototype,' a concept adopted by Julian Bleecker (2009). He interprets it as prototypes or artifacts that provide greater expression and context to fictional narratives, visualizing specific technologies within a fictional context and society. Filmmakers and scientists can situate and sketch possible types of technology used in areas such as medicine, computing, or space (Bleecker, 2009; Kirby, 2009).

"Diegetic prototype" can be exemplified through science fiction films like "Minority Report" (2002), in which a computer prototype with a gesture-manipulated interface is presented. In 2005, CNN reported on actual prototypes being developed based on the idea from the film (Kirby, 2010; Bleecker, 2009). Another example is the "Apple Vision Pro" launched in 2024, which allows an immersive augmented reality experience in the real world, similar to gesture-based interaction with the interface.

Design fiction can be understood as an integral part of speculative design (Dunne & Raby, 2013). Although they are similar and difficult to dissociate, subtle differences can be identified between them. For Bleecker (2009), design fiction combines elements of design, scientific facts, and science fiction to create scenarios and artifacts that project entirely new worlds without constraints on the consequences and needs of the natural world, even if scientific facts confirm they are not possible. On the other hand, speculative design was popularized by Dunne and Raby (2013) as an exploration of alternative futures aimed at understanding current issues and discussing the type of future we wish to create. This approach proposes alternative solutions, critiques, and possibilities for the future, which can also result in artifacts that help represent these concepts and critiques (Dunne & Raby, 2013).

Dunne and Raby (2013) state that while design fiction concentrates more on creating narratives and imaginary worlds, speculative design is focused on reflecting on the social, ethical, political, and cultural implications in the future. Although both emphasize speculation and creativity, their applications and objectives may diverge in specific contexts.

In summary, despite nuances between the two terms, design fiction, and speculative design emerge as enablers for exploring the future, fostering critical thinking, and allowing reflections on ethical, political, or environmental issues.

3. Pedagogical Methodologies for

Extrapolating - Cases revision

Dunne and Raby (2013) characterize "speculative design" as a catalyst for shifting the emphasis from solving problems for clients to solving problems for societies. By developing fictitious scenarios and views concerning society, politics, technology, and culture, speculative design allows designers to evaluate their contemporary cultures. Its framework centers on feasible, probable, and favored futures. (Bardzell Forlizzi, Zimmermann et al. 2012). One of the goals of communication design speculations is to highlight societal issues that require attention to potentially spark change, not to deceive or persuade the audience about issues they do not wish to relate.

By developing methodologies that conduct learning processes with tools that raise questions about their future, mainly about the world's future, under the question "what if," they are opening their competencies for the next level—what is the purpose of designer role-play?

With the use of the speculative design framework, graphic and communication designers can use their skills as a potential catalyst for change and be equipped with a potent tool (Rynning, 2017). The ability to conduct careful design and facilitation, supported by research tailored to stakeholders' needs, anticipate shocks, support engagement, and co-create are among the skills and competencies required. Other competencies include creative, cross-sector, and cross-disciplinary decision-making and innovation (Wilde, 2020). Mostly, sustainability brokers must be able to create global communities of like-minded individuals that bridge disciplinary boundaries and are united by shared values and understandings, as well as methods to support knowledge integration and behavioral change. (Wilde, 2020)

The transition between deconstruction—of preexisting conceptions and ideas of the future—and generation—of new images of the future—reflects Freire's (1970/2005) emphasis that, in order for their efforts to be transformative, oppressed communities themselves must participate in both introspection and action. Thus, a critical future needs to develop ways to involve the public rather than implementing "futuring from above" to live up to its name. Thus, democratizing futures has emerged as a central claim supporting incorporating co-creative or participatory design methods into future endeavors to encourage teamwork and make futures less theoretical and more concrete (Farias, et al., 2022). This does not imply that such skills are out of place in a critical design futures curriculum; in fact, they frequently are. Instead, it means that an analytical way of thinking should be applied to social and emancipatory goals in a group setting while considering the epistemological presuppositions that the field mobilizes (Barendregt, L. et al., 2024).

We also need to think carefully about how

we challenge and reinforce the status quo in our educational activities and rethink them to serve better and reflect emancipatory goals. By positioning ourselves as co-learners with our students and allowing them the freedom to take the lead and contribute to social transformation, we can demonstrate our commitment to criticality in both methods and aims (Barendregt, L. et a.l, 2024).

The interdisciplinary fusion is the foundation for Design Futures' emergence, which has greatly aided in researching future visions (Angheloiu et al., 2020). Incorporating scenarios, long-term critical thinking, and other foresight techniques into their work, designers are, on the one hand, becoming increasingly future-focused. However, futurists are actively involved in creating prototypes, employing them to produce immersive experiences that put their futuristic ideals into context (Candy & Dunagan, 2017).

The expansion of future studies into the area of practice and the adoption of materials, techniques, and approaches from design and art are significant examples of the convergence of design and futurology (Candy, 2010 & Dunagan, 2017). As a result, it is both appropriate and highly beneficial to employ real-world examples as a breakthrough in the subject of design future studies. (Li, T. & Fu, Z., 2024) One of the guiding principles of frameworks such as forecasting, which aims to anticipate the future based on current trends or backcasting, is to define the objective and then ask, "What shall we do today (and subsequently) to achieve the objective?" This question is answered by following the procedures outlined above (Schwartz, 2009).

Speculative design, design fiction, visionary design, transition design, and technological innovation are the five subtypes under the design futures context on which the research focused. It also established a preliminary analytical framework for design futures practice cases, Li, T. & Fu, Z. (2024) raised two fundamental questions for the understanding of the framework and tagging system: First, how can we build a thorough descriptive framework and carry out preliminary framework validation for future practice scenarios in design? Second, how can we identify and measure the unique characteristics and differences of the many genres (subtypes) of design futures to help in educational and creative endeavors and develop heuristic design tools? Their work enables us to recognize that the primary goal of Design Futures is to inspire people, raise awareness of current issues, and motivate them to take action by empowering them to shape the future responsibly and deliberately choose among available options. It also aims to create captivating experiences of future predictions. It offers a complementary approach to design and futures that can be used in exploring transformative changes that align with the social and environmental challenges of our time (Li, T., & Fu, Z., 2024). Li, T., & Fu, Z. (2024) analyzed cases where identified frameworks, models, and

techniques were utilized, which we summarized:

Table 01.: Resume of frameworks, models, and techniques, adapted from Li, T., & Fu, Z. (2024)

Cluster	Theoretical frameworks, models, and tools	Authors
Domain/ Theme-related	STEEP	Inayatullah, 2004
	STEEP +	Saritas & Smith, 2011
	DEGEST	Ratcliffe & Ratcliffe, 2015
	PESTLE	Warner, 2010
	PESTEC	Makela, Parkkinen, Lyytimaki, & Nygren, 2020),
	STEMPLE-Plus	Burrows & Gnad, 2018
	STEEP-V	Manual, 2018)
Worldview/ Scenario-related	Six meta-archetypes: scenario archetypes.	Boschetti, Price, & Walker, 2016
	Global Scenario Group (GSG) with six scenario archetypes: Policy Reform (PR), Market Forces (MF), Breakdown (B), Fortress World, (FW), Eco-Communalism (EC), and New Sustainability Paradigm (NSP)	Gallopín et al., n.d.
	Divergent world end-states: Conventional, Great Transitions, Barbarization, and "Muddling Through."	Gallopín et al., n.d.; Raskin, 2010
	Scenario archetypes can be considered as a statement of worldview, encompassing four states: continued growth, collapse, discipline, and transformation	Dator & Dator, 2019
	Forward five archetypal future images: Evolution and Progress, Collapse, Gaia, Globalism, and Back to the Future	Inayatullah, 2008
	Future archetypal images from 140 sci-fi movies set in the future to propose a new set of scenario archetypes, identifying six archetypes: Growth & Decay, Threats & New Hopes, Wasteworlds, The Powers that Be, Disarray, and Inversion.	Fergnani & Song, 2020
Ideology-related	Ideology is a way of thinking about worldviews and the narrative glue that connects values, beliefs, priorities, hopes, and fears together	Dunne & Raby, 2013
	Political Spectrum Diagram	Eysenck & Coulter, 1972
	The original form of the Nolan Chart has two dimensions: the X-axis represents "economic freedom" and the Y-axis "personal freedom," divided into five sections, each with a label: Statism (bottom left), Left-wing political philosophies (top left), Right-wing political philosophies (bottom right), Libertarians (top right)	Roubelat, 2006
	New ideological systems, proposing four national forms based on the political stance chart comprising left-right, authoritarianism, and liberalism: Communo-nuclearists, Digitarians, Bioliberalists, and Anarcho-evolutionists.	Dunne & Raby, 2013

A mix of methods is necessary, starting not only with the tools but, above all, with an

Possibility-related	Futures Cone: This classification begins by considering all potential futures and then gradually zooms in on the more likely and/or desired ones.	Hancock & Bezold, 1994
	Voros' taxonomy: wildcards and alternative futures: possible, plausible, and probable futures, as well as one preferable future.	Voros, 2003
	Futures Cone	Gustafson, 2010; Hines & Bishop, 2013; Scheepers & Timpe, 2003).
	Extended the original Futures Cone concept, providing additional subdivisions, including seven alternative futures: Potential, Preposterous, Possible, Plausible, Probable, Preferable, Projected, and Predicted futures.	The Futures Cone, Use and History – The Voroscope, n.d.
Temporal/ Phased Frameworks related	Temporal frameworks inherent in practice cases	Brown & Michael, 2003; Heilbroner, 1995
	Temporal characteristics of future research encompass the short term (considered to range from the present to five years), the medium term (from five to ten years, and for some authors, up to twenty years), and the long term (from 20 to 50 years).	Masini, 1993
	In operative or operational management, the timeframe extends up to one year, in strategic management up to ten years, and in visionary management up to thirty or even fifty years	Kaivo-oja, Katko, & Sepp¨al¨a, 2004
Element Composition/ Creative thinking techniques related	The use of structured approaches to scenario planning and mnemonics (such as the SCAMPER acronym) therefore facilitating qualitative improvements in the outputs	Curnin, Brooks, & Brooks, 2022
	Techniques include sense-breaking	Danish Emergency Management Agency, n.d.
	Reframing	Ramírez & Wilkinson, 2016
	Paradigm change	McFadzean, 2000
	SCAMPER- uses idea-stimulating questions to help participants generate different ideas, solutions or products, including creative techniques such as Substitute, Combine, Adapt, Magnify&Minify, Put to another use, Eliminate and Reverse	Serrat, 2017
Creative Generation/ Intention related:	The 'Verge' Ethnographic Futures Framework consists of 6 domains: Define, Relate, Connect, Consume, Create and Destroy	Schultz, Crews, & Lum, 2012

understanding of who we are and the human values in design, which can be listed: Carefulness, Ecology, Justice, Meaningfulness, Personal development, Pleasure, Respect for oneself, Respect for others, and Status. Kheirandish et al. (2020), these nine value items open for a more extensive list, allowing the development of a framework that provides a comprehensive perspective on human values that different design approaches can apply. These values are fundamental, considering the envisioning of Maldonado (1971), who believed that design duties necessitated a strong sense of ethics based on the designer's solid cultural foundation (Celaschi, F., & Celi, M. 2015).

Eriksson et al. (2022) defined it as a teaching activity, Envisioning Future Scenarios based on the

SOLO taxonomy by starting with gaining a deep understanding of the topic and applying their knowledge in various contexts framed with various values-based design approaches. It is essential to introduce support materials in the initial phase, such as a characterization of cases, theoretical texts, and visual media such as series or fiction films. Students may approach their own or others' designs from a single, limited perspective while examining users and user experiences, failing to recognize the possible impact on a broader society. Designs can have positive and negative long-term effects on an extensive range of stakeholders beyond those initially considered. After, students are asked to conceive and examine long-term repercussions, social ramifications, and widespread consequences of their own or other people's designs by creating scenarios for the future. Beyond what they would often define as the intended application of their design, the students visualize at least one usage or user scenario, which may cause them to reconsider their designs and design choices. With the support of Cards and Prompts, for questions, for developing future scenarios to analyze and explain a use or user situation based on four criteria (stakeholders, time, values, pervasiveness) (Eriksson, et al.; 2022).

According to Eriksson (2022), students should be able to achieve the intended learning outcomes:

- create future scenarios to envision and analyze possible long-term effects, widespread consequences, and societal impacts of their own or others' designs;
- apply their understanding of potential long-term effects, widespread consequences, and societal impacts to rethink their design and design decisions.

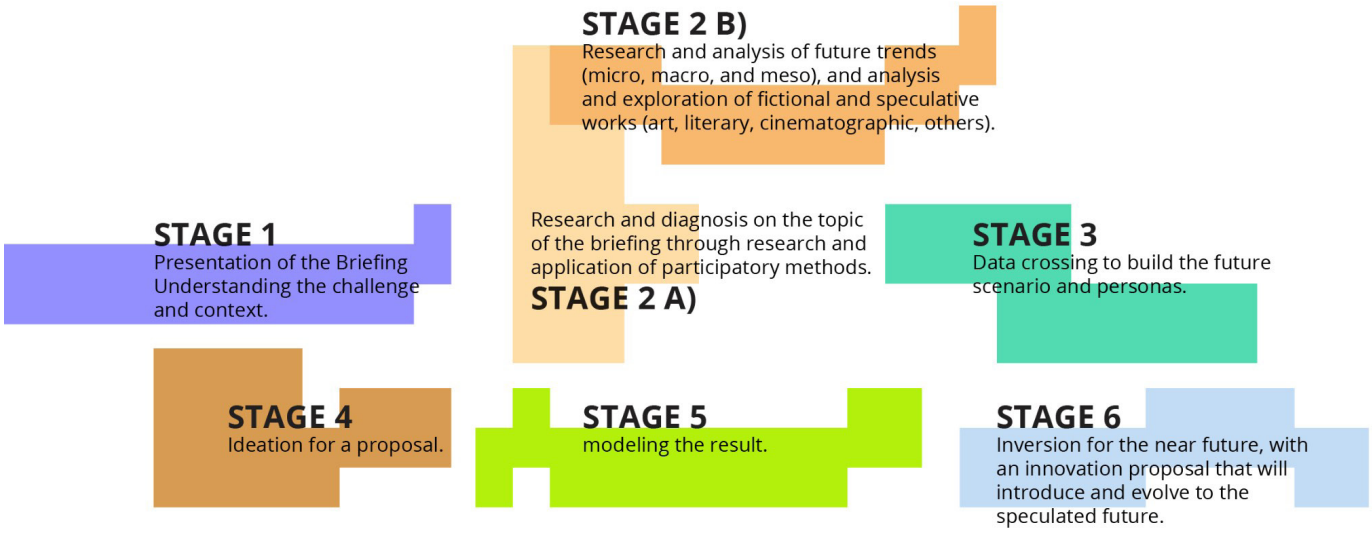
Designers are becoming more future-conscious, incorporating long-term thinking, scenarios, and other foresight tools (Li, T., & Fu, Z., 2024).

On the other hand, they also need to understand the importance of connecting with the public. The idea will not connect with the viewers if it goes too far into the future to show unbelievable ideas or extraterrestrial technology environments. A design hypothesis, thus, necessitates the existence of a bridge between the fictitious aspect of the notion and the audience's view of their reality. This "perceptual bridge" draws inspiration and influence from various disciplines, including observational humor, psychology, ecology, horror cinema, and illusion, due to the insights these areas provide into the intricate workings of the human mind and how it may be skillfully manipulated to elicit a response (Auger, 2013).

4. Apply Pedagogical Model Extrapolating Future Scenarios — Results and quali-quanti evaluation

This article is related to the analysis conducted by applying a framework used in the Advanced Project course. This course is part of the third year of the Communication Design undergraduate program at ISMAT. The course introduces students to speculative design and fictional approaches, starting from an initially given topic or subject to explore; students are required to identify problems and project alternative scenarios and futures in response to the identified questions through different steps. Ultimately, the process culminates in an inversion for the near future, with an innovation proposal that will introduce and evolve toward the speculated future (published by authors.).

Figure 01. The Workframe for Advanced Design Project, by the authors



The framework used in this course is divided into six stages (see Figure. 01)

Phase 1 - presentation of the brief, understanding of the challenge and context;

Phase 2 - divided into two timelines:

2a) research and diagnosis on the topic of the briefing through research and application of participatory methods and,

2b) research and analysis of future trends (micro, macro, and meso), and analysis and exploration of fictional and speculative works (art, literary, cinematographic, others);

Phase 3 - data crossing to build the future scenario and personas;

Phase 4 - ideation for a proposal;

Phase 5 - modeling the result;

Phase 6 - inversion for the near future, with an innovation proposal that will introduce and evolve to the speculated future.

This framework aims to enable students to comprehend, map, and apply the speculative and fictional design approach in a structured manner throughout the semester. Mainly, it is designed with the understanding that by the third year, students are accustomed to processes and methodologies focused on solving problems in the present or near future. This framework seeks to gradually help students understand and visualize the differences in creating a project that extrapolates future scenarios. In this context, instead of presenting a problem to solve, students are given a theme from which they must identify problems, fostering their ability to think and design ideas for what does not yet exist.

Based on interactions with different students from various classes from 20/21 until 23/24, we identified a pattern of similar critical moments within our context experienced by the students. Intending to map this clearly and optimize the framework we presented, which assists in introducing speculative design and fictional design to final-year design students, we prepared questions for 12 former students from different years. So that we can gain a better understanding and analyze their perspectives on their speculative design projects at different stages of the process. Nevertheless, to improve understanding of both the framework that we apply with students throughout the semester to develop for the project and identify the challenges and most critical moments encountered by students during the process, we initially present examples of work carried out during these academic years in this context and using this framework.

4.1 Results

Despite maintaining the framework, a new briefing is presented every year, with different characteristics and themes to be explored. Therefore, we present a selection of various works that illustrate the diversity of themes developed within this framework over the years.

The first class in which we introduced the speculative design approach in the 2020/21 academic year was focused on repositioning the Delta brand for 2060, a leading coffee brand in Portugal.

In this context, we present Ana Silva's project, "Flow Powered by Delta" (see Figure 02). While focusing on the Delta brand, this project required an assessment and projection of different future scenarios of what society could be like in 2060 and what role Delta might play. This former student envisioned optimized and technological urban spaces for 2060. Furthermore, in this future projection,

cities are silent spaces, leading citizens to greater efficiency in work and education with fewer chronic effects.



Figure 02. Flow Powered by Delta Project, by Ana Silva student, published by the authors.

In this future scenario, Delta Flow consists of an experience inside spherical capsules that offer moments of decompression and isolation within urban centers reminiscent of the current cultural tradition of coffee consumption in Portugal. The result of this project reflects a new lifestyle and an innovative vision of technological interfaces for human-machine interaction. For example, booking a moment in a Flow capsule is done through retina recognition screens. This approach also promotes critical reflection on digital security, interaction, and usability of new products and services embedded in urban environments (Leonor & Palma, 2024).
During the 2021/22 academic year, we encountered a new reality that brought about sudden changes in behavioral and professional habits due to the emergence of the SARS-CoV-2 virus. In response, we challenged our students to explore the topic of social nomadism, a broad subject that allowed for diverse lines of inquiry and the extrapolation of various future scenarios.

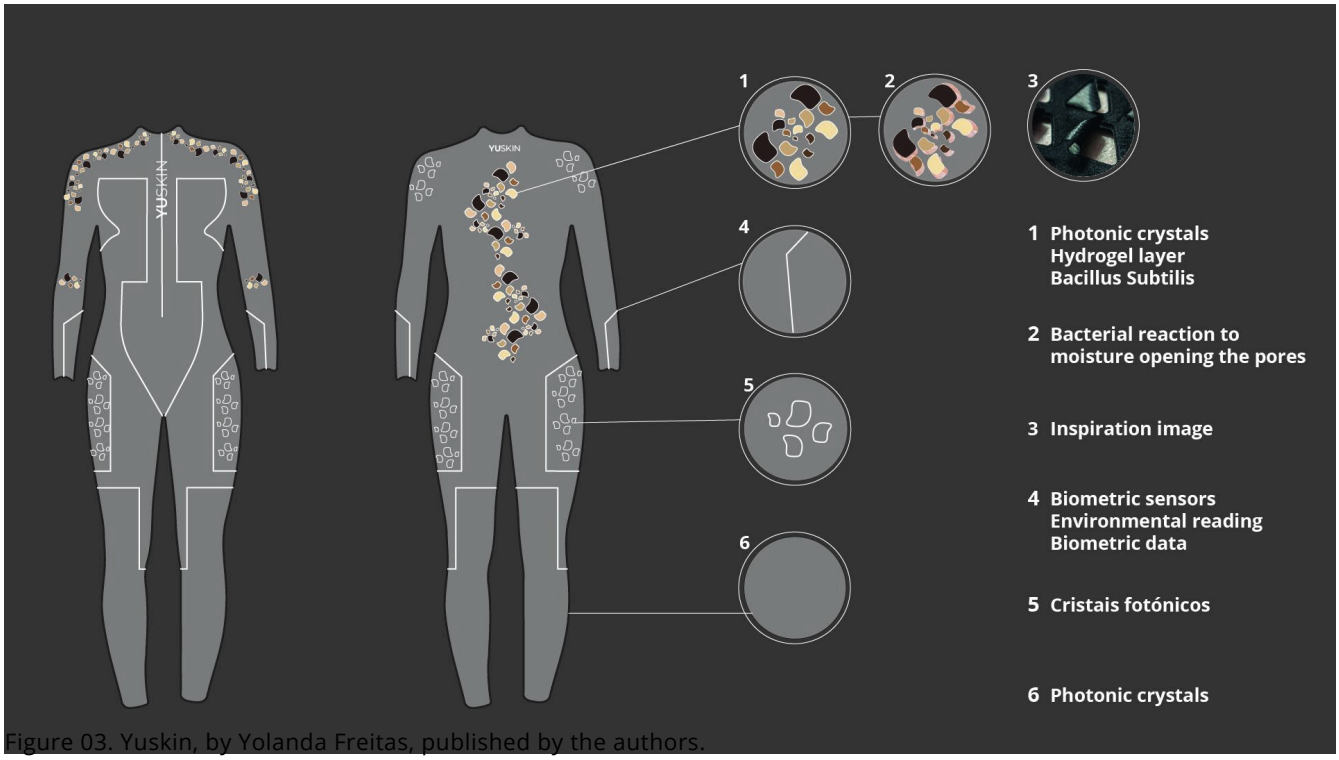


Figure 03. Yuskin, by Yolanda Freitas, published by the authors.

An illustrative example is Yolanda Freitas's project, YUSKIN (see Figure 3). In this project, the former student offers a novel perspective on clothing by envisioning an alternative future for 2050, where smart clothing incorporates nanotechnology and photogenic crystals. The project focuses on issues such as mobility, sustainability, durability, and heat retention. Furthermore, it prompts discussion on problems related to textile waste and fast fashion. This speculative textile product was also designed to allow users to customize colors and shapes through connections with personal electronic devices, enabling a single garment to assume different configurations (Leonor & Palma, 2024).

In the following year, 22/23, the focus was introduced on how we will interact with culture and information repositories in the future, explicitly addressing how museums will evolve. This involves interpreting what they will look like, what to expect from museum experiences, and how they will be structured.

An illustrative example is the work of former student Inês Crisóstomo. Inês focuses on the user experience, envisioning how a museum could offer an immersive visit to Mars without leaving Earth (see Figure 04). The concept revolves around the idea of visiting a museum by simply wearing a suit with a helmet that allows the user to experience all senses as if they were indeed on Mars. This project integrates various fields of knowledge,

including interaction design, equipment design, engineering, information design, and textile design.

The project also considers future developments of the suits, incorporating technological advances such as motion capture and smart fabrics, inspired by megatrends and science fiction. Additionally, it addresses the potential colonization of Mars, emphasizing the need to learn from the mistakes of Earth's colonization and to promote respect and efficient management of natural resources (Leonor & Palma, 2024). We concluded this journey of various challenges and projects developed over the years with a project by the final-year students of 23/24. This year, the students were tasked with envisioning a society in 2080 that honored the legacy of Manuel Nabeiro, a prominent Portuguese coffee entrepreneur known for his philanthropy, entrepreneurship, and innovation. This project challenged the students to speculate and generate future scenarios of how Nabeiro's influence and legacy could make a difference in a new society.

Figure 04. Astronomer - From Earth to Mars, by Inês Crisóstomo student, published by the authors.

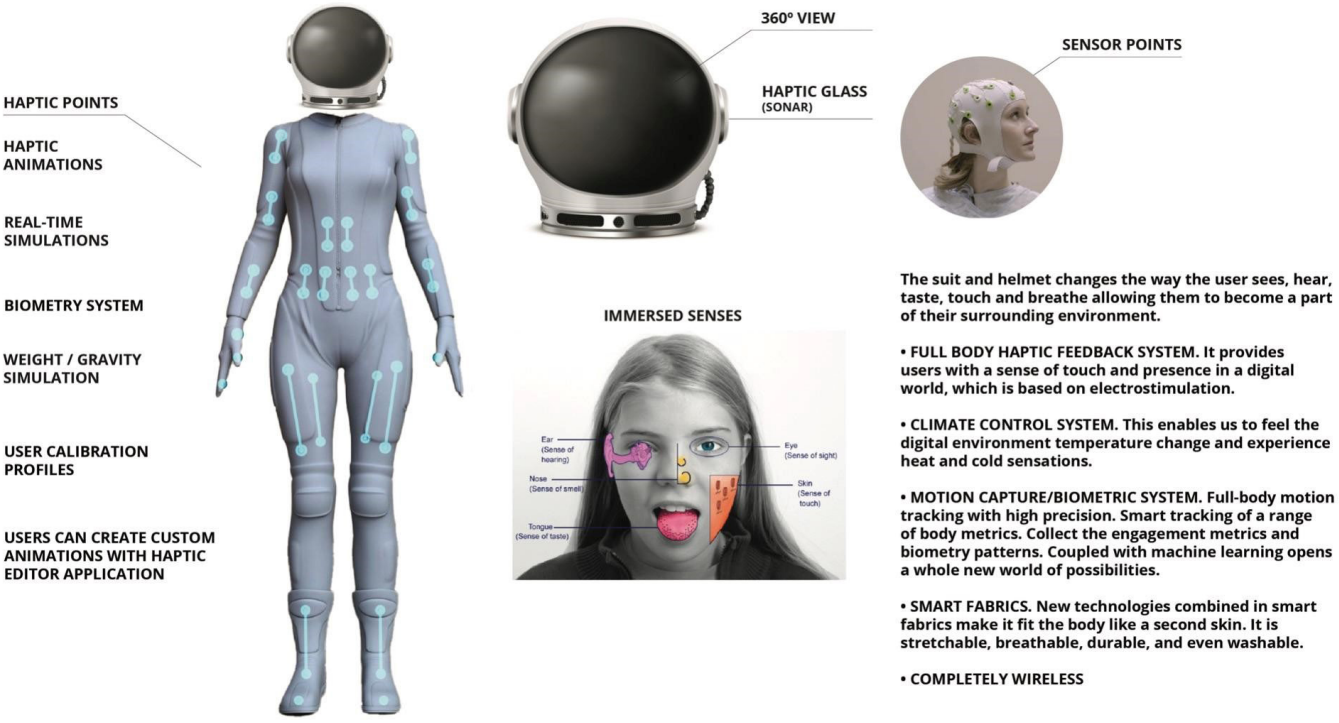


Figure 05. CADAP (images generated by IA), by Pedro Medeiros.

Based on the proposed challenge, Pedro Medeiros presents a complex system for a new way



scenario proposed by Pedro for 2080 envisions society living in hub-like buildings globally, of living and interacting, with a greater consciousness about work and sustainability. The aimed at enhancing human development and sustainable living. This society comprehends the planet's fragility, including ecosystems, animals, and resources, and learns from past actions to adopt thoughtful, informed behaviors focused on THINKING. It prioritizes reflection before action, study before creation, and participation over mere labor. This non-capitalist society lives by the principle that we are part of the Earth's system and must live harmoniously within it, striving for happiness, purpose, and quality of life for all community members.

In this scenario, CADAP (Self-Sufficient Community for Action and Thought Development / Comunidade Auto-suficiente de Desenvolvimento de Ação e Pensamento) (see Figure 05) cities are integrated. These expansive cities, built in harmony with nature, house communities in single structures that provide new professions, social spaces, housing, and local production. CADAP stimulates learning and knowledge generation, fostering communities that uphold values, encourage territorial entrepreneurship, and reject the capitalist model in favor of human knowledge

development.

Figure 06. NADAI (images generated by IA), by Pedro Medeiros.



The community focuses on three core values: Regeneration, Innovation, and Circularity. It by NADAI (Nabeiro's Artificial Intelligence for Action Development/ Inteligência Artificial de Desenvolvimento de Ação de Nabeiro) (see Figure 06), this technology enhances human capabilities by managing, stimulating, and storing community knowledge. Humans oversee NADAI and serves as a tool for advice and stimulation, accessible to all via a bracelet.

constantly explores new ways of living and enhances its capacities and surroundings. Managed

NADAI functions in three key areas:

1. Management: It manages all community resources in an accessible database.
2. Stimulation: It fosters understanding, rethinks concepts, and creates responses to improve human life.
3. Storage: It securely and systematically stores knowledge, facilitating access to present and past information.

NADAI introduces a new learning method through Super Foods, which creates a modular "workspace" in the brain for thinking, learning, and simulating even during sleep. These foods provide essential components for this process, stimulating knowledge through a customized learning system. Biometric sensors in the bracelet record all generated knowledge inspired by Blockchain for secure storage.

This set of student projects from different years allows the perception and interpretation of how various themes and issues can be framed in a future speculation approach. In all cases, there are common points and questions, such as the positive presence of technological evolution and its relationship with humans and the interpretation of new, more sustainable, and conscious lifestyles. Additionally, this project helps extrapolate potential new professions, social habits, services, and experiences that do not exist and that still need to be thought.

4.2 Quali-quanti evaluation

To understand the results of this pedagogical practice over the last years, we applied a qualitative and quantitative questionnaire to students who attended the curricular unit. This questionnaire, composed of evaluation weights, used Likert scales with 5 points to systematically collect a range of viewpoints and attitudes and development questions intended to obtain feedback on each of the six STAGES of the framework.

Regarding STAGE 1 - presentation of the brief, understanding of the challenge, and context - the response was unanimously moderate. However, the final assessment identifies a need for more understanding in the initial phase, perhaps a naive interest in the real purpose of the challenges launched (see Figure 07).

Figure 07. Results from the question for Stage1, by the authors

STAGE 2 - is divided into two timelines: 2a) research and diagnosis on the topic of the briefing through research and application of participatory methods and 2b) research and analysis of future trends (micro, macro, and meso), and analysis and exploration of fictional and speculative works (art, literary, cinematographic, others); a more excellent dispersion in the responses were identified, which allowed us to draw some conclusions such as students with a greater capacity for critical thinking, reported greater ease in carrying out the task, as well as those who selected moderate considered the support resources made available by teachers essential to develop the analyses.

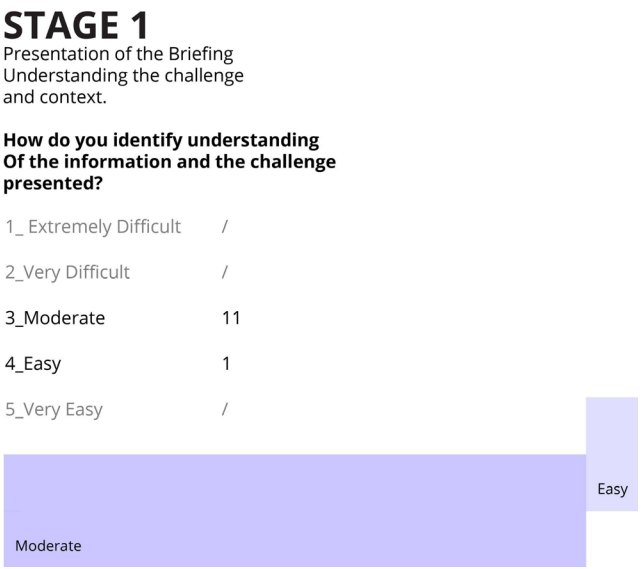


Figure 08. Results from the question for Stage2 A) and B), by the authors

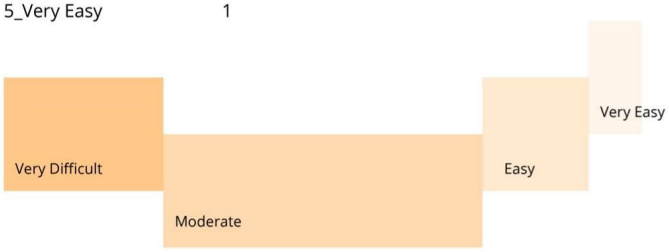
The previous results indicate the progress of STAGE 3 - data crossing to build the future scenario and personas. This phase is

STAGE 2 A)

Research and diagnosis on the topic of the briefing through research and application of participatory methods.

What degree of difficulty did you feel When developing this phase?

1_ Extremely Difficult	/
2_Very Difficult	3
3_Moderate	6
4_Easy	2
5_Very Easy	1

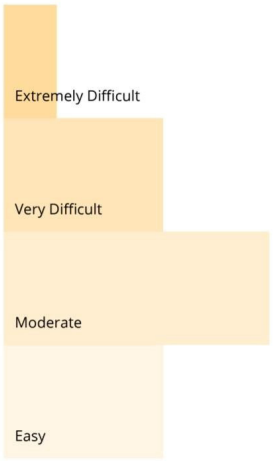


STAGE 2 B)

Research and analysis of future trends (micro, macro, and meso), and analysis and exploration of fictional and speculative works (art, literary, cinematographic, others).

How difficult was it for you to develop this phase?

1_ Extremely Difficult	1
2_Very Difficult	3
3_Moderate	5
4_Easy	3
5_Very Easy	/



From your perspective, were the necessary resources made available to support the development of this phase?

crucial for the project's development and its results. The depth developed in STAGE 2 enables the student to extrapolate possible imaginaries and point out more divergent paths. While the number of students finding this stage difficult is increasing, the majority feeling some moderation demonstrates their progress. They expressed some 'discomfort' in their development responses but also a sense of achievement and growth: "I reached it, but there were several adjustments and some setbacks at the beginning, which could have been avoided. The process was not linear, and there were times when I did not have such a consistent and comprehensive view of the scenario's potential, hence some doubts and incomplete details. So, at first, I was confused about what to do next. However, I think I managed to complete it little by little and move on to the next phase" (Emilia Faria).

Figure 09. Results from the question for Stage3 and Stage4, by the authors

Despite the specificity and the stage being the moment to apply all the knowledge acquired in previous years, STAGE 4 - ideation for a proposal, is surprising because students need more confidence in the work they

STAGE 3

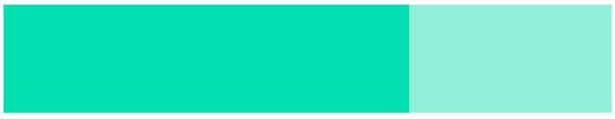
Data crossing to build the future scenario and personas

How difficult was it for you to develop this phase?.

1_ Extremely Difficult	/
2_Very Difficult	5
3_Moderate	4
4_Easy	3
5_Very Easy	/



Based on your answer, do you feel that you managed to achieve an integrated and consistent vision to progress to the next phase?

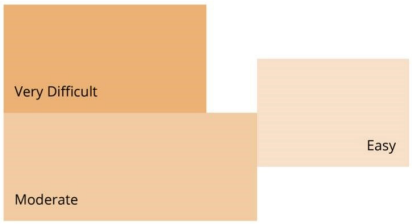


STAGE 4

Ideation for a proposal.

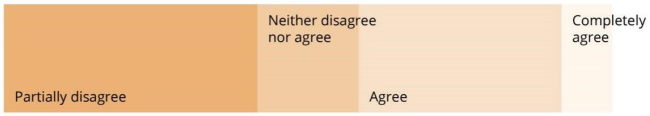
How difficult was it for you to develop your creative idea?

1_ Extremely Difficult	/
2_Very Difficult	4
3_Moderate	5
4_Easy	3
5_Very Easy	/



Depending on your previous answer, consider that you had an absolutely speculative/fictional idea?

1_Totally disagree	/
2_Partially disagree	5
3_Neither disagree nor agree	2
4_Agree	4
5_Completely agree	1

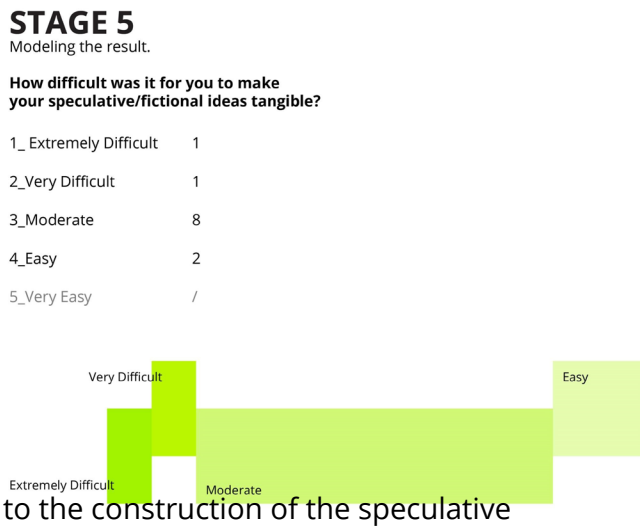


develop. However, they also recognize the importance of this phase and the value of the knowledge they receive: “After the initial idea of creating the project and

doing research on the state of the art, it was a gradual process in which everything made sense" (João Espirito Santo).

Figure 10. Results from the question for Stage5, by the authors

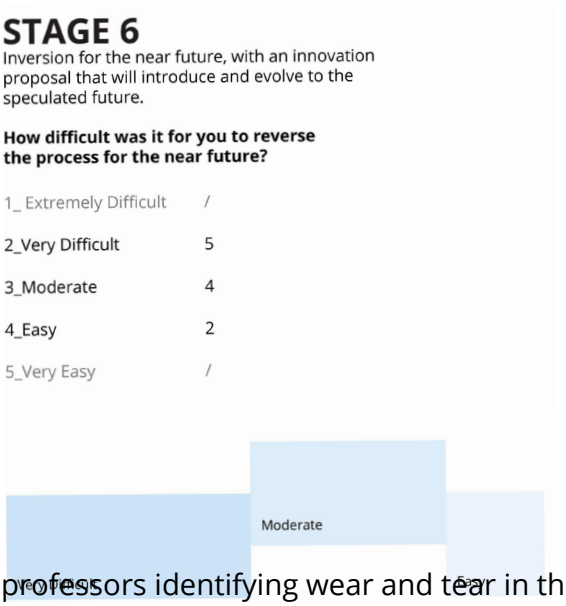
In STAGE 5 - modeling the result, students need some help making it tangible, significantly when they could elevate the prototypes to unique pieces complementary



to the construction of the speculative or fictional narrative. One of the factors continues to be a lack of confidence in the result and maximizing time so that this phase allows greater efficiency and mastery of technologies that allow the creation of "prompts" in the most differentiated results: "It was more difficult to make the ideas tangible. There were doubts and problems before and after arriving at the speculative idea. Which were rectified but still had to be more speculative. Where the objective was to think outside the box and have an even more innovative and futuristic vision than expected" (Emilia Faria).

Figure 11. Results from the question for Stage6, by the authors

To complement STAGE 6 - inversion for the near future, with an innovation proposal that will introduce and evolve to the speculated future, the standards are maintained, with



professors identifying wear and tear in the final stretch, which reveals a lack of time and motivation to respond to this last phase. This phase is fundamental in the methodology, as it conveys to the student that today's actions have repercussions in the future and that the designer must "look" from a distance at the achievements of what is designed today. The majority reveal interest and value in the project developed. "Being able to position ourselves 25 years ahead of time expands our vision even to other projects. To think about the future and not just the present" (Catarina Cordeiro).

Figure 12. Results from the question, by the authors

Time management continues to be an issue, especially with STAGE 3, 4, and 5, where they waste much time researching and converging data to diverge towards a utopian or dystopian scenario. However, the students know the importance of these phases and the need for efficient time management in the learning process.

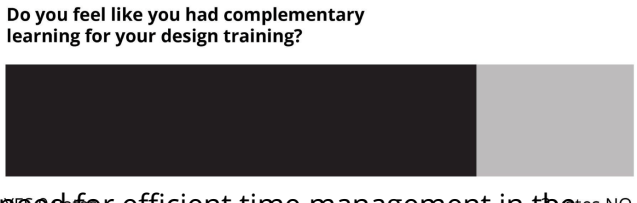
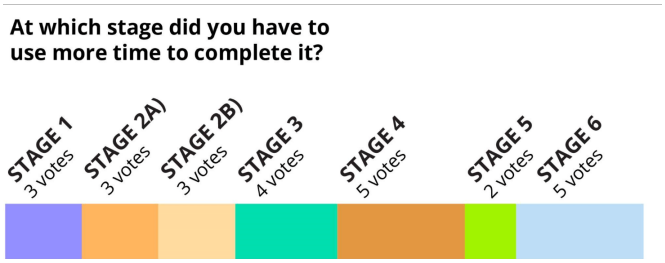


Figure 13. Results from the question, by the authors

In short, it will be necessary to reinforce increasingly, in complementary UCs, projects developed over time and crossed over into different disciplines for a more refined culture and creativity that becomes part of the student's imagination. Students who play,



have more cinematography literacy or have more life experience respond faster to the phases, with better results.

5. Critical Stages in the Process of Extrapolating Future Scenarios - Results discussion

The selection of projects, combined with feedback from surveys, indicates that despite the ability to extrapolate future scenarios, students predominantly develop not only future scenarios but also proposals for products, services, new technologies, and professions that do not yet exist, regardless of the given topic to explore. By understanding the nature of the speculative approach, they sometimes use the same reasoning to envision how visual identities and communication will evolve. They integrate communication and graphic design within the professional context, merging speculative and fictional aspects to project utopian futures and engage in critical reflection (Rynning, 2017).

However, moments of tension and difficulty arise, necessitating a reconsideration of project time management and the introduction of more intermediate exercises to aid in extrapolating future scenarios and personas. It is equally essential to motivate students to explore more insights and creative stimuli concurrently.

Over time—partly due to the course's structural demands—it has become evident how crucial a thorough design research process is. This process underscores that creativity is a product of a structured approach and that effective time management is necessary.

There is also some skepticism towards this

process, particularly among those less critical of the world around them. The ongoing deconstruction and devaluation of creative and critical thinking processes lead to a noticeable lack of interest in developing more positive frameworks and constructing a better world.

Nevertheless, utilizing AI tools has been pivotal in fostering these futuristic or speculative initiatives. AI has facilitated the creation of imagery for characters, scenarios, and anticipated outcomes for goods, services, and communication, resulting in futuristic or fictitious representations that further enhance the work. These representations are presented with the appropriate depth in the final presentations and prototypes.

6. Future Directions

To refine the framework and address the challenges observed in the course, it is essential to incorporate elements that encourage engagement, provide intermediate support, and ensure effective time management.
Here is a revised framework that integrates these aspects:

Stage 0: Provocative Stage

In this reformulation of our framework, we propose introducing a STAGE 0, an initial phase preceding the delivery of the briefing. This stage aims to immerse students in new themes with provocative topics related to 'wicked problems,' fostering an environment of debate and cultivating critical awareness. Similarly, existing resources and toolkits for introducing future projections can be incorporated.

Stage 1: Brief Presentation, Challenge

Understanding, and Contextual Analysis
Objective: Introduce the project brief, ensure a comprehensive understanding of the challenge and its context, and identify a purpose for the student.

Activities:

- Presentation of the brief.
- Group discussions to clarify doubts and define the scope.
- Contextual research to understand the background and current state.
- Identifying the values that are involved in the challenge for a better world.
- Conduct workshops focused on project management and time management skills.

Stage 2: Research and Diagnosis

Stage 2a: Participatory Research Methods

Objective: Gather in-depth insights from stakeholders and users.

Activities:

- Conduct interviews, surveys, and

focus groups.

· Apply participatory design methods to gather qualitative data.

· Intermediate Exercise: Students present initial findings and receive feedback.

Stage 2b: Future Trends Analysis and Exploration

Objective: Analyze trends and speculative works to envision future scenarios.

Activities:

· Research micro, macro, and meso trends.

· Analyze and explore speculative fiction (art, literature, film).Use case studies of successful speculative projects to inspire and motivate students.

· Intermediate Exercise:
Students create mood boards or trend reports and share insights.

Stage 3: Data Synthesis and Persona Development

Objective: Synthesize research data to build future scenarios and develop personas.

Activities:

· Cross-reference participatory research with future trends.

· Create detailed personas and future scenarios.

Integration of AI Tools:

· Provide training sessions on using AI tools for design and visualization.

· Encourage students to experiment with AI-generated content to enhance their projects.

· Intermediate Exercise:
Students draft personas and scenarios, presenting them for peer review.

Stage 4: Ideation and Proposal Development

Objective: Generate innovative ideas and develop proposals based on future scenarios.

Activities:

· Brainstorming sessions.

· Use of creative techniques like mind mapping and sketching.

· Intermediate Exercise:
Conduct ideation workshops with peer and instructor feedback.

Stage 5: Modeling and Prototyping

Objective: Transform ideas into tangible models and prototypes.

Activities:

· Develop prototypes using various media (digital, physical).

· Utilize AI tools to create imagery and

visual representations.

Integration of AI Tools:

- Encourage students to experiment with AI-generated content to enhance their projects.
- Intermediate Exercise: Present prototypes in a mock presentation for critique.

Stage 6: Near-Future Innovation Proposal

Objective: Propose innovations that bridge the gap between the present and the speculated future.

Activities:

- Invert future scenarios to propose immediate innovations.
- Develop a detailed plan for implementation.
- Intermediate Exercise: Final presentations with comprehensive feedback sessions.
- Auto-evaluation and peer review assessment.

These revisions, to the course framework, will address the observed challenges and enhance student engagement, creativity, and critical thinking. This will lead to more innovation and be centered on a global problem.

7. Conclusions

Integrating intended learning outcomes with pedagogical strategies to enhance awareness of evolving behaviors and incorporating self-assessment activities can address the limitations inherent in systematic approaches and instructional materials for values-based design methodologies, such as speculative and critical design. This integration challenges students and facilitates their understanding of how these approaches are already being applied within professional contexts. The reflections presented in this article underpin this assertion. The proposed framework demonstrates how educational strategies fostering critical thinking about emerging technologies can be systematically planned, executed, and evaluated.

Additionally, integrating greater interdisciplinarity in the execution of projects fosters continuous and simultaneous discovery. It is crucial to promote greater autonomy through student-led initiatives by designing a learning experience guided by their own discoveries and beliefs. This necessitates a more integrated vision of intergenerational relationships, enabling students to understand the connections and purposes inherent in building futures oriented towards the common good.

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DESIGN FOR BEING HOME AND CONNECTED: EMERGING TYPES OF DWELLING AT HOME TOWARD SMART FURNITURES

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ABSTRACT | Seeing smart furniture as a design space where technology redefines the dwelling at home, we formed a design project, "Design for Being Home and Connected," for third-year industrial design studio class. In this regard, we further analyzed the notions of "smartness" and "being connected" in the context of household furniture through student projects. Our analysis framework consisted of three types of connectivity: emotional, digital, and functional, and five types of smartness: the ability to cooperate, autonomy, environmental agility, upgradability, and two-way communication. Furthermore, our contribution is twofold: first, we reveal how humans are still omnipresent through smart furniture despite being at home, and second, we scrutinize how smart furniture can provide a more sustainable lifestyle in households.

KEYWORDS | SMART FURNITURE, CONNECTIVITY, SUSTAINABILITY, SMARTNESS, FURNITURE DESIGN

1. Introduction

Furniture has always been a key element in the home environment. Recently, the meaning attributed to furniture has been expanding with technological improvements. Moreover, individuals are physically present in their homes and connected to various digital platforms and identities in the digital age. This shift has created new needs and opportunities for furniture to accommodate and reflect the user's digital identity and lifestyle. Considering the changing needs of dwellers, smart furniture is becoming part of daily life by responding to various novel needs. In other words, by integrating digital features, sensors, and connectivity options, smart furniture can cater to the recent needs of generations x, y, and z. Furthermore, calling them "furniture units," Mohamed et al. (2021) state that smart furniture's capacity to feel, detect, and respond to the wishes and needs of dwellers. IoT and AI are the most prominent technologies that turn furniture into smart (Li & Han, 2022). However, few studies considered the emotional side of this transformation (Li & Han, 2022) and this transformation was continuous reflecting on both society and design. As a way to demonstrate the interrelation between the design decisions of settled life and lifestyle, the designer Ken Isaacs aims to emancipate spaces with new meanings using modular frames around the middle of 20th century (Margolin, 2002). In this sense; considering the furniture as a reflection of society (Baudrillard, 2005), the design and use of smart furniture also provide a discussion space for the novel dwelling types and changing social practices.

The objective of this study is to investigate the ways in which technology, as its utilization in furniture increases, can potentially shape future lifestyles by introducing new possibilities and connections through design. In this regard, we planned a term project "Design for Being Home and Connected" for third year industrial design students to discuss the concept of smartness in furniture design and to analyze how the change in technology related to smartness and connectivity can be reflected in everyday life. In this paper, the design strategies for smart furniture design are discussed through the analysis of student

projects, and our discussion reveals two significant contributions in terms of being connected at home: (1) the omnipresent human, meaning that humans are still connected to the social and organizational networks despite being at home and; (2) sustainable households, addressing how smart furniture can encourage more sustainable lifestyles at home.

2. Changing meaning of dwelling at home and smart furniture

Current research and emerging product scape show that the improving technologies shape the standards and habits of dwelling at home (Desjardins et al., 2019), and current studies on smartness at home have been criticized due to the consideration of only the classical family structures with two parents and two children (Desjardins et al., 2019). Currently, we observe new lifestyles along with new house types; of course, these two are co-shaping each other. Moreover, these changing novel lifestyles and households, such as co-housing (Jenkins, 2018), divorce (Odom et al., 2010), and working at home (Crabtree & Rodden, 2004) have been studied in the design literature. For example, Li and Han (2021) state the need for smart furniture for small-sized households. On the other hand, other variables such as culture (Bell et al., 2005), religion (Woodruff et al., 2007), and financial capacity (Woodruff et al., 2008) have a significant impact on the design of daily life and space. According to a study that explores the added value of furniture, functionality, space-saving, multiple functions, and modularity are the five most important aspects, whereas families with income care more about the security in use, and high-end users give value to design, material, and customization (Blažević, et al. 2021).

The regional and planning design literature defines smart furniture as a touchpoint of smart cities (Krejcar et al., 2019; Nassar et al., 2019; Chesher et al., 2023; Wang & Shmelova-Nesterenko, 2024) along with smart devices, home, security, and environment systems. More precisely, smart furniture is defined as “furniture which brings added value, functionality, comfort and elegance to fit every personalized requirement issued by the user” (Vaida et al., 2014), whereas a more technical definition is “composed of hardware such as computers, sensors, and appliances, and developing software technologies for realizing smart hot-spot services (Ito et al., 2003).” Li and Han (2022) categorize smart furniture as a mechanic, electronic, and AIoT (AI+IoT) intelligent, and the dimensions of smartness are identified as “ability to cooperate, autonomy, environmental agility, upgradability, two-way communication” through overviewing the literature review related to the smartness of products by Rokonuzzaman et al. (2022).

As security is among the important dimensions in dwelling, products such as August smart lock, Amazon key, and Nest cameras allow surveillance of households, and home assistants operate as hubs such as Amazon Alexa, Apple HomePod, and Google Nest of

product networks related to the households. Moreover, Krejcar et al. (2019) consider smart furniture as an opportunity for vulnerable people such as the elderly and people with health issues (Shidiq et al., 2019; Majumder et al., 2017; Hu et al., 2021). In the context of the work environment, Foxels (Perteneder et al., 2020) is studied as a modular smart furniture that allows the user to modify the structure through building blocks. Considering all the definitions and examples, we argue that the definition of smart furniture covers a wide range of furniture, and they do not need an interface or digital connections to be smart. In this sense, we argue that smartness can be provided through distinctive features such as modularity and stackability as well as strengthening its value on the emotional side.

3. The Studio Project: "Being Home and Connected"

Aiming to explore the smartness of furniture and the novel social practices in the home environment, we designed a term project, "Design for Being Home and Connected," for third-year industrial design students in the design studio. The product range included furniture, furniture accessories such as side tables, coffee tables, or products that communicate with each other. Designing furniture in an educational setting can be challenging in certain aspects (Arıburun Kırca, 2021). Following the literature review, we defined the meaning of "being connected" through three criteria emotional, digital, or functional connectivity; we elaborated on these definitions in our methodology section. The project continued for 14 weeks of critique sessions via in-person and online classes twice a week. The project steps until the preliminary jury (sixth week) were introduction (first two weeks), ideation (third to fourth week), and conceptualization (fifth week). Then, we continued with the detailed design phase and product finalization, and; by the end of the project, students were expected to:

- understand the concept of smartness, connectivity, and originality of the concept,
- design the user experience / human-product or product-product interaction,
- comprehend the concepts of semantics/ ergonomics / functionality (ease of use, interfaces, signs of smartness, being connected, etc.),
- consider sustainability in mass production and upgradability,
- demonstrate a visual appeal on the furniture design.

4. Methodology

We followed a research through design (Frayling, 1993; Zimmerman & Forlizzi, 2014) approach since we aimed to create knowledge through design artifacts that the students built. However, we do not see these artifacts as final results, but rather, we see them as part of the design research process (Wakkary et al., 2016). Therefore, we aim not to produce generalizable outcomes but rather contingent

and situated design knowledge (Höök et al., 2015). In this sense, we use design as a form of research (Zimmermann, 2003) to create a space for the discussion on changing social practices since the opportunity to reflect on ourselves comes from reflecting on things (Cila et al., 2015), as well as explore the design strategies in the context of smart furniture.

Student projects (n=33) were collected as digital A3 sheets, and the works were presented on the final assessment day. We used visual content analysis (Rose, 2011) while interpreting the visual data gathered from the students' artifacts. Thus, throughout the study, we followed a back-and-forth deductive and inductive analysis approach (Hatta et al., 2020).

For deductive analysis, we categorized the project contents into six (see Table 1) based on their design concept. Furthermore, we extracted basic explanations, keywords, connectivity types, and dimensions of smartness as the project outcomes were analyzed, see Table 1 in Findings. For the inductive analysis, we considered three types of connectivity: emotional (senses, face-toface communication, etc.), digital (internet, Bluetooth, RFID, etc.) , and functional (charging, cables, etc.), and dimensions of smartness were "ability to cooperate, autonomy, environmental agility, upgradability, visual appeal" gathered from Rokonuzzaman et al.'s study (2022). We described these to justify our further analysis. We elaborated on the definitions of connectivity as follows:

· "emotional connectivity" concentrating on bonding with its users through senses, face-to-face interactions, and in, further levels, building trust and sharing feelings;

· "digital connectivity" addressing the digital networks that are equipped through technologies such as the internet, Bluetooth etc.;

· "functional connectivity" marking the achieved connectivity through the physical materials such as cables and the capacity of the furniture having more functions through stackability, modularity etc.

Subsequently, we adapted five Dimensions of Smartness from Rokonuzzaman et al.'s study (2022) as follows:

· *ability to cooperate* is the capacity to form connections with other objects;

· *autonomy* reflects the independence of furniture's actions with no or little input from the user;

· *environmental agility* is the capacity to adapt and react to changes in the environment;

· *upgradability* is about furniture's capacity for upgradability with the latest technological improvements;

· *two-way communication* is the furniture's capacity to respond and allow two-way communication between itself and the user.

5. Findings

The smart furniture projects are categorized under eight titles based on their functions, connection type, and social impact: working at home, for organizing, for memories, for health & well-being, for living with non-humans, for clothing, for isolation and for leisure. Smart furniture for working at home addresses more efficient spaces while working at home, whereas smart furniture for organizing emphasizes making space management more efficient for certain purposes such as waste management and sleeping routine. Smart furniture for memories is designed to highlight the value of friends and family by reminding their significance to users. Moreover, another product category that benefits from emotional connection is furniture for non-humans since these products improve our bond with non-humans (plants and pets) and their life qualities. On the contrary, smart furniture for isolation aims to cut off interaction with other dwellers at home. Furniture for clothing assists the wardrobe and laundry management at households. Furniture for leisure and health & well-being is important for keeping track of our health and enjoying our time at home. Table 1 shows the related data for all projects, here we limited dimensions of smartness types to two of the most prominent for further analysis (a detailed version with explanation of projects and keywords is presented as Appendix A.

Table 1. List of student projects with their concept category, connection type and dimensions of smartness

Concept Category	Project Title	Connection Type	Dimensions of Smartness
working at home	Nomad	functional	environmental agility, ability to cooperate
working at home	Portable Smart Desk	functional, digital	environmental agility, ability to cooperate
working at home	Extendesk	digital	environmental agility, ability to cooperate
working at home	Duo-Desk	functional, digital	environmental agility, ability to cooperate
working at home	Work & Shoot	functional	environmental agility, ability to cooperate
isolation	Foldex	emotional (dis)connection, digital	environmental agility, upgradability
isolation	Serene	emotional (dis)connection, digital	two-way communication, environmental agility,
memories	Nortia	emotional	autonomy, upgradability
memories	Monumentai	emotional	autonomy, upgradability
memories	Morpheus	digital, emotional	two-way communication, autonomy
health & well-being	Pillo	functional, digital	ability to cooperate, two-way communication,

health & well-being	Diabethelp	functional, digital	ability to cooperate, two-way communication,
health & well-being	Hivefit	emotional, functional	two-way communication, environmental agility
health & well-being	Domat	functional, (emotional?)	two-way communication, environmental agility
health & well-being	Detoxfresh	emotional, digital	autonomy, two-way communication
health & well-being	Yogapy	emotional	two-way communication, environmental agility
living with non-humans	Soil0	functional	environmental agility, ability to cooperate
living with non-humans	Cat-Scan	functional, emotional	autonomy, two-way communication
living with non-humans	My Green Diary	emotional, digital	ability to cooperate, two-way communication
leisure	Smart Tea Bar	emotional, digital	two-way communication, ability to cooperate
leisure	Cosion	emotional, digital	two-way communication autonomy
leisure	Pumpkin	emotional	two-way communication, upgradability
leisure	Relaxknit	emotional, functional	two-way communication
leisure	Spe-Light	emotional, functional	environmental agility, two-way communication
clothing	We-Drobe	emotional, digital	two-way communication, autonomy
clothing	Smuv	emotional, digital, functional	two-way communication, autonomy
clothing	Selfy	emotional, digital	two-way communication, autonomy
clothing	Smarty	emotional, digital, functional	two-way communication, autonomy
clothing	Cornert	functional, digital	two-way communication, environmental agility
clothing	Epignosi	emotional	two-way communication, autonomy,
organizing	Garb-E	functional, digital	two-way communication
organizing	Smart Waste Separation and Storage Modules	functional, digital	two-way communication, environmental agility
organizing	The Start of a Sunrise	functional	autonomy, two-way communication

In total we have the concept categories as follows: five home-office furniture, three furniture as organizer, two furniture for isolation, three furniture for memories, six health & well-being furniture, three furniture for non-humans, five furniture for leisure, and six clothing furniture, see Figure 1. Here, we can read the tendencies of smart furniture application areas inherited by third year design students.

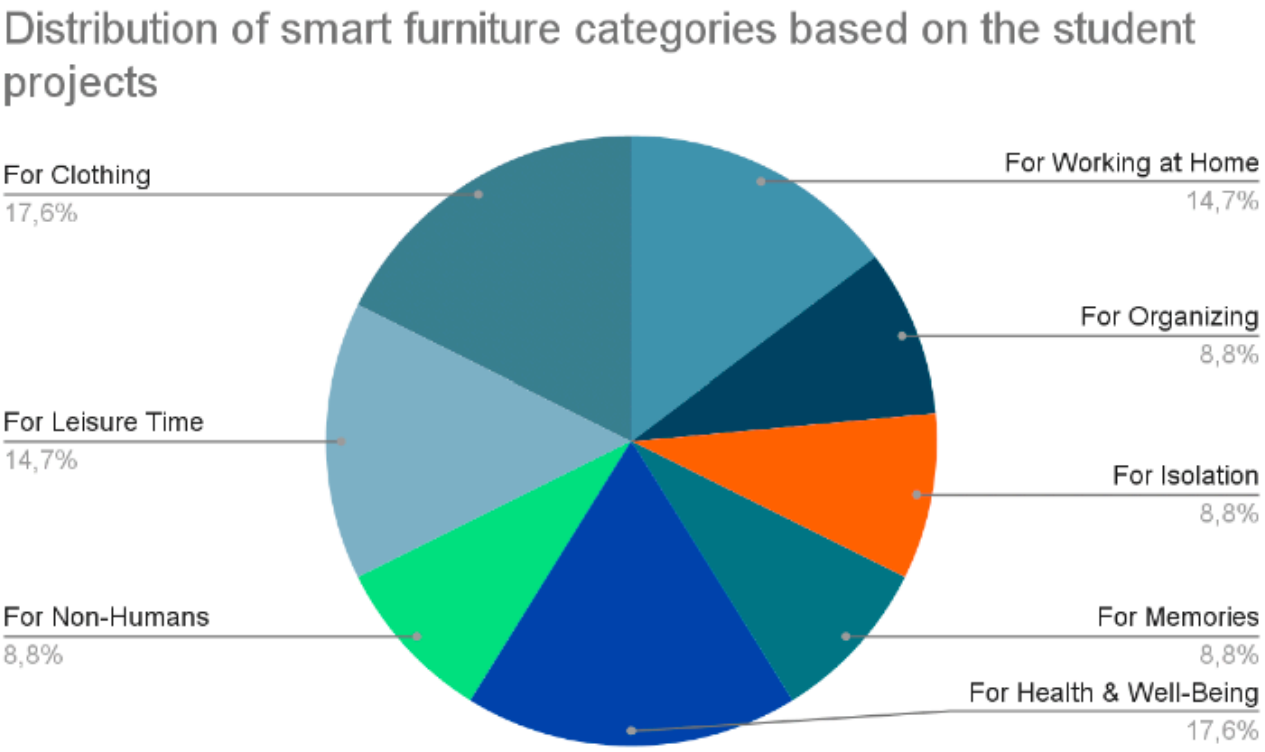

Figure 1: Distribution of smart furniture categories based on the student projects

Working at home is a common issue, especially after the pandemic, and most of the projects involve a surface to use computers and work on. Environmental agility and ability to cooperate were the most prominent smartness features for this category since current working practices require multitasking on the working such as eating, exercising, and streaming while working. To adapt to these needs, students designed flexible products that allow co-working (Duo-Desk), environmental flexibility (Extendesk, Work & Shoot), and portability of the work environment (Nomad, Portable Smart Desk) during work hours, see Figure 2.

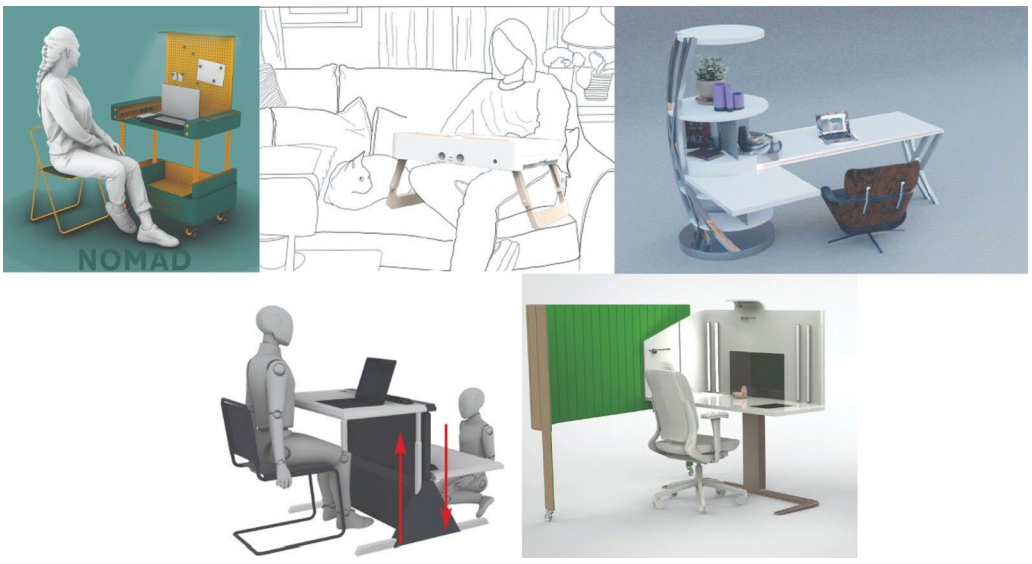

Figure 2. Work At Home Student projects: (Up- Left to Right) Nomad by Elif Özfidan, Portable Smart Desk by Zeynep Konyalıoğlu, Extendesk by anonym student; (Down- Left to Right) Duo-Desk by Hatice Nur Savan, Work & Shoot by anonym student

The smart furniture of the health and well-being category prioritizes *two-way communication* in terms of smartness since the user shares their health data with the system for tracking. Thus, the furniture gives feedback to the user based on their health condition. Furthermore, *environmental agility* was significant for the recent need to exercise and meditate at home. Figure 3 shows the visuals from the projects; *Pillo and diabethelp* were medicine storage tables to track the medicine-taking routine of the patients, whereas *Hivefit, Domat* and *Yogapy* operate as workout assistants that track the exercise routine. *Detoxfresh tracks* nutrition and stores fruits and vegetables with an air filter.

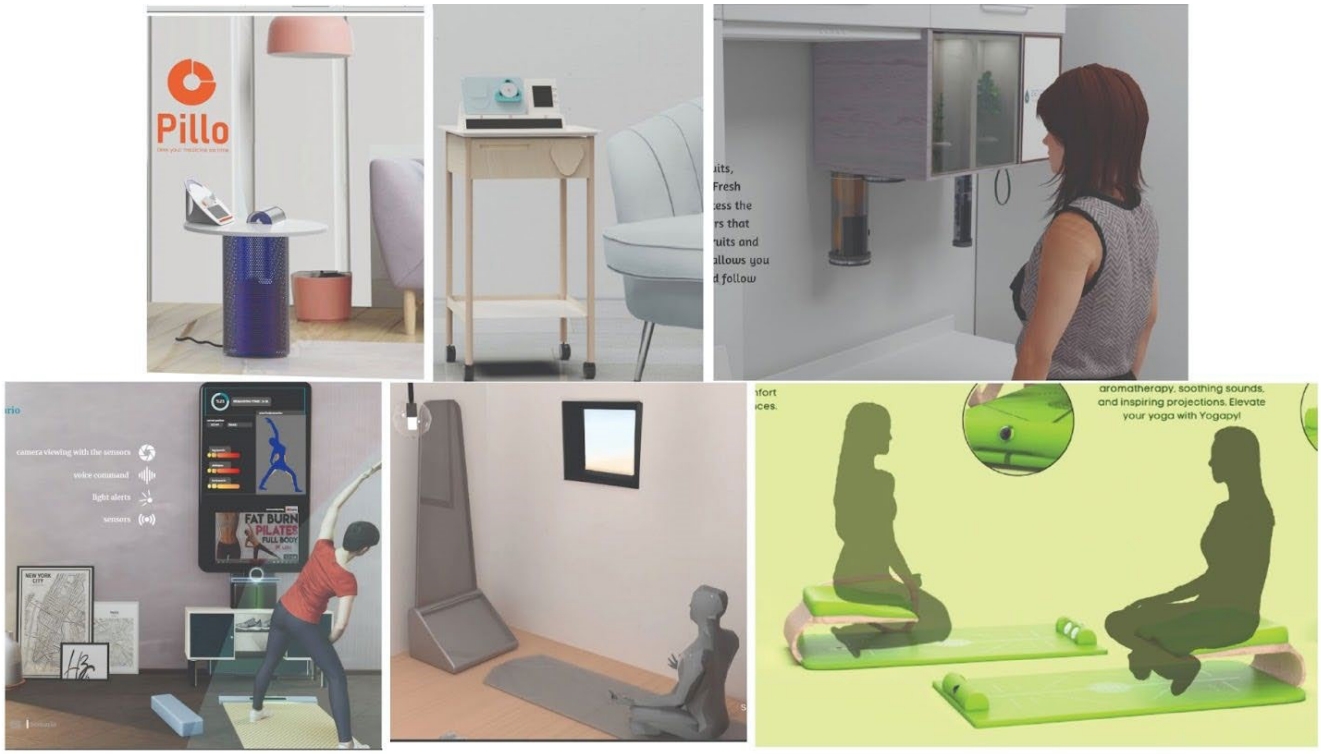

Figure 3. Health & Well-being student projects: (Up- Left to Right) Pillo by Dilara Uçar, diabethelp by Fatma Nur Demir, Detoxfresh by anonym student; (Down- Left to Right) Hivefit by anonym student, Domat by anonym student, and Yogapy by anonym student

As a physical significance of emotional connectedness, smart furniture for memorizing demonstrated tremendous potential. Here, the *autonomy* of the furniture came front since they receive and process data for a satisfactory synthesis of the user. For example, *Nortia* and *Monumentai* remind memories to the household members through digital screens, see Figure 4. In contrast, *Morpheus* animates the dreams of the user even if he may not be able to remember them, see Figure 4.

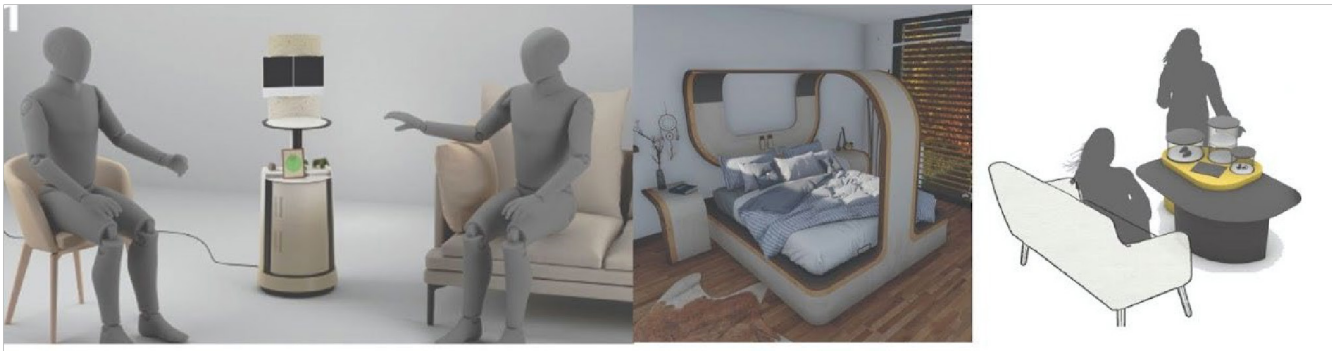

Figure 4. Memories student projects (Left to Right: Monumentai by Osman Arif Kurtuluş, Morpheus by Burak Kıvanç, and Nortia by Mine Koca)

People have lived with non-humans, such as pets and plants, for centuries. In this sense, the furniture is also theirs, and two-way communication of the furniture with both the non-human and house owner becomes prominent. Subsequently, the shared furniture creates a potential to magnify the emotional connectedness. *Soil0* and *My Green Diary* focused on plants whereas *Cat-Scan* touched upon the issue of tracking the health of a cat, see Figure 5.



Figure 5. Living with non-humans student projects: (From Left to Right) Soil0 by anonym student, Cat-Scan by Sıla Arıca, and My Green Diary by anonym student

The leisure category involves furniture to allow users to enjoy activities such as listening to music, knitting, and reading. This furniture category features their capability of two-way communication since they assist the user in certain activities. Moreover, the furniture becomes an emotional touchpoint for the user by allowing them to relieve stress through such activities at home. *Smart Tea Bar* allows an interactive tea experience. *Cosion and Relaxknit* support the user while knitting, and *Spe-light* is a modular speaker and lighting. In the context of the parentchild relationship, *Pumpkin* helps children adapt to reading (Figure 6).



Figure 6. Leisure student projects: (Up-Left to Right) Cosion by anonym student, Pumpkin by anonym student, Relaxknit by Eylül Çakır; (Down-Left to Right) Smart Tea Bar by anonym student, Spe-Light by Buse Akar

The clothing practice is a private activity that mostly belongs to the bedrooms of households. On this occasion, the users share their clothing inventory data with smart furniture AIs to get recommendations for their daily clothes. Certainly, the ability to communicate in two ways was significant in discussing smartness. However, we argue that autonomy also has a substantial role since, this time, the furniture was able to direct the appearance and preferences of the user by analyzing the given data. Students mostly studied this as smart wardrobes (We-drob, Selfy, Smarty, Epignosi), whereas few of them studied it as a smart mirror for make-up (Smuv) and laundry basket (Cornert) for tracking the availability of clothes, see Figure 7.

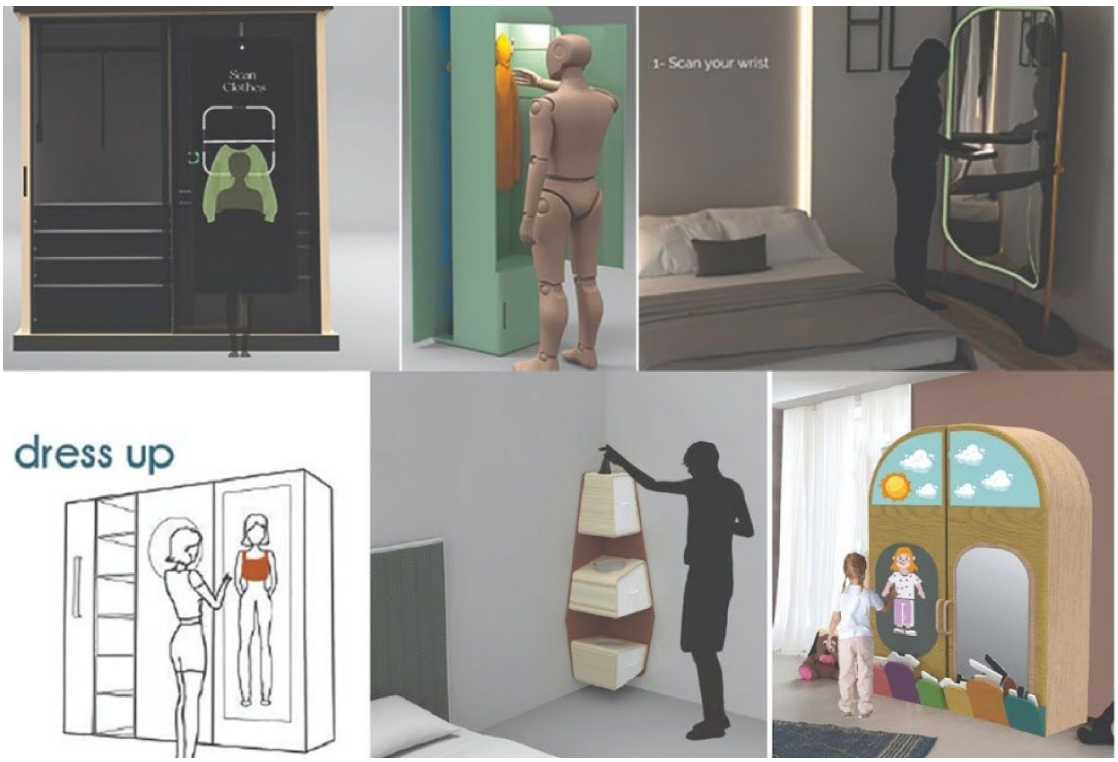

Figure 7. Clothing student projects: (Up-Left to Right) We-Drobe by anonym student, Smuv by anonym student, Selfy by anonym student; (Down-Left to Right) Smarty by anonym student, Cornert by Onur Çelik, Epignosi by anonym student.

With the household going small and increasing number of accessories, packages make the issue of organizing crucial for novel generations. In this sense, recycling management at home has been an issue that people struggle with, and two smart furniture examples (*Garb-E and Smart waste separation and storage modules*) create solutions for that by raising the awareness of the user as well as facilitating the waste management process. On the other hand, *The Start of a Sunrise* touches upon the issue of morning routines and organization of belongings in the bedroom, see Figure 8.



Figure 8: Organizing student projects: (Left to Right) Smart waste separation and storage modules by Emir Sahil Yüksel, Garb-E by anonym student, The Start of a Sunrise by Onur Taşdönderen

One of the most apparent effects of smart technologies in daily life is increased individualism. For that reason, people prefer to enjoy their time themselves rather than interacting, even at their homes. Based on that need, students designed smart furniture that allows isolation at home through sound and visual blocks featuring environmental agility. *Foldex* is a minimalist separator with screen foldable surfaces that can make white noise, which strengthens the isolation, whereas *Serene* is a foldable meditation unit that allows the user a space for stress relief and self-peace, see Figure 9

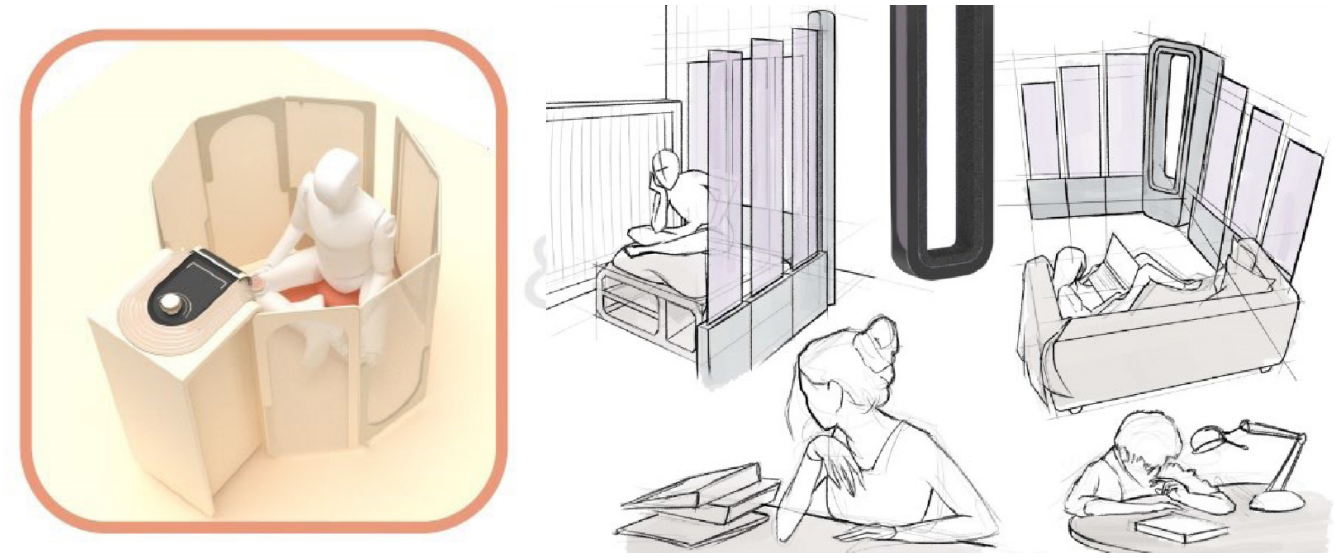

Figure 9. Isolation student projects: (Left to Right) Serene by Aleyna Gök and Foldex by anonym student

Figure 10 compares the inclusion of dimensions of smartness based on the projects. *Two-way communication* comes to the front, showing that the most significant feature of smart furniture is its capacity to respond to the users. Secondly, *environmental agility* reflects how significant it is for furniture to adapt to the environment and be flexible. Third, autonomy is definitely increasing as a concept. However, some people still prefer some level of control in the context of furniture. Moreover, this is also a good point to discuss the changing definition of furniture. For example, a robot vacuum cleaner is a strong representative of autonomy at home due to its capability to move and clean autonomously. However, it has a place like a piece of furniture when it is in passive mode. In this sense, the inclusion of autonomy in the house questions the definition of what should be called furniture. Fourth, *the ability to cooperate and upgradability* are crucial, and we expect it to be more dominant in the future since it allows the furniture to be an extension of other objects or a base of different objects. In the current world, we are glued to our smartphones, meaning that we are glued to plugs or any energy transfer points, and furniture is taking this role. Moreover, another way of cooperating with

other objects for smart furniture is sharing data. For example, smart wardrobes and medicine tracker furniture gather the data from phones and cooperate with it.

The findings address that the students have demonstrated two main approaches to the projects: (1) adding features to the existing products by making them smarter, (2) designing a new furniture type based on a need that exists with digitalization, aiming to activate digital identities at home. Through the existence of smart devices such as PC, tablet, and smartphones as anchor points to the furniture, it becomes an extension of these digital needs at home. We see this as a crucial step for our further discussions.

For the first category of products, we can mention Smart tea bar (Figure 6, Down-Left), a kitchen table supported by an interactive interface. By adding the interactive interface, the design responds to the need for emotional disconnection at home. However, in its most basic form, this is still a table. For the second category of products, Serene (Figure 9, on left), a meditation unit for households, can be given as an example. Here, this product is totally and responds to the need to do meditation and isolation at home. In this sense, it is a niche furniture that is adapted to the novel needs of people.

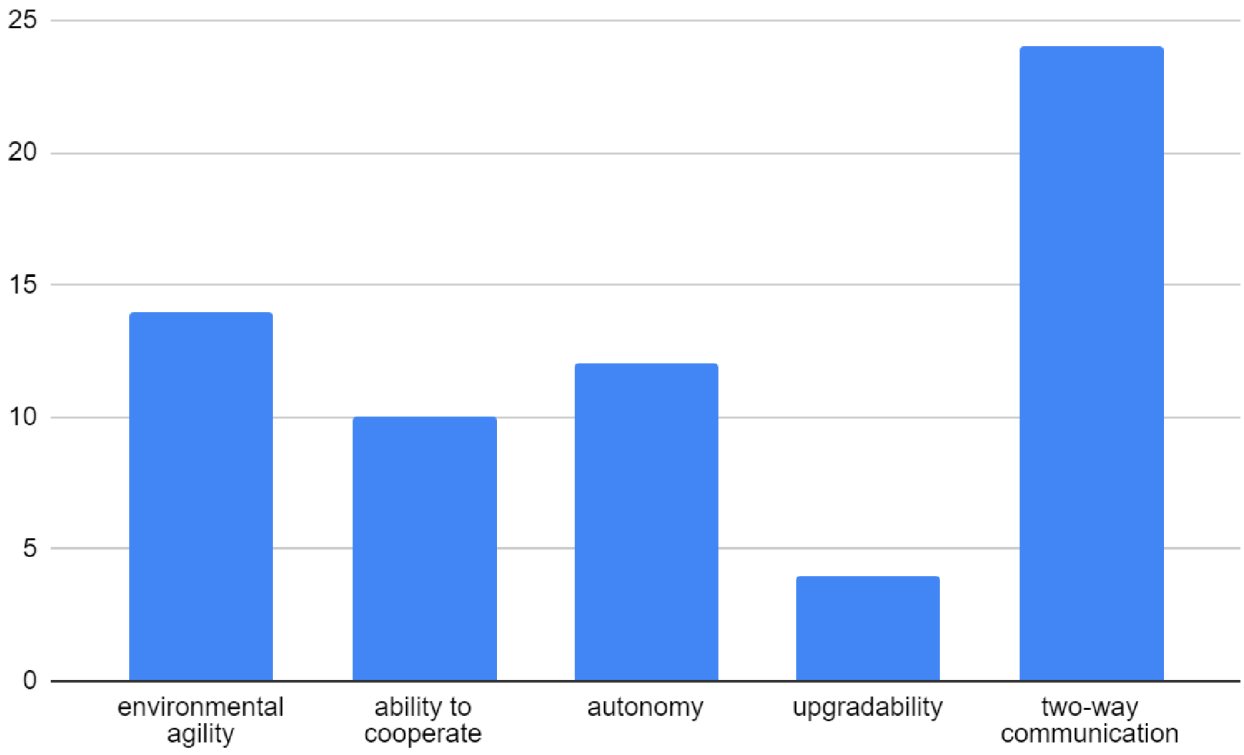

Figure 10. Comparison of dimensions of smartness included in smart furniture projects

6. Discussion

We argue that the existence of smart furniture is inevitable, and we see the awareness of its effects and future consequences as a significant step in smart furniture design. Therefore, in this section, we discuss the smart furniture phenomenon from two different perspectives. First is the omnipresence of humans; this issue was prominent for us since *two-way communication* and *environmental agility* were the first two types of smartness marked by the projects. In this sense, smart furniture magnifies a human's capacity to be present in multiple spaces and turn the home into different spaces. Hence, both the human and the household are flexible and can have distinct identities. For example, the human can work, exercise, and meditate while still being social and following the practices of its owner, the house turns into a gym, a workspace, or a temple. The second issue that stepped forward was sustainability; we see smart furniture as an opportunity to spread sustainable behaviors and well-being. Similarly, *two-way communication* and *the ability to cooperate* are crucial dimensions of smartness for us since tracking behaviors and habits is critical to maintain routines. We discuss these by aligning with two Sustainable Development Goals; SDG 3: Good Health and Well-being and SDG 12: Responsible Consumption and Production.

6.1. The omnipresent human

All the digital networks knitted around people allow easier communication; thus, the need to physically be somewhere has started to fade away. It is deduced that as furniture gets smarter, it is compelling to change the definition of furniture. The main reason behind that is the new needs that have emerged as our lifestyles have adapted to technological improvements. Here, the notion of *co-performance* (Kuijer & Giaccardi, 2018) is a significant aspect of the discussion of smartness, since the capacity of smart furniture allowing two-way communication, brings both advantages and disadvantages. According to Kuijer and Giaccardi (2018), humans coperform with technological artifacts both co-shaping each other. For example, Kuijer (2019) studies this on clothes washing practice, considering how it has changed with the involvement of washing machines. In this sense, we co-perform with smart furniture, giving them certain tasks to ease daily practice. Furthermore, this attachment allows *background relations* (Verbeek, 2008) with the furniture, allowing the user to operate multiple tasks simultaneously, making the user omnipresent.

Moreover, this omnipresence requires instant space managements, allowing both digital and emotional connections as well as disconnections in the household. Particularly in two projects, we observed that the design enables emotional disconnection, which addresses the category of isolation, see Figure H. Hence, when we are interacting with

technology via *alterity relations* (Verbeek, 2008), we are already being present in a different reality. These furniture examples also magnify these senses with physical and emotional isolation techniques, reducing the necessity of being physically present in certain cases.

Contrary to the definition of furniture, the products are becoming more mobile. This was also a game-changer for society; for example, typewriters played a role in the movement towards the liberation of women (Herkimer County Historical Society, 2019) since they gave independence to their users. In this sense, by making smart devices such as PCs, tablets, and smartphones an anchor point, furniture is becoming an extension of these digital needs at home. Vice versa, mobile products use furniture as base stations; primarily, their dependency on energy necessitates this. However, it also reflects our dependency on them by emphasizing how deeply digitalization is embedded into our social practices. Continuing with the typewriter, Heidegger (1982) mentions the transformation from pen to typewriter, and he was concerned about the lost character of handwriting. In this sense, any new technology comes with its cons and pros. Although we are concerned with immobilization, we also see that smart furniture has beneficial sides for sustainability, especially through behavior change, as we will discuss in the next section.

6.2 Sustainable Households

We see a potential for the design of smart furniture to be aligned with Sustainable Development Goals (SDGs) and here we discuss it through project examples. The study emphasizes the issue of connectivity in smart furniture through digital, physical, and emotional connections. Smart furniture can enable individuals to seamlessly interact with their digital identities and enhance their overall experience at home. Whether it is through integrating smart features that allow for remote control of home devices, personalized settings based on user preferences, or even emotional interactions through ambient lighting or music, smart furniture has the potential to transform the way people live. The changes initiated through smart furniture can contribute to sustainability in several aspects by supporting SDGs.

First, one of the most prominent themes during the project was tracking medical conditions at home. Health applications are currently in use; however, to improve this connectivity and ability to track, there was a need for furniture that is connected to those applications. Thus, adapting furniture within the context of *health and well-being was* promising for some students, and it was observed that these smart furniture aimed to track medicine use or improve sleep patterns, supporting SDG 3: Good Health

and Well-being. Second, another theme was waste management at home; through *smart furniture for organizing projects*, students created a positive effect towards the behavior change for sustainability since the users will be more aware of their consumption and disposal rituals, supporting SDG 12: Responsible Consumption and Production.

7. Conclusion

Through “Design for Being Home and Connected” projects, it is deduced that as the furniture gets smarter, the definition of furniture dislocates, becomes mobile and independent, reflecting the recent human character of “being omnipresent” and the main reason behind that the new needs emerged through our lifestyles adapted to technological improvements. In other words, the furniture reflects the user’s identity and evolves into smart furniture because of the digital needs in society. Moreover, with its potential as a tool for connectivity within the home setting, furniture holds significant potential to revolutionize everyday life through various forms of smartness and make people’s lives better by pursuing a future with sustainable households.

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Appendices

Appendix A: List of students' projects with their concept category, explanation, keywords, connection type and dimensions of smartness

Nomad	**mobile and adjustable workspace**	**mobility, working, studying**
Portable Smart Desk	portable smart desk	working, studying
Extendesk	an extendable table for work and leisure	working, studying, leisure
Duo-Desk	work table for two people in a shared room context	working, studying
Work & Shoot	adjustable work table for streamers	working, video-making
Foldex	extendable separators for isolation at home	white noise, working
Serene	meditation units-cabin for home	meditation, well-being
Nortia	table to collect and display physical objects and photos	memories, being connected to others
Monumentai	enhance your memories with AI to carry them to the future	memories, being connected to others
Morpheus	a bed and integrated audio visual system that reproduces images of dreams through AI according to the prompts given by the user	sleeping
Pillo	smart medication table that allows the user to track and store the medicines	health
Diabethelp	smart side table for diabetic people to organize their medical belongings	health
Hivefit	a console system with screen and mat to enable the user workout interactively	exercise, well-being
Domat	smart mat system	exercise, well-being
Detoxfresh	fruits and vegetable dispenser with air filter and tracks nutrition	eating, well-being
Yogapy	yoga chair for enhanced comfort and immersive yoga experiences	meditation, well-being
Soll0	a furniture designed for tracking and practicing hydrophonic agriculture at home	growing plants
Cat-Scan	smart furniture for cats - early diagnosis of diseases	tracking pets

My Green Diary	a gardening space with seat to emotionally connect and grow plants	tracking, growing plants
Smart Tea Bar	interactive table for tea time	drinking, hanging out, connection with others
Cosion	side table that operates as an interactive smart assistant with sound and display	leisure
Pumpkin	smart library for kids that improves parent-child relationship	leisure, reading
Relaxknit	knitting for stress relief	knitting, leisure
Spe-Light	speaker and ambiance lighting with a modular structure	ambience
We-Drobe	a wardrobe that is also a clothing assistant-organizer	clothing
Smuv	clothing organizer- smart mirror	tracking, clothing
Selfy	smart mirror-make-up & clothing assistant	make-up, clothing
Smarty	smart wardrobe - organizer	tracking, clothing
Cornert	smart laundry basket with a tracking system	laundry, clothing
Epignosi	wardrobe to increase physical and personality awareness in children	clothing
Garb-E	smart recycle bin that separates waste	organizing waste
Smart Waste Separation and Storage Modules	smart waste separation and storage modules	organizing waste
The Start of A Sunrise	bedside organizer with night stand with lighting & alarm	morning routine, organizing

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ADAPTIVE LEARNING EXPERIENCE FOR ART AND DESIGN GRADUATES IN A CHANGING WORLD

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ABSTRACT | In today's fast-paced world characterized by rapid technological advancements, preparing professionals in art and design fields has become crucial. This necessity stems from the transformative impact of technology across society, highlighting the need for adaptable skills and continuous innovation in future professionals, especially considering projected scenarios up to the year 2050.

The research aims to address this urgency by equipping students with skills to navigate a rapidly changing environment. A key insight from Garry Bolles is the accelerated pace of technological progress, leading to increased job scarcity or abundance based on automation levels. 35 years ago, Shoshana Zuboff further adds that disruptive technologies create a dual labor scenario, emphasizing the importance of training strategies and flexible labor policies, when referring the computer disruptive technology, today's disruption is Artificial intelligence and in 35 years into the future would be any other disruptive technology.

To meet these challenges, an innovative adaptive learning experience was introduced in 2023 at a Mexican university, focusing on empowering students with a forward-thinking point of view (Mindset), developing their set of competences and skills (Skillset) through portfolio creation, and providing the necessary knowledge in cutting-edge technologies (Toolset) for navigating a digitized work environment. The approach is holistic, considering cognitive, emotional, and professional aspects to foster human flourishing.

The World Happiness Report and academic literature stress the importance of holistic education, emphasizing personal strengths, positive relationships, meaning in life, and positive emotions alongside technical knowledge. This approach aims to prepare students not just for the

workplace but for life's challenges, contributing to a balanced and prosperous society. The methodology for the design of this adaptive experience included historical analysis, interviews with industry professionals, and research on cutting-edge technologies. These approaches ensured alignment with current and future industry needs, creating a dynamic educational environment.

The course implementation focused on three modules: exploration for career paths, exposure to cutting-edge technologies, and development of a personalized professional portfolio. Feedback from teachers and students was mostly positive, highlighting benefits in personal and professional development. However, challenges such as overwhelming tasks and delayed feedback were noted, suggesting areas for improvement in future iterations.

The adaptive learning experience prepares students for a constantly changing world by promoting personal purpose, positive relationships, and adaptability. Future iterations should consider the importance of feedback, to enhance student participation and timely feedback, emphasizing the importance of comprehensive education encompassing technical, personal, and social aspects to support holistic development and successful navigation of life beyond university.

KEYWORDS | EDUCATIONAL INNOVATION, HIGHER EDUCATION, ADAPTIVE LEARNING, HUMAN FLOURISHING

1. Introduction

In the current context, characterized by a rapid pace of changes and constantly evolving technological advancements, the education of professionals in the fields of art and design emerges as a key imperative. The transformative influence of technology across all spheres of society, from industry to everyday life, underscores the need to equip these professionals with the necessary skills to face future challenges. This becomes even more crucial when considering speculative futures and education in the arts and design area, projecting the training of these future professionals towards the year 2050. In this time horizon, a more complex and changing landscape is anticipated, requiring future professionals to be equipped with adaptable skills, knowledge, and a mindset for continuous innovation and adjustment.

The objective of this research is to address the urgent need to equip students in these fields with the skills and competencies required to navigate an environment characterized by rapid technological and social changes. The general context of the designed adaptive learning experience was implemented as part of the final course in various technological professional paths of the Bachelor's Degree in Digital Arts at Tecnológico de Monterrey, State of Mexico Campus.

The rapid technological advancement poses an urgent need to adapt to it. Garry Bolles, in his conference "The Next Rules of Work" (2023), pointed out that what used to take a year in terms of technological progress in 2000, is now achieved in just a week in 2023. This phenomenon underscores the urgency of educating students according to the "next" rules of work: the Mindset, Skillset, and Toolset, as mentioned in his eponymous book. Additionally, Gary Bolles presents three possible scenarios for the future of work. In the first prospective scenario, automation and the increasing integration of robotic technologies dominate the workplace, leading to a scarcity of job opportunities. This situation, a result of the efficiency and productivity of technological innovations, leads to increased unemployment and challenges in wealth redistribution and job

retraining. There is a need for redefining economic and social structures to address these implications.

The second projected scenario outlines a landscape characterized by an abundance of job opportunities, where the intervention of robots and automated systems acts as a facilitator in the workplace. In this context, technological advances have triggered exponential job growth, to the extent that the demand for labor surpasses the supply of available human workers. This situation arises as a direct result of the efficiency and enhanced productivity that robots bring to industrial and service processes. Consequently, there is a growing dependence on technology in the creation and execution of work tasks, leading to a wide range of professional opportunities across various sectors.

In the third prospective scenario, according to Shoshana Zuboff (1988) in her work "In the Age of the Smart Machine: The Future of Work and Power," a labor duality emerges due to disruptive technologies, with elements of scarcity and abundance. Aspects of dystopia and utopia coexist, with an increase in job opportunities but also significant underemployment and unemployment. Adapting allows for thriving, while lack of adaptation leads to job failures and social exclusions. Strategies for training and flexible labor policies are needed to address this labor duality.

Due to the need to prepare future professionals to face the challenges of the future, an innovative design of adaptive learning experience was conceived, first implemented in 2023 as part of the final course in various technological professional paths at Tecnológico de Monterrey, State of Mexico Campus. This revolutionary pedagogical approach is based on the premise of enhancing human flourishing, comprehensively addressing students' cognitive, emotional, and professional aspects. The essence of this proposal lies in its threedimensional approach, represented by the key components of the Mindset, Skillset, and Toolset, declared as Gary Bolles' (2023) next rules of work.

Firstly, the mindset focuses on empowering the student to chart and explore possible career paths beyond the conventional limits of university, fostering a mindset of adaptability and continuous growth. On the other hand, the skillset focuses on validating and developing the skills acquired throughout university life, through the creation and refinement of a professional project poraolio. Finally, the toolset, composed of cubng-edge technological tools, provides the student with the necessary skills to navigate effectively in an increasingly digitized and dynamic work environment. At the same time, the design of this adaptive learning experience invites reflection on the impact of our actions in shaping the future we collaboratively create, aspiring to a scenario where no individual is lec behind and where future engineering professionals are adequately equipped to face upcoming challenges with confidence and resilience.

The comprehensive analysis presented in the 2023 World Happiness Report, issued by the United Nations Sustainable Development Solutions Network (2023), provides a complete view of well-being and happiness in various regions of the world, assessing a range of key factors such as per capita Gross Domestic Product (GDP), level of social support, and healthy life expectancy. This study represents an essential pillar for understanding the environment in which human flourishing is sought, serving as an essential guide to addressing challenges in promoting the overall well-being of society.

On the other hand, the relevance of human flourishing has been extensively examined in academic literature, emphasizing the urgent need to promote holistic well-being. According to Seligman and Csikszentmihalyi (2000), human flourishing encompasses the promotion of personal strengths, cultivation of positive relationships, search for meaning in life, and experience of positive emotions. These research findings highlight the importance of an education that not only focuses on preparation for the workplace but also aims at the primary goal of forming well-rounded individuals.

In this sense, holistic education not only focuses on imparting technical knowledge but also seeks to cultivate aspects such as happiness, physical and mental health of students. Human flourishing thus becomes a key objective of 21st-century education, promoting a holistic vision of personal and professional development. Student preparation for life becomes equally crucial, providing them with the tools and skills necessary to face everyday challenges with resilience and confidence, thereby contributing to a more prosperous and balanced society.

The rapid technological advancement, as Bolles (2023) points out, has become a key component in the design of adaptive learning experiences. This constantly evolving technological landscape demands that students acquire specific skills to tackle a future of constant change. This implies, as the author mentions, developing a Mindset that allows them to effectively manage changing challenges, a Skillset that empowers them to adapt to these changes, and a suitable Toolset for the digital era in which we are immersed.

The importance of these elements for designing an effective educational experience that fosters human flourishing and prepares students for future challenges cannot be underestimated. By integrating the Mindset, Skillset, and Toolset into the educational process, students are provided with the necessary tools to develop a sense of purpose in their learning, cultivate positive interpersonal relationships, and strengthen their personal and professional skills. This comprehensive combination of elements also enables them to effectively adapt to technological and social changes, preparing them to face current and future challenges with confidence and resilience. Despite the mostly positive results observed in the implementation of this adaptive experience, some limitations were identified that need

to be addressed in future iterations. In particular, the need for increased student participation and timely feedback was highlighted, as well as the importance of adapting the design to the different realities and contexts of university campi.

2. Methodology

The methodology employed for creating this adaptive experience preparing future professionals in arts and design was grounded in a multifaceted approach that incorporated historical analysis, interviews with industry professionals, and exhaustive research on current and cubng-edge technologies. This comprehensive approach was meticulously designed to ensure that the resulting educational experience was innovative and aligned with both the current and future needs of students and the industry.

Firstly, historical analysis provided a solid foundation for understanding the evolution of education in these areas and the challenges that have emerged over time. By studying past trends, key paferns and lessons were identified that helped inform the design of the adaptive experience. This historical analysis allowed not only an understanding of the current context of higher education in arts and design but also projected possible future scenarios and anticipated emerging needs of both students and the industry.

Additionally, interviews with industry professionals played a vital role in the methodology as they provided valuable insights into the skills and competencies that are most valued in the current work environment. These interviews helped identify the most relevant technical and soc skills for future professionals, as well as understanding emerging trends and areas of specialization that could be important in the future. Lastly, research on current and cubng-edge technologies provided a deep understanding of the tools and resources available to enhance the educational experience. By staying abreast of the latest innovations in technology, it was possible to effectively integrate them into the design of the adaptive experience, ensuring that students were exposed to tools and practices that are relevant and necessary in both the current and future work environments.

Together, this combination of methodological approaches allowed for the development of an adaptive educational experience that not only addresses the immediate needs of students but also anticipates the future demands of the industry. By integrating historical analysis, interviews with industry professionals, and research on current and cubng-edge technologies, a dynamic and relevant educational environment was created that prepares future engineering professionals for success in an ever-evolving world.

The implementation process of the course that included the adaptive learning experience was carried out meticulously and structured, focusing on the integration of three main modules, each designed to address one of the dimensions of Bolles' (2023) next rules of work.

The first module, titled “My Life Plan Beyond Tec”, focused on the Mindset and sought to promote deep reflection among students about their post-graduation plans. Through this module, students were guided to explore a variety of career paths, from teaching to entrepreneurship, and were provided with advice and practical recommendations from professionals who had traversed those same paths before them. This approach allowed students to broaden their perspective and consider various options for their professional future.

During the “My Life Plan Beyond Tec” module, activities were designed to prepare students for their next path outside of university, aiming to develop a wide range of soc skills that are essential for success in the current and future job market. These skills are not only necessary for effective performance in the workplace but are also valued by employers and significantly contribute to the professional and personal development of individuals.

One of the key skills sought to be cultivated is self-awareness and management, which involves the student’s ability to understand their strengths, weaknesses, values, and personal goals, and use this understanding to make informed decisions and effectively manage their own emotions and behaviors.

Additionally, fostering innovative entrepreneurship is encouraged, which involves the ability to identify opportunities, generate creative ideas, and effectively implement them, demonstrating initiative, creativity, and resilience in the face of challenges.

Furthermore, promoting social intelligence is sought, which refers to the student’s ability to understand and manage their own and others’ emotions, establish and maintain effective interpersonal relationships, and work collaboratively in diverse teams.

Another important skill sought to be developed is ethical and civic commitment, which involves acting with integrity, responsibility, and respect towards others, as well as contributing positively to society and the environment.

A cross-cubng competence that is sought to be promoted is reasoning for complexity, which involves the student’s ability to analyze, synthesize, and evaluate information critically and solve complex problems creatively and effectively.

Effective communication is also a fundamental skill sought to be developed, as the student must be able to express their ideas clearly and persuasively, actively listen and understand others’ perspectives, and adapt their communication style according to the context and audience.

Lastly, but not least, fostering digital transformation is sought, which involves the student’s ability to effectively use information and communication technologies to access, analyze, interpret, and share information, as well as to adapt to technological changes and seize

the opportunities offered by new technologies. The second module, named “cubng-edge technologies,” plays a fundamental role in the comprehensive approach of the adaptive learning experience, focusing on the Toolset aspect according to Bolles (2023). This module provides the student with a deep and updated understanding of emerging technological tools that are transforming the industry. It consists of lectures delivered by industry experts, including distinguished alumni and external professionals with experience in the field. These lectures allow students to firsthand learn about the latest trends and advances in socware and hardware technology.

In these interactive sessions, industry professionals address a wide range of topics related to cubng-edge technologies, from socware and application development to the implementation of innovative hardware and the implications of artificial intelligence and machine learning. In addition to presenting concrete examples and relevant case studies, experts highlight the importance of staying abreast of the latest trends and advances in technology and provide practical advice on how the student can stay updated and develop relevant skills for the ever-evolving job market.
Particularly emphasized is the need to acquire specific technical skills related to cubng-edge socware and hardware tools, as well as the importance of developing critical thinking, problem-solving, and adaptability skills to tackle the challenges posed by rapid technological innovation. Additionally, topics such as cybersecurity, data privacy, and ethics in technology are discussed, highlighting the importance of addressing these aspects responsibly and ethically in the development and implementation of new technologies.

The third module, named “Professional Poraolio,” constitutes an essential part of the adaptive learning experience approach, focusing on the Skillset aspect as proposed by Bolles (2023). This module was carefully designed to adapt to the specific needs and professional goals of each student, recognizing that each individual possesses a unique set of skills, experiences, and professional aspirations. From the beginning, a flexible structure was established to allow the student to personalize their learning experience and develop a poraolio that accurately and meaningfully reflects their strengths and areas for development.

During the first week of the module, a comprehensive assessment process was carried out to validate the competencies acquired by the student throughout their professional career. This process focused on identifying the technical, cognitive, and soc skills that the student had developed during their academic training and previous experiences. Based on the results of this assessment, each student’s career integrator project was adapted to address specific areas for improvement and provide opportunities to demonstrate their level of competence in various areas.

One of the main goals of this module was to create awareness in the student about the

competencies and soc skills they had acquired throughout their professional career. To achieve this goal, activities and reflections were implemented that allowed the student to identify and value their interpersonal skills, problem-solving ability, leadership, and teamwork, among others. Additionally, the importance of these skills in the current job market was emphasized, and resources and guidance were provided for their continuous development. The research was carried out using a convenience sample, consisting of students to whom the researcher was assigned as co-teacher.

Data was primarily collected through a opinion survey conducted by students each semester, a focus group with implementing teachers to assess the understanding of the design, and a semi-structured survey of the students themselves to gain a more detailed insight into their experience acer completing the experience. Acer data collection, a qualitative analysis was conducted to extract meaningful conclusions. This methodological approach allowed for the design of an adaptive educational experience that not only addressed the immediate needs of the student but also anticipated the future demands of the industry, thus preparing them for success in a constantly changing world.

3.Results

The results obtained from the implementation of the adaptive learning experience revealed a mostly positive reception from the teachers, who expressed having gained valuable insights for future training instances. According to the analysis conducted by the academic communities board and the questionnaire applied, there was a notable interest in the integrative project modules and cubng-edge technologies. However, it was identified that some of the adaptive activities might be overwhelming for certain students, as not all campuses offered the same level of choice flexibility.

Regarding the first module, focused on life beyond university, it was evident that in some implementations, it was not executed according to its adaptive approach. For example, in certain campuses, tasks related to creating resumes and cover lefers were assigned as part of this module. Upon investigating students' experience in relation to the university's purpose toward the 2030 vision of preparing students for life, a perception of lack of comprehensive preparation to face the challenges of the job market was found.

In contrast, in other campuses where the design was implemented as planned, the purpose of the module was achieved thanks to continuous support and feedback provided by the teachers, which gave students the necessary freedom to explore their interests and make informed decisions about their future. Some students expressed that this module encouraged them to question their goals and aspirations, facilitating clearer and more authentic decision-making.

In the second module, focused on cubng-edge technologies, conferences were held with industry experts who shared their experiences and tools used in the professional field. This allowed students to understand the importance of tool knowledge and the need for lifelong learning. Although some conferences were perceived as beneficial, other students felt that they took away time from developing their integrative project.

Regarding the third module, "Professional Poraolio," most campuses implemented it as planned, resulting in high-quality projects. However, in some cases, students were asked to submit a preliminary version of their poraolio as part of the initial diagnostic process, allowing for the assessment of achievement levels and the establishment of strategies for their development.
One of the aspects that possibly affected some implementations was the lack of timely feedback, as well as waiting until nearly the end of the course to request activities.

4.Conclusions

The study conducted highlights the relevance of preparing students not only for the workplace but also for facing life's challenges in a constantly transforming context. The adaptive learning experience proved to be highly beneficial in promoting personal purpose, cultivating positive interpersonal relationships, strengthening soc skills, and efficiently adapting to the technological and social changes that characterize the contemporary world. The implementation of this educational design closely aligns with the constantly evolving vision of the university where it was implemented, which aims to foster leadership, innovation, and entrepreneurship as key pillars for the holistic human development of its students.

It is important to note that future iterations of this adaptive experience should carefully consider the feedback and suggestions received during the initial implementation. This approach will ensure greater participation from students and allow timely feedback that contributes to the continuous improvement of the program. Likewise, there is an emphasis on the need to promote greater awareness and understanding of the importance of comprehensive education that encompasses both academic and personal, emotional, and social aspects.

Furthermore, it is crucial to design specific strategies to support students' holistic development, providing them with the tools and resources necessary to successfully face the challenges they will encounter in their life outside of university. This entails not only strengthening technical and cognitive skills but also fostering autonomy, resilience, and critical thinking, which are key aspects for their personal and professional growth.

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“DECONSTRUCTING THE TRADITIONAL BOUNDARIES OF THE AUTOMOTIVE SYSTEM THROUGH THE RECYCLING OF COMPOSITE MATERIALS IN THE DESIGN AND PRODUCTION OF THE FUTURE CAR”.

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ABSTRACT | The automotive sector is one of the most environmentally impactful contexts, not only in terms of the car production chain, but also in the use phase, which is still associated with the consumption of fossil fuels. The type of materials used also contributes to its overall impact. However, what happens when eco-design is followed in the automotive scenario, deconstructing traditional boundaries of design and production phases, and embracing the circular economy approach? Experimentation in bio-based materials and the recycling of high-performance materials is developing a broad strand of research. Therefore, investigating consumer perceptions of sustainability in the automotive industry is crucial. Although the demand for products with a low environmental impact lifecycle is steadily increasing, in the automotive context the research for sustainable solutions has to deal with other priority requirements, such as mechanical performance, fuel consumption, etc. The requirement of environmental sustainability often remains secondary. This contribution aims to present the research conducted by the Department of Applied Sciences and Technologies of the Polytechnic University of Turin (Italy), which explores new possibilities of recycling carbon fiber and glass fiber-based composite materials, which, for the same performance, can be reintroduced circularly in the production of new components, to contribute to the reduction of emissions by 2030. The ultimate goal is to design a systemic scenario based on the recycling of composite materials in the automotive industry, in which the user will be able to ‘drive sustainability’, expanding the boundaries of what the car product has identified until now.

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KEYWORDS | CAR SYSTEMS, ECODESIGN, RECYCLED COMPOSITE MATERIALS, AUTOMOTIVE SUSTAINABILITY, CIRCULAR ECONOMY

1. Introduction

1.1 The impact of the automotive sector and the value of material selection

Nowadays the automotive sector contributes significantly to the social well-being of several urban and peri-urban areas of the world, as it allows the rapid mobilization of one or more individuals and the reaching of more or less distant destinations with comfortable methods and less effort, compared to the past. This industrial product, of intricate design and production, has been able to modify the lifestyle of entire communities enormously and, at the same time, the structure of cities and neighborhoods, encouraging the development of districts and outskirts, in this way not more isolated from the workplaces, health services, places of leisure, etc. (Handy, 2005; Jacobs, 1961).

Therefore, the car has also changed the urban infrastructure, requiring the planning and construction of roads, highways, parking lots, etc. However, the complex production and supply chain of current cars is progressively leading to negative environmental and social impacts, such as air pollution and climate change, due to the constant extraction of resources, the consumption of fossil fuels, and the consequent emission of greenhouse gasses (Levente, 2021; Hawkins, 2012).
In the past, the research for sustainability in this production field has focused exclusively on the use phase of the motor vehicle rather than on its entire life cycle. This direction was motivated by the fact that the use phase represents a key point in terms of economic impact on the end user and energy consumption (Traverso et al., 2015).

These elements, added to the increase in crude oil prices and the introduction of stringent limits for vehicle emissions, have led to a growing interest in the design and production of more efficient and less impactful cars on an environmental level, influencing consumer purchasing choices. Automotive companies have thus expanded their research into the materials sector,

with a specific focus on very light materials, capable of reducing the overall weight of the car and improving its efficiency during use. In this, Automotive Design has played a significant role, in particular for its ability to study and design aerodynamic shapes, as well as Materials Technology. Currently, however, to reduce the environmental impact of the automotive industry, the focus extends to the entire life cycle of the product, also contemplating the impact of the extraction of raw materials, the production of materials and components, the assembly and manufacturing of the car, of its disposal at the end of its life. In the automotive production chain, the selection and processing of materials is a fundamental phase that consistently contributes to the level of sustainability of the finished product, its use, and its end of life. Nevertheless, it is good to point out that a material is also characterized by its own life cycle and, therefore by its ecological burden (Lanzavecchia, 2000). For this reason, a growing interest has emerged in the use of less energyintensive materials, secondary source materials (generally composite, thermoplastic, and metallic materials), and biobased materials, to facilitate the recyclability of components at the end of their life and a reintroduction of recycled materials into the production chain.

In this scenario, the tools and approach of EcoDesign, and in particular of Systemic Design, are fundamental for considering the entire life cycle of the car upstream, up to evaluating the methods that can facilitate the recycling of its technical components, once decommissioned. Furthermore, these approaches can support the analysis of the complexity of current supply chains and their impacts, facilitating the development of future predictive scenarios, to trigger a change in production models starting from the design of more sustainable products, in their complexity. In this context, the research conducted by the Department of Applied Sciences and Technology of the Polytechnic of Turin (Italy) was born, which intends to explore new possibilities for recycling composite materials based on Carbon-Fiber and Glass-Fiber (S.R. Naqvi et al., 2018, Chen et al., 2019), which with the same performance can be circularly reintroduced into the design and production of new components of the car, to contribute to a 50% reduction in emissions by 2030.

1.2 The high-impact linear production processes of Carbon Fiber and Glass Fiber used in the Automotive Sector

The present project intends to contribute to the decarbonization process through the awareness of the composition and impacts of a set of innovative materials for automotive applications. Specifically, the project assesses the impact in terms of carbon footprint of the production of carbon fibers and glass fibers.

Carbon fiber is a fibrous material with a carbon content of more than 92 %wt [Huang, 2009]. The atomic structure of carbon fibers consists of carbon atoms

organized in hexagonal structures. These fibers have interesting characteristics in terms of mechanical strength as well as electrical and thermal conductivity [Huang, 2009], making them an attractive material in various industrial fields, such as aerospace, sports (suits, shoes, frames), and automotive. Currently, about 90% of commercially available carbon fibers are produced from polyacrylonitrile (PAN), a polymer derived from oil exploitation. The traditional process consists of three main steps: spinning, stabilization, and carbonization (Figura 1). The first consists of treating the starting compound, called precursor, to obtain a raw filament product. The latter is then treated with oxygen in a furnace between 200 and 400 °C, and then passes into the stabilization phase, to stabilize the fiber. Subsequently, the filament undergoes gradual heating in a no oxygen atmosphere, up to a temperature of 1000 °C, to remove all non-carbon from the fiber surface [Huang, 2009].

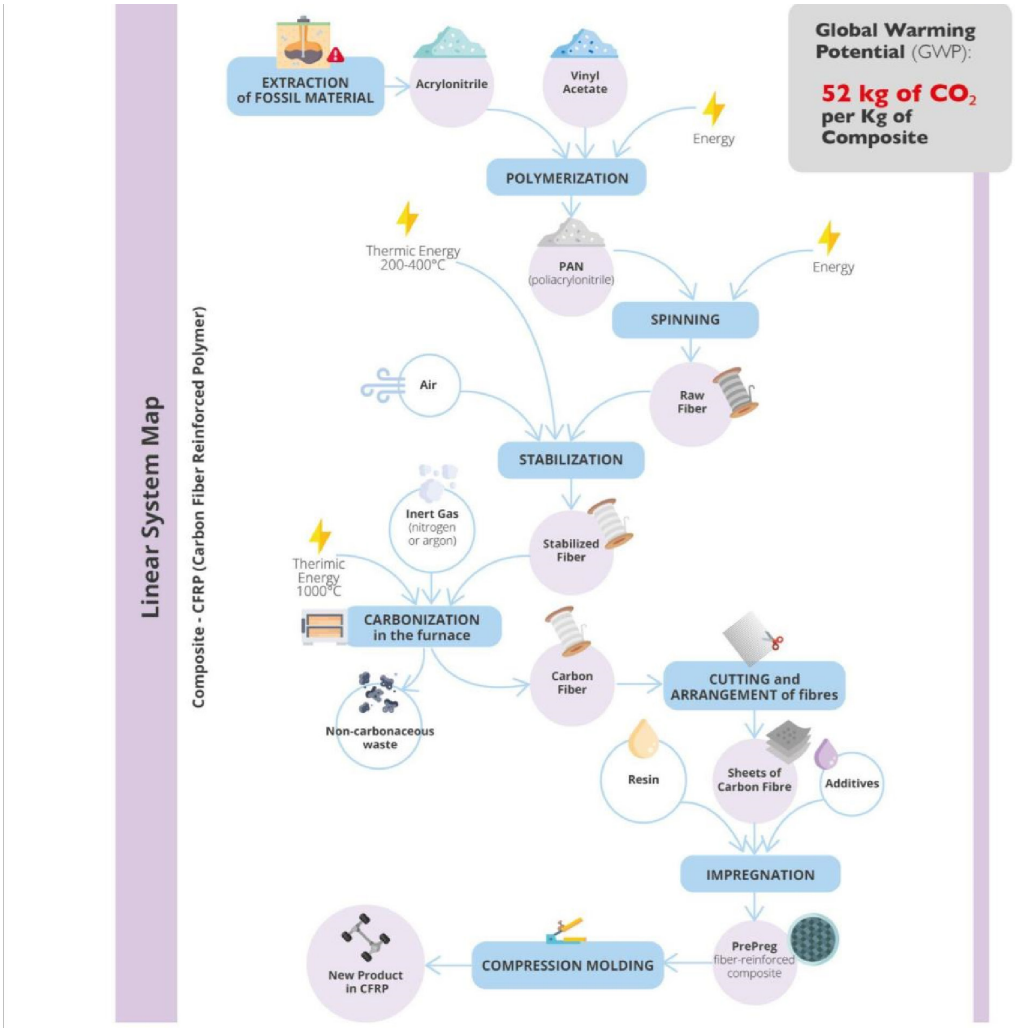

Figure 1. Design of the graphic map of the high-impact linear production system of Carbon Fiber, evaluating inputs and outputs through the Holistic Diagnosis phase described in the methodology.

The conventional carbon fiber production process is critical in terms of the cost of the precursor, which accounts for 53% of the total process [Le et al., 2022], and does not guarantee the sustainability of the process itself, since polyacrylonitrile is a fossil polymer. Consequently, it becomes necessary to focus on the choice of raw material that will be transformed into fiber, thus proceeding to a change of compound, preferring a bio-based precursor (lignin, cellulose), or implementing the use of recycled carbon fiber.

The main application of carbon fibers in the industry is their use in composites with a polymer matrix (epoxy resin, PP, PA6, etc.), defined as a 'fiber-reinforced polymer composite' (FRPC). Specifically, carbon fibers constitute 'carbon fiber reinforced plastic' (CFRP) with percentages between 30-60%wt. These composites are widely used in the aerospace, renewable energy (wind power), and automotive sectors, due to their high mechanical strength, high stiffness, and good corrosion resistance. In addition, they exhibit low density, making them a suitable candidate as a substitute for steel parts in chassis, in the context of weight reduction in cars, with a consequent saving in fuel consumption and thus environmental impact [Das, 2011].

The lifecycle of CFRP is 15 to 20 years [Chen et al., 2023], and considering an increase in the use of this material, attested by the passage from 28,2 to 48,7 billion dollars of global revenue from the sale of CFRP in 2020 [Karuppannan, Karki, 2020], makes the issue of the treatment of the composite at its end-of-life preponderant to avoid the intensification of the environmental impact of the production chain. As a consequence of this, the multidisciplinary research group of the Politecnico di Torino focused on the recycling treatment of the carbon reinforced composite, considering it interesting to search for a recycled treatment that would guarantee both sustainability and adequate mechanical properties to the fiber. In particular, pyrolysis (thermal degradation without oxygen) has been chosen as the best way of treatment, because the fiber recovered has mechanical properties similar to virgin fiber's ones and it does not request a high energy to operate at a commercial level.

Glass fiber is a fibrous material generally consisting of silica, used in several industrial applications, and can be classified into different categories according to its chemical composition and consequently its technical characteristics. A common application is within composites with plastics, to strengthen thermal resistance, gas penetration, and impact resistance. According to the EuCIA (European Composites Industry Association), 95% of the FRPC trade is for glass fiber composites (GFRP). These composites are used in many industrial sectors, such as building, electrical and electronics, transport, production of renewable energy (wind), etc. Their life cycle is around 20-25 years and the estimated waste production of GFRP in 2025 will be 80,000 tonnes from the transport sector only, including the automotive one. This is the third contribution to overall waste production, behind the building industry and electronic sector. In addition, the increase of waste glass fibers due to the development of a growth sector such as wind energy production should not be underestimated, as blades are made of

62%wt GFRP [Gonçalves et al., 2022].
In the automotive sector glass fiber composites are implemented in internal components such as center stack retainer, pull handle, console reinforcement etc. The cost of virgin glass fibers is around 1,20-1,90 €/kg, while carbon fibers cost 105 €/kg in the highest quality cases [Naqvi et al., 2018]. This significant price difference means that the valorisation and disposal costs of glass fiber waste are crucial in seeking to implement an improvement in waste management. As a consequence of the low cost of raw materials for virgin glass fibers, mechanical recycling is the most widely used process to recycle, reducing the size of composites through a grinding machine. The resulting mill is composed of resin, fiber, and possible filler, which are separated by gravity (Figura 2). It has several advantages such as industrial scale-up, low environmental impact, and cost-effectiveness, but It causes a significant degradation of fiber that will not be used in the same components as a virgin material. In this project we evaluate the impact of mechanical recycling compared to the traditional process of manufacturing glass fiber composite.

With a view to applying the Circular Economy to the production system of materials used in the automotive sector, in the following paragraphs the design methodology applied in the explored research project will be described and the experiments carried out with a view to recycling materials and producing new components of the car starting from greater sustainability of the system.

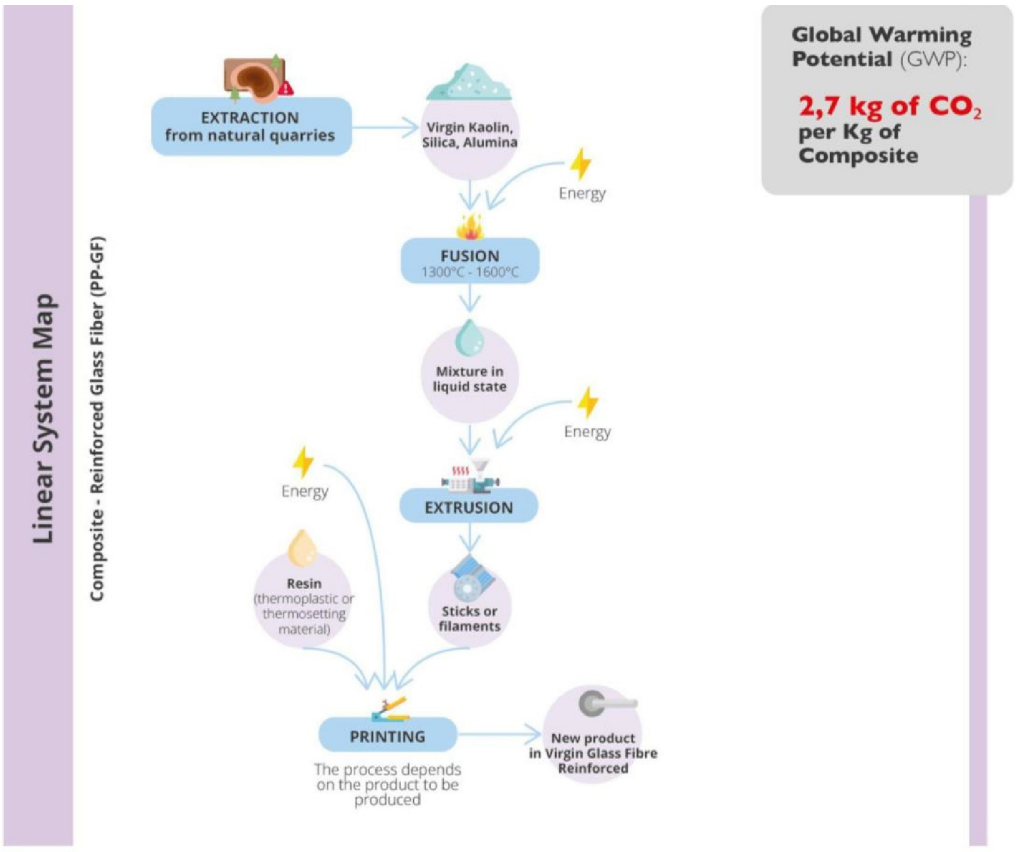

Figure 2. Design of the graphic map of the high-impact linear production system of Virgin Glass Fiber, evaluating inputs and outputs through the Holistic Diagnosis phase described in the methodology.

2. Methodology

2.1 The EcoDesign approach in the methodological path undertaken

For the general development of the project, the typical EcoDesign methodology was followed, with a specific focus on systemic design. EcoDesign is an ecological approach applied to the design of products, structures, architectures, technologies, industries, and processes, aimed at bridging the gap between sustainable ecological systems (therefore what is part of the great system of Nature) and artificial human scenarios (thus what has been designed, produced and created by man to develop his contemporary lifestyle). For this reason, the EcoDesign principles reflect the organizational ones that Nature has always used to support life. Adopting the EcoDesign approach requires first of all a change of cultural, design and production paradigm (Capra & Luisi, 2014). It overcomes the linear production model (Take-Use-Dispose)(Ellen MacArthur Foundation, 2012) whose objective is to exclusively exploit natural systems for the constant extraction of resources, in order to develop new design and production strategies that look to Nature as a model, measure, and guide and try to understand how to cooperate with it, rather than dominate it (Benyus, 1997).

For simplicity, it is possible to summarize two large macro-categories, intrinsically connected, into which EcoDesign is dissected:

- the recycling of elements, materials, and waste products mainly within the production chains, where further specific approaches are used that are compatible and complementary to those of eco-design, such as the Systemic Design and Circular Economy approach;

- the sustainable design of products, structures, processes, architecture, and even cities, giving space to Design by Components or the development of EcoCittà and Green Architecture which follow the Biomimicry approach, according to which many human problems have already been largely solved by other living organisms present in Nature.

At the basis of these approaches is the key principle of ecology (Commoner, 1971) according to which nature knows no waste, therefore every manufactured product, every transformed material and all industrial or domestic output produced must necessarily become a form of nourishment for others systems, compatible with the first pillar of Systemic Design, according to which the outputs of a system must be valorized as inputs of another system (Bistagnino, 2011). This form of nourishment depends on the type of metabolism (biological or technical) in which a working group operates. In the case of production chains such as the automotive

one, the outputs are considered real technical nutrients, i.e. all those non-biodegradable elements that belong to industrial cycles and which consequently cannot be metabolized by other living organisms, as instead happens in biological metabolisms (e.g. composting or fermentation processes) (McDonough, 2013). A technical nutrient is designed to be part of a technical cycle, therefore its recycling in the industrial field is profoundly different from other types of ordinary recycling (such as domestic recycling), as it is necessary to preserve the high intrinsic quality of the material, which must undergo reduced levels of contamination and degradation.
In this research the discipline of EcoDesign met that of Chemical and Environmental Engineering and that of Materials Technology, developing a technical methodology in which the evaluation of environmental impacts is fundamental.

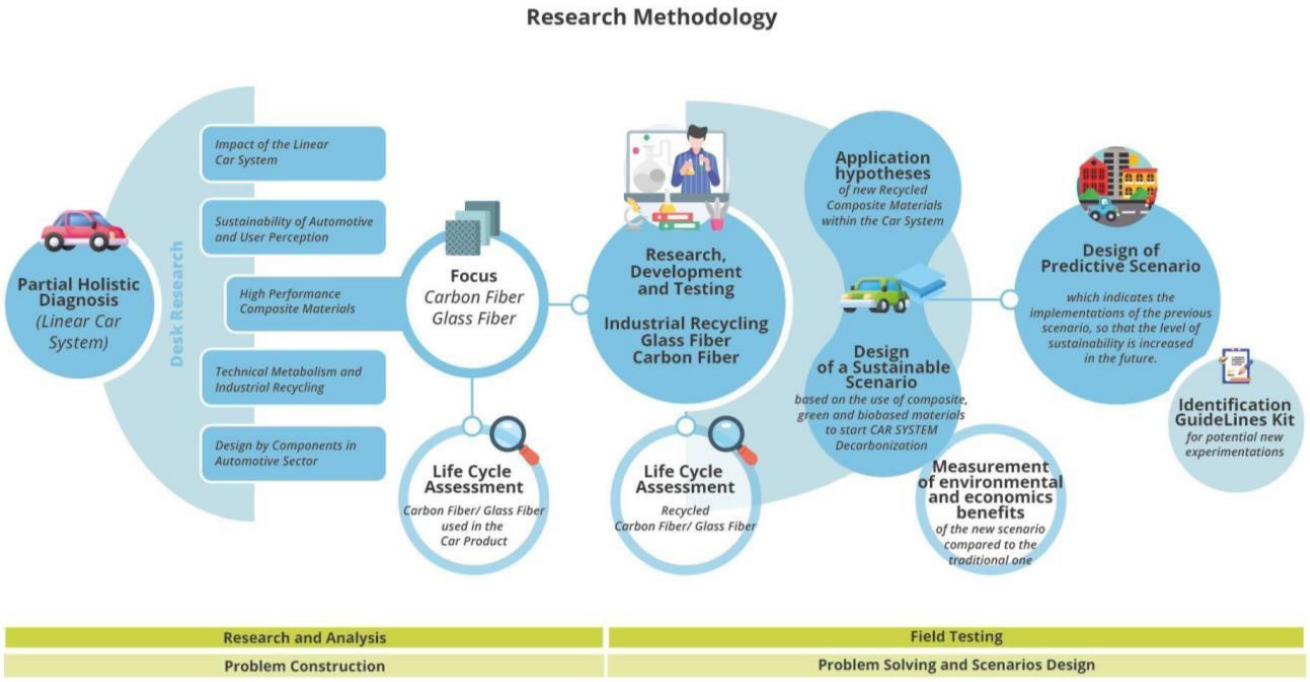

Figure 3. The methodology followed in the research undertaken for the application of circularity to the car system: the complementarity of EcoDesign and LCA approaches and tools

The starting point was the development of a partial Holistic Diagnosis of the car's high-impact linear system (Figura 3). Considering the complexity and breadth of this system and the choice of predefined materials (Carbon Fiber and Glass Fiber), only the car components made of these materials were considered, but it was also useful to evaluate those which, although produced in different materials, they could potentially be produced with study materials, in the future.

Through desk research, the generic environmental impacts of the motor vehicle and the perception of sustainability in the purchasing decisions of a car by the end user were investigated. Furthermore, the existing scientific literature on traditional production models of carbon fiber and glass fiber and their recycling possibilities was examined. Finally, considering the technical metabolism to which the automotive supply chain belongs, the potential of Design for Components (Felfernig et al., 2014) in the Automotive sector was explored. The latter is an approach adopted upstream in the design of a product, in order to facilitate its disassembly at the end of its life cycle, the recovery of materials and components, differentiation according to materials and, in cases of reconditioning, the replacement of specific damaged components. It is therefore fundamental in the case of complex multi-material products, especially if the objective is to extend their life cycle and/or that of the materials used in them.

The second fundamental step was carrying out the Life Cycle Assessment of Carbon Fiber and Glass Fiber currently used in the automotive sector, which supported the start of the phase of concrete experimentation and the development of recycling techniques for these composite materials. The objective will be to develop a new LCA on new materials obtained from the recycling process to evaluate the benefits of using the latter in the same sector, as well as in others.

Subsequently, specific hypotheses for the application of the new circular materials to the car system will be developed, designing a more sustainable scenario based on the recycling of composite materials to contribute to the process of decarbonization of the car product. In this way, it will be possible to compare the new scenario with that emerging from the Holistic Diagnosis of the high-impact linear system.

To conclude, the last step involves the design of a predictive scenario that can indicate the necessary implementations of the project, so that the level of sustainability achieved is expanded, also considering additional factors in addition to decarbonization (e.g. water footprint, social sustainability, etc.). In this sense, a kit of guidelines will be developed for new potential experiments not only in the sector of the materials investigated, but also in the use of further materials explored by the Polytechnic of Turin, such as bioplastics, lignin, hemp, and the use of low impact alternative batteries.

2.2 The role of Life Cycle Assessment in ongoing research

As already mentioned, within the methodology followed, the evaluation of the environmental impacts of the life cycle of the materials investigated was a key element. In detail, the Life Cycle Assessment (LCA) is an international standardized methodology (ISO 14040-44) adopted to evaluate the environmental impacts of products, processes, and services. The assessment

encompasses all stages from raw material extraction through materials processing, manufacturing, distribution, use, repair and maintenance, and disposal or recycling. The study of Life Cycle Assessment (LCA) in the automotive sector plays a crucial role in evaluating and reducing the environmental impact of vehicles throughout their entire life cycle. LCA can quantify the vehicle's environmental impact from the raw material extraction phase, through production, use, and disposal, by identifying the life cycle stages with the highest environmental impact. This stage represents the bottleneck and requires to be reduced to decrease the whole environmental impact associated with the investigated product, process, and services. Currently, the key actions taken by the automotive sector include optimizing materials and resources to design vehicles with lower environmental impacts across various impact categories and contributing to the decarbonization of vehicles in their whole life cycle. Specifically, the optimization of materials and resources for vehicle design involves two fundamental points: 1. material recovery and recycling and 2. optimization of production processes. Material recycling involves studying the life cycle to improve the recycling of vehicle components, reducing waste, by enhancing material efficiency and preventing resource consumption (Del Pero et al, 2018). Optimization of production processes identifies energy-intensive production stages and develops strategies to reduce energy consumption and emissions, like for instance considering alternative and renewable energy or increasing efficiency. For automotive companies, the LCA represents a credible tool for clear and transparent communication of their commitment to environmental sustainability to stakeholders (customers, regulators, investors). Environmental studies based on LCA can support marketing strategies and corporate social responsibility initiatives. Information obtained from LCA supports strategic decisions regarding research and development, new product design, and supply chain management. Companies can make informed choices to improve the overall sustainability of their operations.

In the present study, the LCA aims to evaluate the impact of the processes of manufacturing traditional composite and composite made of recycled fiber, either for glass and carbon fiber.

This comparison is based on global warming potential (GWP) ($kg_{CO2}/kg_{Composite}$). For the production process of composite from virgin fiber, we will analyze production "from cradle to gate", meaning that we consider the production system from the raw materials to the composite ready for the application stage in the car. The production system of recycling process is evaluated "from grave to gate", so from the composite at the end of its life to another composite ready for the use phase (Gregson et al., 2015; Braungart et al., 2007; Hauschild et al., 2005),. The scope is increasing use of materials from circular economy processes in the overall design of automotive production chains. In this sense, we aim to contribute to the general

sustainability of the car product, acting on the steps that precede the use phase and which do not have direct contact with the end users, although they can influence in them purchasing choices.

3. Results

3.1 The recycling of Carbon Fiber and Glass Fiber as a process to increase the level of decarbonization of the cars of the future

As mentioned in the previous paragraph, the first phase of analysis of the methodology undertaken involved carrying out the Life Cycle Assessment of the materials analyzed in order to evaluate the current environmental impact of carbon fiber and glass fiber in the traditional car product.

Specifically, concerning results of LCA for carbon fiber, the amount of carbon dioxide released into the atmosphere from the production of the composite from virgin carbon fiber is 52,4 kg CO2 eq. The process of treating CFRP to obtain rCFRP releases 11,4 kg CO2 eq into the atmosphere. In the carbon fiber production process, the carbon dioxide impact of the initial compound is considerable, as it accounts for around 53% of the total. This is due to the use of raw material of a petroleum nature, but above all also due to the energy-intensive nature of the process, as the high energy required to produce one kilogram of carbon fiber, a value that is also consolidated in the literature [Chen et al., 2023]. As far as the composite calculation is concerned, carbon fiber plays a greater role than epoxy resin. On the other hand, the carbon footprint of the thermal recycling treatment of CFRPs is mainly dependent on the energy required for pyrolysis process and on the impact related to the use of new epoxy resin to produce composites from recycled fiber. The latter is the raw material that can be considered as the main contributor to the environmental impact of the recycling treatment. Possible process improvements to reduce the CO2 release are the possibility of exploiting the pyrolysis gas, initially by trying to recover possible condensable compounds that together with a liquid phase produced by pyrolysis (not considered in this first analysis) can constitute a compound comparable to a resin of a phenolic nature [Quan,2010].

To evaluate possible improvements of the process, experimental tests were conducted on the pyrolysis of a carbon fiber composite to evaluate the products obtained, analyze them, and hypothesize energy and chemical enhancement solutions. Experimental tests designed showed the excellent recovery of carbon fiber from the composite, with the production of a gas phase and an oil component (Figure 4). These two phases are composed of all those molecules resulting from the degradation of the resin present in the starting composite. The gas phase was analyzed, showing the increased presence of compounds such as hydrogen and methane, making it actually interesting from the point of view of energy utilization for the purpose of powering the recycling process itself. The oil phase has compounds called “phenols,” which

have various applications in industry, from nylon production to cosmetics. Moreover, the presence of such molecules in the oil phase is also attested in literature [Quan, 2010].

To better trace the qualitative comparison between the traditional production systems of the investigated materials and the circular systems experimented with their recycling and reuse in the automotive sector, graphic relational maps (generally typical of Systemic Design) were developed. Indeed, through a graphic representation, understanding the inputs and outputs of both processes, as well as the different phases used in them, is more immediate.

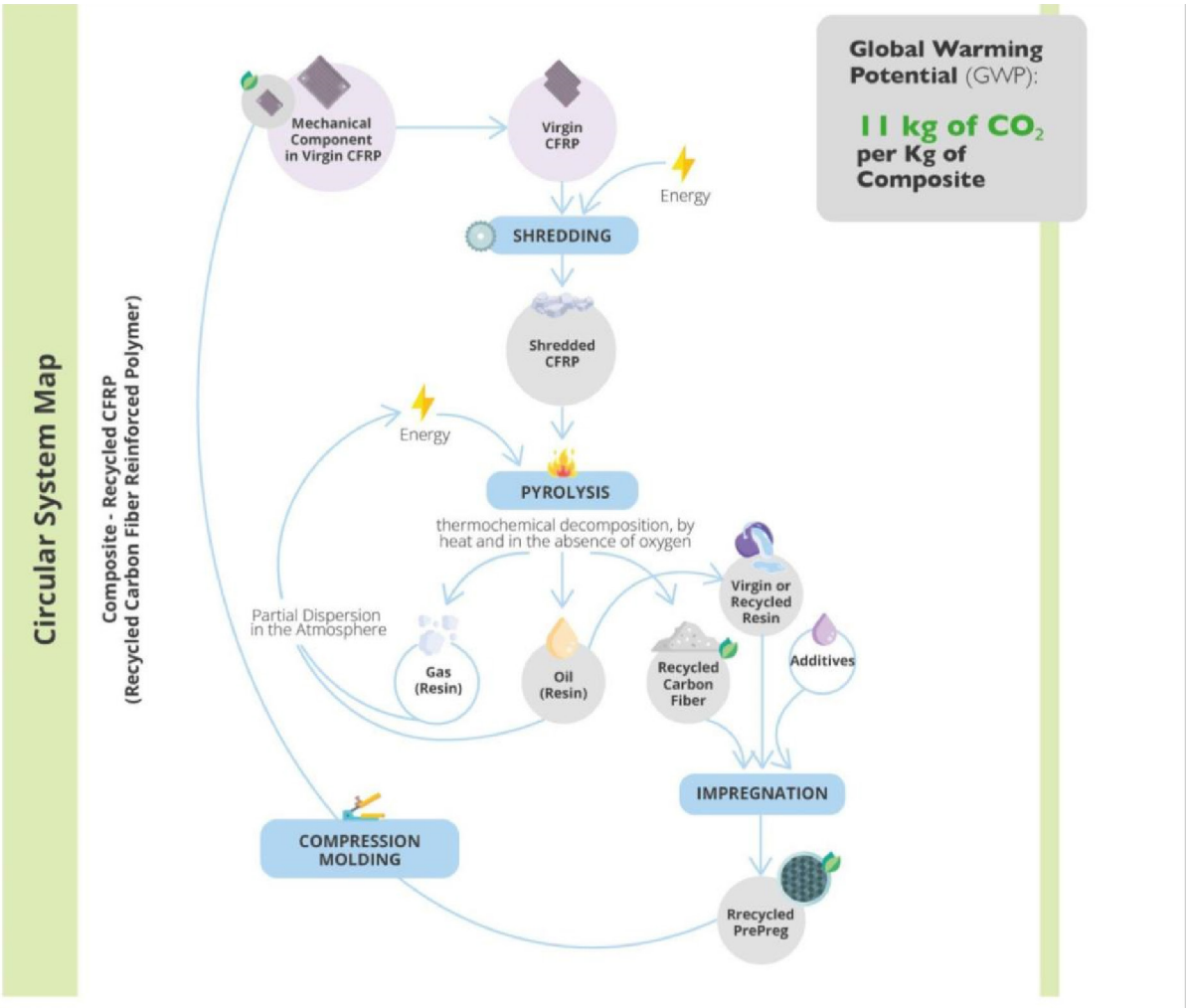

Figure 4. Design of the graphic map of the circular production system designed, experimented and tested for the Carbon Fiber Composite. Inputs and outputs reintroduced into the system were evaluated.

The same evaluation and design process for new recycling processes was also carried out for glass fiber. The amount of carbon dioxide released into the atmosphere from the production of glass fiber composite (GFRP) is 2,7 kg CO2 eq. Instead, the alternative process of grinding GFRP and re-moulding recycled glass fiber with virgin fiber and polypropylene releases 2,3 kg CO2

eq into the atmosphere (Figure 5). The main contribution to the carbon footprint of the composite with only virgin fiber and with the virgin/recycled blend is given by polypropylene (respectively 59 and 65% of the total GWP calculation). There is a difference between the two processes: the recycling process is less impactful than the traditional one, but this is not so wide. It could be a consequence of not reusing the polypropylene from the mechanical separation by grinding, stressing the concept of consumption. The mechanical recycling process of composites can be improved through the above-mentioned reuse of recovered polypropylene, but also by considering a higher percentage of recycled fiber within the composite. Consequently, a further project could be the evaluation of all the blend options proposed by Kang et al. (2021), including the use of long glass fibers, both virgin and recycled. To assess the consistency of the work carried out, it is interesting to compare the results obtained with what can be found in the literature. As far as the modeling of the traditional process is concerned, the GWP related to the traditional production of GFRP is around 3-5 kg CO2 eq, thus in line with what was calculated through this analysis [Rajendran et al.,2012] [Reichenbach et al.,2021]. In fact it is necessary to consider that the process of recycling and producing a composite has one more step compared to the traditional one, namely the mechanical treatment, which, by its nature, requires the use of energy.

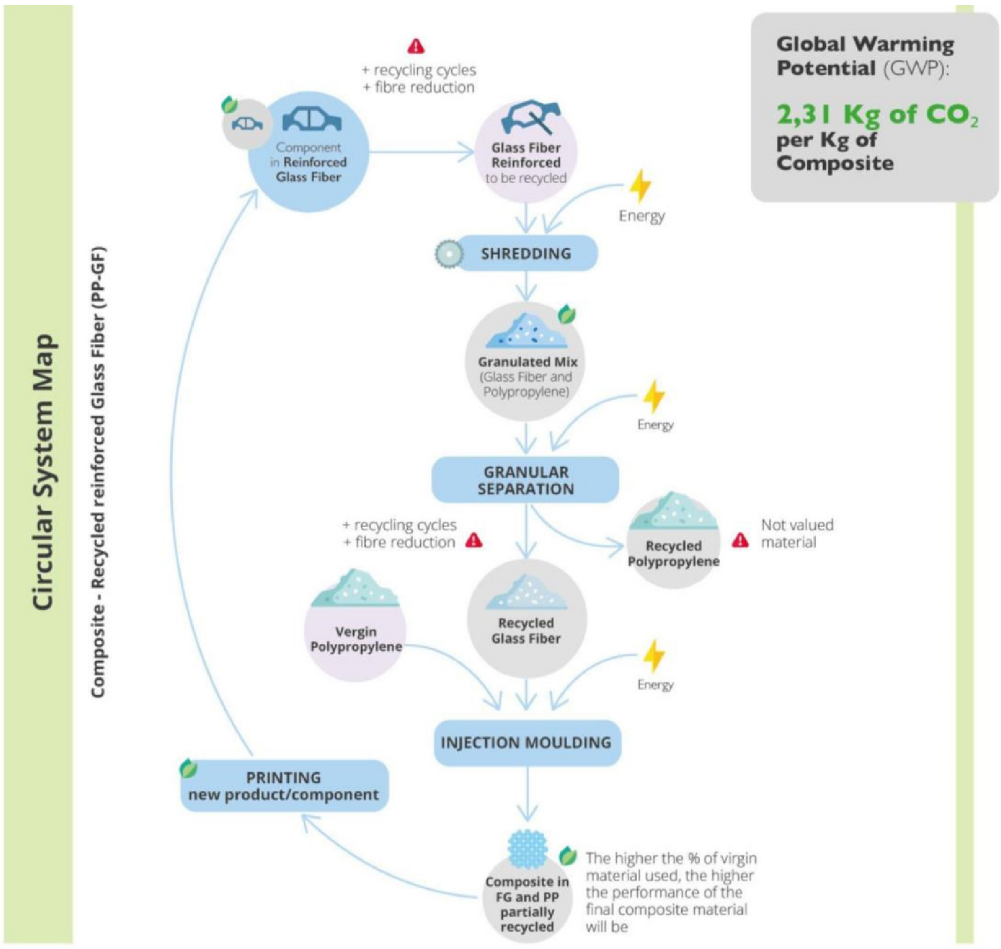

Figure 5. Design of the graphic map of the circular production system designed, experimented and tested for the Glass

Fiber Composite. Inputs and outputs reintroduced into the system were evaluated.

To conclude, it is possible to assert that the mechanical performances, properties of the composite made from recovered carbon fiber are about 90%, compared with the composite made from virgin carbon fiber [Chen et al., 2023]. To prove this, experimental mechanical stress tests will be conducted in the future in order to have direct data. Also regarding glass fiber reinforced composite, the formation process of the composite made from the recycled fiber was modeled in order to have mechanical properties not less than 90% of those of the virgin fiberreinforced composite. The blend (recycled fiber + virgin fiber) that allows the composite to meet this standard is at 60:40 (wt%). This choice has been made by taking in consideration a similar study conducted by Kang et al. (2021), where the authors tested blends of virgin mixes (glass fiber + polypropylene) with recycled ones. In this case we model a blend of virgin and recycled glass fiber with virgin PP. For these reasons, investing in the recycling of these composite materials is an important direction to achieve greater levels of sustainability of the vehicle.

Considering that they are adequate to offer good structural resistance and durability, comparable to virgin fiber in many cases, some application hypotheses have been presumed in the automotive system to reduce the overall weight of the macro-product, increasing efficiency in terms of speed, emissions, and fuel costs. It has been estimated that recycled carbon fiber composite can be used in some components of the external bodywork of the car, such as the bonnet, bumpers, and doors, and other internal components, such as the dashboard, the internal structures of the seats, defined as underbody sections and frame, handles, etc. Complementarity, the recycled fiberglass composite can be used to cover side mirrors and grilles, which, in addition to requiring a weight reduction, need excellent resistance to atmospheric agents. However, it can also be used in the production of the center console and trunk linings, acoustic/thermal insulation panels.

3.2 The uses of EcoDesign for a more sustainable Automotive System

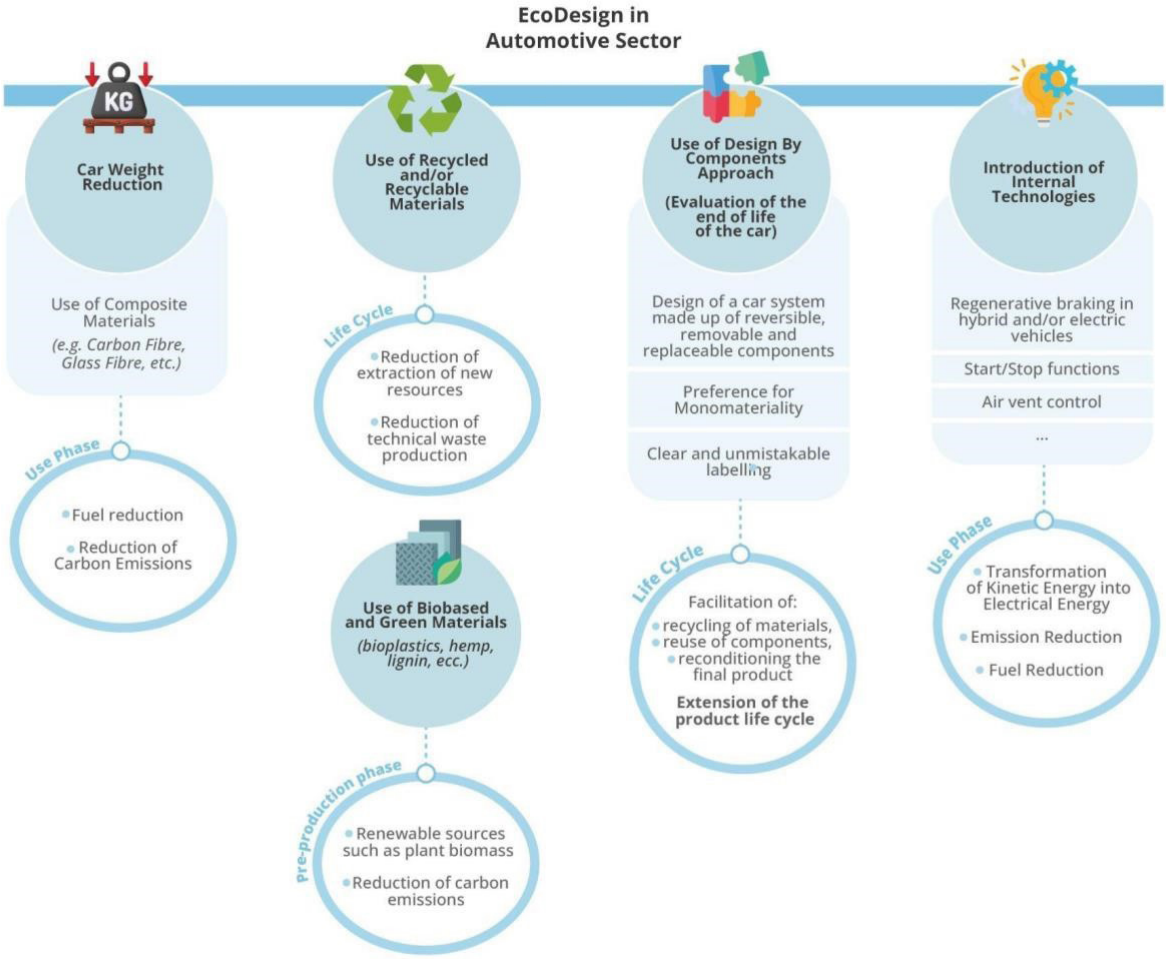

Figure 6. Applications of EcoDesign Approach in the Automotive Sector

Designing products with a minimum weight, by reducing the quantity of materials used and through the use of lightweight, high-performance, and durable materials at the same time, is a challenge that does not only belong to the automotive sector but in general to any market segment who wish to design and produce sustainable and easy-to-use everyday products. The scenario of increasingly lighter products (to the point of reaching dematerialisation) and with a reduced ecological burden is also increasingly requested by consumer communities. In the case of extremely complex products that require numerous components, some of which are characterized by high thicknesses and metallic materials, good eco-design is fundamental. This is the case of the car system, which increasingly requires a change in the design of its life cycle. In this project, fundamental guidelines have been drawn up which, through the adoption of the EcoDesign approach, can lead to the production of increasingly green cars, not only in terms of decarbonisation (Staniszewska et al., 2020), where the requirement of a correct choice of materials remains imperative.

These guidelines can be summarized in (Figure 6):

· Reduction of the overall weight of the car, through a formal and functional design of its components and the use of highly performing composite materials characterized by a low specific weight, such as carbon fiber and glass fiber. The reduction in weight, in fact, allows to reduce the need for fuel during use phase, consequently minimizing the emissions produced.

· The use of recycled and/or recyclable materials, coming from the automotive production chain (closed system) or other supply chains (open system), in order to decrease the extraction of new resources and the disposal of difficult-tomanage technical waste.

· A significant growth in the use of green materials and/or biobased materials, coming from renewable sources such as plant biomass, to reduce the extraction of resources from fossil sources. An example of these materials are hemp, lignin, and the entire family of bio-polymers, characterized by a less impactful life cycle.

· The adoption of Design by Components as a design approach, although considered upstream in the life cycle of a car, allows for efficient and sustainable actions at its end-of-life. The design of a system characterized by reversible, removable, and replaceable components, distinguished as much as possible by monomateriality and clear labeling, would greatly facilitate the recycling of materials used in the automotive system and their reintegration into the same or other production chains, thereby extending the life cycle of both the materials and the vehicle itself (also overcoming the barrier of planned obsolescence).

· Finally, the adoption of technologies inside the car capable of strategically reducing emissions and fuel use during use (a good example could be the design of regenerative braking, in the case of electric cars, useful for transforming energy kinetics into electrical energy to power the batteries).

These design directions demonstrate the fundamental role of the eco-designer in the preproduction phase of a product's life cycle. The eco-designer is capable of having a systemic view of the production chain, evaluating the inputs and outputs of each phase of the chain, and consciously designing an end-of-life for the product that avoids material and energy losses, thereby extending the life of materials and products. However, implementing such a design and production change in the automotive sector requires overcoming a series of organizational and economic obstacles. These are not only connected to the research and development of new technologies but also, and more importantly, to managerial resistance (Kayikci, 2021). For this reason, it is essential to plan training and awareness programs for stakeholders throughout the production chain to promote a corporate culture oriented

towards sustainability. Additionally, fostering partnerships with other companies, research institutes, and governments is crucial to creating true ecological clusters where the exchange of resources, energy, and information is fundamental to deconstructing the traditional boundaries of the automotive system.

4. Conclusion

The experiments initiated within the project presented in this paper are not yet concluded. The project is considerably broader, and the Politecnico di Torino, through the transdisciplinary collaboration of various departments (Department of Applied Science and Technology, Department of Environmental, Land and Infrastructure Engineering, and Department of Energy), where several designers are working, is indeed initiating a series of research and development tests on additional materials and technologies of interest for a more sustainable and comprehensive automotive system scenario, with the aim of modeling a design and production change for the latter in the coming years.

The results presented focus exclusively on the recycling of high-performance composite materials, such as carbon fiber and fiberglass; however, their use in the automotive industry must be considered by evaluating all the dimensions and requirements of EcoDesign previously explored.

Similarly, it is possible to assert that the use of Life Cycle Assessment (LCA) is not exhaustive if the goal is to calculate the most comprehensive dimension of a product's sustainability (environmental, social, and economic). In fact, in the experimental tests presented, LCA was primarily used to evaluate the Global Warming Potential (GWP) of the composite materials investigated. However, currently, techniques such as the Life Cycle Thinking Approach (LCT) (Traverso et al., 2015) exist, which are capable of implementing a joint evaluation of the results derived from Life Cycle Assessment, Life Cycle Costing (LCC) (evaluation of all costs related to the product life cycle and translation of these into environmental costs), and Social Life Cycle Assessment (SLCA) (evaluation of the social performance of a product's life cycle, considering working conditions, impact on the local community, etc., and extending this evaluation to all actors in the production system).

Within the sustainability of the automotive system, the final consumer also plays a key role, influencing product and technology design through their preferences and purchasing choices. Although the car is an extremely functional consumer good, it is not uncommon for it to represent a status symbol, especially as brands, models, and materials used increasingly align with the luxury sector, thus distancing themselves from the concept of sustainability (Fitt, 2023). While in the agri-food sector and fast fashion, there is a progressive increase in the demand for products with a low environmental and

social impact life cycle, in the automotive context, the search for sustainable solutions and processes must contend with other priority requirements, such as mechanical performance, maintenance needs, consumption, costs, safety, and so on. In this regard, environmental sustainability often remains a secondary requirement, especially during the demand phase by buyers (Hetterich et al., 2012; Saari et al., 2020). Nevertheless, growing environmental awareness is having a direct influence on diverse purchasing decisions. Linked to the introduction and strengthening of increasingly stringent government regulations regarding vehicle emissions and air pollution, as well as appealing tax incentives, it is leading consumers to be more willing to spend more on more sustainable products and vehicles, which can result in future fuel savings and a reduction in environmental impact even during use. Environmental impact is indeed an increasingly important factor in the purchasing process. In this context, which certainly presupposes a transitional era, designing for low-impact life cycles can lead to substantial changes in the production sector and in the daily lives of consumers, who are increasingly eager to “live” and “drive” sustainability.

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BRIDGING THE GAP: LINKING TRANSFERABLE SKILLS TO POTENTIAL FUTURES IN GRAPHIC DESIGN.

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ABSTRACT | This paper discusses the concerns related to the future of the graphic design profession. It analyzes the international educational context and how the programmes adapt to respond to the VUCA environment, including the change in the naming of the programmes. In order to contribute to this discussion and find a way to improve the "Graphic design" educational programme, we chose "Futures Thinking" as a metacognition methodology to apply for self-reflection and adaptation to the turbulent context. The achieved result positions graphic design describes "Meta-communication design" as one of its potential futures. Thus, this paper represents a discussion on the future of graphic design as a profession, the reflection on the design methodologies, the skills that will be needed, how educational programmes should behave in future contexts, and eventually, the students' aspirations regarding their future career paths. In the following steps, we aim to conduct a "Back-casting" workshop to understand which strategic decisions the students could take now to prepare for the future.

KEYWORDS | VUCA (VOLATILITY, UNCERTAINTY, COMPLEXITY, AMBIGUITY), FUTURES THINKING, GRAPHIC DESIGN EDUCATION, TRANSFERABLE SKILLS, STRATEGIC FORESIGHT, SCENARIO-BUILDING, ADAPTABILITY

1. Introduction

In light of the rapidly emerging technologies, there is an ongoing discussion on the future of art and design and a concern about whether the graphic design profession will disappear. In other words, the graphic design profession is subject to a volatile, uncertain, complex, and ambiguous (VUCA) environment, as identified in futures studies (Bennett & Lemoine, 2014). However, Graphic Design educational programmes still exist, and current and future graphic design students may question their future career trajectories due to the rapid transformations occurring in the field, particularly driven by emerging technologies and changing business landscapes.

In recent decades, the training of designers has shifted from obtaining traditional hard skills to a variety of transferable soft skills (Meyer & Norman, 2021). Bell (2004) and Slaughter (2004) stated that in the face of this VUCA scenario, designers should adopt a long-term vision and strategic foresight approach to cope with uncertainties and anticipate potential changes.

Moreover, in light of the ongoing societal, economic, environmental, technological, and political challenges, designers are increasingly expected to transcend their traditional roles and become strategists and decision-makers capable of analyzing long-term dynamics and proactively responding to change (Brown, 2008; Norman, 2023). To address the rising anxiety among graphic design students and to explore the future of the graphic design profession, an iterative futures thinking practice can be integrated into the educational curriculum. After the completion of each year/semester of studies, students will delve into an intensive hands-on workshop, where they will go through the Futures Thinking research and design methodology: identifying trends, scenario-building, and world visualization (Balagtas, 2021), – to rethink their own future. At step one, students will analyze the environment of the Graphic Design profession using trend research and analysis methods from foresight. In step two, students will develop alternative scenarios emphasizing the implications of the technology and other identified factors

on the creativity of future designers and their response to the challenge using available skills. Eventually, they will brainstorm and visualize the potential deliverables the future designer can bring to the world.

This practice would enable students to explore potential future scenarios and link them with the transferrable skills they acquire throughout their studies. In addition, if carried out regularly, this practice can serve as a research methodology on the relationship between emerging technologies, the future of the design profession, and creativity. This paper will share the first results of the tester workshop and discuss the visions of the future of graphic design and the value of this methodology for educational programmes.

2. Context

2.1 Continuous transformations

The research "AIGA Designer 2025", dating back to 2017, examines the trends that would affect design careers and design education in the future. Referring to the US Bureau of Labor Statistics, it suggested that "the growth in traditional graphic design positions between 2014 and 2024 will estimate 0-1%, which is well below the anticipated 7% growth in all sectors of employment" (AIGA, 2017). Today, in 2024, the US Bureau of Labor Statistics reports that "employment of graphic designers is projected to grow 3% from 2022 to 2032, about as fast as the average for all occupations" (Bureau of Labor Statistics, 2024). Despite unfulfilled predictions about the numbers, the ongoing crisis in the profession cannot be denied. The preconditions of the crisis are the long-standing contradictions between the education system and the industry: there is a certain mismatch between design education programmes objectives and average job requirements. As Juliette Cezzar writes, "Nowhere is this incongruence more evident than in the field of graphic and communication design, which has vigorously debated its boundaries, histories, and even its name" (Cezzar, 2020, p. 214).

Indeed, along with the common revision of values, approaches, and tools in design, we observe gradual changes in the names of educational programs in different schools all over the world. The Icograda manifesto (Poggenpohl & Ahn, 2002) declares that within the developments in media technology and the information economy, the term "graphic design" is becoming "technologically undermined" and suggests that "visual communication design" is more relevant. Schools are trying to distance themselves from the traditional wording "Graphic Design" as it is related to the negative connotations that accompany the discipline. The description of the Graphic Communication Design educational program at the University of the Arts London (UAL) says that "historically, graphic design has serviced various imbalanced power structures, and in this way, has contributed to perpetuating climate, racial, and social injustices". Today, design schools are striving for names that will reflect the challenges students will have to work on.

Ubiquitously, the wording “Graphic design” is being replaced by “Communication Design,” and there is an emerging trend of inventing new names, primarily for master’s degree programs, e.g., “Communication Complexity” at UAL, “Information Experience Design” at the Royal College of Art. There is also a tendency to form problemoriented and transdisciplinary programs: “Contextual Design” and “Geo-design” at Design Academy Eindhoven, “Transdisciplinary Design” and “Strategic Design for Global Leadership” at Parsons School of Design, “Approaching Language”, “Voice Master” at Sandberg Instituut.

These new names are consistent with the values and objectives of these major design schools. The “Graphic Communication Design” educational program at the University of the Arts London aims to “continuously remix and redefine the future of our discipline and how it interacts with environmental, cultural, and social complexities.” The Parson School of Design encourages students to “create and share compelling messages from concept stage to final form while exploring the social and environmental dimensions of communication”. Department of Design at Sandberg Institute guides “students to develop tools and methods for research, articulation, and visualization that enable them to express and intervene with current discourses and the politics inherent in design”. Throughout these texts, design schools promote the idea of a designer as an agent of change. At the same time, if we take a closer look at the reality of the industry, we may find that average design assignments are rather trivial. According to the description of the design duties (Bureau of Labor Statistics, 2024), graphic designers typically do the following:

- Use digital illustration, photo editing software, and layout software to create designs;
- Create visual elements such as logos, original images, and illustrations to help deliver a message;
- Design layouts, including selection of colors, images, and typefaces;
- Present design concepts to clients or art directors;
- Incorporate changes recommended by clients or art directors into final designs;
- Review designs for errors before printing or publishing them.

Following this industry-related vision, design practice has no space for critical and even creative thinking. Designers seem to be the executors of someone else’s will, be it the will of the market, the target audience, or the client. Despite the rapid progress in communication technologies, there is a relatively slow pace of change in the industry, which leads to stagnation throughout the system. There is a certain vicious circle: Design educators and academics are willing to develop critical approaches but have to face the reality of the industry, where conventional forms and methods are still dominating. At the same time, graduates become hostage to

the situation when their competencies can't be applied in practice and often have to work on assignments that lag behind contemporary social, technological, political, and economic contexts. The question is how to resolve this contradiction between the intentions that are shaped in the academy, the framework that the industry dictates, and the reality in which problems continue to accumulate, and very few solutions emerge.

2.2 Graphic design in VUCA context

The above observations prove that the graphic design profession is subject to a volatile, uncertain, complex, and ambiguous (VUCA) environment, as identified in future studies (Bennett & Lemoine, 2014). The VUCA environment affects the graphic design and all the contexts, including business, economic, political, etc. To meet the external challenges coming from the surrounding environment of an organization, the organization needs to be agile and invest in leadership development, and their employees should have the ability to influence the organizational and relational dynamics (Kolga, 2021). Complex relationships and networking are prioritized over control, standards, and autocracy (Uhl-Bien & Marion, 2009). In the educational environment, this led to a need to promote more active learning approaches that transfer to the students responsibility for learning and entrepreneurial mindset (Fernandes & Afonso, 2021).

Graphic design as a profession obtained its popularity thanks to the Swiss school of typography, which influenced our understanding of what represents a good standard of graphic design. However, the reality of the graphic design profession is associated with a number of delusions related to the negative sides of its working process, such as project-based regimes and work-life disbalance, low wages, and low social protection, prevailing individualism and self-promotion, and the overall uncertainty related to the development of a professional career (Quintela, 2016). What further contributes to the uncertainty of the profession is the frequently changing market trends and consumer preferences that are hard to predict and keep up with.

Secondly, rapidly emerging technologies, and especially the GPT and other AIassistants, have created heavier pressure on the designers and even a sense of competition with AI. In addition to that, the introduction of new software, platforms, and devices constantly reshapes the tools and techniques used by graphic designers, necessitating continuous adaptation of their skills, which may lead to a lack of professional confidence among designers and push them to opt for "junior" positions at work. Additionally, the rise of digital media has led to an increased emphasis on responsive design, motion graphics, and interactive experiences, further contributing to the volatile nature of the profession, changing rapidly and often unpredictably. Thirdly, the graphic design profession is marked by complexity, involving multiple stakeholders, varying requirements, and the need to balance creative vision with technical constraints. The

integration of design with other disciplines, such as marketing, IT, and others, adds to the complexity of the profession. Designers must navigate complex workflows, project management, and team dynamics to deliver design solutions that often become a compromise between the stakeholders rather than a strong, visionary design with an individual style that many designers dream of achieving (Quintela, 2016). The need to work with ambiguous design briefs and mediate the opinions navigating through diverse perspectives of clients, end-users, and design teams characterizes the profession as ambiguous, which completes the VUCA environment description.

2.3 Transferable skills

The volatile, uncertain, complex, and ambiguous nature of the design practice is addressed in the research "AIGA Designer 2025". According to the forecast made in 2017, in 2024, designers should be trained to collaborate among experts in different fields, bridging gaps between related information and activities, bridging physical and digital experiences, searching for new approaches to forecasting change, structuring strategic conversations, innovating business models, and making sense of research data; identifying the social and ethical responsibilities; being responsible for data-aware research methods and systems; adapting methods borrowed from other disciplines to design problems and define acceptable evidence for practical applications in practice e.t.c (AIGA, 2017). To achieve such educational outcomes, design educators have to pay more attention to raising transferable skills, such as problem-solving, analytical reasoning, critical thinking, leadership, adaptability, teamwork, communication, and writing.

Jan Eckert, the head of the Master's Programme in Design at Lucerne University of Applied Sciences and Art, describing the process of revision of the educational approach makes the emphasis on the development of connective competencies (Eckert, 2018). In opposition to the common "Tshaped Skills Model" based on the combination of cross-discipline expertise and deep-discipline expertise (Eckert, 2018), Eckert proposes the YShaped Designer model. The proposed model aims to catalyze "the shift from authorship towards stewardship in design". In order to accomplish these goals, "designers need to be a step ahead to become involved or even lead the conversation" (Eckert, 2018, p.52). This idea corresponds with the increased relevance of co-design approaches, giving the community a major say in the design process. "The most important skills are management and leadership — traditional training in typography, color, form, and materials would be of little or no relevance" (Meyer & Norman, 2021, p. 17).

Afonso Pereira de Matos, design student at the Design Academy Eindhoven, addresses this issue in his graduation project "Who can afford to be critical?" (2022):

"Instead of solving market-defined problems, 'critical designers' produced by institutions like Design Academy choose to address social, political and environmental conditions. Yet, who can afford to continue such a practice after graduation? Why do we ignore the material and socioeconomic constraints that bind us as designers, claiming instead that we are powerful agents of change? Do we really have any political agency through our individual design practices? Could designers' own working conditions be targeted as one immediate site for collective action?"

Interrogating the design educational system and design industry helps students to become more conscious about planning their educational and career paths and to become responsible, future-conscious designers with the ability to be "a step ahead". The methods proposed during the workshop aim to strengthen these capabilities.

3. Methods

3.1 Futures Thinking

To address the questions posed, we have used the methodology of "Futures Thinking" (Balagtas, 2021). This methodology organizes the creative process to envision and visualize the alternative scenarios that may occur in the future. The key idea was to introduce to the students the concept of the plurality of time and the idea that the future is not given but should be created by us, as Elvin Toffler suggested in his book "The Third Wave" (1980). Thus, while going through the methodology, students had to think critically through the bigger-picture effects to project multiple future consequences of the ongoing technological developments and propose relevant solutions.

Students worked in groups, where undergraduate students were guided by the postgraduate students. PG students pre-researched the potential directions that may be of interest to the graphic design profession, and UG students developed these directions further following the "Futures Thinking" methodology. The topics proposed by the PG students were:

- "AI and the future psycho type of the graphic designer."
- "New forms of transdisciplinary communication".
- "Designing with the Big Data".
- "New forms and technologies for sketching and visualizing ideas".

One PG student had led each topic. All students belonged to the educational programme "Graphic Design". Each workshop day would include the briefing and the presentations of each workshop phase. This approach allows students to stay focused

and not postpone the process of design to the last moment. The design process serves to avoid jumping into the first solution and keep the minds open and free from presumptions. The methodology included three analytical steps, such as “Trends research,” “Trends analysis,” and “Worldbuilding,” and the creative step, such as brainstorming and visualization of the ideas. The workshop lasted seven working days and was finalized with the presentations of conceptual installations representing their visions for the future of the graphic design profession.

The first step of the workshop was to research the emerging trends, where students used the method of “Environmental-Scanning”. The second step was to analyze the identified trends using the “Probability/Impact Matrix” and “Futures Wheel”, and the final step of the analytical phase was to describe alternative scenarios using the “Dator’s Four Futures”.

The “Environmental-Scanning” method identifies early indicators suggesting emerging alternative futures (Gordon & Glenn, 2009). Students were given instructions to conduct quick internet searches and pick up short phrases that describethe connection between the emerging technology and how it can be used in the given theme, e.g., “personalized AI to co-develop with the designer”. The Impact Matrix analyzes the trends in relation to their likelihood of becoming ubiquitous and their impact on the market and society at large to help prioritize them. “Impact” refers to the impact on the Graphic Design profession, and likelihood refers to the possibility of this trend becoming ubiquitous (Fig. 1).

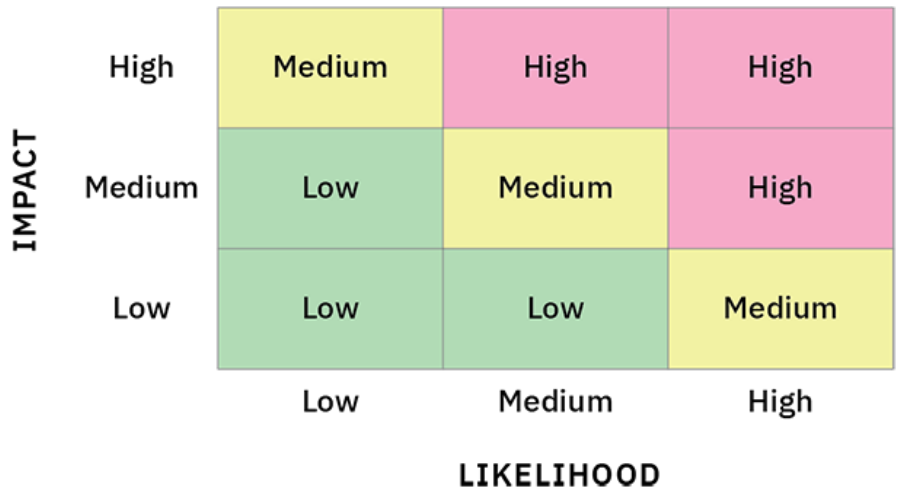

Figure 1. Probability/Impact matrix (Balagtas, 2021).

Students were instructed to discuss in groups which trends that they had identified could become more or less ubiquitous and of impact. This matrix is normally used to assess the risk in the business environment; in our case, we used this matrix as a facilitating tool to help students prioritize the trends. Futures Wheel is a sort of brainstorming analytical technique. Students had to place one of the identified trends at the center of the mind map (wheel) and discuss within groups how it will affect different aspects of the design profession, tools, designers, business, outcomes, etc. (Fig. 2).

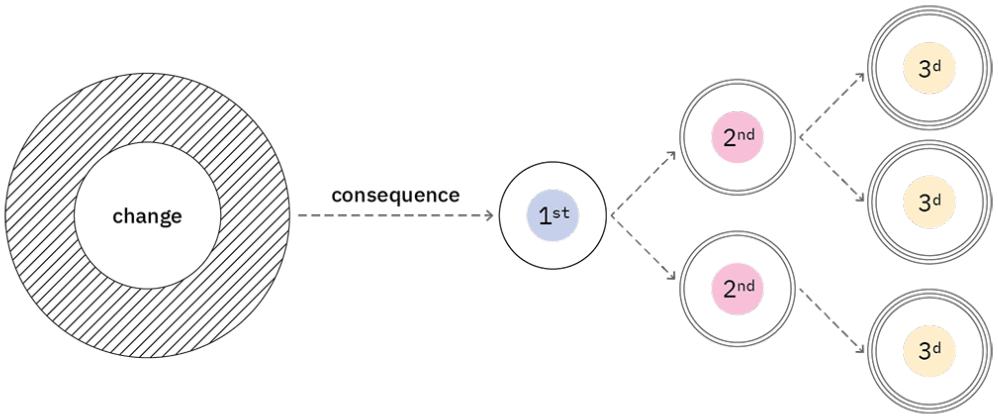

Figure 2. Futures Wheel – logics of brainstorming.

In the workshop, we used Dator's four futures (2009) to describe how a trend might evolve in different scenarios. Scenarios allow designers to see how different consequences may evolve in the future they refer to. According to the methodology, students had to describe the following scenarios: "Continued growth", "Transformation", "Collapse", and "Discipline" (Fig. 3).

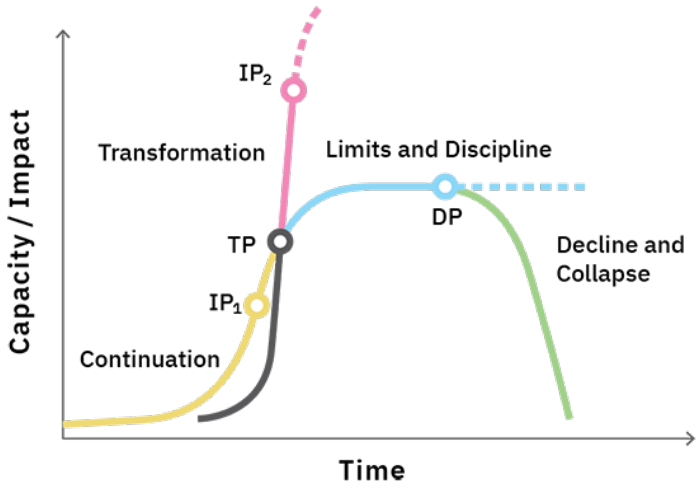

Figure 3. Smart's four futures, adapted from Jim Dator 1979.

"Continued growth" is a future of continuation and intensification of the current trajectory and problems, it is a development of the present. "Transformation" is a breakthrough of the present that leads towards new standards and activates new events. "Collapse" is a dystopic future where the system reaches its limit and breaks down, and a failure of one system triggers failures in the others. "Discipline" is a future of equilibrium, where a certain degree of sustainability is achieved but has limitations, and the growth does not bring transformational evolution. After completing the analytical part, students have brainstormed and visualized their ideas using a free technique, including the suggested forms of visualization, such as sketches, moodboards, and scaled tangible models or renders of their installation.

To further understand the students' perception of their future profession, we have inquired their opinions using the "Ethnographic Futures Research" method (Textor, 1995). This method invites to explore how the target group perceives ongoing trends and possibilities and which related changes they 1) want, 2) fear, and 3) expect. The answers were collected using online forms.

In the paragraph 2.2, when discussing the VUCA environment, it was mentioned that educational institutions tend to promote more active approaches to learning to invite students to own the responsibility for their learning and professional development in order to develop skills needed to adapt to that kind of environment. The "Futures Thinking" workshop and the "Ethnographic Futures Research" method served as means for practicing the responsible approach to students' learning as well as a way to research the potential futures of graphic design as insights for further development and adaptation of the "Graphic design" educational program to the needs of the near future context.

4. Results and Discussions

4.1 Student's work and reflections

In this paragraph, we will discuss the experience of implementation of the above methods by describing the workflow of one of the design teams exploring the theme "New forms of transdisciplinary communication". This theme was selected as exemplary as it fits our research task to rethink the graphic design discipline, at least within the given educational programme: this theme represents the overall trend in modern research approaches to aim at the transformation of ideas, discoveries, and tools and radically change the understanding of existing concepts or lead to the creation of new paradigms and scientific fields (Darbellay & Lubart, 2017). Creative Interdisciplinarity is an innovative approach that intersects with design thinking and aims at solving complex problems from an innovative perspective focusing on human experience, transcending disciplinary boundaries.

In this context, design becomes not just a set of methods and techniques but an important paradigm that facilitates the integration and interaction of various fields of knowledge. It stimulates creative thinking and interdisciplinary collaboration, becoming more of a way of thinking and acting. While the descriptions of the exercises represent a reflection on the nature and possible futures of graphic design, we will also add some reflections below each exercise on how it contributes to the students' take on their future, development of transferable skills, and other aspects.

Environmental Scanning

In the process of Environmental Scanning, special attention was paid to atypical ways of communication, predominantly non-verbal, which can serve as a basis for creating a metalanguage capable of overcoming barriers and limitations arising from differences in terminology and thinking among specialists from various fields. One vivid example of such an approach is the project "Dialogues" by a London photographer and director Lisa Jahovic (2023). In her work, she explores the absurdity of everyday life by filming an abstract ballet with dialogues. The author uses inanimate objects as a means of self-expression, allowing her to reveal life and emotions in their mechanized interaction through a series of kinetic experiments with household items. This approach demonstrates how visual and kinetic means can convey complex emotional and conceptual messages without using traditional verbal language. Besides that, students also considered examples of communication in the plant world. Plants communicate through visual signals, such as light, and through biorhythms, which can be translated into music (Plantwave). These forms of interspecies communication show how natural processes can be used to create new forms of interaction that can be perceived and interpreted by humans. Sign languages, such as dactylology, were also analyzed. Deaf-blind people use teletactors and biomorphic devices that convert information into electrical signals and project it into the brain as simplified pixels (Lewis et al., 2015). These technologies not only expand communication possibilities for people with disabilities but also offer new ways of transmitting information that can be useful in various professional fields, including design. Students also explored modern technologies for visualizing neural connections, which allow communication without words and accelerate the process of mutual understanding (Chen, Qing & Zhou, 2023). The reconstruction of video signals from brain activity can change our understanding of graphic design, opening new possibilities for visual representation of information and interpretation of thoughts and ideas. Thus, students' have summarized this exercise as "neural connection visualization technology" as the key trend to be further explored in the workshop.

In this exercise, students' research identified that the future of communication and design lies in the integration of disciplines and the use of innovative technologies that allow

overcoming traditional barriers and creating new forms of interaction and expression. This finding supports the trend described by AIGA in the introduction paragraph that “designers should be trained for collaborating among experts in different fields”. Thanks to this exercise, the trend obtained a more specific shape in the students’ eyes and became more credible through examples of the use of new technologies, scientific discoveries, and artistic and design projects that they found during the exercise.

The Probability/Impact Matrix

Following the given methodology, students applied The Probability/Impact Matrix (Figure 4) to assess the impact of neural connection visualization technology in the context of the graphic designer profession. This method allowed them to systematize their ideas and analyze the future of graphic design as affected by the development of these technologies. One of the prioritized findings concerns the likely emergence of mental piracy. The design team discussed that with the development of this technology, there is a danger of ideas and thoughts theft, leading to increased attention to digital security and mental health issues. These changes require new approaches to protecting one’s intellectual resources. Additionally, students thought that the visual transmission of brain activity will significantly alter existing formats of graphic media. The emergence of braincomputer interfaces with new types of screens or even their absence will radically change the means of visual communication, requiring the development of a new visual language. This can open new horizons in the field of graphic design, providing designers with tools for more direct and intuitive interaction with the human brain.

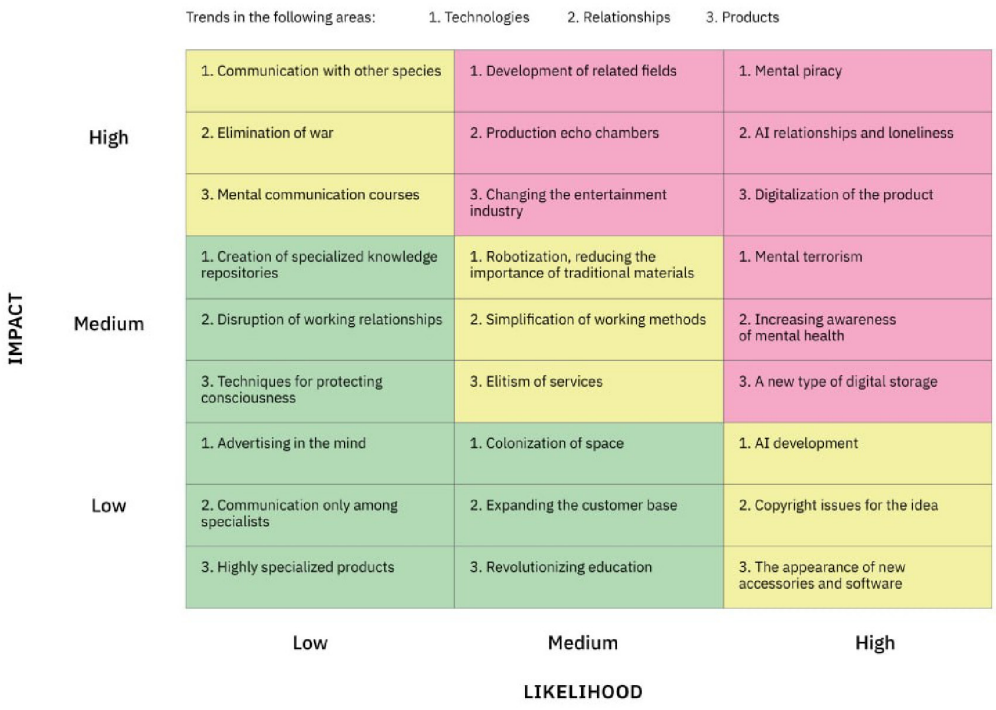

Figure 4. Imact Matrix developed by the design team exploring the theme “New forms of transdisciplinary communication”.

Working on The Matrix without access to interviewing the leaders in the field becomes an exercise similar to brainstorming rather than a thorough research activity, as it becomes hard to evaluate the probability and impact of certain events without knowledgeable people in the field. Yet, it helps develop transferable skills of teamwork and analytical reasoning by organizing the discussion and providing some keys for selecting the most prominent ideas thanks to the matrix structure.

Futures Wheel

Using the Futures Wheel, students were able to capture a broader spectrum of influences of neural connection visualization technology beyond graphic design (Figure 5). In analyzing changes in tools and technologies, they noted the need to increase databases and servers for mental communication. This raises risks related to server space shortages and data leakage threats, as well as the possibility of thought interception. However, such changes may foster the creation of specialized knowledge libraries and the revision of copyright laws adapted to new realities. In the context of the impact on consumers of design products, students suggest that neural connection visualization can improve communication between designer and client but also raise user expectations and devalue the designer's work. The introduction of such technology may lead to information overload, where the consumer's consciousness will be unable to process the vast flow of information. From the designer's perspective, neural connection visualization technology can simplify work methods and allow focusing on concept and creativity. This will speed up the process of idea realization, but the increased pace of work and idea flow may contribute to professional burnout. The issue of remuneration remains open: it may increase due to the high cost of technology and shorter project completion times, but it may also decrease due to automation and the accessibility of such tools to a wide audience.

Futures Wheel is an important exercise that can teach students the plurality of consequences of each innovation. Today, we are taught to praise the new technologies and wait with excitement for the new releases of cell phones and other gadgets. However, the technology costs may appear different to different stakeholders, as demonstrated in Moore's first and second laws (Schaller, 1996), where the cost of the computer technology to the consumer gets cheaper, while for the manufacturers it rises. With the Futures Wheel structure, students are invited to explore broader consequences of change and engage into a structured strategic conversation.

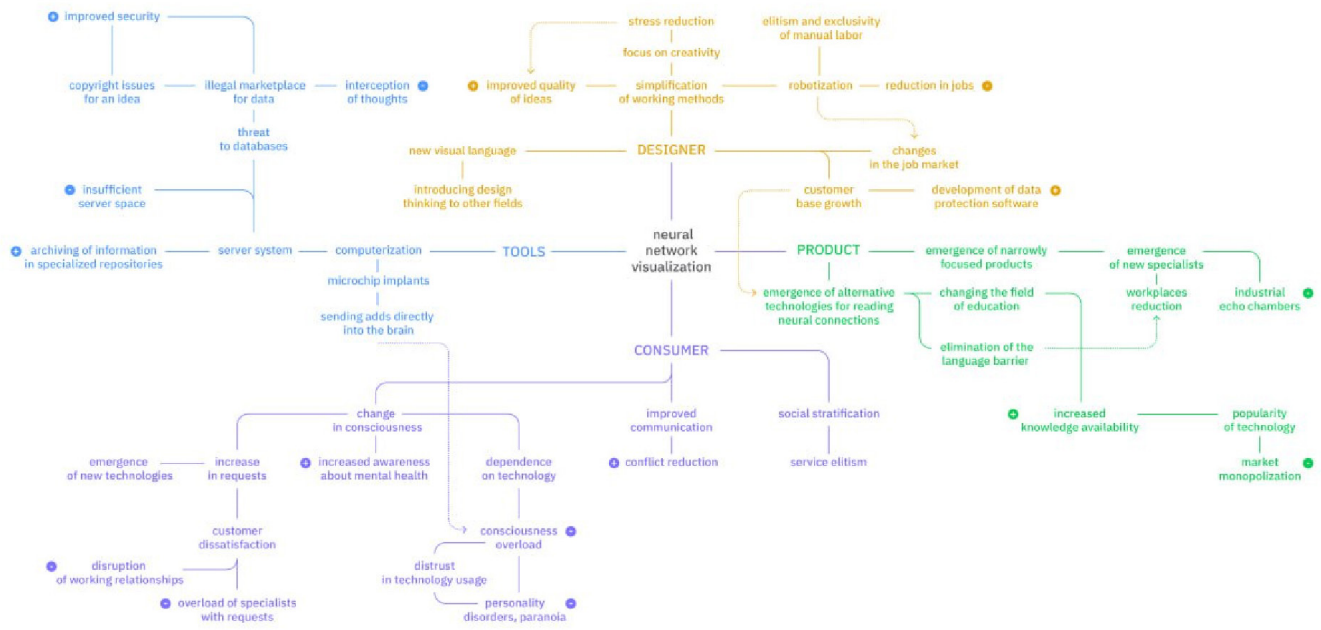

Figure 5. Futures Wheel developed by the design team exploring the theme “New forms of transdisciplinary communication”.

Future scenarios

Students imagined possible future scenarios related to the development of mental technologies, reflecting not only potential opportunities for societal transformation but also emerging threats. Here we will discuss two scenarios: transformation and collapse. In the ‘transformation scenario’, students suggested that with the development of mental advertising, “mental block” programs will emerge, allowing users to limit or block unwanted ads or monetize them by allowing personalized ad broadcasting. Accordingly, strict control over mental advertising is expected, including a ban on such advertising for children, as well as on tobacco, alcohol, and dubious services. Competition and filtering of unscrupulous content will lead to qualitative growth in the advertising market. Moreover, the direct transmission of information to the brain will require enhanced data protection from piracy and negative impacts, stimulating the development of the data protection and intellectual property industry. Additionally, free mental libraries with open access will appear, enabling people to learn regardless of social status and age, significantly transforming educational system.

Considering the ‘collapse scenario’, students expect significant impacts of neural connection visualization technology on the user’s personality, contributing to consciousness exhaustion and anxiety growth. Specialists will face increased idea generation volumes, while ordinary people will be concerned about protecting their

data. Manipulation of academic and personal experience will lead to global knowledge falsification and concept substitution, causing a personality crisis. The manipulative advertising will create dependence on technology. Refusal to subscribe to a secure service will result in the user's data being publicly available, enhancing social inequality and product elitism. Technologies visualizing personal fears and weaknesses will be used as leverage, leading to mental slavery and terror. There may be complete erasure of individual information in lower-class people, followed by their use as production units or cloning data to eliminate dissenters. This will lead to dehumanization and totalitarian control over the individual.

The analyzed future scenarios highlight the profound consequences of mental technology implementation. The transformation scenario demonstrates the radical change in the quality of life and education, while the collapse scenario emphasizes the dangers of consciousness manipulation and social inequality. Such analysis of the future development of mental technologies allows maximizing positive effects and minimizing negative consequences for society and the individual when introducing innovations.

Concept

The final stage of the workshop was the creation of a conceptual installation representing a reflection of the conducted research. Students presented a project to explore non-verbal interdisciplinary multilog through an installation. The experiment created conditions for the emergence of interdisciplinary non-verbal interaction among people by creating a joint design object. With this installation, students plan to observe how specialists not connected to the design world will create artistic compositions from objects, light, and sound, demonstrating their own vision of the world and studying the thinking principles of others. From the 'Environmental Scanning' to the 'Probability/Impact Matrix', to 'Futures Wheel', to 'Scenarios', the whole research and discussion methodology invites students to make their future visions from generic to more and more clear, specific, and researched from different perspectives. Besides, in addition to such transferable skills as analytical reasoning, critical thinking, communication, and teamwork, the 'scenarios' exercise also trains the writing, which is commonly overlooked in the design education. The final step was the visualization that indicates the meanings of the described change and the possible interaction with the technologies in the future.

Overall, the proposed workshop methodology allows, on the one hand, to build the transferable skills and promote responsible learning among students, and on the other hand, it serves as a research tool that allows both the students and the educators to self-reflect through research on design and its future to adapt timely to the change occurring in the discipline and the society. This design team proposed a vision of the future of graphic design as "Meta-communication design" which refers to the strategic

structuring of communication processes to enhance understanding and effectiveness in the context of evolved technologies supporting new forms of communication. It focuses on how messages are conveyed and interpreted beyond the content itself.

4.2 Conclusions and students' expectations, fears, and desires

In the last paragraph, we would like to share the opinions regarding the future of graphic design collected from the participating students. In this workshop-tester, we applied design research methods to reflect on the future of design as an important step of acknowledging the value of design methodologies and processes not only for the business environment but also as part of metacognition: design for the sake of improvement and evolution of the design discipline. Also, by giving to the students the power to self-interpret their skills and future, we recognize that the current programmes to some extent fail to fit the current and future job requirements. In the introduction paragraph, we shared examples of how the programmes change and position designers a "conversation leaders", however, instead, should we listen to how students feel about their profession rather than imposing our idealistic visions? By looking at the students' results in this workshop and in general, throughout the educational practice, we can observe the need and a strong capacity of the designers to be intellectually challenged. Yet, current job requirements do not reflect this capacity.

How can we assist our students and create a path leading them to the world where they apply their intellectual skills at maximum? With this workshop, students interrogated the design industry to project what might change and which skills may still remain constant in this VUCA environment? Even if, "Graphic design" will live a transformation from "Communication design" to "Meta-communication design", we can still observe that both transferrable (e.g., teamwork, analytical reasoning, writing), and professional skills (e.g., visual design) will preserve in the future, e.g., to support visual ad design, information visualization design, etc. Noticing the area of stability is an exercise to be repeated in the intensifying VUCA environment we are experiencing today.

Below are the results collected from the online forms of the survey using the "Ethnographics Futures Research" method applied to grasp students' desires, fears, and overall expectations related to the future of the graphic design profession. Below, we will report the answers students submitted in the forms, indicating their names, corresponding themes, and the role in the project from the who students gave permission to share it.

1. The summary of the realistic view

Daniil Leoshko, the leader of the theme "New forms and technologies for drawing", when sharing the realistic view on the future of the profession highlights the tendency towards the need to personalize the graphic systems, where complex systems will be

more appreciated while the logo will lose its dominating role in the visual identity. 3D and animation will affect the aesthetics, and the Internet will "teach" people to perceive the information through visual-sensory language. Graphic design will find more means and contexts for its implementation, and research will play a more significant role in project development.

Stepan Petrov, the leader of the theme "Designing with the Big Data", shared that 90% of the design will be created for the digital environment; the algorithms and programmable templates in creating a design product will increasingly become more important; the design process will be optimized and the human work may be replaced; in parallel, there will be a tendency to move away from the universality of visual language and search for a new language linked to the local cultural features and return to the artistic origins of design (painting, sculpture, architecture).

2. The summary of the negative view

Daniil Leoshko shared that the most disturbing aspect is the aesthetics of AI becoming mainstream. Also, he mentioned that the rapid development and accessibility of the professional tools blurs the professional identity of a designer. Stepan Petrov also mentioned that the templates availability will lead to eliminating the need in the designer. Also, he is worried about the decreasing value of tangible materials; design losing its creativity and becoming totally subordinated by the market needs; a constant need to adapt to the new programs and algorithms; reduced demand for design services due to economic instability.

Alisa Doroshenko, a design team member, shared her concerns regarding the unstable relationship between graphic design and AI. The problem of the overuse of artificial intelligence is already becoming noticeable when jobs are being cut, the quality of the product deteriorates significantly (e.g., we can see poorly generated posters in the streets). She is concerned regarding the copyright and plagiarism, the depletion of the creative potential of designers due to the intense use of AI and other digital tools. Similarly to the previous student, she fears the impact of the economic crisis on the profession's future.

3. The summary of the positive view

Daniil Leoshko wishes to bring design and creativity closer together, so that design solutions become contextually unique. Also, he mentioned that currently designers lack a clear definition of who they are and what they are valued for in the society, and he would like to see this situation changing. He wishes that there will be more variety in specializations and forms of aesthetical realization in graphic design, and that the project-driven nature of design will transform into a continuous, eventdriven project improvement. Eventually, he mentions the importance of the design community and presence of likeminded people exchanging meaningful thoughts and ideas.

Stepan Petrov shared that he would like to see the growing demand for design services; non-digital design and the return to its artistic origins; the priority given to the uniqueness of the design vision, both individual and geographical, and the end of the era of the International style. He wishes to see the emergence of new technologies and methods for creating digital images mixed with the use of analog equipment in the production process, new media for graphics delivery and distribution (e.g., E-ink screens), and the accessibility of open-source software for designers and artists. Eventually, he shared a hope for overall improvement of the cultural level of designers based on high-quality humanitarian education. Alisa Doroshenko hopes that the need in graphic design will be growing because more people will understand and appreciate what designers can do. Designers will get better equipment, training, healthcare services and as a consequence, they will coexist in a healthy competition; and the AI will only serve to assist in the routine work.

We hope these visions will serve as a source of inspiration for any purposes related to the future of graphic design, such as future design projects, educational programmes naming, identifying future research questions, programme re-design to fit the job requirements, and more. The next step we are going to take is to set up a seminar where students can reflect on which strategic actions they should take in order to prevent or prepare for the future possibilities they have identified. The workshop was held in July 2024, and the seminar “Back-casting discussion” will be held in the beginning of October 2024. The gap between the two activities allows for the continuous reflection on the future career but also for a fresh look at the previous results. Thus, we aim to make this reflective practice become a habit and part of the design skillset.

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DESIGN FOR CHILDREN'S ACTIVE SCHOOL COMMUTING ENVIRONMENTAL SAFETY EMPOWERED BY ARTIFICIAL INTELLIGENCE AND AUGMENTED REALITY.

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ABSTRACT | ***Background:*** It is critical for the improvement of urban living conditions to enhance the safety of active school commuting environments for children. However, social innovation design interventions are absent from current designs for children's active school commuting safety, which primarily concentrate on stability indicators such as hardware, infrastructure and social management. ***Methods:*** The environmental safety elements are classified into a fourdimensional model in this study, which consists of physical, social, cognitive response, and infringement prevention. To investigate abundant media accident texts that may be applicable to our four-dimensional model analysis, we cluster 607 media text samples using NLP technology, identify the eleven primary clusters, and perform further quantitative calibration for other components. Finally, we provide a summary of the assignment and classification criteria for four dimensions, nine categories and seventeen factors. ***Result:*** To resolve the deficiencies in children's safety responses, a design strategy identified as "strengthened perception and graded intervention" was proposed subsequent to an examination of safety response action chains and established safety design interventions. Machine learning algorithms train models to analyse accident causes and outcomes, enabling intelligent security observation and prediction. Light devices, projectors and augmented reality are combined to assist in the development of intervention components that cater to the cognitive experiences and interests of children. ***Conclusion:*** The AI and AR co-empowered dual-chain design framework is developed. We effectively communicate comprehensive and accurate safety cognition and response measures to children, enhancing the specificity and effectiveness of children's active school commuting environment safety design.

KEYWORDS | ARTIFICIAL INTELLIGENCE, AUGMENTED REALITY, CHILDREN'S ACTIVE SCHOOL COMMUTE, ENVIRONMENTAL DESIGN

1. Introduction

The spatial quality and environmental structure of urban residential areas play a crucial role in children's growth and development (Visser & Van Aalst, 2022). A large amount of school-age children's activity time is devoted to school commuting, and the school commuting environment and school commuting behavior are crucial to children's growth (Kaseva et al., 2023). school commuting behavior has a clear destination and chain of activities (Hoelscher et al., 2022). Active school commuting is defined when commuting behavior is based on walking and promotes developmental dimensions including independence and sociality (Morris & Hardman, 1997; Tudorlocke et al., 2001). It is particularly effective for static lifestyles such as childhood obesity (Martin-Moraleda et al., 2022) . It also allows children to wander periodically through community life circles and develop social communication and behavior (Ding et al., 2023). Therefore, it is advisable to advocate Children 's Active School Commuting.

However, complex commuting environments are also dangerous for children (Jansson et al., 2022). Most of the existing safety solutions for children's school commuting are passive and static, relying mainly on human activities and top-down policymaking, and lack real-time performance. The government of the United States implemented the SRTS program in New York by improving the environment and facilities around the campus (Boarnet et al., 2005). The Dutch government created the Kindlint Children's Walking Network (Liangwa, 2017). A "walking school bus" pilot project was implemented in northeastern Ontario (Scharoun Benson et al., 2020). The Japanese government has promoted the safety of specific groups such as children, to the design of architectural streets that limit access to pedestrian areas, to the environment of natural surveillance, and to the community atmosphere that has a sense of domain (Hino et al., 2021). The design that excessively prioritises physical change requires a significant amount of time to execute and lacks relevance.

The aim of this study is to analyse media texts and identify the factors that influence the safety of children's school commute. By using a large sample size and data analysis algorithms, we will investigate how these factors impact children's safety. The ultimate goal is to develop design methods and intervention strategies to enhance the safety of children's school commute in urban areas.

2. Literature review

Security means both safe and stable, which is the most basic need for human survival. Environmental safety planning and design refers to the use of scientific methods and technologies in environmental design, with the goal of ensuring the safety needs of human survival, from macro to micro, from the whole population to specific users, comprehensively considering various factors such as the natural environment, social environment and humanistic environment. This section compares the safety of Children's Active School Commuting environment with that of urban scale environmental design, safety in road traffic, and safety in children's activity environment, and distinguishes the characteristic factors of the safety of Children's Active School Commuting environment, so as to better study and conclude the conceptual model of influencing factors.

2.1 Safety influencing factors at urban and community scales

The research on urban and community security focuses on the improvement of urban resilience and the level of public security. The European Union carried out the MOVE program from 2008 to 2011 to encourage and promote a lot of research and practice on urban disaster prevention and reduction, economic and social sustainability (David & Jörn, 2013). The London Development Plan 2021 highlights cooperation between government and relevant actors to deal with climate disasters (Greater London Authority, n.d.). In 2020, the United Nations Office for Disaster Risk Reduction (UNDRR) launched the *"Creating Resilient Cities (MCR2023) Initiative"*, which will include disaster prevention and mitigation and urban resilience in the mainstream assessment of urban sustainability levels, advocating collaboration across municipal agencies and city functions to integrate resilience and sustainability in urban development. Many evaluation indicators and tools, such as *City Resilience Profiling Program*, *Disaster Resilience Scorecard for Cities Scorecard and Enhanced Vulnerability and Capacity Assessment,* guide city managers from two aspects: risk assessment and emergency response.

2.2 Safety influencing factors at street scales

However, compared with urban communities, children's school commuting is a special space with mobility, relatively fixed functions and behavioral purposes. Therefore, the planning and design theories, models and tools of road traffic environment safety will also provide inspiration for the safety and planning of Children's Active School Commuting environment. The Highway Safety Strategic plan of the United States distinguishes the nine causes of traffic accidents, expounds the complexity of pedestrians' road traffic safety, and defines the safety and applicability of pedestrians' use of road systems as Walkability (Hughes et al., 2016). Neighborhood Environment Walkability Scale was used to measure walkability using six indicators: land diversity, road connectivity, walking infrastructure and walking safety, aesthetics, traffic safety and crime (Cerin et al., 2006). Ewing and Cervero define a "5D framework" of factors that influence walkability in the built environment, including density, diversity, streetscape design, destination accessibility and public transport systems (Ewing & Cervero, 2010). According to the theory of "Streetscape Skeleton", elements such as buildings and trees are regarded as the skeleton variables of streetscape. Based on the principle of human-oriented design, the relationship between streetscape from human perspective and walkability is discussed (Harvey et al., 2015).

2.3 Safety influencing factors at children's outdoor activity space

From the research on the safety of children's activity environment, this paper seeks the cognitive and behavioral design thinking for children as a special group, summarizes the types and characteristics of children's daily activity environment, and understands how the design of children's activity space provides an effective guarantee for children's safety. The vulnerability of children's bodies lies in the weak and small impact resistance of children's bodies, but the vulnerability of children is not only related to the safety risks brought by physiological abilities such as grasping and balance, but also the vulnerability in cognitive judgment and perceived response is also an important risk factor for children's safety. At the environmental system level, the spatial layout of the activity venue also affects the perception of safety by children and the community. Transparent enclosure, familiar signs, neat ground, safe facilities, friendly atmosphere and accessible space are children's images of public space safety (Horelli, 1998).

2.4 Safety influencing factors of human encroachment

Human encroachment includes intentional crime and unintentional injury. According to the Defensible Space theory, the natural supervision of the community will greatly improve the exposure of residents to potential hazards while moving in the urban

space (Perkins et al., 1993). Both social and physical elements are integral components of a successful defense space. At the theoretical and methodological levels, the population, economy, facilities and other data of the community have been linked to the community man-made crime through CPTED theory in different studies. Oscar Newman summarized the four core elements of sense of domain, natural supervision, environmental image and neighborhood environment into the security design model of defense space (Newman et al., 1976). By constructing the relationship between socio-economic characteristics and victimization behavior according to CPTED principle, we can explore how different spatial types, community socioeconomic variables (length of residence and family income) and residents' victimization experience affect community safety (Hedayati Marzbali et al., 2012). In her book, Vania Ceccato describes the impact of the characteristics of nodes in urban infrastructure networks on crime in surrounding communities (Ceccato, 2014).

3. Concept Framework of children's active school commuting environmental safety

The previous section conducted a thorough examination of safety in urban community intervention, road traffic, children's activity environmental safety, and environmental design against human infringement. This examination was done through literature review and case research. The section defined safety and evaluated its dimensions. It also identified and categorised the main theories, models, methods, and tools related to safety. Additionally, the section compiled and analysed data on the factors involved in environmental safety. The sufficiency and necessity concept of safety planning and design reveals the binary opposition categorisation logic of subject and object, as well as internal and external factors. To adhere to the principle of safety planning and design, the evaluation dimensions are defined by dividing the two-dimensional coordinate system into four quadrants. A conceptual framework is then established to represent the element model in four aspects: material space, social space, cognitive response, and assault prevention.

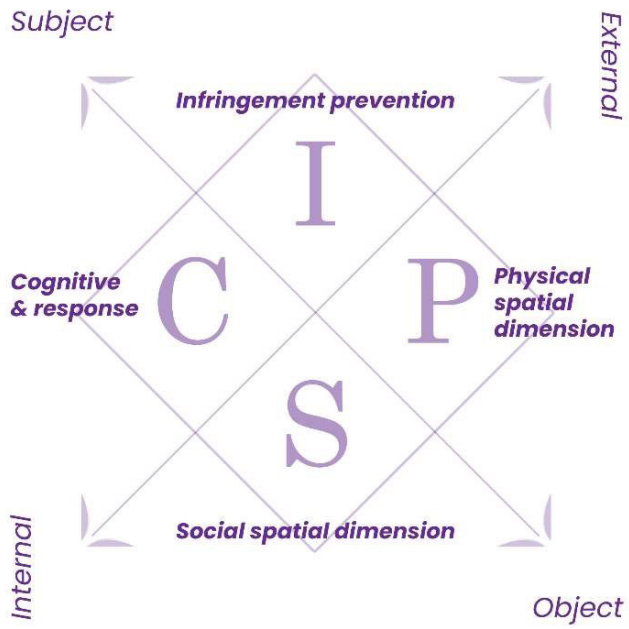

Figure 1. A four-dimensional framework of influencing factors of Children's Active School Commuting environmental safety.

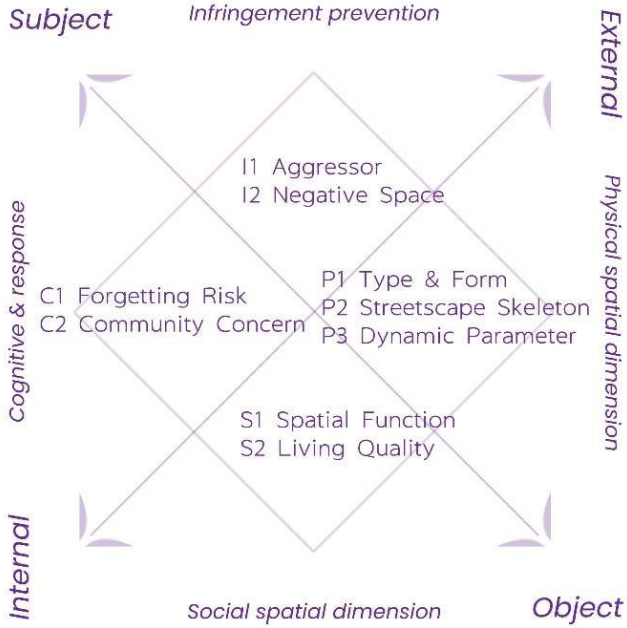

Figure 2. The zonal relationship of nine security impact factors.

This led to a summary of 9 factors that can be used to evaluate the safety of a child's active school commute setting. The physical dimensions of space are categorised into three aspects: spatial type and form, streetscape skeleton, and spatial dynamic parameters. The social dimensions of space are categorised into spatial function and living quality. The cognitive and

response dimensions are forgetting risk and community concern. The measures to prevent infringement are aggressor and negative space. The next chapter outlines methods for discerning various components based on this conceptual map.

4. Methods

When it comes to ensuring the environmental safety of children's school commuting, one of the challenges faced in conducting empirical research is the limited number of witnesses to safety accidents. This makes it difficult for researchers to gather first-hand information about accidents using traditional research methods. This study examines accidents as a result of the impact of many elements and can aid in determining the safety conditions by consolidating environmental safety factors and accident patterns. Initially, a substantial quantity of data on kid safety accidents is gathered through media research. Subsequently, the four-dimensional safety model of Children's Active School Commuting environment is employed as the catalogue framework to augment other components.

4.1 Data collection

We extracted media information from different types of news websites, including social media platforms, news portals, and professional websites focusing on production safety and emergency management, and grabs a total of 730 raw data. Because the basic data structure and parameters of each platform are different, there are old, duplicate or irrelevant data, this paper determines 617 valid data through manual screening, and carries out basic standardized cleaning of the data set.

Table 1. Media accident text data source information

Data source	Data type	Raw data	Valid data
Sina Weibo	Social media	127	107
Security management network	Professional website	284	252
Toutiao	News portal	175	161
China news network	News portal	144	97

4.2 Data analysis

In order to examine a significant amount of media accident texts that may be appropriate for our four-dimensional model analysis, we employ NLP algorithms to group these samples of media texts. This process allows us to identify 11 main clusters and carry out additional quantitative calibration of other components. In conclusion, we provide an overview of the distribution and classification criteria for four dimensions, nine categories, and seventeen variables.

Table 2. Cluster analysis results

Cluster	Content description	Samples
1	Peripheral area	Elevator, fountain, water, park, railway, parking lot, pool, construction site, curve...
2	Streetscape skeleton	Buildings, windows, traffic lights, sidewalks, lighting, garbage cans, greenery...
3	Core object	Children, primary schools, kindergartens, teenagers...
4	Relevant group	Parents, staff, elderly, adults, guardians, lifeguards, medical staff, passers-by...
5	Commercial form	Canteens, libraries, parks, residences, shops, business districts...
6	Aggressor specification	Motorcycles, cars, electric cars, vans, bikes, scooters, gangs, assaults, buses, tricycles...
7	Accident result type	Drowning, falling, electrocution, trapped, heat, suffocation, crevices, poisoning, burns...
8	Accident result severity	Fracture, death, injury, casualty, death toll, trauma...
9	Safety education	School, parents, education, reminder, psychology, publicity, teaching quality...
10	Community governance	Police, public security, jurisdiction, police station, Public Security Bureau...
11	Basic news information	Time of incident, time of publication, media source...

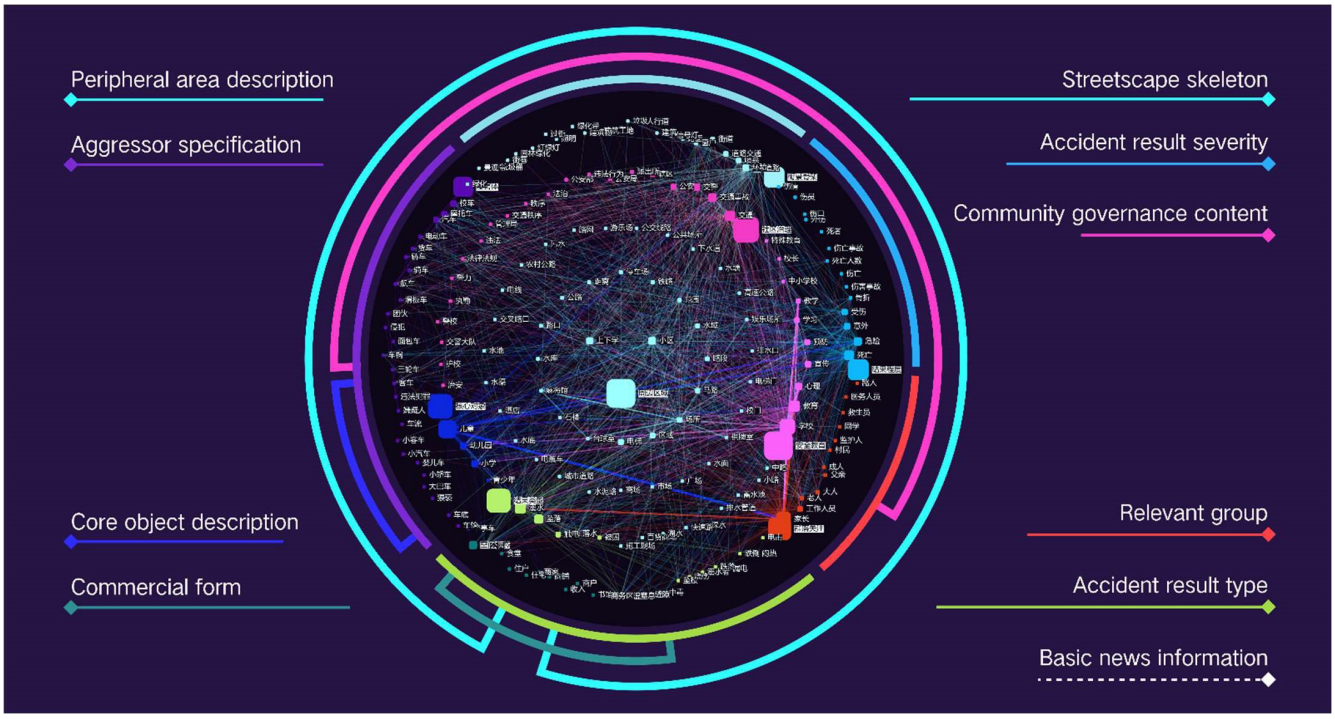

Figure 3. Media text lexical network diagram.

After word frequency cluster analysis and visualization of 617 media texts using Latent Dirichlet allocation (LDA), this paper finds that the following 11 types of information are fully covered in media texts, as shown in Table 2. The result type and result degree are accident dependent variables. Community governance and safety education have nothing to do with the focus of this study, but are related variables. The remaining six clusters belong to accident independent variables. Therefore, the relationship between these 6 types of independent variables and accident type and severity can be obtained through media investigation.

5. Result

5.1 Output factor of security situation judgment

By combing through the media texts, this paper identifies the six most important and common types of children's outdoor space activities, and the clear definition of the types of hazards provides an important basis for further safety research and preventive measures, see Table 3.

Table 3. Common outcome factors of children's outdoor activities safety accidents.

	Factor	From cluster	Classify	Introduction
Y1	Accident type	7	6	Falling or falling from a height
			5	Mechanical injuries, such as collisions, beatings, car accidents
			4	Falling into the water or choking
			3	Electrical injury
			2	scald
			1	Biological damage such as poisoning
Y2	Accident severity	8	3	Cause death
			2	Cause non-fatal injuries
			1	No casualties

5.2 Input factor of security situation judgment

Ideally, we want to be able to take full advantage of big data technology and integrate information from all the independent and dependent variables to build a model that can predict the dependent variables. However, after conducting media research, we found that these elements need to be grouped into two categories based on their source. The first category is elements taken directly from the news text that can be used directly to build relationships between elements and event outcomes, classified by enumeration in this section.

Table 4. Influencing factors of Children's Active School Commuting environmental safety based on media text.

	Factor	From cluster	Classify	Introduction
P1	Road type	1	3	Highways, traffic hubs, parking lots and other vehicle gathering places
			2	Special or non-standard roads such as mountain roads, village roads, bridge
			1	Standard urban street
			0	Not urban road accidents
P1	Prominent features of surrounding area	2	4	Crowded places such as downtown, urban center area and business districts
			3	Water bodies such as swimming pools, rivers, ponds and surrounding areas
			2	Site with roof, slope, high wall, fencing, or deep holes
			1	Isolated or enclosed spaces
			0	Not mentioned
P2	Time	11	2	Daytime (7:00-19:00)
			1	Night (19:00-7:00 the next day)
S1	Commercial form	5	5	Comprehensive function area
			4	Industrial functional areas such as chemical factory
			3	Commercial function area
			2	Green area
			1	Residential community and campus area
			0	Not mentioned
C1	Age	3	4	Adult (over 18 years old)
			3	Youth (13-17 years old)
			2	Children (7-12 years old)
			1	Infant (0-6 years old)
			0	Multiple ages included
C2	Connection type	4	1	Accompanied or supervised
			0	Unaccompanied or unsupervised
I1	Aggressor	6	4	Motor vehicle
			3	Non-motor vehicle
			2	criminal
			1	Natural object
			0	Not mentioned

Although there is a lot of information in media texts about many different types of events that can be used as useful examples for safety study, they are still not able to fully explain what causes crashes. according to the four-dimensional model, it is not possible to conduct a comprehensive quantitative analysis merely on the types of components included in media

material. We utilised safety research models and tools to accurately measure the influence of element information on safety that is not addressed in media texts. It adopts an affirmative approach to reference this data and proposes a comprehensive three-level classification system to assess the severity of these factors on the safety of children's active school commuting (Y2). Thus, the components of the four-dimensional model are transformed using a consistent and measurable conversion.

Table 5. Additional factors added according to the four-dimensional model.

	Factor	Assignment grading	Data source	Assignment basis
P2	Pavement quality	1-3	Street image	STA-YOLOv7 algorithm
P3	Real-time distance	1-3	GPS data	Spatial familiarity/spatial distance
P3	Environmental disturbance	1-3	Street noise	Noise exposure dose-response relation
S2	Quality of residents	1-3	Statistical survey	Educational level
S2	Community economic level	1-3	Statistical survey	Per capita disposable monthly income
S2	Living convenience	1-3	POI data	Ease of living index
C1	Safety education	1-3	Statistical survey	Completion of safety education
C1	Coping ability	1-3	Statistical survey/test	Measurement of motor coordination
I2	Negative space probability	1-3	Statistical survey	Spatial vitality evaluation

5.3 Design strategy

In the natural process of handling danger, the effective completion of the risk response process depends on the seamless progression of the four linkages, see Figure 4. Children have a high probability of not being able to complete the action chain of the coping period by themselves, and parents or companions cannot help children through external forces, which is why children accidents will occur even if they are accompanied by parents.

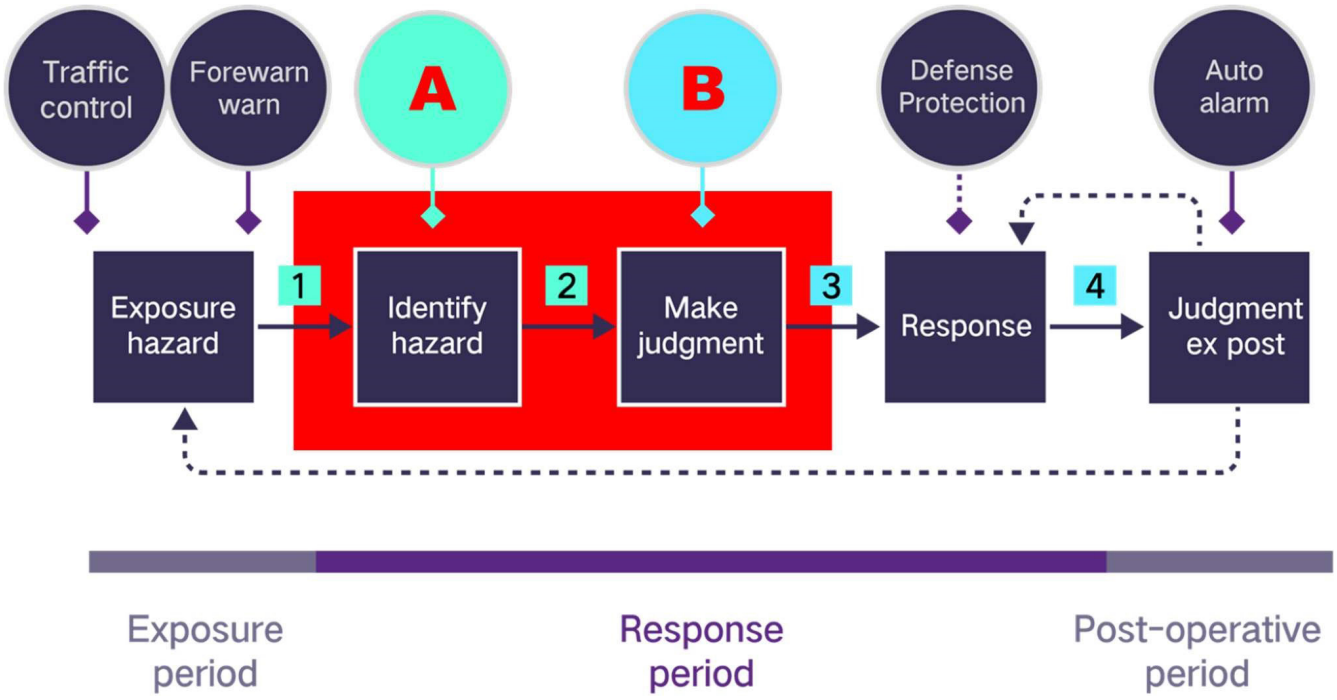

Figure 4. Design strategy derivation process.

Children, due to their limited experience and abilities, may encounter situations where they either overreact or fail to respond adequately. Hence, it is crucial to prioritise enhancing children's receptiveness to design intervention and their understanding of the objective world when designing kid safety measures. Hence, the objective of the design is to provide an intervention that can provide unambiguous action directives.

5.4 Intelligent perception

In order to improve children's safety reactions, a design method called "enhanced perception and graded intervention" was suggested after analysing the safety response action chain and existing safety design interventions. This study utilises the Python programming language, namely the Pandas and TensorFlow libraries. The training data is read and then the input variables and output results are separated. A basic neural network model is employed for

training, consisting of two hidden layers with a Rectified Linear Unit (ReLU) activation function, as well as an output layer. The model was compiled using the mean square error loss function and the Adam optimizer, and nine epoches were trained on the training set. In this paper, 504 pieces of data with complete and standardized media text structure are divided into training sets and verification sets. After the model is obtained, the segmented test set data is imported to verify the effect of the model. The X variable of these validation data points was input into the model to generate the corresponding predicted values of Y1 and Y2. By comparing with the actual values of Y1 and Y2, the performance of the model was preliminarily evaluated using the indicators of *Accuracy, Precision and Recall.*

Table 6. Model evaluation result.

Index	Value	Index	Value	Index	Value
Y1 accuracy	0.37	Y2 accuracy	0.66	Comprehensive accuracy	0.54
Y1 accuracy rate	0.52	Y2 accuracy rate	0.70	Overall accuracy	0.62
Y1 recall rate	0.44	Y2 recall rate	0.64	Combined recall rate	0.56

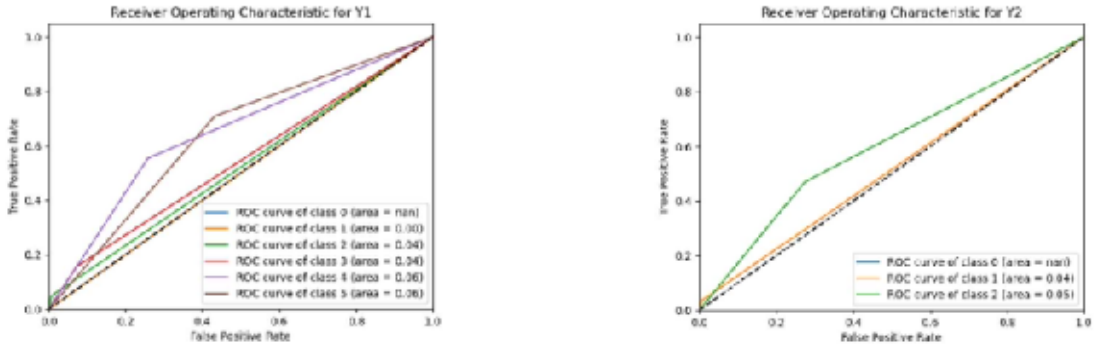

Figure 5. Receiver operating characteristic curve result.

However, the prediction effect of this model for different types of results is quite different, which may be due to the limited sample of valid media reports and the significantly higher proportion of mechanical injury (Y1=5) and high fall (Y1=6) accident types.

Table 7. Training set data classification frequency statistics.

Category	Frequency	Percent	Category	Frequency	Percent	Category	Frequency	Percent
Y_1=1	9	2.23%	Y_1=3	24	5.96%	Y_1=5	215	53.35%
Y_1=2	29	7.20%	Y_1=4	62	15.38%	Y_1=6	64	15.88%
Y_2=1	44	10.92%	Y_2=2	50	12.41%	Y_2=3	309	76.67%

Therefore, the prediction results of mechanical damage (Y1=5) with the largest amount of accident data in the training set were statistically analyzed in this paper. The prediction deviation was only 0.17, and the average deviation of Y2 was 0.22. The performance effect of accuracy, accuracy and recall rate was also better than the comprehensive evaluation effect of all types of accidents in the test set.

5. 5 Design implement

Based on the different levels of security posture, this study defines three levels of design intervention, aiming to provide different levels of protection and intervention for children's school commuting environment according to the degree and urgency of the security threat. Through the setting of these three design intervention functions, the design intervention can be accurately and effectively delivered based on intelligent perception, and effectively protect the safety of Children's Active School Commuting environment.

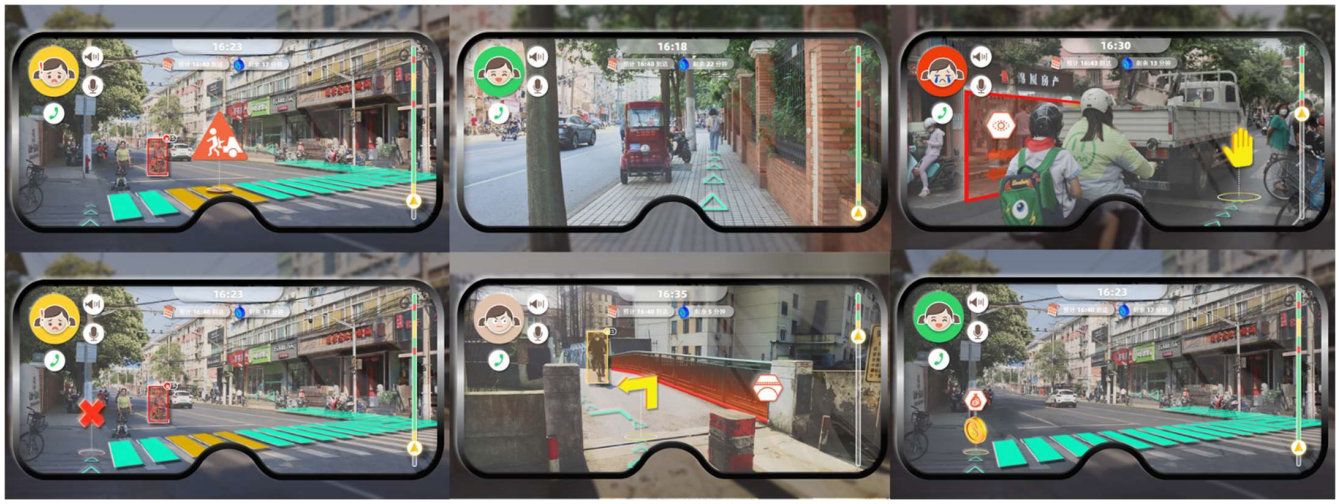

Figure 6. Design prototype of safety intervention in Children's Active School Commuting environment.

In the upper left corner of the field of view are the main functional areas, including mood artboards, volume and voice input control buttons, and contact functions, triggered by gesture clicks and voice interaction. The center of the visual field is the danger indication area. Under normal conditions, the danger indication area does not superimpose any content to ensure that children's users have a clear vision of the real environment. However, when a hazard occurs, the design content related to the hazard type, hazard labeling and action instructions will be displayed in this area. The information is located at the child's normal eye height, ensuring that the child can quickly receive the intervention information and directly observe the correspondence with the source of danger.

6. Discussion

The paper presents a conceptual framework consisting of four dimensions to identify the aspects that influence the safety of Children's Active School Commuting environment. The influential factors are categorised based on the binary opposition logic of subject and object, internal and external, which accurately and comprehensively represents the essence of ensuring the

safety of children's active school commuting environment. There might still be constraints in categorising the nine items within the four-dimensional model. The division of the nine elements preserves independence, while there is still a link between distinct elements. Nevertheless, appropriateness is the paramount factor in security prevention. While there may be a link in the analysis of individual aspects, it is important to examine the many directions of prevention and completely evaluate the reasons of risk from various perspectives in order to accomplish comprehensive and targeted security prevention objectives.

On the other hand, the drawback lies in the fact that the training data used to establish the association model between accident causes and accident outcomes in this study is derived solely from media accident reports. While this approach guarantees a substantial number of accident samples, it may have some limitations. Yet, the media accident data only covers a restricted range of variables. Therefore, this study provides a temporary summary of the safety situation by manually classifying and calculating parameters that are not included in the media data. Future research should incorporate additional urban data, gather more extensive and detailed information on safety factors in accident statistics, develop comprehensive datasets that link factors to accident outcomes, construct a comprehensive database of urban children accidents based on the four-dimensional safety framework, and refine a more precise safety situational awareness model through training.

7. Conclusion

The paper explores the concept of environmental safety planning and design in the context of the Children's Active School Commuting environment. The purpose is to outline the primary goals of planning and designing for environmental safety, along with the related fields of study. Then, by employing the notion of sufficiency and necessity in safety planning and design, the logic of categorising subjects and objects, as well as internal and external elements, is determined. To evaluate the adequacy of dimensions, the four quadrants of the two-dimensional coordinate system are defined, following the principles of safety planning and design. The conceptual foundation of the element model is originally built inside a two-dimensional coordinate system. In addition, a comprehensive set of nine components has been established for evaluating the safety of the Children's Active School Commuting environment.

This paper develops a theoretical foundation for a model that incorporates established theories and methods from relevant research domains in a comprehensive manner. This framework enhances the ability to precisely define the safety of Children's Active School Commuting environment. The fourdimensional framework establishes a basic relationship between the factors that contribute to and the consequences of guaranteeing the safety of children's active school commuting environment. The paper examines the use of new technologies to improve environmental space planning and design. The aim is to improve comprehension of child-friendly city principle, undertake thorough research on the safety of Children's Active School Commuting, and help for the planning and construction of safe community. Promote the development of unified and safe communities, while providing specialised knowledge in improving community governance skills and developing the creation of intelligent communities. We recognise the significance of precisely sensing ambient information and user state during the design process. This enables us to establish accurate assessments of security issues and systematically guide the development of intervention elements in the design. By taking this step, we guarantee that security interventions are adequate and effective.

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“ENSURANCE” ENVIRONMENTAL INSURANCE: RESEARCH AND PRACTICE BASED ON SOCIAL INNOVATION DESIGN

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ABSTRACT | “Carbon Peaking” represents a significant challenge for developing countries in balancing economic development with environmental issues. The lack of well-defined laws and regulations creates new creative spaces for financial services and sustainable development needs. This paper explores how financial insurance services can construct relationships between government regulation, corporate rights, and sustainable environmental development, thereby encouraging industrial enterprises to proactively implement green transformations. Through desktop research, in-depth interviews, and field surveys, this study comprehensively understands the main types of environmental pollution and the current state of protection in the region, and proposes new service models in conjunction with commercial market insurance behaviors. A named “ENSURANCE” environmental liability insurance service system platform was designed to facilitate a multi-win situation among residents, industrial enterprises, governments, and insurance companies. “ENSURANCE” promotes green technological innovation in industrial production through citizen oversight, government regulatory measures, and economic incentives, particularly via carbon trading, enhancing market competitiveness and environmental responsibility; simultaneously reducing pollution risks and improving regional environmental quality. “ENSURANCE” offers new approaches for policymakers and insurance practitioners entering the field of environmental protection, providing more possibilities for global environmental conservation.

KEYWORDS | DEVELOPING COUNTRIES, ENVIRONMENTAL PROTECTION, SUSTAINABLE DESIGN, ENVIRONMENTAL INSURANCE, SOCIAL INNOVATION

1. Introduction

With the escalating severity of climate change, global attention on environmental protection has intensified. The Paris Agreement, adopted in December 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), aims to limit global temperature rise to well below 2°C above pre-industrial levels and strives to keep the increase to 1.5°C. The Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC, 2021) highlights the urgent need to significantly reduce greenhouse gas emissions over the next decade to achieve carbon peaking by 2030 and carbon neutrality by 2050.

Developing countries face unique challenges and opportunities in meeting these goals (Sumiani et al., 2007). Key challenges include reducing emissions while sustaining economic growth, transitioning from fossil fuels to green energy, and closing technological gaps in low-carbon and zero-emission technologies (Yu et al., 2022). Additionally, efforts to achieve carbon neutrality are complicated by the degradation of natural carbon sinks due to deforestation, agricultural expansion, and coastal development. In recent years, with economic development and technological advancements, developing countries have made a series of improvements in environmental governance and regulatory measures, including industrial upgrades, public disclosure of environmental information, and civil society participation in decision-making. Despite some progress, there is still a lack of efficient coordination among different actors in society, as well as between different levels of government and local authorities (Li et al., 2021), in addressing the increasingly severe global environmental challenges (Rogelj et al., 2016).

This paper explores the potential of innovative financial services in supporting environmentally sustainable development in developing countries. Specifically, we examine how the “ENSURANCE” environmental liability insurance platform can bridge gaps between government regulation, corporate responsibility, citizen participation, and environmental sustainability, thereby promoting the green transformation of industrial enterprises.

2. Literature Review

Early economic theories generally posited that economic growth was inextricably linked to environmental degradation, particularly during the rapid development phase of industrialization. This perspective has been supported by numerous empirical studies, primarily based on the severe environmental pollution experienced by developing countries (Grossman and Krueger, 1995). The Environmental Kuznets Curve (EKC) hypothesis further refines this theory, suggesting that environmental pollution increases during the initial stages of economic development but decreases after reaching a certain income level, forming an inverted U-shaped curve (Stern, 2004). However, in recent years, scholars have proposed the theory of sustainable development, arguing that economic growth and environmental protection can achieve a win-win situation through green technologies and policy interventions (Wang and Feng, 2021). This theory emphasizes that innovative technologies and effective policies can significantly reduce pollution while promoting both environmental protection and economic development.

Environmental pollution liability insurance (or pollution insurance) emerged as a product of comprehensive liability insurance in the 1960s in industrialized countries, particularly in the United States, France, and Germany. Currently, there are two main types of pollution insurance worldwide: mandatory pollution insurance and voluntary pollution insurance (Feng et al., 2014). Many scholars believe that pollution insurance has significant advantages as an environmental regulatory tool (Krutova et al., 2021). Firstly, pollution insurance ensures that victims of pollution can receive compensation, even if the polluting company goes bankrupt. Secondly, pollution insurance can mitigate environmental risks by offering lower premiums to those who invest in risk reduction and preventive measures (Freeman and Kunreuther, 2003). Thirdly, as an insurance tool, pollution insurance spreads the risk and cost of environmental pollution across a group of polluters, protecting individual insured companies from bankruptcy (Yang and Zhang, 2022). In summary, pollution insurance serves two key functions: risk transfer and incentive mechanisms. By transferring potential environmental risks to insurance companies, it reduces the financial burden on enterprises. Additionally, by lowering premiums, it incentivizes companies to comply with environmental regulations, take preventive measures, and reduce the occurrence of environmental incidents (Shi et al., 2023). In contemporary China, studies have shown that the implementation of mandatory environmental liability insurance, compared to voluntary insurance, helps local governments quickly establish relatively mature pollution insurance systems (Feng et al., 2014;).

Social innovation design combines design thinking with social needs, proposing solutions to complex social problems through interdisciplinary collaboration and

innovative methods. Manzini (2015) studied several social innovation projects and found that incorporating design thinking and community participation can effectively enhance public environmental awareness and promote sustainable behavior. Mulgan et al. (2007) showed that through design thinking and social innovation, communities can better respond to environmental changes, improving disaster response and resilience. In recent years, social innovation design has demonstrated unique advantages in the field of environmental protection and sustainable development, driving social change and solving environmental problems (Batle et al., 2018).

3. Research Methods

This study employs a mixed-methods approach, including desktop research, in-depth interviews, and field investigations, to comprehensively understand the current state of environmental pollution in Ningde, a city in southeastern coastal China, along with its control measures, main types of environmental pollution, and existing protection measures. Data on water pollution, air pollution, soil pollution, and marine pollution were collected by searching academic databases and government reports, including the “China Environment Yearbook” and environmental quality reports published by the Fujian Provincial Environmental Protection Bureau.

In-depth interviews were conducted with 15 respondents, including environmental protection department staff, industrial enterprise representatives, insurance practitioners, and residents living around the industrial areas. These interviews were carried out face-to-face and via telephone, with the content recorded and transcribed to ensure data accuracy and completeness. Additionally, major industrial zones and coastal areas in Ningde were selected for field investigations to verify the actual situation of environmental pollution and the effectiveness of control measures, with on-site photographs taken for documentation.

Finally, qualitative analysis was conducted to code and perform thematic analysis on the text and image information obtained from the interviews and field investigations.



Figure 1. Tall chimneys emit industrial waste gas



Figure 2. Rivers around CATL electric vehicle factory

4. Research Findings

The study identifies four main types of environmental pollution in the Ningde area: water pollution, air pollution, soil pollution, and marine pollution (Zhou et al., 2018). Despite the implementation of existing policies and regulations, several challenges remain in effectively protecting the environment.

4.1 Water Pollution

Industrial wastewater, domestic sewage, and agricultural runoff are the primary sources of pollution. Due to insufficient treatment facilities, untreated or improperly treated wastewater is discharged into rivers and coastal areas. This leads to water quality degradation, posing significant risks to aquatic ecosystems and public health, affecting drinking water safety, and reducing biodiversity.

4.2 Air Pollution

The main sources of air pollution include industrial emissions, motor vehicle exhaust, and construction dust. The burning of fossil fuels in industrial activities and the increasing volume of motor vehicles significantly contribute to air pollution. Poor air quality has led to higher incidences of respiratory and cardiovascular diseases among residents, especially during peak industrial activity periods and traffic congestion.

4.3 Soil Pollution

Soil pollution is caused by the disposal of industrial waste, agricultural chemicals, and improper waste management. Heavy metals and persistent organic pollutants released during industrial activities accumulate in the soil. Contaminated soil adversely affects agricultural productivity and food safety, posing long-term risks to human health through the food chain.

4.4 Marine Pollution

Marine pollution results from land-based pollutants, maritime transportation, and fishing activities.
Industrial and domestic sewage discharged into coastal waters deteriorates the marine environment. Marine pollution disrupts coastal ecosystems, reduces fishery resources, and threatens the livelihoods of local communities.

4.5 Environmental Protection Measures

The Ningde municipal government has implemented several initiatives, including the construction of sewage treatment plants, waste management facilities, and air quality monitoring stations. Advanced technologies such as bioremediation and physicochemical treatment have been introduced. While these measures have improved environmental quality to some extent, challenges remain in facility management and maintenance.

Insufficient treatment capacity and weak enforcement of regulations hinder overall effectiveness. Strengthening regulatory enforcement, increasing public awareness and participation, investing in advanced pollution control technologies, and improving infrastructure management are essential to ensure long-term sustainability.

5."ENSURANCE" Environmental Liability Insurance Service System

To enhance overall environmental awareness among residents and ensure the sustainability of environmental protection, all stakeholders related to environmental interests are integrated into the "ENSURANCE" platform: promoting a rules-based approach to public participation (Johnson, 2010). This platform leverages resident supervision, government regulatory measures, and economic incentives— particularly through carbon trading—to guide industrial enterprises in green technological innovation, boosting market competitiveness and environmental responsibility. It aims to reduce pollution risks and improve regional environmental quality. The specific stakeholders, user journey map, and service blueprint design and analysis are as follows

5.1 Stakeholder Analysis

· **Government Departments:** Responsible for the formulation and implementation of regional environmental policies. Support the development of environmental liability insurance business and the carbon trading market through specific regulations.

· **Regulatory Agencies:** Oversee the insurance market to ensure that insurance products comply with industry standards and regulatory requirements.

· **Environmental Protection Organizations:** Act as policy advocates and disseminators of environmental knowledge. Promote higher awareness of environmental risks and guide public and corporate demand for environmental liability insurance.

· **Insurance Companies:** Direct providers of environmental liability insurance. Design and sell insurance products tailored to environmental risks.

· **Insured Enterprises:** Purchase corresponding environmental liability insurance as required by mandatory policies from relevant government departments. Manage environmental responsibility and risks.

· **General Public:** Beneficiaries of environmental liability insurance or those affected by environmental issues. Their demand for environmental policies and measures can indirectly influence the environmental insurance market.

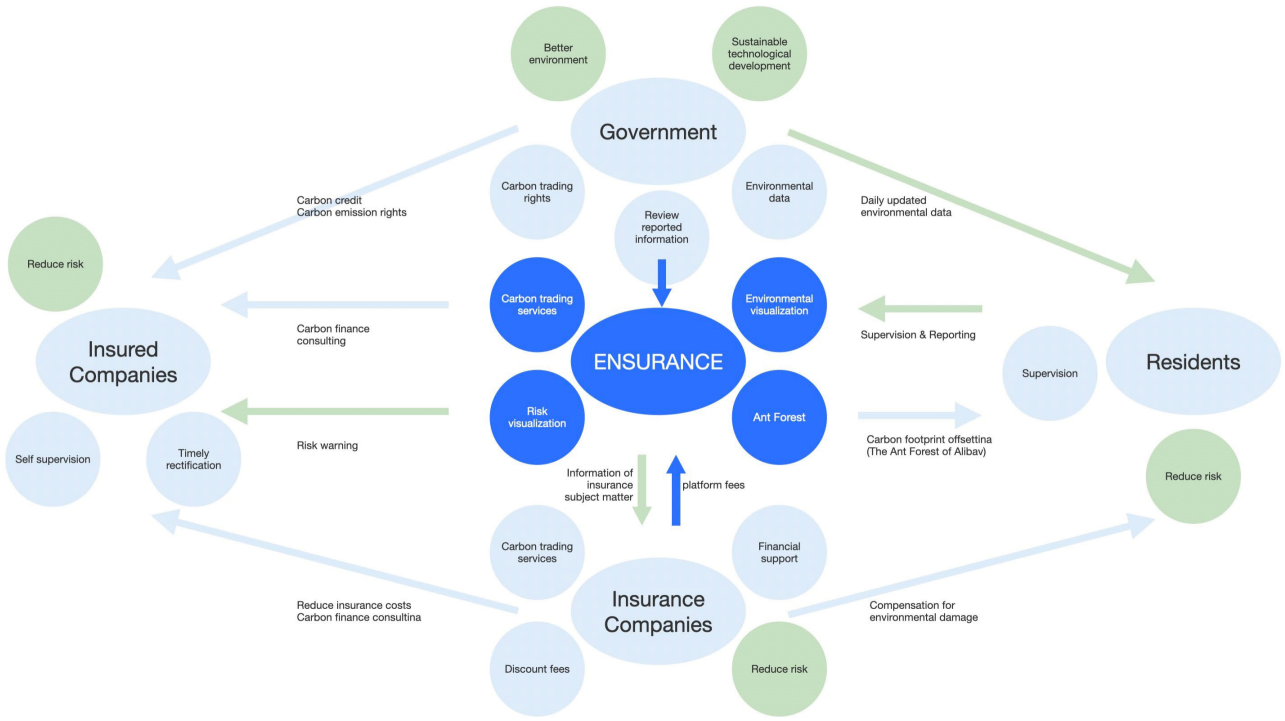

Figure 3. “ENSURANCE” Service system stakeholders

5.2 User Journey Map

· **Opening the Application:** Users open the application to view the surrounding environmental conditions based on real-time monitoring data.

· **Viewing Environmental Data:** The application provides data displays for the current location, including air quality index and water quality indicators, allowing users to understand the current environmental situation promptly. Users can input an address or use GPS to locate and search for nearby chemical and other polluting enterprises. The platform displays the environmental protection measures and emission information of these enterprises.

· **Reporting Pollution:** When users detect pollution, they can use the application to take photos and record the pollution source. The system automatically identifies the type of pollution and provides corresponding pollution control toolkits, guiding users on preliminary handling. Users submit the pollution report through the application, including detailed pollution data and photo evidence. The platform system sends the report to relevant departments, initiating the treatment process.

· **Tracking Rectification Information:** Users can track the progress of pollution reports within the application, learning about the implementation of corrective measures. The platform provides updates on rectification information, ensuring that users are informed of every step in problem resolution.

· **Submitting Environmental Credit Applications:** Enterprises and individuals can submit environmental credit applications through the application. The system evaluates their environmental behavior and credit status. Based on the evaluation results, the platform grants environmental credit ratings and offers related benefits and rewards, such as loan discounts and policy support.

Through these features and processes, the service system not only improves the efficiency of environmental monitoring and management but also enhances user engagement and responsibility through interaction and incentive mechanisms, promoting sustainable environmental development.

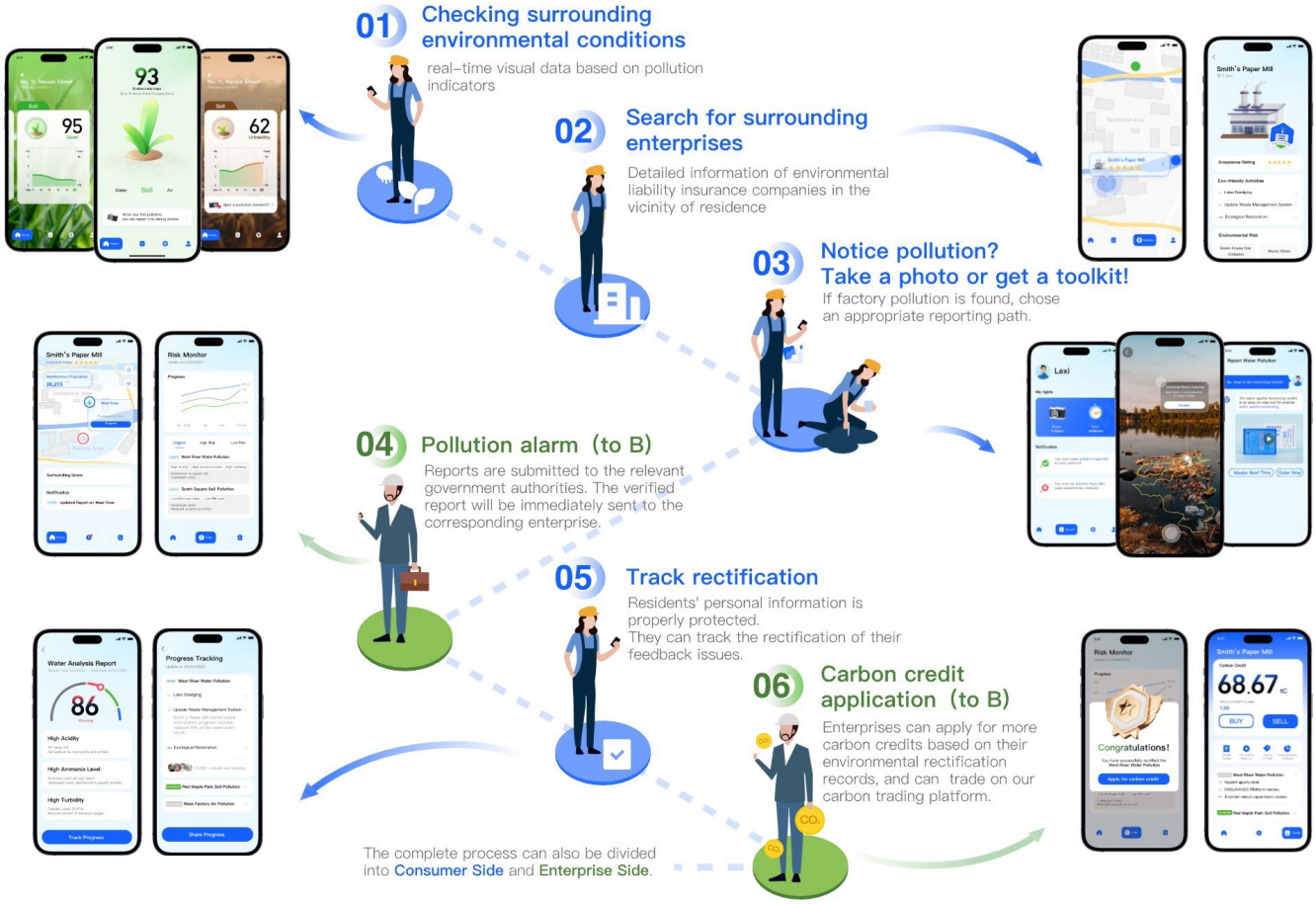

Figure 4. “ENSURANCE” User Journey Map



Figure 5. “ENSURANCE” User Guide for System Usage

5.3 Service System Blueprint

The “ENSURANCE” Environmental Liability Insurance Service System comprises three main service stages: Information Acquisition, Basic Services, and Advanced Services. Each stage encompasses five levels: User Journey, Front-End Interaction, Technical Support, Back-End Interaction, and Policy Support.

Information Acquisition Stage

- **User Journey:** Users access the system to learn about the surrounding environment and nearby enterprises’ insurance information.
- **Front-End Interaction:** The system uses environmental information visualization technology to provide daily environmental risk reports.
- **Technical Support:** The system collects and processes environmental data, ensuring up-to-date information is available to users and enterprises.
- **Back-End Interaction:** Coordination between the system and environmental data sources to deliver accurate reports.
- **Policy Support:** Government regulations and guidelines ensure the system delivers necessary environmental information and supports awareness.

Basic Services Stage

· **User Journey:** Users detect pollution, take photos, and upload them to the system along with a submitted toolkit for initial response.

· **Front-End Interaction:** Users use image recognition technology and professional environmental sample analysis to report pollution.

· **Technical Support:** The system identifies pollution types, collects information on surrounding enterprises, and processes user submissions.

· **Back-End Interaction:** The platform pushes daily rectification progress reports from enterprises, ensuring users are informed about the implementation of corrective measures.

· **Policy Support:** Policies enforce transparency in environmental management, requiring enterprises to provide rectification progress reports.

Advanced Services Stage

· **User Journey:** Users achieve personal carbon neutrality through environmental public welfare activities, and enterprises benefit from carbon trading incentives.

· **Front-End Interaction:** The system facilitates user participation in public welfare activities and provides access to the carbon trading platform.

· **Technical Support:** The system conducts environmental impact analyses and supports financial consulting and trading for enterprises on the carbon trading platform.

· **Back-End Interaction:** Continuous analysis and reporting on the effectiveness of environmental protection measures and carbon trading activities.

· **Policy Support:** Carbon trading incentive policies support enterprises in their green transformation efforts, providing financial and regulatory backing.

Through these stages, the “ENSURANCE” system not only enhances the efficiency of environmental monitoring and management but also promotes user engagement and accountability. This comprehensive approach ensures sustainable environmental development by integrating real-time data, user interaction, and policy support.

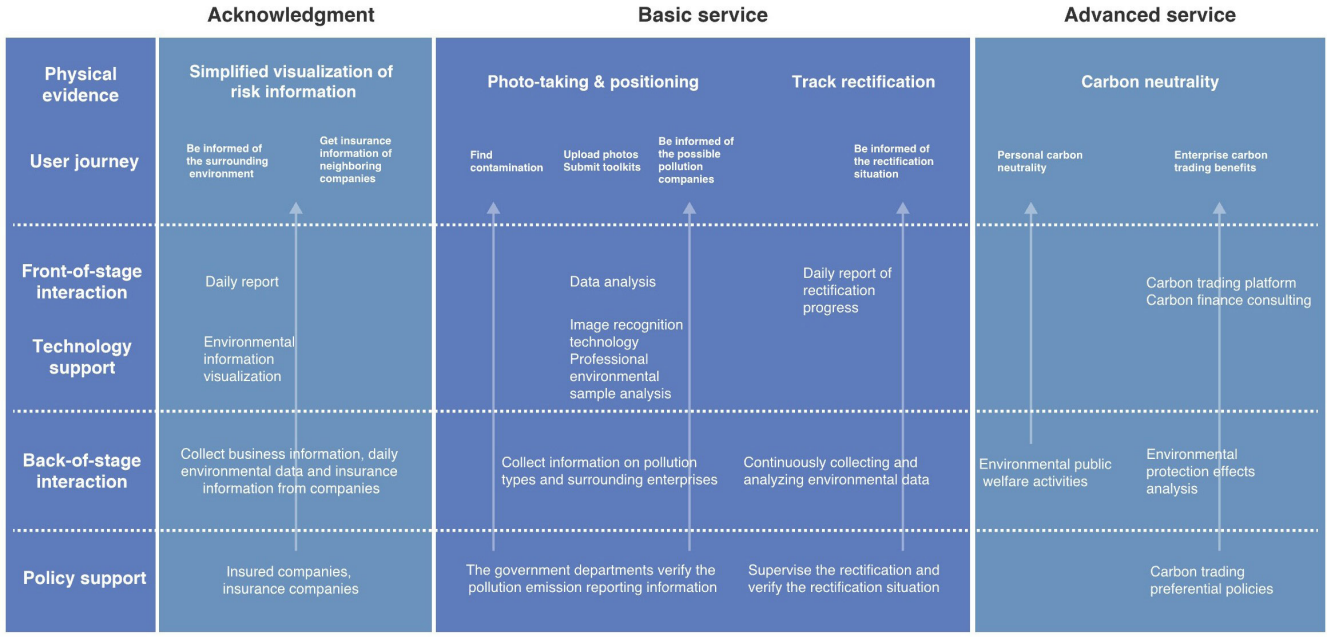

Figure 6. “ENSURANCE” Service System Blueprint

6. Conclusion

This study highlights the major environmental challenges faced by regions in developing countries like China, including water pollution, air pollution, soil pollution, and marine pollution. Despite existing policies and measures, there is still room for improvement in effective regulatory enforcement, public participation, and technological innovation.

The “ENSURANCE” environmental liability insurance platform offers an innovative approach by bridging the gap between government regulation, corporate responsibility, and environmental sustainability. By leveraging resident supervision, government incentives, and carbon trading mechanisms, “ENSURANCE” has, to some extent, promoted green technological innovation and enhanced overall public environmental responsibility.

Future research should focus on improving the “ENSURANCE” model, exploring its applicability in other regions, and evaluating its long-term impact on environmental sustainability. Policymakers and practitioners can benefit from the insights provided by this study to develop more comprehensive and effective environmental management strategies.

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RESEARCH ON HEALTH DETECTION PRODUCT DESIGN BASED ON AFFORDANCE AND TRADITIONAL CHINESE MEDICINE (TCM) WELLNESS CONCEPTS

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ABSTRACT | This study explores the dynamic interactions among individuals, health monitoring products, and the environment under the backdrop of Traditional Chinese Medicine (TCM) preventive healthcare. The main goal is to analyze user experience components related to health monitoring products influenced by TCM wellness trends, exploring subconscious interaction methods to deepen the connection between users and products. Methodologically, this research uses the TCM Four Diagnostics Device and TCM Thermal CT as examples, relying on sample records and user interviews to identify operational challenges and user expectations during the health monitoring and wellness process, thereby clarifying users' experience needs. To achieve this goal, the study integrates TCM wellness concepts to deeply explore the affordance design strategies of health monitoring products, covering aspects such as form, interaction experience, and service innovation, culminating in the practical design of TCM wellness health monitoring products.

KEYWORDS | THEORY OF AFFORDANCE, TRADITIONAL CHINESE MEDICINE WELLNESS CONCEPTS, HEALTH DETECTION PRODUCT DESIGN

1. Introduction

Over time, Traditional Chinese Medicine (TCM) wellness has seen significant advancements in its concepts, usability, and human-computer interaction, expanding its role beyond traditional healthcare in contemporary Chinese society. Today, TCM wellness has evolved into an integrated health management approach that combines personal health monitoring with lifestyle adjustments, leading to the concept of "lifestyle-based health management." Due to the complex individual differences inherent in TCM diagnostic and treatment processes, health monitoring products must provide more personalized and precise services.

This paper introduces the concept of "affordance" from the perspective of ecological psychology to explore the user experience elements in the design of health monitoring products based on TCM wellness principles.

2. The Role of Affordance in User Experience Systems

Donald Norman redefined the concept of affordance in his series of books on design psychology, thereby introducing the concept into the design field (Norman, 1990). In subsequent research, Norman further explained that the reciprocity of affordance in product design is manifested as "physical constraints," which facilitate or inhibit certain user behaviors to inspire user needs. Based on Norman's research, Rex Hartson extended the classification of affordances, defining and using four types: cognitive affordance, physical affordance, sensory affordance, and functional affordance (Hartson, 2003, p.315). Many scholars have further elaborated on these classifications:

- Cognitive affordance helps users recognize and understand the design features of a product, providing cues on how to use it.

- Sensory affordance refers to design features that can be perceived by users through senses such as sight and hearing.

· Physical affordance helps users perform actions within the interface.

· Functional affordance involves design features that assist users in completing actions, representing purposeful action design.

Jordi Vallverdu introduced the concept of emotional affordance in the study of humancomputer interaction, suggesting that users experience emotional responses when perceiving the affordance characteristics of a product. Therefore, emotional affordance refers to design features that provide emotional satisfaction to users during interaction (Vallverdu, et al, 2018, p.78).

In the field of communication studies, Leonardi and other scholars view affordance as the potential for technology to influence daily life, such as the various functions provided by the internet and the potential characteristics of using technology to conduct actions (Leonardi, 2011, p.147). Therefore, in the design field, technological affordance can refer to design features that rely on technology, such as user experiences generated through the application of new technologies.

In user experience research, it is widely accepted that user experience should focus on three aspects: the user, the product, and the interactive environment. Among the definitions, ISO 9241-210 provides the most influential one: it describes user experience as the reactions and outcomes that individuals have when using, or anticipating the use of, a product, system, or service. The user experience process is influenced by a variety of factors, such as the user's psychological state and the context, making the process inherently uncertain due to the diversity and complexity of these factors. This uncertainty often leads to user experience being perceived as a subjective sensation that is challenging to design directly.

Therefore, this paper introduces the concept of "affordance" into the analysis of user experience. The core of the affordance concept focuses on the relationship between people and objects in specific contexts. By incorporating affordance theory, there is an opportunity to translate subjective user experiences into objective elements within the product or environment. This approach provides valuable design strategy guidance for enhancing product interaction and improving user experience.

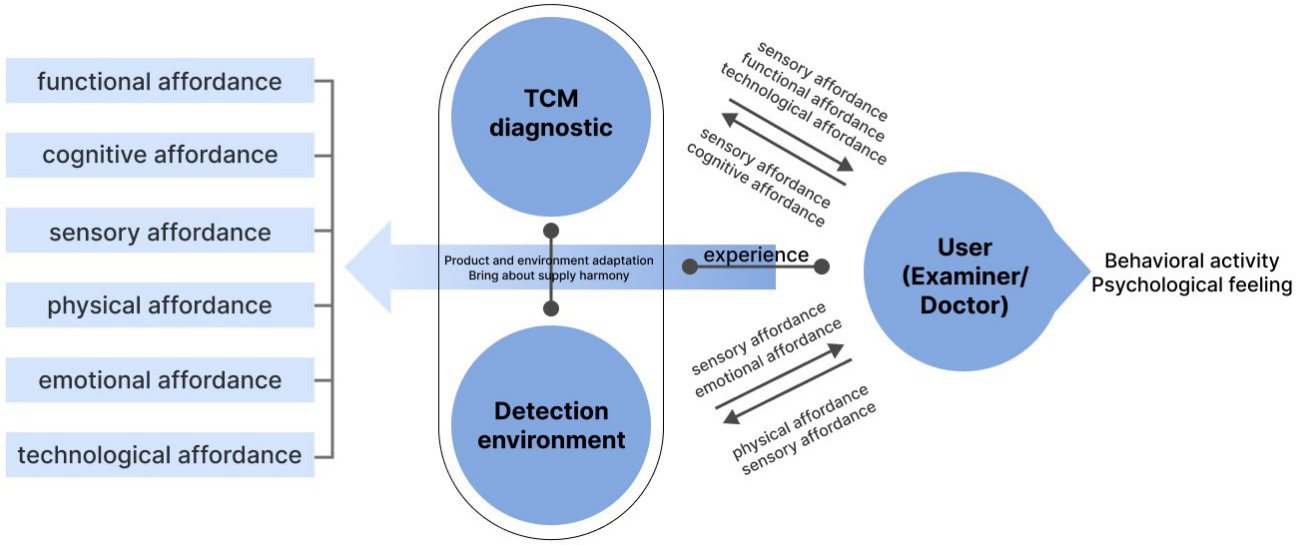

Figure 1. Affordance theory in user experience

3. The Role of Traditional Chinese Medicine (TCM) Wellness Concepts in Health Management

With the accelerated pace of modern life and increased work stress, sub-health conditions have become a common issue affecting many people today. The TCM concept of "preventing disease before it occurs" (治未病) utilizes body constitution identification to understand an individual's current health status. If a person is in a sub-health state, personalized adjustments and optimization based on their constitution can help prevent diseases and maintain or improve health. This approach supports individualized health improvement and enhances quality of life.

In 2009, the China Association of Chinese Medicine established the "Standard for Classification and Determination of TCM Body Constitutions" (ZYYXH/T157.2009), which was implemented on April 9 of the same year. As illustrated in Figure 2, this standard, based on Wang Qi's nine-type classification method, divides body constitutions into nine categories and specifies the characteristics and determination rules for each type (Wang Qi, 2005, p.5). The development and implementation of this standard have laid the foundation for the development of TCM health assessment products.

Currently, TCM body constitution identification is widely applied in clinical settings, epidemiological surveys, health management, and public health. Yang Lingling et al. "added TCM body constitution identification to routine physical examinations for 207 individuals, finding that it increased the detection rate of sub-health conditions and potential health risks, effectively addressing the shortcomings of routine check-ups" (Yang Lingling, et al, 2018, p.4595).

Jia Danbing et al. “discussed the characteristics of body constitutions in patients with impaired glucose regulation, fatty liver, hepatitis B, hyperthyroidism, and hypothyroidism, discovering that body constitution identification can provide insights into the balance of Qi, blood, Yin, and Yang, offering new perspectives for clinical diagnosis and treatment” (Jia Danbing, et al, 2014, p.2037).

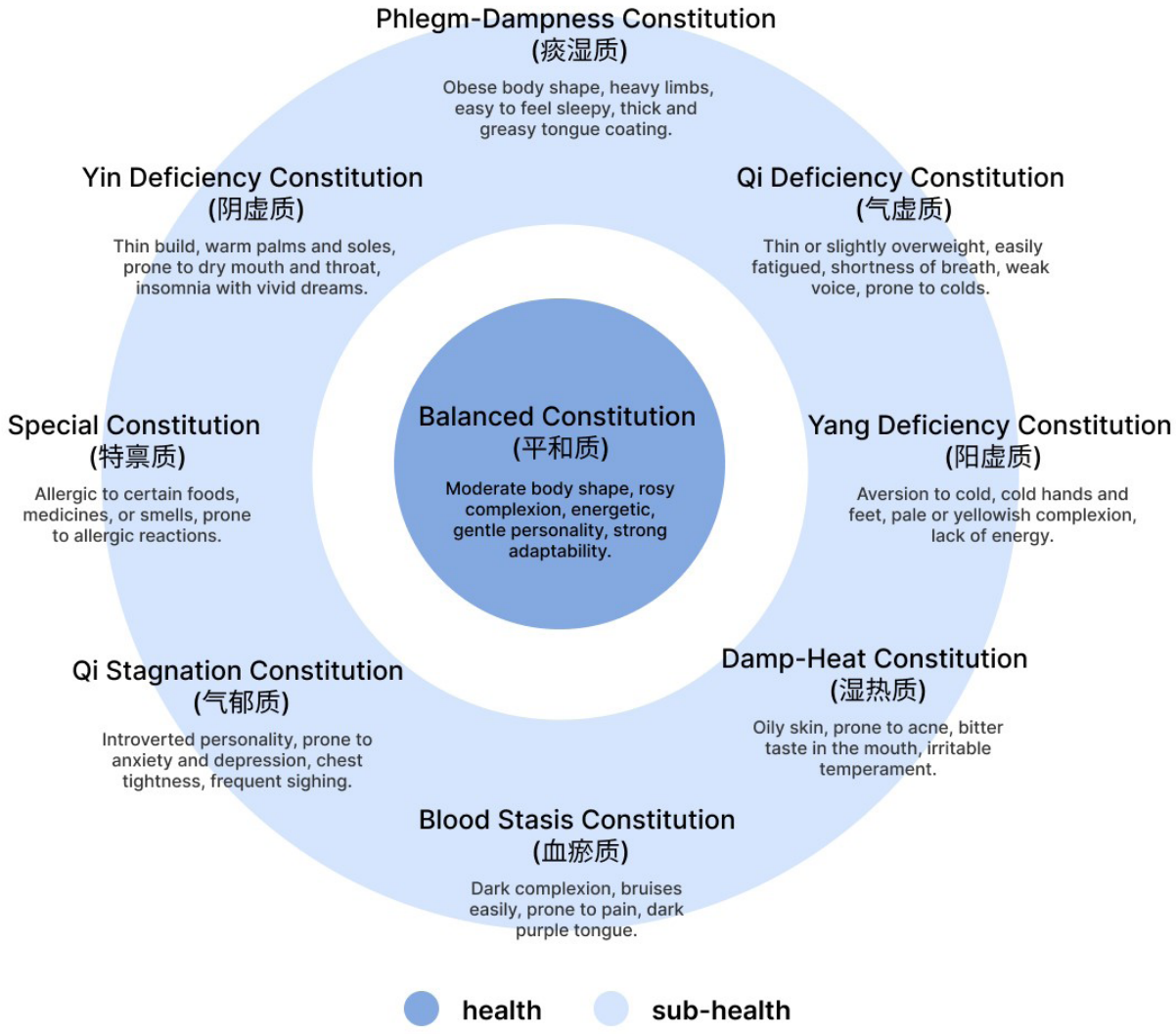

Figure 2. Classification of the constitutions of TCM

4. Current State of User Experience with TCM Health Monitoring Products

Traditional Chinese Medicine (TCM) diagnostic methods encompass observation (望), listening and smelling (闻), inquiry (问), and palpation (切诊), collectively known as the Four Diagnostic Methods (四诊合参). Health monitoring products developed based on TCM diagnostic principles act as a bridge between traditional medicine and modern technology. These products integrate TCM concepts with contemporary health assessment technologies, aiming to help users better understand and manage their health conditions, as shown in Figure 3.

TCM diagnostic	Specific expression	Health testing product	Extent of application
Inspection	This involves observing the patient's general appearance, including their facial complexion, body shape, posture, and behavior. The practitioner also examines the tongue and its coating.	**Facial Diagnosis Device**: It classifies physical signs by objectively and intelligently analyzing facial complexion, facial luster, and lip color.	Commercial and Clinical Applications: Integrated into the Four Diagnostics Device in a modular format.
		Tongue Diagnosis Device: It diagnoses TCM syndromes based on the characteristics of tongue color, tongue shape, and tongue coating.	Commercial and Clinical Applications: Integrated into the Four Diagnostics Device in a modular format.
		Ocular Diagnosis Device: It performs intelligent analysis and completes health assessments based on the characteristics of spots and blood vessels in the scleral area of the eyes.	Academic Research Phase
		TCM Thermal CT: Using infrared thermal imaging technology, it captures infrared thermal images formed by the metabolic heat sources of the user's body tissues and cells. These images assist in TCM constitution classification based on the body's cold, heat, deficiency, and excess characteristics.	Commercial and Clinical Applications
Listening and Smelling	This involves listening to the patient's voice, breathing, and coughing sounds, as well as smelling any body odors or breath odors that might indicate certain conditions.	**Voice Diagnosis Device**: The subject vocalizes specified sentences or syllables in a low-noise environment (below 30 or 45 decibels). The experimenter collects these sound signals with professional recording equipment. The data is then denoised, sampled, and audio features are extracted. Consistent low-noise sound information is obtained, and pathological diagnosis is conducted through modeling and analysis.	Academic Research Phase
		Olfactory Diagnosis Device: It analyzes the patient's exhaled breath. The process primarily includes three steps: gas sampling, gas composition analysis, and disease diagnosis.	Academic Research Phase
Inquiry	This involves asking the patient about their medical history, symptoms, lifestyle, diet, emotional state, sleep patterns, and other relevant information.	**Constitution Identification Questionnaire**: It uses a standardized syndrome diagnosis questionnaire to collect health information from users through a Q&A format. Based on data analysis, it identifies the user's TCM constitution.	Commercial and Clinical Applications: Integrated into the Four Diagnostics Device in a modular format.
Palpation	This involves feeling the patient's pulse at various points on the wrist and palpating specific areas of the body to detect any abnormalities in temperature, texture, tenderness, and masses.	**Pulse Diagnosis Device**: Sensors are placed on the measured area to collect pulse signals and convert them into electrical signals. These signals are amplified and recorded, or converted into digital form for computer processing. The data is then analyzed for pulse wave characteristics and used for diagnosis.	Commercial and Clinical Applications: Integrated into the Four Diagnostics Device in a modular format.
Four Diagnostics Device	Four diagnostic methods of Inspection, Listening and smelling, inquiry and Palpation were performed at the same time.	**Four Diagnostics Device**: This device operates through various modules, capturing tongue images with a camera, conducting inquiries through a constitution identification questionnaire, and measuring the pulse with sensors. All data is analyzed by the system, and a report is generated to assist doctors in making diagnoses.	Commercial and Clinical Applications

Figure 3. Health testing products combined with traditional Chinese medicine

In China, a variety of TCM body constitution identification systems and products are available, primarily used in hospital preventive medicine departments and TCM wellness centers to assess users' constitutions and provide corresponding health services. However, due to limited public awareness and design shortcomings that overlook users' cognitive load and emotional needs, these products often fail to meet user requirements accurately, resulting in unsatisfactory user experiences.

To assess and optimize the user experience of TCM health monitoring products, this study utilized methods including user interviews, field observations, and sample recordings. In-depth interviews were conducted with 13 experienced users and 10 TCM practitioners, and observational data was collected from 59 participants across various cities such as Xi'an, Shanghai, Nanjing, and Changsha. The study tracked users' interactions with TCM health monitoring activities, as depicted in Figure 4.

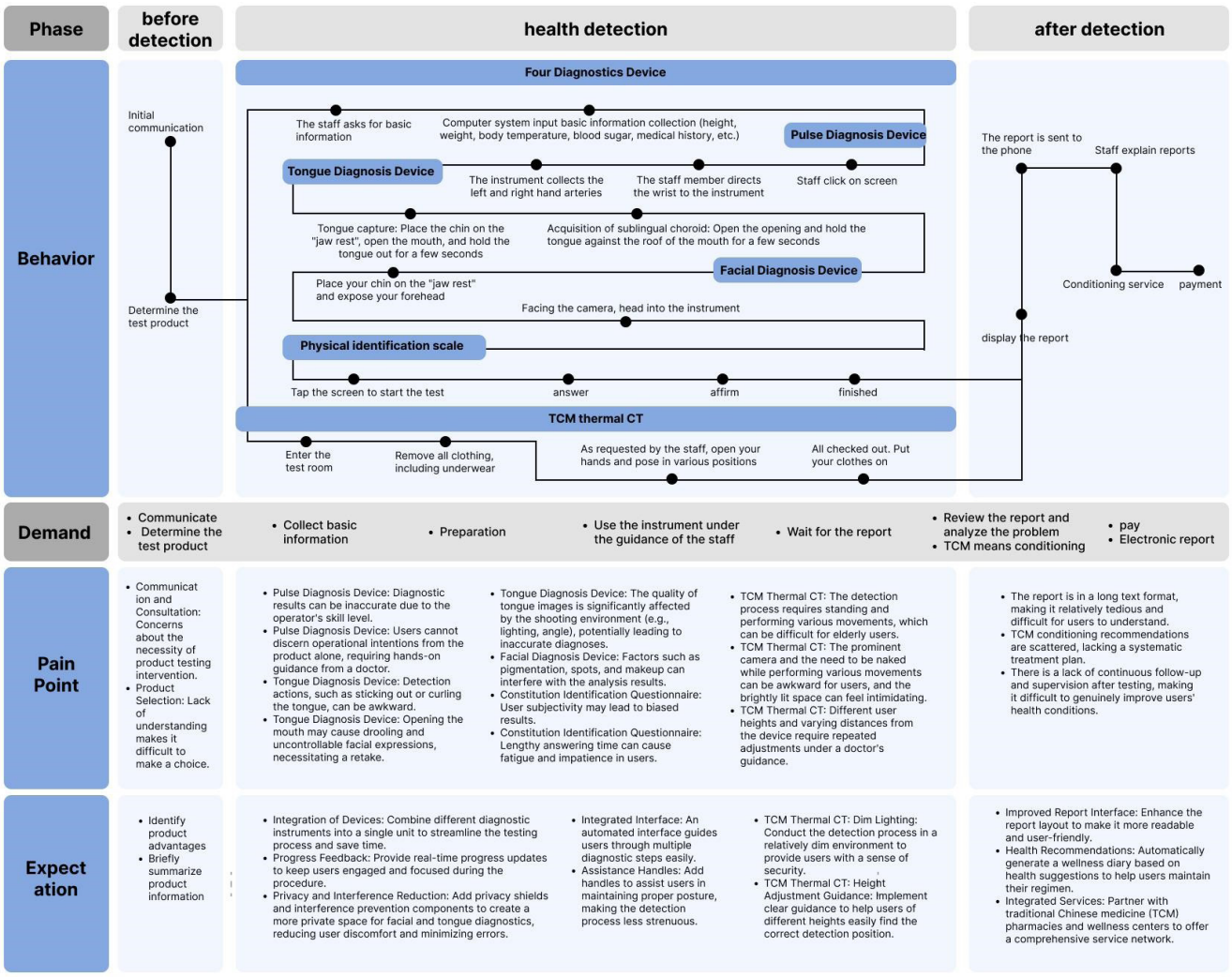

Figure 4. TCM health testing user journey map

The personal TCM health monitoring process primarily involves information inquiry, data recording, constitution analysis, and lifestyle adjustment recommendations. Through a comprehensive analysis of subjective feedback and both conscious and subconscious user behaviors, the user experience was examined from six affordance perspectives: functional affordance, cognitive affordance, physical affordance, sensory affordance, emotional affordance, and technological affordance.

· Functional Affordance: While the devices generally offer a complete set of features, the complexity of some functions may lead to operational difficulties, reducing ease of use and practicality. Many devices are used independently and lack integration, making it challenging to form an efficient and streamlined detection process.

· Cognitive Affordance: Users often lack an intuitive understanding of device operation logic and result interpretation. For instance, the lack of direct operational guidance

for adjusting the pulse diagnostic device and TCM thermal CT can lead users to frequently seek external help, affecting the efficiency of the detection process and user autonomy.

· Physical Affordance: Devices such as facial diagnostic instruments and TCM thermal CT fail to accommodate diverse body sizes, requiring users to make multiple adjustments to fit, which increases operational difficulty and affects the smoothness and comfort of the user experience.

· Sensory Affordance: The devices lack adequate auditory or visual feedback during operation. For example, the pulse diagnostic device lacks progress feedback, and the operation instructions for the TCM thermal CT are not sufficiently clear. This deficiency makes it difficult for users to determine whether they have completed the operation correctly, leading to a lack of confidence, anxiety, and confusion.

· Emotional Affordance: Devices like the tongue diagnostic instrument and pulse diagnostic device can cause discomfort due to awkward positioning or prolonged fixed stances. The TCM thermal CT, which requires users to expose themselves, can induce anxiety and discomfort due to overly bright environments and visible cameras, increasing psychological burden.

· Technological Affordance: The technical accuracy and stability of devices such as the facial diagnostic instrument, tongue diagnostic instrument, and TCM thermal CT are limited. Variations in lighting conditions can impact result accuracy, decreasing user trust in the results. Additionally, the current inability of TCM thermal CT technology to perform non-invasive clothed assessments increases users' psychological burden. Advances in this area could reduce this burden and enhance user experience.

5. Affordance Design Strategies for TCM Health Monitoring Products

Based on user surveys, we have identified key pain points and expectations related to TCM health monitoring products. To align with affordance design principles and better reflect the tenets of traditional Chinese health management, we have re-evaluated and refined the design strategies for these products as follows:

· Functional Affordance: Integrate diagnostic functions into a unified system that combines tongue, facial, and pulse diagnostics. This approach reduces the number of steps required and simplifies the operational complexity for healthcare providers. Additionally, optimize the functionality of components such as facial and tongue diagnostic devices to minimize the impact of external conditions on diagnostic accuracy.

· Cognitive Affordance: Provide clear cognitive guidance and feedback to ensure users can intuitively understand how to use the product and its functions, thereby reducing cognitive load. Utilize clear icons, color coding, and animations

on the interface to guide users, ensuring that information is presented in an easily comprehensible manner to minimize learning curves and operational errors.

· Physical Affordance: Design an intuitive user interface and enhance ergonomic features to simplify product use. This will make the devices accessible to elderly users and those unfamiliar with technology, ensuring ease of operation and comfort throughout the diagnostic process.

· Sensory Affordance: Incorporate visual and auditory feedback to enhance multi-modal sensory interactions. This will boost user confidence and make the diagnostic process more engaging and interactive.

· Emotional Affordance: Integrate elements of TCM culture into the design to strengthen emotional and cultural connections. Provide interactive prompts that reflect TCM philosophy and create a warm, relaxing environment through thoughtful spatial design and interaction methods. This will help users feel comfortable, secure, and culturally validated during the diagnostic process.

· Technological Affordance: Reduce errors caused by user operations and environmental conditions through well-considered design, thereby improving diagnostic accuracy. Additionally, offer multilingual support and interfaces tailored to various user proficiency levels, including guided operations for beginners and customizable options for advanced users.

5.1 Integration of Product Functions and Unconscious Design to Optimize User Experience

To minimize cognitive and physical burdens for users of TCM health monitoring products, we have integrated the functionalities of pulse diagnostic instruments, tongue diagnostic devices, facial diagnostic tools, and TCM constitution assessment scales into a unified design. This integration streamlines the operational steps and enhances the overall fluidity of the diagnostic process. By reimagining the product's appearance and structure, we enable users to complete multiple tests through simple actions, thereby mitigating result deviations caused by improper use. For example, in the TCM thermal CT, we have designed various handles to physically guide users into the correct posture; similarly, the TCM Four-Diagnosis Instrument includes humansized features to assist users in performing tests with greater accuracy and comfort. These design enhancements aim to reduce cognitive load, improve overall user-friendliness, and simplify operation for elderly users.

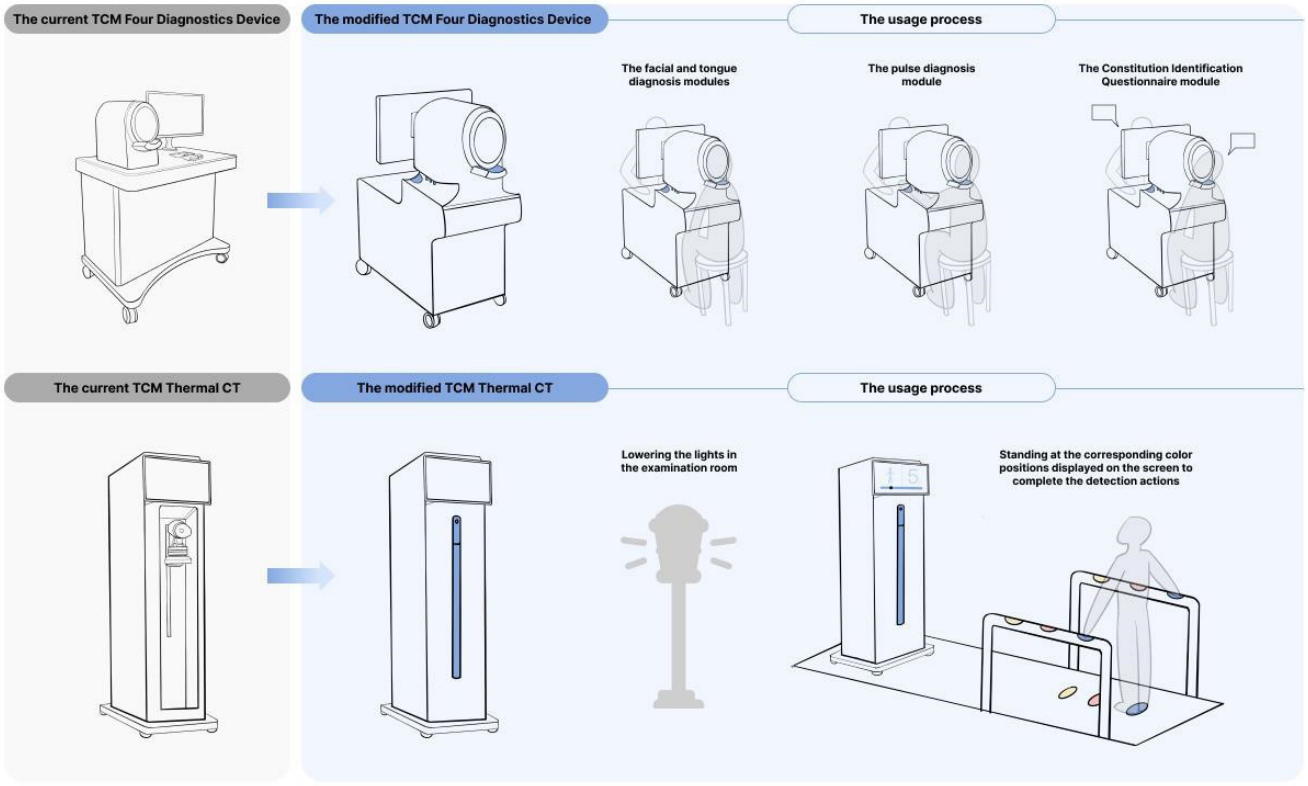

Figure 5. Design of TCM health monitoring products based on affordance design strategies.

5.2 Enhancing Sensory and Emotional Affordance to Strengthen Emotional and Cultural Connections

Enhance multimodal sensory interaction to improve user confidence and satisfaction. Increase the sound of successful operation and error warnings during the testing process to instantly correct operational errors and improve the accuracy of testing. The interface is equipped with clear signs and operating guidelines, using simple and clear language and diagrams to help users easily understand the upcoming operation steps and reduce the anxiety caused by uncertainty. The testing environment incorporates TCM cultural elements, such as the use of traditional patterns and colours, as well as the provision of interactive prompts rich in TCM philosophy, to enhance the user's emotional experience and sense of cultural identity. In addition, the camera of the TCM Thermal CT is hidden to ensure that the testing process is dimly lit to alleviate the embarrassment of naked testing and enhance the user's sense of security when using the product.

5.3 Improve service links to promote sustainable user experience

By integrating intelligent algorithms, user health testing data is automatically transformed into personalized wellness

advice and recorded in an easily accessible and manageable digital wellness diary. This approach helps users track their health status and wellness progress while increasing their engagement and sustainability in health management activities. The wellness diary provides a timeline view that displays trends in the user's health indicators, implementation of wellness recommendations, and assessment of their effectiveness. Additionally, establishing partnerships with Chinese herbal medicine and wellness centers can offer users a complete service chain from testing to healthcare. For instance, based on health test results, the system can recommend nearby Chinese herbal medicine halls or wellness centers and facilitate appointment scheduling. This cooperation not only helps users implement and follow up on healthcare recommendations but also brings potential customers to partner organizations, forming a mutually beneficial and win-win business model.

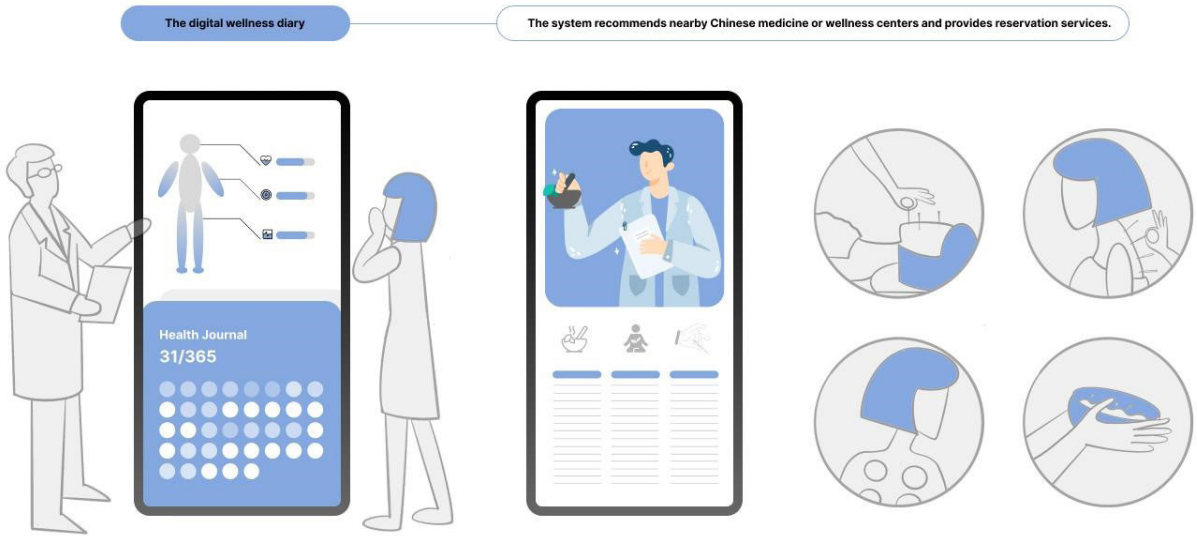

Figure 6. Extended services of TCM health monitoring products based on affordance design strategies.

6. Conclusion

Health testing products have evolved into multifunctional centers for personal health management, encompassing health testing, lifestyle adjustment, and cultural heritage, thereby providing diverse experiences. The emergence of health testing products based on the principles of Chinese medicine and health maintenance aligns with societal and lifestyle changes. From the perspective of ecopsychology's affordance theory, we derive design strategies to enhance the experience of health testing products across multiple dimensions, including functional, cognitive, physical, sensory, emotional, and technological aspects.

These strategies support the development of Traditional Chinese Medicine (TCM) health testing products in several key areas: integrated functional design, simple and accurate user interaction, multimodal sensory feedback, continuous service link experience, and the deep integration of emotion and culture. This approach emphasizes optimizing human-computer interaction, deepening the emotional connection between the user and the product, and promoting a greater understanding and practice of TCM health culture. Consequently, users not only enjoy an enhanced health testing experience but also deepen their identification with and appreciation of TCM culture through the product's use, achieving a harmonious integration of technology and traditional medicine.

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CROSS-CULTURAL DESIGN INNOVATION THROUGH TECHNOLOGY AND CREATIVITY.

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ABSTRACT | Over the past 15 years, a research collaboration has been established between several universities within the Latin Design Network as a Process, involving numerous academic exchanges and participation in international forums on topics such as design, biodiversity, territory, and emergencies. This collaboration culminated in the eighth forum in Bologna in 2022, focusing on "Disrupting Geographies in the Design World." The project explores innovation at the intersection of design, technology, and traditional craft across Colombia, Brazil, and Italy. Its primary aim is to bridge cultural gaps by incorporating modern technology to breathe new life into traditional art forms, focusing on transformative design practices and cross-border collaboration.

The project reflects the evolution of co-design from user-centered methodologies to co-creation, showing how contemporary technologies such as artificial intelligence, data visualization, and biocreativity can redefine traditional craftsmanship and educational practices. Designers act as mediators between knowledge, emphasizing interdisciplinary contamination to add complexity and developing collaborative and cross-disciplinary skills that foster creative innovation based on cultural diversity.

Through “Design Experience” modules, participants gain hands-on experience with innovative tools and methodologies. These workshops explore the potential of these technologies to enhance traditional crafts and foster new modes of artistic expression. The use of AI allows for unprecedented levels of data-driven creativity, while bio-creativity emphasizes sustainability through circular and local materials.

The outcomes of the workshops indicate a broader potential for AI and technology to reshape design and art fields, fostering unique design practices and creative exploration. The project emphasizes cross-cultural collaboration, uniting students, researchers, and artisans from different countries in shared learning and experimentation, leading to a comprehensive understanding of traditional crafts and innovative design processes.

KEYWORDS | CROSS-CULTURAL DESIGN, AI DESIGN, TECHNOLOGY, INNOVATION, TRADITIONAL CRAFT

1. Introduction

Over the past fifteen years, a partnership between the research team Advanced Design Unit of the University of Bologna and the Universidad Nacional de Colombia and University of Vale do Rio dos Sinos in Brazil has been consolidated through the Latin Network of Design as Process. This partnership has generated a shared research reflection, characterised by a strong link with the local territorial capital. This territorial capital is defined as a systemic set of material and immaterial factors and resources, including communities, entrepreneurs, landscapes, innovation capacity, traditions, technologies, infrastructures and skills.

For example, the network, through forums such as "Disrupting Geographies in the Design World" (https://www.forumdesignprocess.org/dgdw22/), has opened the space for design communities to share design perspectives and transitions, to imagine and create the future of design in accordance with the cultural diversity that characterizes communities around the world.

From this reasoning, a shared reflection has developed in recent years focused on the need to understand how new technologies can support design skills, promoting and enhancing local knowledge with a future vision. The research led to the collaboration of universities in the project "Frontier Design Innovation and traditional craft": an exploration, in the form of an educational format of a workshop and multidisciplinary nature, of the potential of the innovation process at the intersection of design, technology and traditional craftsmanship applied in Colombia, Brazil and Italy.

The exploration took the form of an international workshop, held between February and July 2023 in Italy and Colombia. The objective was to bridge cultural divides by incorporating technology to breathe new life into traditional art forms. Furthermore, the aim was to explore the potential of these technologies to improve traditional crafts in the three countries and promote new modes of artistic expression and design. In this process, we saw the integration of, on the

one hand, artificial intelligence as enabling unprecedented levels of data-driven creativity, and on the other, biocreativity to emphasise the importance of sustainability using circular and local materials.

The paper aims to reflect on the potential of artificial intelligence technologies through a critical analysis of the results that emerged from the workshop in order to identify which transformative design practices emerge through an approach based on cross-border collaboration. After an indepth review of the literature with respect to the evolution of co-design practices in processes of interdisciplinary contamination and characterised by design cultural diversity, the article presents the methodology applied in the workshop and analyses the results in a punctual manner, highlighting useful design directions to outline design practices, implications and challenges of the introduction of artificial intelligence technologies to reshape the design and the arts fields.

2. Literature review

2.1 Co-design evolution

The evolution of co-design reflects a shift from user-centered methodologies to co-creation. Over the years, co-design has incorporated various theories and models, such as design thinking and the user-centered design approach. This has led to a greater emphasis on collaboration and participatory innovation (Brown, 2008; Sanders & Stappers, 2014).

Recently, co-design has seen greater integration with digital technologies and expansion into sectors such as healthcare, education, and urban development. Sustainability and inclusivity have become central themes, with particular attention to the participation of marginalized communities (Bason, 2010; Björgvinsson, Ehn & Hillgren, 2012). As an approach that involves stakeholders in the design process, it fosters listening and responsive interactions between stakeholders and the design team, ensuring outcomes in line with community needs (Interaction Design Foundation - IxDF, 2023).

Co-design practices include collaborative workshops, brainstorming sessions, rapid prototyping, and the use of digital tools to facilitate remote collaboration. These methodologies have evolved to adapt to different contexts, such as the design of services, products, and public policies (Steen, Manschot & De Koning, 2011).

This evolution demonstrates how the integration of contemporary technologies, such as artificial intelligence, data visualization, and bio-creativity, can redefine traditional craftsmanship and educational practices (Davis et al., 2021; Light et al., 2022; Sanders & Stappers, 2008, Singh et al., 2018).

The evolution of co-design reflects a growing awareness of the importance of collaboration and user participation in the design process. Co-design practices and methodologies will continue to evolve, influenced by new technologies and the emerging needs of society.

2.2 Interdisciplinary Contamination: Importance of cross-disciplinary skills and cultural diversity in design

Interdisciplinary contamination emphasizes the importance of cross-disciplinary skills and cultural diversity in design. It involves the blending of knowledge from various disciplines to foster innovation and creativity. This approach is particularly valuable in design, where different perspectives can lead to more comprehensive and innovative solutions. The literature highlights several successful examples of interdisciplinary contamination, where the integration of diverse skills and cultural insights has led to groundbreaking design solutions (Augsburg, 2014). Thompson (2014) raises the concept as a possibility to transcend from reliable scientific knowledge to socially robust knowledge, through alliances between different stakeholders.

The paper aims to address precisely how new technologies can help implement cross-cultural processes in order to practise inclusive non-discriminatory analyses.

2.3 Technology in Design: overview of AI in enhancing traditional craftsmanship

The integration of Artificial Intelligence (AI) into traditional craftsmanship represents a transformative intersection between advanced technology and age-old artisanal techniques (Eglash et al., 2020). This fusion not only preserves but also enhances the unique characteristics of handmade goods, providing a contemporary edge while maintaining cultural authenticity. In recent years, AI has been leveraged across various facets of design and craftsmanship, from initial conceptualization to the final production stages.

Applications of AI in traditional craftsmanship ranges from the realm of design optimization for functionality and aesthetics (Wang et al., 2024) to the customization process, making personalized craftsmanship more accessible (Deng et al., 2024), passing through the preservation and documentation of traditional skills and knowledge (Ghaith et al., 2024).

Hence, the incorporation of AI into traditional craftsmanship is not about replacing human artisans but augmenting their capabilities (Buš, 2024). It offers a bridge between the past and the future, ensuring that the essence of craftsmanship is preserved while embracing the efficiencies and possibilities of modern technology (Garvin et al, 2023).

As AI continues to evolve, its role in the craftsmanship sector is likely to expand, offering new tools and techniques that further enhance the artistry and precision of handmade goods.

3. Methodology

The project's methodology was developed through three main phases: Design Modules, Cultural Probes and context mapping, and Technological Integration. Each phase was designed to maximize participation and interaction between Italian and Colombian students, fostering an environment of co-design and mutual learning.

The Design Modules were conducted before the trip to Colombia, during a series of initial workshops designed to prepare participants and select the best projects for the next phase. The structure of the Design Modules included:

- Workshop Structure: Each day was divided into theoretical and practical sessions, with specific objectives for each session. The theoretical sessions included lectures on key co-design concepts, artificial intelligence techniques applied to design, and prototyping methodologies. The practical sessions allowed students to apply this knowledge by developing concrete projects;
- Participants: Italian and Colombian students were divided into mixed groups to promote intercultural collaboration. Each group worked on a specific project, using a combination of digital and analog tools, such as interactive whiteboards, design software, rapid prototyping materials, and brainstorming kits;
- Winner Selection: At the end of the Design Modules, a panel of experts evaluated the projects developed by the students. Evaluation criteria included innovation, feasibility, technology integration, and social impact potential. The project evaluation was conducted by averaging the individual assessments provided by the professors and lecturers, ensuring a balanced and comprehensive review of the participants' work.
- The best projects were selected, and the respective teams had the opportunity to participate in the next phase in Colombia.

3.1 Cultural Probes and context mapping

An important component of our methodology was the implementation of Cultural Probes and context mapping. This phase was conducted directly in the field in Colombia and included:

- Data Collection: Using surveys, interviews, and direct observations to collect qualitative and quantitative data on local practices and stakeholders' perceptions. Use of field guides (see Figure 1) in order to record gestures, smells, sounds, tastes and scenes at some points along the route;

· Context Mapping: Site visits and immersive experiences in cultural identity locations and with local artisans, to gain an in-depth understanding of the local cultural and artisanal dynamics. A route was established in the context by places associated with these dynamics with the use of Google Maps;

· AI Analysis: The collected data were analyzed using artificial intelligence tools. A database was built from a Google Forms survey where responses were entered based on field guides. AI was fundamental in processing a large amount of data and conducting research, eliminating biases from co-designing between two different cultures. Additionally, AI helped break down linguistic and creative barriers, thus improving the quality and effectiveness of the co-design process.

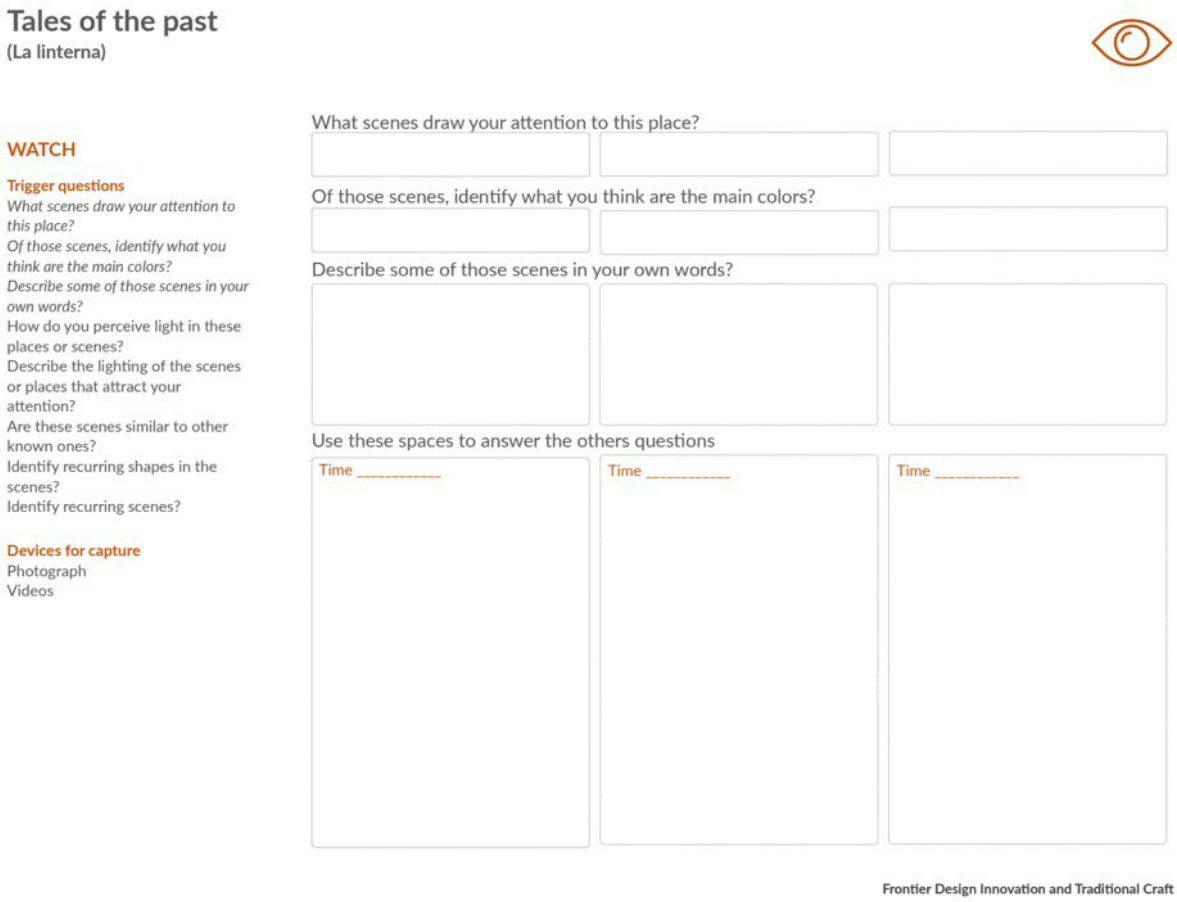


Figure 1. Observation sheet "Tales of the Past" used to collect visual data during the project. Participants respond to trigger questions about scenes that draw their attention, identify main colors, describe lighting and recurring shapes, and note similarities to other known scenes. Responses are recorded in designated spaces to capture visual and narrative characteristics of the observed location. Devices used for capture include photographs and videos.

3.2 The integration of technologies

The integration of technologies, particularly artificial intelligence, was crucial for our project. The main aspects of this phase included:

- AI Integration: Implementing AI tools to support data-driven creativity, facilitating idea generation, prototyping, and concept evaluation. AI played a key role in breaking down linguistic and creative barriers, enabling smoother collaboration between participants from different cultures. Moreover, Data collected in various languages were provided as input to a Large Language Model, which democratized access to the information. This allowed all participants, regardless of their spoken language, to have a uniform knowledge base, enabling deeper engagement and idea exchange; Use of Digital Technologies: In addition to AI, other technologies such as data visualization and bio-creativity were used, allowing for the exploration of new forms of sustainable craftsmanship and design;

- Remote Collaboration: Using digital tools such as video conferencing platforms and online collaborative tools to facilitate continuous communication and collaboration among participants, even after the in-person workshop concluded.

The adopted methodological approach allowed us to achieve significant results in terms of innovation and intercultural collaboration. The integration of contemporary technologies demonstrated the potential to redefine traditional practices and promote new forms of artistic and design expression. Reflecting on the outcomes of the workshops, we were able to identify transformative design practices that develop through a cross-border collaborative approach.

3.3 Generative Reasoning and Systemic Mapping in Cross-Cultural Design Innovation

Systemic mapping is a valuable tool in the analysis and development of complex design projects, especially those involving cross-cultural collaboration. The systemic map created during our project (see Figure 2) illustrates the intricate relationships between various elements of traditional craftsmanship and modern technology. This map served as a generative tool, merging AI-driven analysis with group creativity to drive innovation and deeper understanding in our cross-cultural design workshops.

Systemic mapping facilitated the identification of connections between cultural elements and modern design practices, highlighting potential areas of innovation. The visual nature of the map helped bridge language and cultural barriers, making it easier for participants from different backgrounds to contribute equally. By visualizing the design ecosystem, participants could see new possibilities and intersections that were not immediately obvious.

The systemic map created in our project is a rich tapestry of post-it notes and images, each representing a critical component of the design process. Various traditional crafts and local practices were mapped to show their relevance and potential for modernization. Points where AI and other technologies could enhance or preserve traditional methods were highlighted, and central points where cross-cultural interactions were most effective were identified, showcasing successful collaboration.

Post-analysis of the systemic map involved several steps: gathering qualitative data from participants' experiences and insights during the workshops, using AI tools to identify patterns and recurring themes in the data collected, and generating new design concepts based on the identified patterns. This integration of AI analysis and group creativity yielded significant insights and innovations, such as hybrid designs combining traditional craftsmanship with modern design principles, leveraging local materials and sustainable practices, and developing new educational modules that incorporate systemic mapping and AI tools to teach design students about crosscultural collaboration. Several case studies emerged from the workshops, demonstrating the practical application of insights gained from the systemic map. For example, a project that combined traditional Colombian weaving techniques with Italian design aesthetics created a sustainable product line, directly informed by the systemic map. Another project used AI to analyze and map community data in a Colombian village, providing deeper insights into local needs and cultural practices. A third case study explored the use of bio-based materials in design, driven by insights from the systemic map about local resources and sustainable practices.

While the systemic map provided numerous benefits, several challenges were encountered, such as managing the complexity of the map, ensuring cultural sensitivity, and overcoming technological barriers. Solutions included conducting interactive sessions to help participants become familiar with the systemic map, holding workshops focused on cultural sensitivity and the respectful integration of technology, and providing additional technical training and support to participants less familiar with the digital tools used.

The integration of systemic mapping into our cross-cultural design project proved to be a transformative approach, enabling generative reasoning that drove innovation and deeper cultural understanding. By visualizing complex relationships and facilitating collaborative creativity, systemic mapping bridged the gap between traditional craftsmanship and modern technology, paving the way for future cross-cultural design endeavors. This section outlines how systemic mapping and generative reasoning can be effectively utilized in design innovation projects, providing a robustframework for future research and practice in cross-cultural design.



Figure 2. Systemic map from cross-cultural design workshops, illustrating connections between cultural heritage, technological integration, and collaborative nodes to identify potential innovation areas.

4. Case studies and results

The results reflect the impact of this comprehensive approach, as evidenced by the diverse range of innovative projects and the mutual learning experiences of the participants.

4.1 Intercultural design collaboration

In one of the standout projects, Italian and Colombian students collaborated to develop a sustainable product line that blends traditional Colombian craftsmanship with modern Italian design aesthetics. This project exemplified how cross-cultural collaboration can lead to the creation of products that respect and innovate upon cultural heritage. The team used digital prototyping tools and AI-driven data analysis to refine their designs, ensuring both cultural authenticity and contemporary appeal.

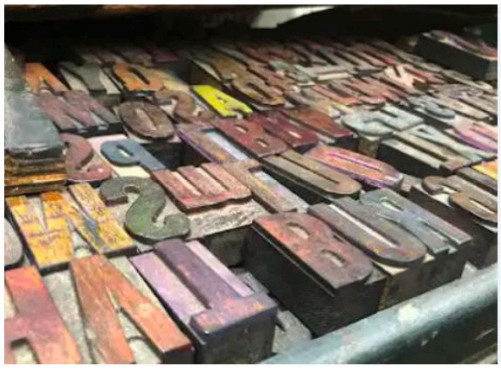
Image	Where	Archive name	Extracted objects
	Cali - Mercado	iimg2332.jpg	letters
	Cali - gatos	imgen3633566.jpg	cat bag
	Cali - Linterna	la linterna 1 - Anny Gicela Guerrero Chapal.jpg	person (3) bottle (3) cup (3) bowl (1)

Table 1. AI image analysis

4.2 AI-Enhanced Community Mapping

Another significant project involved the use of AI for community mapping in a Colombian village. Participants collected data through interviews and observations, which were then processed using AI tools to identify key cultural and social patterns. This project demonstrated the power of AI in enhancing understanding and visualization of complex cultural contexts, leading to more informed and culturally sensitive design solutions.



Figure 2. Image labelling examples

4.3 Bio-Creativity in Sustainable Design

A third case study focused on the integration of bio-creativity techniques with local materials. Italian and Colombian students worked with local artisans to create sustainable design prototypes using bio-based materials and techniques. This project not only highlighted innovative uses of local resources but also provided new economic opportunities for the artisans involved.
The outcomes of these collaborative efforts were multifaceted, showcasing the potential of blending traditional and modern practices through advanced technology and intercultural teamwork.

4.4 Innovation in Design

The collaborative process resulted in several innovative products and design solutions that were both culturally relevant and technologically advanced. For instance, the sustainable product line project combined traditional weaving techniques with modern materials, creating a unique blend of old and new that appealed to both local and international markets.

4.5 Enhanced Understanding through AI

The use of AI tools in data collection and analysis proved to be highly effective. AI helped break down language barriers and provided deep insights into cultural nuances that would have been difficult to discern through manual methods alone. This led to more accurate context mapping and betterinformed design decisions.

The projects not only fostered innovation but also emphasized sustainability. The use of biomaterials and the focus on local craftsmanship helped promote environmentally friendly practices. Additionally, the economic impact on local communities was significant, as the projects opened up new avenues for income generation and skill development.

4.6 Digital tools and AI technologies

Throughout these projects, various digital tools and AI technologies were employed to enhance the participants' perceptions and capabilities. Digital tools were used to generate new information from the collected elements in the systemic map, such as identifying key concepts from text documents, transforming audio interviews into text, recognizing entities in images, converting ambient sounds into numerical data, and generating images from text using tools like DALL-E.

Text processing involved using AI, in particular ChatGPT, for topic modeling to reveal the main topics in extensive texts, identifying entities such as people, objects, and places mentioned in the texts, and performing keyword extraction to list all keywords and create co-occurrence tables of keywords found in the same sentences or paragraphs.

Image processing was conducted using YOLO (Redmon et al., 2016), where images were analyzed to label and identify key elements. This process included uploading images, running scripts to process them, and obtaining labeled outputs.

Interview transcription was facilitated by Otter.ai (Corrente et al., 2022), which transcribed audio files into text, making it easier to analyze and identify keywords. Sound processing involved converting sounds into numerical representations, similar to the image labeling process but using audio-specific tools.

Ethical considerations were paramount in the use of AI tools. All AI applications complied with ethical standards, ensuring the transparency of training databases and using local languages to avoid cultural biases. This integration of digital tools and AI technologies enabled a more comprehensive, inclusive, and non-discriminatory approach to design, significantly enhancing the quality and impact of the collaborative projects.

By leveraging these advanced technologies, we were able to achieve a deeper understanding of cultural contexts, foster innovation, and promote sustainable practices. This comprehensive and inclusive

approach has shown how modern technology can be harnessed to support and enhance traditional craftsmanship and intercultural collaboration in design.

5. Learnings from the Workshop: key insights and challenges faced during the project.

The workshops showed the strong potential of combining new technologies with traditional craftsmanship in a cross-cultural setting. We found that technology, when used carefully, can connect different cultural expressions rather than separate them. Using AI and digital tools highlighted the importance of preserving the essence of traditional methods while enhancing them with modern innovation. This balance was achieved through ongoing discussions and iterative design processes, promoting a sense of shared ownership and mutual respect among participants from different cultural backgrounds.

However, the process was not without its challenges. Working with diverse cultures required sensitivity and adaptability. Language barriers and different levels of comfort with technology among participants sometimes slowed progress. Yet, these challenges also became opportunities for growth, as they required the development of new communication strategies and teaching methods that could accommodate various learning styles and cultural perspectives. The workshops underscored the value of patience and the need for flexible, inclusive approaches in co-design projects.

5.1 Comparison with existing literature: how the findings extend or challenge current understanding of cross-cultural design and AI integration.

Our findings provide a detailed perspective that both supports and extends current discussions on cross-cultural design and AI integration. While existing literature often emphasizes the theoretical benefits of interdisciplinary and cross-cultural collaboration (Augsburg, 2014; Thompson, 2014), our project offers concrete evidence of these benefits in practice. The use of AI tools not only facilitated more inclusive and unbiased design processes but also revealed new dimensions of cultural synthesis and innovation that had not been fully explored before.

Moreover, our project challenges some prevailing assumptions about the role of technology in design. Contrary to the view that technology might overshadow traditional practices, we found that AI and digital tools can enhance and preserve cultural heritage when used thoughtfully. This finding prompts a re-evaluation of the perceived divide between tradition and innovation, suggesting instead a mutually beneficial relationship where each can enrich the other.

5.2 Broader Implications: potential for AI and technology to reshape the design and art fields.

The broader implications of our project are significant, suggesting that the strategic integration of AI and technology can change the fields of design and art. By facilitating deeper cultural understanding and fostering innovative practices, these technologies have the potential to transform how we approach creativity and craftsmanship.

AI proved to be a powerful tool in this transformation. Its ability to process and analyze large amounts of data quickly and accurately provided insights that were previously unattainable, enhancing the design process's depth and precision. Additionally, the use of digital platforms for remote collaboration broke down geographical barriers, enabling continuous and dynamic interaction between participants from different parts of the world.

Furthermore, the project highlighted the potential for AI and technology to support sustainable practices. By optimizing resource use and promoting eco-friendly materials, these tools can help designers and artists create works that are not only beautiful and culturally significant but also environmentally responsible.

However, the reliance on technology also introduced certain drawbacks. For instance, the need for continuous access to digital tools and platforms could create disparities among participants with varying levels of technological access and expertise. Additionally, the integration of AI raised ethical concerns regarding data privacy and the potential for algorithmic biases, which require careful consideration and ongoing oversight.

5.3 Conclusion

This research underscores the transformative potential of integrating contemporary technologies, particularly artificial intelligence (AI), with traditional craftsmanship in a cross-cultural context. The project's methodology, which combined design modules, cultural probes, context mapping, and technological integration, facilitated a dynamic and inclusive environment for co-creation and innovation. Through this approach, we observed significant advancements in design practices, fostering an environment where modern technology and traditional craftsmanship synergistically enhance each other.

The findings highlight several key insights. First, AI and digital tools are not merely adjuncts to traditional methods but can actively preserve and amplify cultural heritage. By providing unprecedented levels of data-driven creativity and sustainability-focused innovations, these technologies bridge the gap between the old and the new, ensuring the continuity of cultural narratives in contemporary design contexts.

Second, cross-cultural collaboration, as evidenced by the diverse and innovative projects generated through this initiative, is pivotal in enriching the design process. The integration of different cultural perspectives and expertise led to the development of products and solutions that are both culturally resonant and technologically advanced. This collaboration not only fostered mutual learning and respect but also unveiled new dimensions of cultural synthesis and innovation, challenging prevailing assumptions about the role of technology in design.

However, the project also illuminated the challenges inherent in such interdisciplinary and intercultural endeavors. Language barriers, varying levels of technological proficiency, and the need for adaptive communication strategies emerged as critical factors requiring careful navigation. These challenges, while significant, also offered opportunities for growth and the development of new, more inclusive methodologies.

The broader implications of this research suggest that the strategic integration of AI and technology in design can profoundly reshape the fields of art and craftsmanship. By enabling deeper cultural understanding and fostering innovative, sustainable practices, these technologies can transform traditional design processes, making them more inclusive, precise, and environmentally responsible. Nonetheless, it is essential to address the ethical considerations associated with AI, such as data privacy and algorithmic biases, to ensure that technological advancements do not perpetuate inequalities or cultural insensitivity.

In conclusion, the project's outcomes reaffirm the value of blending traditional craftsmanship with contemporary technology within a cross-cultural framework. This fusion not only enhances the creative process but also promotes a richer, more inclusive understanding of design. The insights gained from this research provide a robust foundation for future explorations into the integration of AI and other advanced technologies in design, advocating for a balanced approach that respects and leverages cultural diversity to foster innovative and sustainable design practices.

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RESEARCH ON THE EXPERIENCE PRODUCT DESIGN OF INTANGIBLE CULTURAL HERITAGE “SONG DYNASTY KITES” BASED ON THE PERSPECTIVE OF USER NEEDS

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ABSTRACT | Intangible Cultural Heritage (ICH) is an important symbol of the historical and cultural achievements of a country and a nation, and in recent years, as the awareness of ICH protection has been raised, Experiential ICH Products are gradually attracting wide public attention. The purpose of this paper is to explore how to design experiential ICH products based on the user needs perspective, using China’s Song Dynasty Kites (SDK) as an example. According to Donald A. Norman’s Emotional Design Theory, semi-structured interviews and observation methods are used to obtain users’ initial needs. And by building the KANO-AHPQFD integrated model, the user needs are weighted and transformed into design elements. The result is a completed experiential product design solution for SDK based on the first 10 design elements derived from building the House Of Quality. The combination research method of this study deeply mines user requirements and applies them to ICH experience products, which can effectively improve satisfaction and thus user stickiness, promote the living inheritance of ICH, and also provide an innovative path and reference model for the design of other ICH experience products.

KEYWORDS | INTANGIBLE CULTURAL HERITAGE, SONG DYNASTY KITES, KANO, AHP, QFD

1. Introduction

Since the 1990s, global academics have paid great attention to the relationship between globalization and cultural diversity. The protection and transmission of ICH has become one of the key issues, and in 2003, UNESCO promulgated the Convention for the Safeguarding of the Intangible Cultural Heritage. The safeguarding of ICH is an important factor in maintaining social coherence and cultural diversity, but it is also a challenge in modern society (Pistola et al., 2021). Overall, the safeguarding of ICH of all peoples of the world is not only a consensus of all countries in the world, but also a universal demand of all peoples. As a cultural power with five thousand years of inheritance, as of May 2024, China has 43 items inscribed on the UNESCO ICH list and register, which is the highest number in the world. In the diversified and integrated pattern of China's civilization, the Central Plains culture plays a central and dominant role (Fan Yuchou, 2006). As an important carrier of the Central Plains culture, Henan has not only preserved rich historical relics and cultural heritages, but also nurtured many ICHs with local characteristics.

Among them, Song Dynasty Kites (SDK) is one of the outstanding representatives. SDK comes from the royal family in the Northern Song Dynasty. According to legend, the kite flew out of the palace when the emperor of the Northern Song Dynasty was playing with a kite, and it flowed into the people until now. The Song family also developed a unique double-headed shape in the process of being passed down from generation to generation. SDK, as an important part of Chinese kite culture, carries rich historical information and cultural connotation. The evolution of kites has witnessed the social and cultural changes and development as well as highlighted the spirit of Chinese art and philosophical thinking of the unity of heaven and man. SDK have become a bright pearl in Chinese kite culture with its unique kite style and kite making skills.

Given that kites have been developed so far, they are mostly used as recreational toys. Therefore, the design of experiential products for SDK can not only help more people understand and love SDK, but also inherit and promote ICH.

2. Status of research

In recent years, under the guidance of China's policy of supporting the innovative development of ICH, experiential products related to ICH have attracted much attention from the public, and along with the rapid development of cultural tourism and study education (Ma, Yunlin & Zhang, Fang, 2023), they have become one of the most important ways of ICH inheritance and preservation. The cultural connotation of ICH is embedded in the production and creation process of "non-materials", and experiential products can maximize the user's understanding of the unique production techniques of ICH. He Jia et al. suggested that expanding the multichannel public participation system by means of handmade experience would be a way to help ICH dissemination (He Jia & Ben Zhang, 2022). Lu, Zhicong et al. successfully stimulated students' interest in ICH by engaging them in an ICH-oriented experience design (Lu, Tan, Ji, & Ma, 2022). Yue Zhang's team made it easier for children to acquire knowledge of ICH embroidery through a gamified interactive experience design, allowing for better transmission and popularization of today's ICH skills (Zhang, Xu, Wang, Yang, & He, 2023). Zhu Junjie's team developed an experiential game product of ICH "Bu hu Hunting" through an experiential educational game model (Zhu, Li, Zheng, & Sun, 2024). Dong Chaonan et al. improved the design process and methodology of ICH bamboo weaving handicraft experience products by using the double diamond model through design thinking research (Dong, Chaonan, Chen, Ruoru, Xia, Zhiyuan, & Wu, Jue, 2022). Tingting Ma explored the users' demand for ICH cultural products in Shanxi under the perspective of service design by establishing a KANO model, and analyzed the strengths and weaknesses of ICH cultural and creative products in Shanxi in combination with SWOT (Tingting Ma, 2022). However, with the promotion of ICH experiential products, the lack of demand side has become a key issue in ICH product development. Although current research on ICH experiential products has reached a certain scale, there are still many flaws and deficiencies. On the one hand, there is a lack of in-depth and precise analysis of user needs, a lack of systematic methods and models, and a lack of integration of multiple effective design tools and methods in the design process of experience products. On the other hand, under the background of experience economy, consumers pay more attention to the emotion carried by the products and the humanized experience, which is also an important factor restricting the further development of ICH experience products.

In order to try to make a solution to the above problems and to design ICH experience products based on the perspective of user needs, the "SDK" is used as an example for research in practice. In order to further inherit and promote SDK, and to combine it with cultural tourism and study tour, this paper is based on the user needs perspective. This paper is guided by Donald A. Norman's

Emotional Design Theory, and uses both qualitative and quantitative research methods to construct a KANO-AHP-QFD integrated model to guide the development of the SDK experience product. We explored an innovative and effective path for the design of ICH experience products, promoted the inheritance and development of ICH culture in contemporary society, and scientifically optimized the user experience.

3. Research method

In user needs-based design research, commonly used design models include the KANO model, Analytic Hierarchy Process (AHP), Quality Function Deployment (QFD), Axiomatic Design (AD), Kansei Engineering (KE), etc. In recent years, researchers have constructed complementary integrated models based on the differences of the design models to guide their practice. For example, Ruo-Mei Tang et al. used the KANO-AHP-AD theoretical model to develop the design practice of a pediatrics dental chair (Ruo-Mei Tang, Junjie Li, Qiong Luo, Dadi Lin, & Xiangbin Peng, 2023). Jia Li and KieSu Kim used an integrated Kano-QFD model to design an app for ICH crafts so that users can quickly and easily perceive ICH culture through mobile devices (Li & Kim, 2023). Shi Yuanwu and Han Shan used QFD and KANO models to analyses the users' styling design requirements for medical service robots and proposed effective design solutions accordingly (Shi Yuanwu & Han Shan, 2017). Chen Xu et al. completed the interaction design of age-appropriate smart home products through QFD-TRIZ integrated model (Chen Xu & Xue Biao, 2019).
The KANO model, originally proposed by Japanese scholar Noriaki Kano in 1984, is a tool used to categories and priorities users' needs, and is designed to help companies better understand their customers' needs and improve their products or services accordingly to increase customer satisfaction (Barsalou, 2023). It classifies user needs into five types, namely Must-be Quality (M), One-dimensional Quality (O), Attractive Quality (A), Indifferent Quality (I) and Reverse Quality (R). KANO model can reveal the non-linear relationship between product performance and user satisfaction, but KANO model can only achieve the effect of qualitative analysis in acquiring user needs, and it cannot judge and analyze the degree of importance between each user need, and there is a certain degree of subjective error, so it needs to be combined with other quantitative methods in order to ensure the scientific nature of the design strategy.

AHP was proposed by Thomas L. Saaty, a famous American operations researcher and professor at the University of Pittsburgh, in the mid-1970s. The model combines qualitative and quantitative analysis methods, and its core lies in constructing a hierarchical model to decompose the decision-making problem into Goal Layer, Criterion layer, and Alternative layer, and determining the relative importance or priority of each factor by comparing them two by two to provide a basis for the optimal choice of alternatives

(Liu, Eckert, & Earl, 2020). AHP is able to determine the weighting factors for each user requirement, but it is unable to convert user requirements into specific design requirements.

QFD is a systematic approach proposed by Japanese scholars Yoji Akao and Shigeru Mizuno in the 1960s. The method is a user demand orientated quality management tool that translates user demand into design parameters and completes the mapping from demand to design strategy to ensure that the product design and production matches the user demand, thus ensuring that the final product meets or exceeds the customer's expectations. However, this method is unable to obtain important user requirements indicators.

Based on the analysis of the above model, this study proposes a product design process that integrates KANO, AHP and QFD, as shown in Figure 1. This design process is orientated to the user needs of SDK non-heritage experience products, combining both qualitative and quantitative research methods, and mapping out specific design elements through a scientific research process while considering user needs.

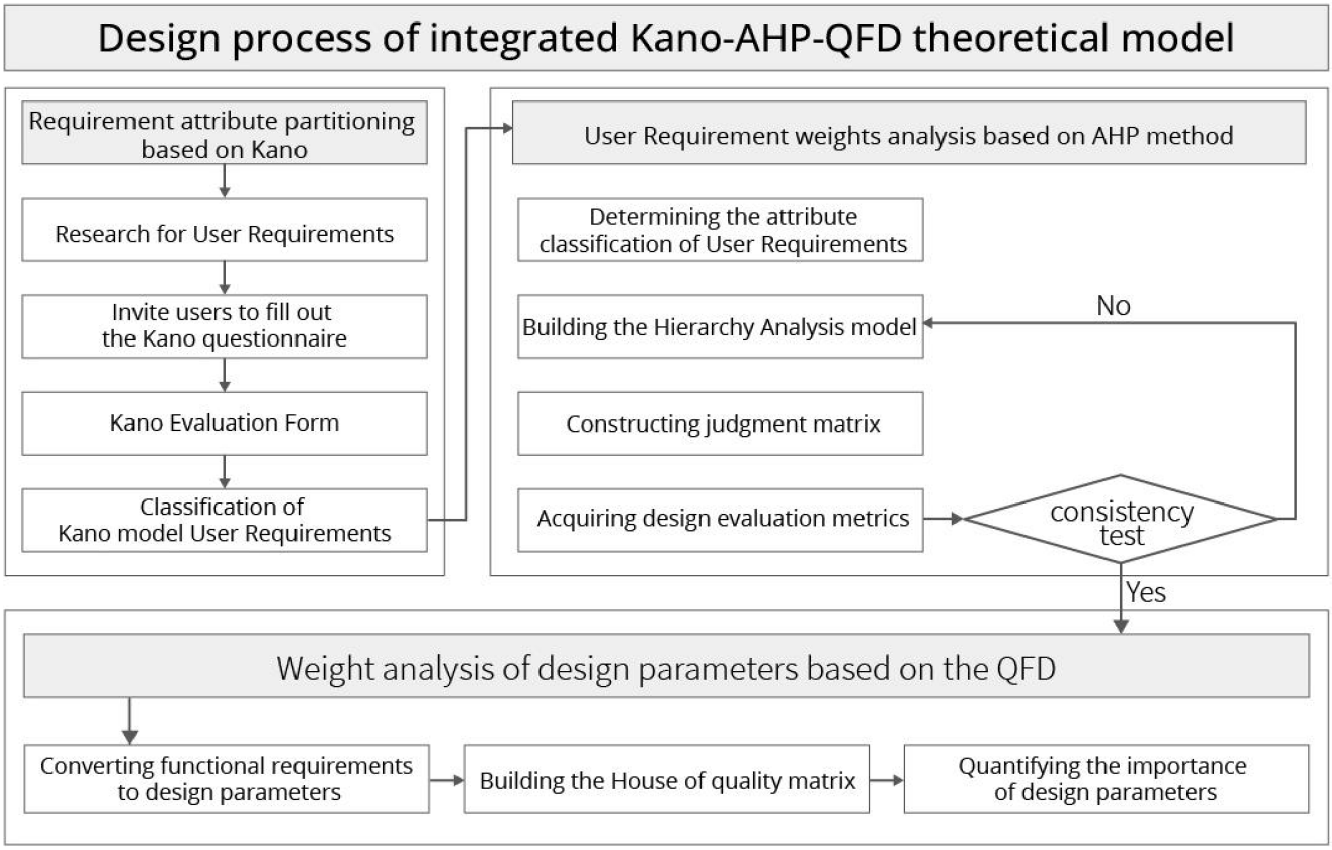

Figure 1. Design process of integrated Kano-AHP-QFD theoretical model

4. KANO-AHP-QFD integrated modelling of SDK experience product design process

4.1 User experience element acquisition

Regarding the user's experience needs, the Emotional Design Theory proposed by Donald A. Norman in Emotional Design systematically divides people's emotional needs into Instinct layer, Behavior layer and Reflection layer, and stresses that no kind of design can be completely independent of these three levels. Instinct layer design is the law of nature, in this level plays a leading role in people's five senses of experience, for example, traditional cultural books using antique paper can be from the sense of touch to bring direct feelings. Behavior layer is the user's experience of the product in terms of functionality, utility and ease of use (Lu, Chunfu, Xiao, Zihao, & Fu, 2020). Products with a Reflection layer create a mood that establishes an emotional connection with the user, evoking a deep-seated response based on personal values, such as pride, satisfaction, and happiness.

This paper maps Emotional Design Theory to the design of ICH experience products, corresponding to the refinement of the Sensory experience, Interaction experience and Emotional experience three experience elements, as in Figure 2, only when all of them are satisfied, users can get the best experience.

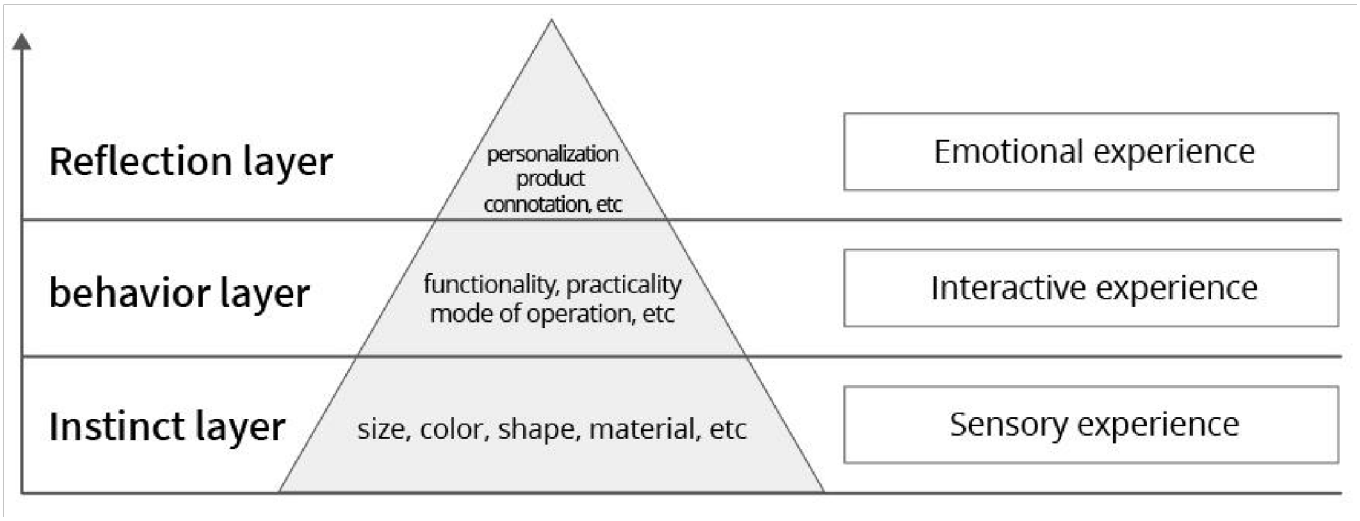

Figure 2. Mapping Emotional Design Elements for Experience Products

The author cooperated with the inheritor of SDK and conducted a research and analysis based on the current study and visit experience groups of SDK. It is found that the users interested in SDK experience products are mostly young people aged 15-25, who are mostly in the stage of education, full of curiosity about new things, with strong learning ability and hands-on desire. Among them, students are interested in SDK experience products due to the guidance of various

cultural activities organised by schools, their own desire for traditional culture and the characteristics of experience products. Therefore, this paper chooses the student group aged 15-25 as the target group of SDK experience product design.

In order to make the research more targeted, semi-structured in-depth interviews and observation methods were firstly adopted to obtain explicit and implicit needs around the target group. Secondly, the primitive descriptions of the experiencers were transformed into clear user needs, and finally, the card analysis method was used to classify and merge them into three categories and 16 preliminary user needs vocabularies in accordance with the Emotional Design Theory. As shown in Table 1.

Table 1. User need extraction

Experience elements	Requirement number	User needs
Sensory experience	1	Ancient colors
	2	Representative kite shape
	3	The material presents a simple and ancient texture
Interaction experience	4	Clear instructions
	5	Timely operation feedback
	6	Complete set of tools
	7	Estimation of experience time
	8	Moderately difficult to operate
	9	Lightweight materials to ensure flight
	10	Display and storage of the finished product
	11	Material safety
	12	Spare materials are available
	13	Long-term storage of the finished product
Emotional experience	14	Cultural stories
	15	A certain sense of modern design
	16	Personalization

4.2 Classification of User Requirement Attributes Based on the Kano Model

In this study, based on the KANO model and the 16 acquired user experience requirements, a KANO questionnaire in the form of a Five-point Likert scale was constructed by designing standardized positive and negative questions with the aim of exploring the requirements attributes in depth. The questionnaire answer options

were like, necessary, irrelevant, tolerable and dislike as shown in Table II. A total of 100 questionnaires were distributed to students aged between 15 and 25 years old, and all of them were validly returned. The results of the questionnaires were then consolidated and analyzed. According to the answers of the questionsanswered by the users, based on the demand codes in the Comparison table for the classification of KANO evaluation results in Table 3, the number of demand codes for each question was counted. The number of demand codes for each question was counted and converted into a percentage.

According to the outcome attributes that accounted for the largest share of the results attributed them to Must-be Quality (M), One-dimensional Quality (O), Attractive Quality (A), Indifferent Quality (I) and Reverse Quality (R).

Table 2. KANO model Five-point Likert scale

Serial number	Concern	Like (5)	Necessary (4)	Irrelevant (3)	Tolerable (2)	Dislike (1)
1	How do you feel if the experience product has ancient colors?					
2	How do you feel if the product does not have ancient colors?					

Table 3. Comparison table for the classification of KANO evaluation results

Positive	Negative				
	Like(5)	Necessary(4)	Irrelevant(3)	Tolerable(2)	Dislike(1)
Like(5)	Q	A	A	A	O
Necessary(4)	R	I	I	I	M
Irrelevant(3)	R	I	I	I	M
Tolerable(2)	R	I	I	I	M
Dislike(1)	R	R	R	R	Q

And the importance level of this need is obtained by calculating the satisfaction index (SI) and dissatisfaction index (DSI) (Chaudha, Jain, Singh, & Mishra, 2011), which ultimately results in Table 4

$$\text{Satisfaction index}(SI) = \frac{(A_i + O_i)}{(A_i + O_i + M_i + I_i)}$$
$$\text{Dissatisfaction index}(DI) = -1 * \frac{(M_i + O_i)}{(A_i + O_i + M_i + I_i)} \quad (1)$$

Table 4. Results of KANO questionnaire analysis

Requirement number	M	O	A	I	R	Q	KANO Positioning	SI	DI
1	31.00%	4.00%	29.00%	22.00%	2.00%	12.00%	M	0.38	-0.41
4	31.00%	19.00%	18.00%	18.00%	2.00%	12.00%	M	0.43	-0.58
6	32.00%	17.00%	17.00%	20.00%	1.00%	13.00%	M	0.40	-0.57
9	6.00%	33.00%	17.00%	26.00%	1.00%	17.00%	O	0.61	-0.48
11	16.00%	38.00%	15.00%	15.00%	0.00%	16.00%	O	0.63	-0.64
13	5.00%	37.00%	25.00%	14.00%	2.00%	17.00%	O	0.77	-0.52
2	6.00%	7.00%	49.00%	25.00%	1.00%	12.00%	A	0.64	-0.15
3	3.00%	8.00%	52.00%	24.00%	1.00%	12.00%	A	0.69	-0.13
10	2.00%	9.00%	46.00%	23.00%	2.00%	18.00%	A	0.69	-0.14
14	2.00%	9.00%	47.00%	22.00%	3.00%	17.00%	A	0.70	-0.14
15	3.00%	6.00%	50.00%	23.00%	1.00%	17.00%	A	0.68	-0.11
16	3.00%	7.00%	52.00%	19.00%	2.00%	17.00%	A	0.73	-0.12
5	5.00%	14.00%	20.00%	46.00%	3.00%	12.00%	I	0.40	-0.22
7	4.00%	8.00%	27.00%	48.00%	0.00%	13.00%	I	0.40	-0.14
8	3.00%	11.00%	21.00%	49.00%	4.00%	12.00%	I	0.38	-0.17
12	10.00%	12.00%	22.00%	42.00%	1.00%	13.00%	I	0.40	-0.26

As can be seen in Table 4, four types of KANO requirement attributes appear in the 16 user requirements. In the table, 1, 4, and 6 are Must-be Quality (M) These types of needs are essential points for SDK experience products, and if they are met, user satisfaction will not increase significantly, and if they are not met, user satisfaction will decrease significantly. Since all of these needs have been largely satisfied in the current ICH experience products, they should continue to be provided. Serial numbers 9, 11, and 13 are One-dimensional Quality (O) The better such needs are considered in the design of the SDK experience product, the higher the user satisfaction will be. On the contrary, it will cause user dissatisfaction. Therefore, such needs need to be satisfied as much as possible. Attractive Quality (A) is 2, 3, 10, 14, 15, 16, when this kind of demand is satisfied, it will bring some surprises beyond the expectations of the users, which can greatly improve the user satisfaction, so it should be considered in the design of SDK experience products. The remaining 4 items are Indifferent Quality (I), i.e., these needs will not affect user satisfaction no matter whether they are satisfied or not, so these 4 user needs will be excluded and will not appear in the subsequent design process.

4.3 AHP-based weighting analysis of user requirements

In this study, the user requirements of SDK experience products were first classified using the KANO model. In order to further clarify the focus of the subsequent product design, this paper will apply the AHP Analytic Hierarchy Process to construct a hierarchical analysis model after the analysis of the KANO model, and to clarify the weights of the user requirements, so as to enhance the accuracy and objectivity of the analysis of user requirements. According to the user requirements and design objectives of SDK experience products, the AHP model is divided into Goal Layer, Criterion Layer and Sub-Criterion Layer.

The Goal Layer is the SDK experience product design solution. The Criterion layer (Primary Indicator) is based on Donald A. Norman's emotional design theory of Sensory experience, Interaction experience and Emotional experience.

The Sub-criterion layer (Secondary Indicator) is the 12 design elements filtered out by the Kano model in the previous section, and these 12 elements are corresponded and recoded according to the Criterion layer, which are: ancient colors M1, representative kite shape A1, The material presents a simple and ancient texture A2, clear instructions M2, complete set of tools M3, lightweight materials to ensure flight O1, material safety O2, long-term storage of the finished product O3, Display and storage of the finished product A3, Cultural stories A4, Certain sense of modern design A5, Personalization A6. as shown in Figure 3.

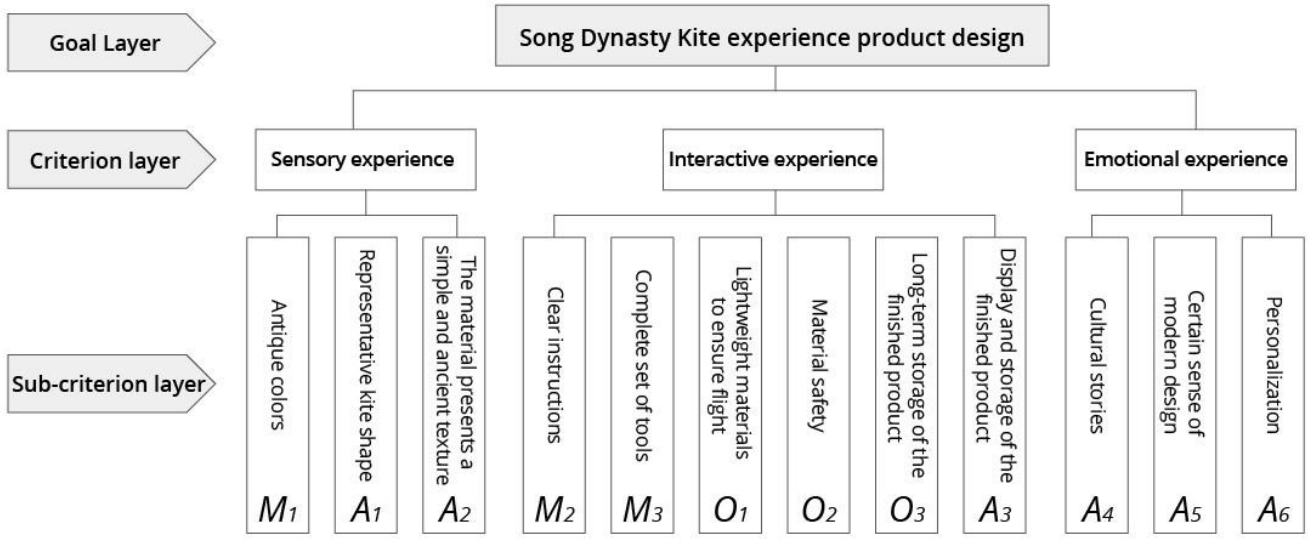

Figure 3. SDK Experience Product Design AHP Model

In order to ensure the scientific and objectivity of the results of user requirements weighting, this study invites 15 researchers related to the product design of SDK experience, including five non-geneticists, four doctoral students of product design, two professors of visual communication design, and four postgraduate students related to the study of ICH. They were invited to compare and rate the importance of the needs of each level of SDK experience products two by two according to the 1-9 scale method, and the arithmetic mean was used as the basis for weight calculation to derive the judgement matrix of each level. And then the geometric mean method was applied to calculate the weighting results to derive the weighting values of user requirements of SDK experience products, and the consistency test was conducted on the matrix scoring, and the arithmetic process was as follows, and the results are shown in Table 5 and Table 6.

1）Construct the judgment matrix, in the formula, $a_j \cdot a_{ji} = 1$，$i \neq j = 1, 2, \cdots, n$.

$$S = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a \end{bmatrix} \quad (2)$$

2）According to the judgment matrix, the mean value is obtained by geometric average method V_i.

$$V_i = \sqrt[n]{\prod_{j}^{n} S_{ij}} \quad (3)$$

The results are normalized, and the average weight W_1 and weight vector W are obtained.

$$W_1 = \frac{\sqrt[n]{\prod_{j}^{n} S_{ij}}}{\sum_{i=1}^{n} \sqrt[n]{\prod_{j}^{n} S_{ij}}} \quad (4)$$

$$W = (w_1 w_{2,\cdots} w_n)^T \quad (5)$$

3）Computing the Maximum Eigenvalue (λ_{max}) :

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{S_{wi}}{W_i} \quad (6)$$

In the formula, S_{wi} represents the i-th component of vector S_w , n represents the order of the matrix.

4）Conducting a consistency check on the results. (I_{CI}) :

$$I_{CI} = \frac{\lambda_{max} - n}{n - 1} \quad (7)$$

$$I_{CR} = \frac{I_{CR}}{I_{RI}} \quad (8)$$

In the formula: n represents the order of the judgment matrix, IRI stands for the Index of Random Consistency, ICR denotes the Consistency Ratio.

Table 5. Criterion layer weights

Primary Indicator	Sensory experience	Interaction experience	Emotional experience	weight value	I_{CR}
Sensory experience	1	1/2	3	0.3090	
Interaction experience	2	1	5	0.5816	0.0036
Emotional experience	1/3	1/5	1	0.1095	

Table 6. Sub-criterion layer weights

Primary Indicator	Secondary Indicator	Judgment Matrix						weight value	ICR
Sensory experience	M1	1	1/2	2	×	×	×	0.2970	0.0088
	A1	2	1	3	×	×	×	0.5396	
	A2	1/2	1/3	1	×	×	×	0.1634	
Interaction experience	M2	1	3	7	2	5	4	0.3817	0.0198
	M3	1/3	1	5	1/2	3	2	0.1625	
	O1	1/7	1/5	1	1/6	1/2	1/4	0.0360	
	O2	1/2	2	6	1	4	3	0.2535	
	O3	1/5	1/3	2	1/4	1	1/2	0.0628	
	A3	1/4	1/2	4	1/3	2	1	0.1035	
Emotional experience	A4	1	2	4	×	×	×	0.5584	0.0176
	A5	1/2	1	3	×	×	×	0.3196	
	A6	1/4	1/3	1	×	×	×	0.1220	

When the I_{CR} (Inconsistency Rate) ≦ 0.1 in the consistency test result, it is usually considered to have high consistency and reliability. The ICR of the Criterion layer is 0.0036, and the subCriterion layers are 0.0088, 0.0198, and 0.0176 are all less than 0.1, passing the consistency test. It was obtained to multiply the weight value of Primary Indicator by the weight value of the corresponding Secondary Indicator to calculate and rank the relative weights in the whole model, as shown in Table 7.

Table 7. Relative Weight Calculation Ranking

Number	M1	A1	A2	M2	M3	O1	O2	O3	A3	A4	A5	A6
Relative Weight	0.092	0.167	0.051	0.222	0.095	0.021	0.147	0.037	0.060	0.061	0.035	0.013
Ordering	5	2	8	1	4	11	3	9	7	6	10	12

4.4 Analysis of design elements of SDK experience product based on QFD

The core purpose of QFD is to transform customer needs and preferences into product design features (Wang Genxin, 1998). After clarifying the priority of user needs of SDK experience products through AHP in the previous section, it is necessary to map user needs into design elements through QFD and complete the weight calculation of design parameters by establishing House Of Quality (HOQ). When converting user requirements into design elements, firstly, the initial acquisition was made through literature research method, secondly, 10 ICH experience products currently on the market were selected for analysis through case study method, and finally, Table 8 User Requirements-Design Elements Conversion Table of SDK Experience Products was obtained by summarizing and combing through group discussion method.

Table 8. User Requirements-Design Elements Conversion Table of SDK

Goal Layer	Criterion layer	User needs	Design elements
SDK experience product design	Sensory experience	M1	D1 Traditional color combinations of cinnabar red, stone green and rattan yellow
		A1	D2 The representative two-headed parrot kite
		A2	D3 Using natural bamboo, rice paper, silk cloth, etc.
	Interaction experience	M2	D4 Demonstrate the steps of making the kite with drawings
		M3	D5 Provide special scissors, glue, brushes, paints and other tools.
		O1	D6 Bamboo is as light as possible
		O2	D7 Materials are non-toxic and harmless, especially paints and glues
		O3	D8 Provide anti-oxidation treatment and design moisture-proof packaging.
		A3	D9 Design display space inside the package
	Emotional experience	A4	D10 Tell the story of the history of kites/SDK
		A5	D11 Design incorporating modern elements such as simplicity, geometry and abstraction
		A6	D12 Add your own name, logo or favorite pattern on the kite

HOQ is a graphical method for determining the link between customer needs and corresponding product or service performance. Using HOQ, core user needs can be filtered out (Yueqian Yang, Yushan Zhu, & Wei Xu, 2022), user needs and their corresponding Relative Weights are imported into the left wall, and design elements are imported as ceilings. Five professors and PhDs in product design where invited to score the relevance of user needs and design elements. Strong correlation is denoted by ● , general correlation by ◎ , and weak correlation by △ , with ● , ◎ , and △ corresponding to weight values of 1.5, 1.2, and 1.0, respectively.The sum of the products of all user requirements and their corresponding Relative Weights under the Design Element is the final weight of the element (Qiang Wei, 2022). The results are shown in Table 9.

Table 9 . House Of Quality and Design Element Weightings

User needs		Design elements											
User needs	Weight value	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
M1	0.092	●											
A1	0.167		●										
A2	0.051	◎	△	◎		◎	△				△		
M2	0.222				●							△	
M3	0.095			◎	△	●			△				
O1	0.021			△			△						
O2	0.147			△		◎		●					
O3	0.037		△						◎	△			△
A3	0.060		◎		△			△	◎	◎	◎		△
A4	0.061	△	●	△							●		
A5	0.035											△	
A6	0.013					△							◎
Final weight		0.259	0.501	0.403	0.488	0.393	0.071	0.281	0.211	0.109	0.214	0.257	0.113
Rank		6	1	3	2	4	12	5	9	11	8	7	10

5. SDK experience product design

Based on the comprehensive model of Kano-AHP-QFD in the previous section, the transformed design elements were finally ranked, and the top ten items with high weighting were focused on in the process of design practice, and a SDK experience product that can optimize the user experience was designed from the three aspects of Norman's Emotional Design Theory, namely, Behavior layer (Instinctive experience), Behavior layer (Interaction experience), and Reflection layer (Emotional experience). As shown in Figure 4, The specific features of the product are as follows.



Figure 4. SDK Product Photograph

The SDK experience product consists of eight parts: a production instruction card, a kite ID card, and six kits of materials related to SDK production. Through this experience product, users are able to make a SDK that carries the essence of ICH culture. As shown in Figure 5.

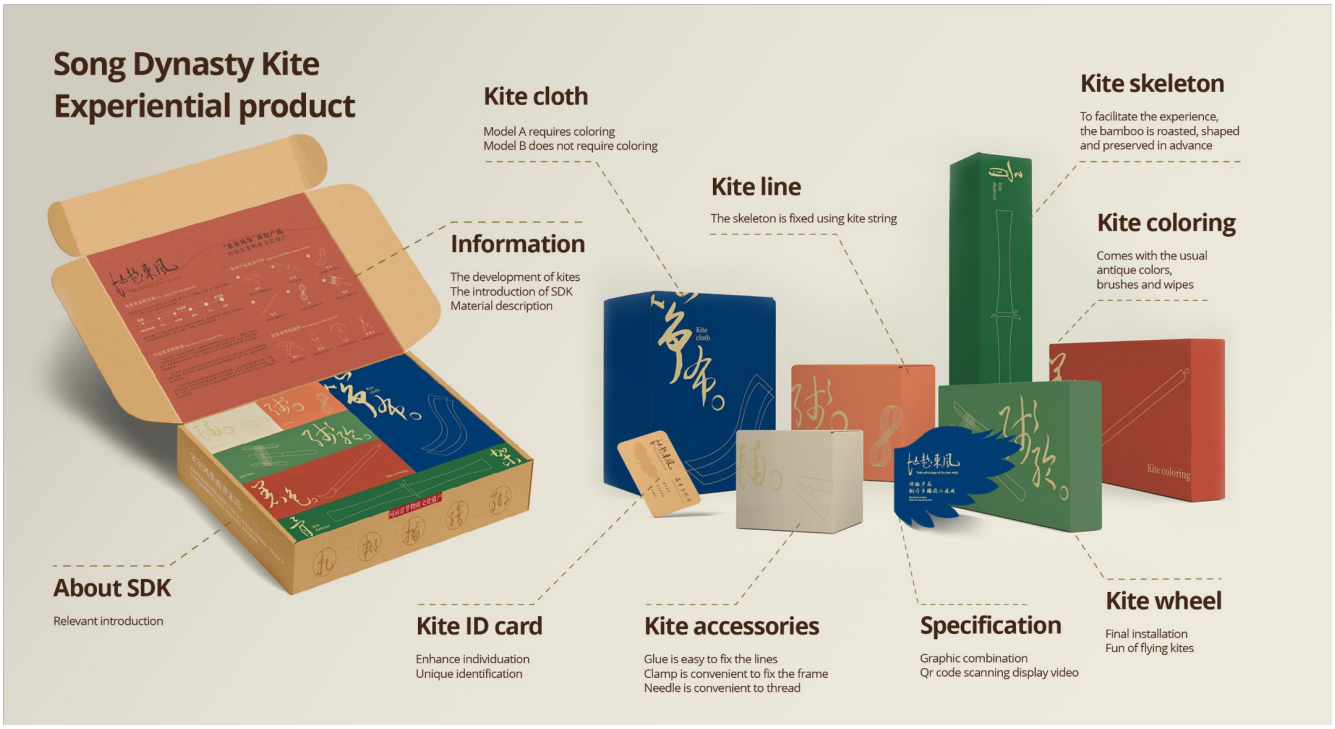

Figure 5. SDK Experience Product Composition Description

In the design of Sensory experience, the overall shape of SDK experience product skillfully integrates ancient style elements and simple design concept. The traditional Chinese brush characters and colors were used to show the deep traditional charm, and the packaging material was chosen to be special paper with texture, so that users could have a special experience in terms of tactile sensation. The most representative SDK, the two-headed parrot kite, which symbolizes the wise and heroic, and a hundred-year happiness, was used as the type of SDK for the experience (Lin Lin & Chen Hui-Ling, 2023), which further highlights the product's cultural connotation and characteristics.
In terms of Interaction experience design, in order to ensure that users have a high-quality production experience, an illustration of the production instructions is designed, and a production video that can be viewed by scanning the QR code is equipped, so that users can intuitively and clearly understand the production process. In addition, a full range of tools, such as glue, needles, brushes, paints, etc., are provided, and the materials used are strictly ensured to be safe and non-toxic. Especially worth mentioning is the antiseptic treatment of the bamboo in the material kit, which effectively enhances the shelf life and durability of the product. In terms of Emotional experience design, not only the long history of Chinese kites as well as the origins of SDK are detailed inside and outside the box, but also a kite identity card is carefully designed. Users are able to give a unique name to their handmade kites and solemnly record the date of production, thus deeply integrating their personal emotions into the production process and enhancing the emotional connection with the product.

6. Conclusions

At present, ICH is not only a remarkable manifestation of national cultural confidence, but also an important symbol of cultural diversity and creativity. This paper focuses on the design of ICH experience products from the perspective of user needs, taking the SDK as an example of Henan's non-heritage. Based on Norman's Emotional Design Theory, the three experience elements of Sensory experience, Interaction experience and Emotional experience are refined, and the integrated model of KANO-AHP-QFD is explored and constructed. The KANO model is used to classify and prioritize the original user needs, and the weight of the needs is further refined with the AHP, to ensure the scientificity and accuracy of the design decision. The user requirements were transformed into specific design elements through QFD, and the experience elements of SDK were finally completed according to the first ten design elements transformed. The design solution not only considers the practicality and aesthetics of the product, but also emphasizes the transmission of cultural inheritance and Emotional experience value, thus realizing the living inheritance of ICH culture, and at the same time, its combination of research methods also provides an innovative path and reference model for the design of other ICH experience products.

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RESEARCH ON ENVIRONMENTAL REGULATION DESIGN OF SUSTAINABLE COMMUNITY FROM THE PERSPECTIVE OF THERMODYNAMIC SYSTEM.

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ABSTRACT | With the rapid growth of urban population density and calls for energy conservation and carbon reduction, the sustainability of the built environment in communities is a growing concern. While there are many studies on the physical environment of urban blocks and building units, the research that considers the performance of community environments from a systems perspective and design behavior remains notably limited. The community serves as the fundamental system for human life, integrating diverse energy flows, including acoustic, light, electrical, and thermal energies. These flows are not limited to individual buildings but typically consider the community environment as the primary unit of energy circulation. Moreover, the human comfort level in the community is closely related to their energy consumption.

This paper, based on Lou's Four Systems framework ,explains the interactions among the four systems—Nature, Human Beings, Artificial Systems, and Cyber Systems—from a thermodynamic perspective within a community, viewing the microclimate, the built environment, the inhabitants, with energy, information, matter flowing within the system. It analyzes how to improve human comfort in the environment through design, thereby improving the community's energy use and carbon emissions and ultimately leading to a more sustainable community environment.

This paper reviews historical research and analyzes and compares cases to summarize several strategies for environmental regulation of community from a thermodynamic perspective. It also provides an analysis and explanation of the interactions among these systems, aiming to offer a reference for the design of sustainable communities in the future.

KEYWORDS | ENVIRONMENTAL REGULATION, THERMODYNAMIC SYSTEM, HUMAN COMFORT, SUSTAINABLE COMMUNITY, DESIGN

1. Introduction

Systematic considerations of the living environment can be traced back to B.C., where it was already recognized that the location, orientation, building materials, and forms of housing significantly influenced people's lifestyles. Two thousand years ago, Vitruvius highlighted in "De Architectura" the importance of considering tangible and intangible resources in the environment, such as water, wind, food, sunlight, and sound, when constructing residential areas to ensure the physical and mental well-being of the inhabitants.

Communities, as collections of architectures and products of design, bear a significant social responsibility to ensure the well-being of residents and the ecological health of urban environments. Yongqi Lou pointed out that communities are composed of the interactions between the Four Systems that constitute human activities: nature, human beings, cyber system, and artificial system (Figure 1). Different disciplines often focus on one of these themes, while the interactions among them are realized through design practice (Lou, 2018). Designers play a crucial role in dissolving the opposing relationships between these systems.

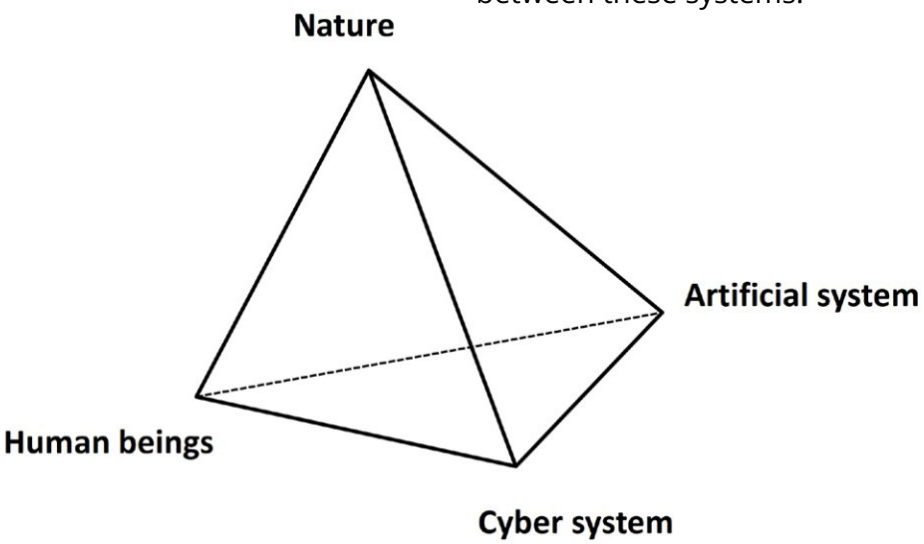

Figure 1. The interactions of the Four (nature, human, cyber, and artificial) Systems (image source: Lou, 2018).

According to China's seventh national census, the urban population has reached 63.89%, an increase of 14.21% over the past decade(Chen, 2021). As more people migrate to cities, extensive efforts are being made in community development and the renovation of old neighborhoods. The World Commission on Environment and Development (WCED) highlighted in the 1987 Brundtland Report that energy, economy, and environment are the three pillars of sustainable development(Federal Office for Spatial Development ARE, 1987). However, according to a review of sustainable development policies and interventions by Mamudu et al., 80% of publications on sustainable development in academia focus on science and technology, including environmental science, energy, agriculture, engineering, and chemistry. Research in the fields of social sciences and economics accounts for only 20% (Akudugu & Ogwu, 2024).

In the fields of architecture and design, the advancement of science and technology has led to the quantification of all quantifiable aspects of the construction process. In 1964, Reyner Banham criticized in "The Architecture of the Well-Tempered Environment" that architects were becoming accustomed to delegating all environmental control work, except for structural concerns, to engineers, HVAC specialists, telecommunication experts, and other technical personnel. He considered this a severe dereliction of duty (Banham, 1964). He also mentioned that an overreliance on quantification can lead to a neglect of human comfort and sensory stimulation. William W. Braham also noted that when people talk about energy, their focus tends to be limited to listing efficient equipment and applying high-energy fuels. He argued that energy flows in natural, technological, and social environments should all be considered (Braham, 2015).

With the advancement of information technology, information as a new form of energy is influencing community living patterns. The internet has given rise to remote work and digital nomad, altering the composition and consumption patterns of community residents (Jiwasiddi et al., 2024). New electronic products and appliances bring new energy consumption demands. People can achieve a balance between energy consumption and comfort through remote operation or centralized control by power companies (Kim et al., 2023). These energy flows shape people's lifestyles and work patterns.

However, even with such dramatic social changes, designers still lack a voice in the construction process regarding the development of energy systems. To improve this situation, it is crucial to create a universal tool for designers in community design. This paper will explore the following question from the perspective of energy flows: How can design work achieve a positive interaction between humans, machines, and the environment when designing sustainable communities?

Research Methodology:

1. Conduct extensive literature research to delineate the boundaries of community energy and human perception, analyzing their constituent elements and characteristics.

2. Perform case analyses of related works grounded in Yongqi Lou's "Four Systems" theory, explaining the role of design in resolving conflicts among the elements within the Four Systems in these projects.

3. Construct a foundational knowledge framework for low-carbon community design based on case analysis, aimed at enhancing designers' understanding and application.

2. Literature Review

2.1 Start From Architecture

The theoretical origins of habitat environment regulation stem from the field of architecture. Initially, it was observed that the chosen environment for constructing residential areas significantly impacts the physical health of the inhabitants. Around 250 BCE, the ancient writing "Mozi: Ci Guo" records:

"In ancient times, when people did not know how to build houses, they lived on hills and in caves. The dampness from below harmed the people, so the wise king created palaces and houses. The method for building houses was as follows: the rooms should be high enough to avoid dampness, the four sides should be sufficient to protect against wind and cold, and the roof should be adequate to withstand snow, frost, rain, and dew." (J. Li, 1925)

Vitruvius also mentioned in his renowned work, "Ten Books on Architecture," that houses in the north and south should have different designs due to the varying effects of sunlight(Hawkes et al., 2002, p. 3). At that time, people primarily considered the relationship between the environment and human comfort. Architecture, as an intermediary, mainly served the function of being a "dwelling," providing a healthy living environment for people.

By the 1920s, with the post-war population boom and housing shortages, mass production had become mainstream in society. At the second CIAM (Congrès Internationaux d'Architecture Moderne) conference, the group form northern European cities discussed the issue of Existenzminimum, which refers to housing units that could be afforded by families with minimum wage incomes(Mumford, 2019, p. 291). This type of housing aimed to minimize expenses, providing more economical housing for ordinary people. However, due to the lack of systematic consideration of residential architecture, many houses based on this belief encountered problems. A typical example is Minoru Yamasaki's Pruitt-Igoe. To save costs, this building used a large amount of cheap materials and fixtures, such as doors and windows,

resulting in extremely poor living conditions. The building was completed in 1954 and was eventually demolished in 1972(Heathcott, 2012). The consequence of non-systematic consideration is more severe waste; such short-lived buildings are no different from the Kleenex culture criticized by Papanek.

In the 1960s, Buckminster Fuller, in his renowned "Operating Manual for Spaceship Earth," pointed out that the economic accounting systems of the time unrealistically regarded wealth as material, which does not increase. Therefore, this method of accounting was "anti-synergetic, depreciative, and entropic mortgagization." He called for the establishment of a truly economic accounting system, using design to change the Earth's environment(Fuller, 1969, p. 95). He called for the world to shift from a negative economic accounting system to a positive, global economic accounting system, proposing that "energy is wealth." (Fuller, 1967, p. 35)

Banham, in "The Architecture of the Well-Tempered Environment," pointed out that architecture is a self-regulating machine, with energy serving as a continuous thread throughout the work. He emphasizes that architectural technology involves the storage, selection, and regeneration of elements such as air, light, and humidity, corresponding to three architectural modes: "conservative mode," "selective mode," and "regeneration mode." The "conservative mode" and "selective mode" are associated with building forms in dry cold climates and humid warm regions, respectively. With technological advancements, more sophisticated techniques and materials, such as glass curtain walls and air conditioning, have enabled better control of the indoor environment. In Banham's view, the form of modern architecture is largely a natural outcome of humanity's pursuit of comfort through environmental regulation. (Banham, 1964). Therefore, energy and comfort are essential topics in community development, both historically and in the present, and will remain crucial in the future.

2.2 To Community

With the acceleration of urbanization and the advancement of the internet, more and more things are becoming interconnected. Knowledge originally used in the field of architecture is gradually being transferred to community design. Li and colleagues used the emergy analysis method to conduct a comprehensive evaluation of the renewal activities in old communities. Their analysis accounted for numerous variables, ranging from basic building materials to social welfare. They pointed out that community renewal remains a resource-intensive process; however, this process is not universally applicable (D. Li et al., 2021). Ayyoob and colleagues summarized existing Neighborhood Sustainability Assessment (NSA) tools, noting that most of these NSAs are derived from the field of sustainable building. They discussed the limitations of these tools, such as insufficient consideration of specific contextual issues, excessive complexity making them difficult to understand, and their inability to adequately address local contexts and specific needs (Sharifi et al., 2021).

In this paper, "Community" refers to commonly seen urban residential areas, also known as Housing Estates, Neighborhoods, or Blocks. These communities typically consist of multiple buildings and both indoor and outdoor public areas, which can be further subdivided into indoor private areas, indoor public areas, and outdoor public areas. The Sources and Flows within these communities are more numerous, making the design process more complex and harder to fully comprehend.

2.3 The Four Systems

In 2018, Yongqi Lou proposed the Four Systems, calling for attention to the interactions between nature, human, cyber, and artificial systems to address threats to human survival (Figure 2). He highlighted the significant gaps between various disciplines:

research on humans is concentrated in social sciences, such as psychology and sociology; natural sciences focus more on the laws governing physical existence; and artificial systems encompass the combination of human and natural elements, such as architecture and economics (Lou, 2018). Today, cyber systems are rapidly evolving, with 5G networks making the Internet of Things (IoT) a reality. The development of artificial intelligence (AI) has made many tools smarter and more convenient to use, while also increasing the uncertainty of systems.

The Four Systems provide a clear and straightforward explanation of the composition of our world, helping more people understand the connections and interactions between the systems human live within.

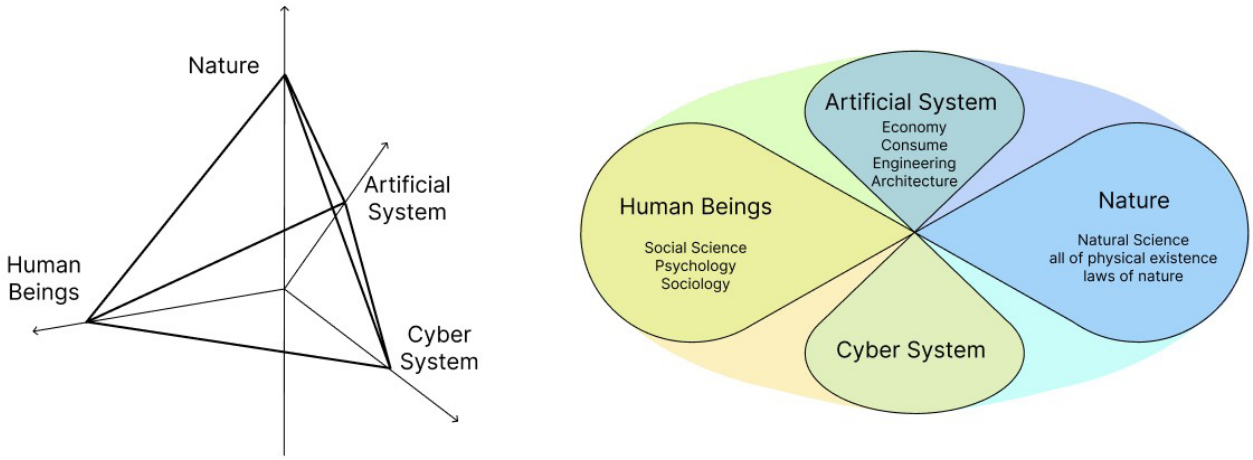

Figure 2. Coordinate system of the Four Systems and integration of disciplines.

2.4 Thermodynamic Lens

Ecologists Eugene P. Odum and Howard T. Odum pioneered eco-energetics. Eugene P. Odum proposed that the flow of energy in the environment could be represented using flow charts, commonly used in mathematics and computer science (E. P. Odum, 1968, p. 16). In the 1980s, Howard T. Odum, in his book "Systems Ecology," created the Energy Systems Language (Figure

3.). He elevated this thermodynamics-based analytical method from the field of ecology to the social level, transforming it into a scientific tool for social and environmental analysis(H. T. Odum, 1983). This analytical tool can help designers and decision-makers cope with increasingly complex environmental systems. Half a century later, its scope continues to evolve and expand, allowing information to be presented as a tool for energy flow. Based on the Energy Systems Language, Odum proposed using the solar joule (semj) as a unit of account for emergy, to quantify the energy embodied in all systems within the biosphere(Campbell, 2016, p. 97) This tool can be used to discuss any system capable of performing work.

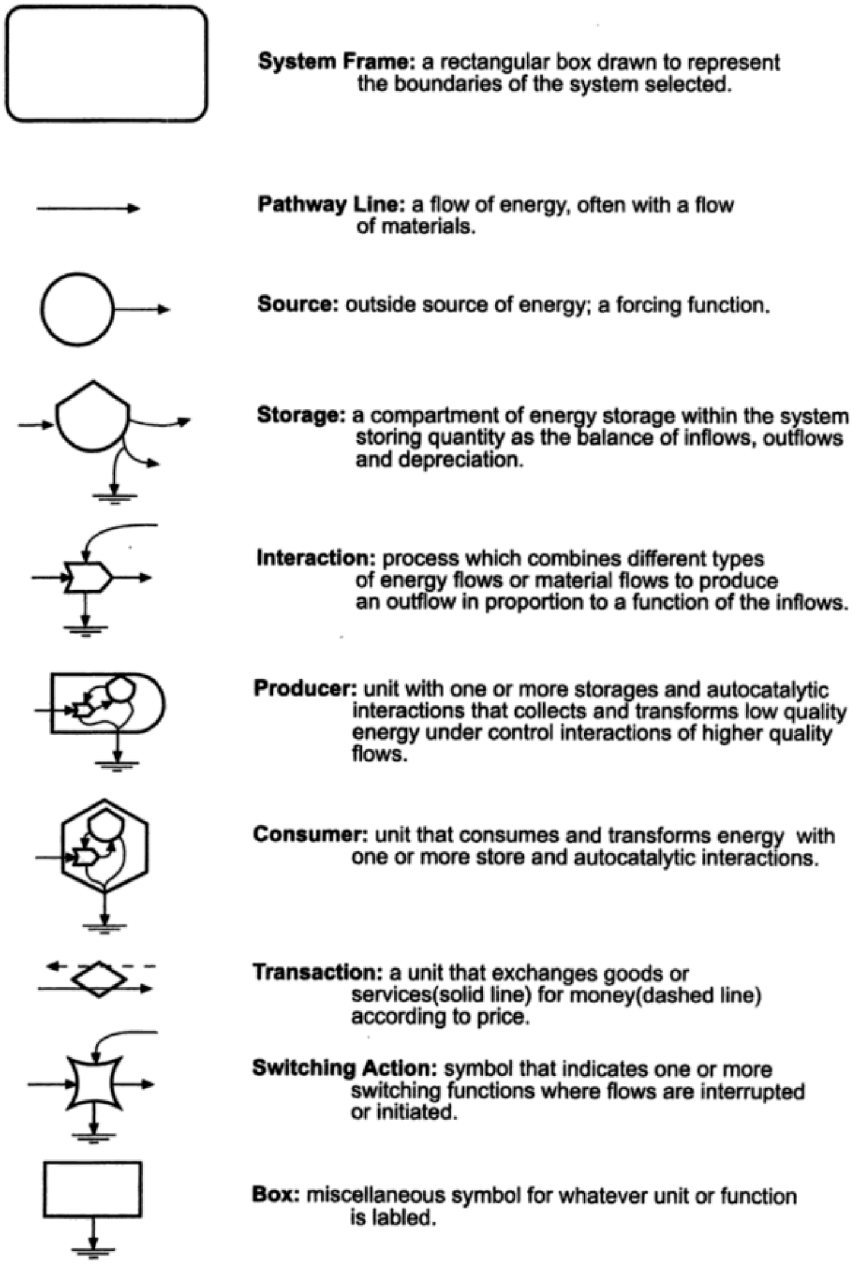

Figure 3. Energy Systems Symbols by Odum (image source: Muller, 2000, p. 282).

Thermodynamics involves the study of energy laws, focusing on thermodynamic systems. A thermodynamic system is a finite macroscopic region used for thermodynamic research, representing a specific part of the material world under study. Since this system is finite, it has boundaries; these boundaries separate the system itself from its external space, known as its surroundings. The boundary of a thermodynamic system delineates the spatial region occupied by the system, through which mass, heat, and mechanical energy can flow. The system can exchange various forms of energy with its surroundings through this boundary.

Thermodynamic systems can be classified based on the type of energy transfer permitted by their boundaries, including isolated systems, closed systems, mechanically isolated systems, adiabatic systems, and open systems (Figure 4). An open system is one that allows the transfer of both energy and matter with its surroundings. The built environment is an open, nonequilibrium thermodynamic system, a dissipative structure. The climate serves as the system's surroundings, while the building interface acts as the system's boundary. For the system to continue functioning, it must continuously obtain matter and energy from its environment.

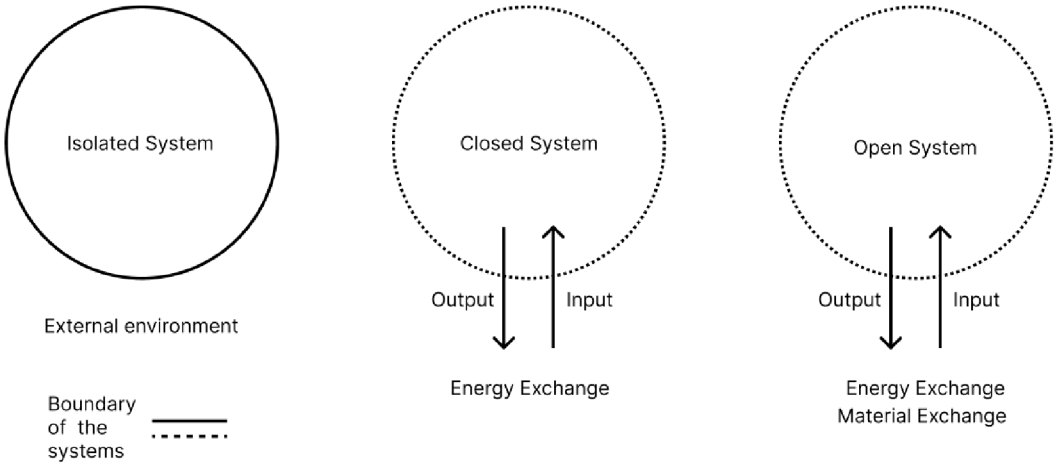

Figure 4. Three kinds of thermodynamic systems.

Building on Banham's theory, Abalos introduced the concepts of thermal source and thermal sink. In cold, dry northern climates, the interior acts as a source, providing heat through a thermal comfort core. To maximize sunlight exposure, houses are compact, and urban structures are loose, turning buildings into thermal machines. Conversely, in warm climates, the interior acts as a sink, where buildings are "empty" and no longer serve as machines for living but rather as centers for social life influenced by natural climatic patterns. Abalos advocates for a thermodynamics-based approach to managing built spaces, aiming to balance various thermodynamic factors to create spaces more conducive to social interaction and sensory experiences. This balance arises from the interplay between form, materials, and air(Abalos, 2015).

Braham introduced Odum's Energy Systems Language into the built environment, dividing the analysis of buildings into three purpose scales: site, shelter, and setting. In this framework, "Building-as-site" emphasizes the location, forming the first energy system shaped by various climatic factors. "Building-as-shelter" involves modifying and maintaining the microclimate through the enclosure of the building interface in a specific climate (Figure 5), representing the secondary energy system. "Building-as-setting" refers to the behavioral space for human activities, such as work and living, and includes material services like water and food, as well as concentrated flows like fuel, information, and money, making up the third energy system. Each level represents an environmental performance standard in building design, with continuous interaction between these scales. The movement of building interfaces and people transforms buildings into open systems (Braham, 2015).

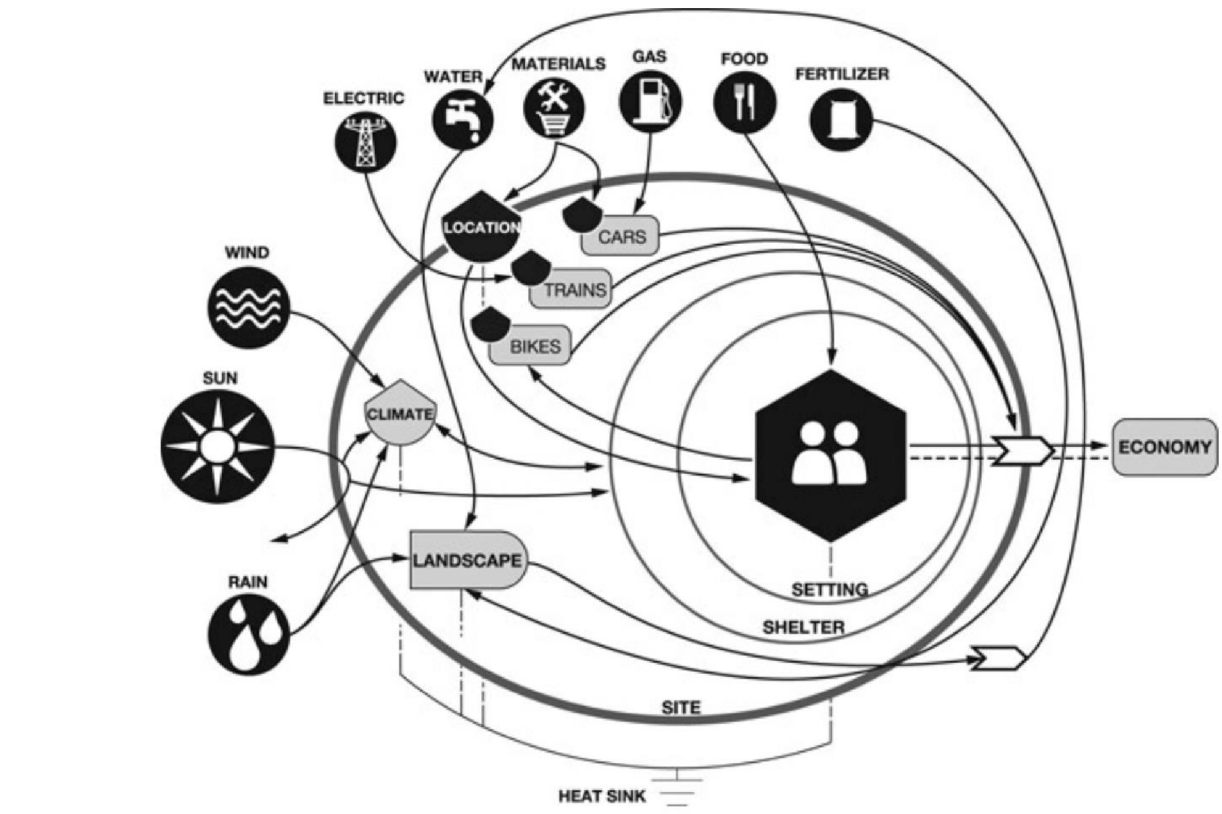

Figure 5. Thermodynamic diagram of the building-as-site (image source: Braham, 2015, p. 221)

3. Case Study

To better explain the connections among the Four Systems, this paper is based on Lou's Four Systems framework. It selects eight research cases that involve interactions between two or more systems and classifies them according to the two most relevant systems, as shown in the table below:

Table 1. Table layout. Captions for Tables are placed above.

Case No.	Reference	The included systems	Key Words
1	(Labdaoui et al., 2021)	Human Beings，Artificial System	Comfort Walkability Index, thermal comfort
2	(X. Deng et al., 2023)	Human Beings，Artificial System	Outdoor thermal comfort, Mobile measurement
3	(Ma et al., 2023)	Human Beings, Cyber System	Occupant behavior , Energy use intensity
4	(Konis et al., 2020)	Human Beings, Cyber System	Participatory sensing, Thermal comfort
5	(Hou et al., 2023)	Nature, Artificial System	Mean radiant temperature, Radiant heat transfer , Local thermal comfort
6	(Z. Deng & Chen, 2020)	Nature, Artificial System	Thermal comfort, Artificial neural network, Wearable device
7	(Necira et al., 2024)	Nature, Human Beings	Boulevard, heat stress, mitigation strategies
8	(Baquero Larriva et al., 2022)	Nature, Human Beings	Thermal comfort Older people Nursing homes Naturally ventilated Mediterranean climate

3.1 Human Beings & Artificial System: Case 1 and Case 2

The spaces inhabited by humans need to meet various needs, with the most fundamental being physiological comfort. Humans, as complex organic beings, are constantly exchanging energy and matter with their external environment. In this process, the human body must maintain a relatively stable core temperature to achieve a dynamic balance between heat production and heat dissipation, thereby ensuring comfort. This is related to the objective physical environment, affecting how the skin adapts to indoor conditions through its own temperature regulation, which can be improved through the design of community spaces or equipment. At the same time, as a subjective evaluation of human perception, it is also related to physiological and psychological states, such as activity level, clothing thermal resistance, social and cultural background, and behavior patterns.

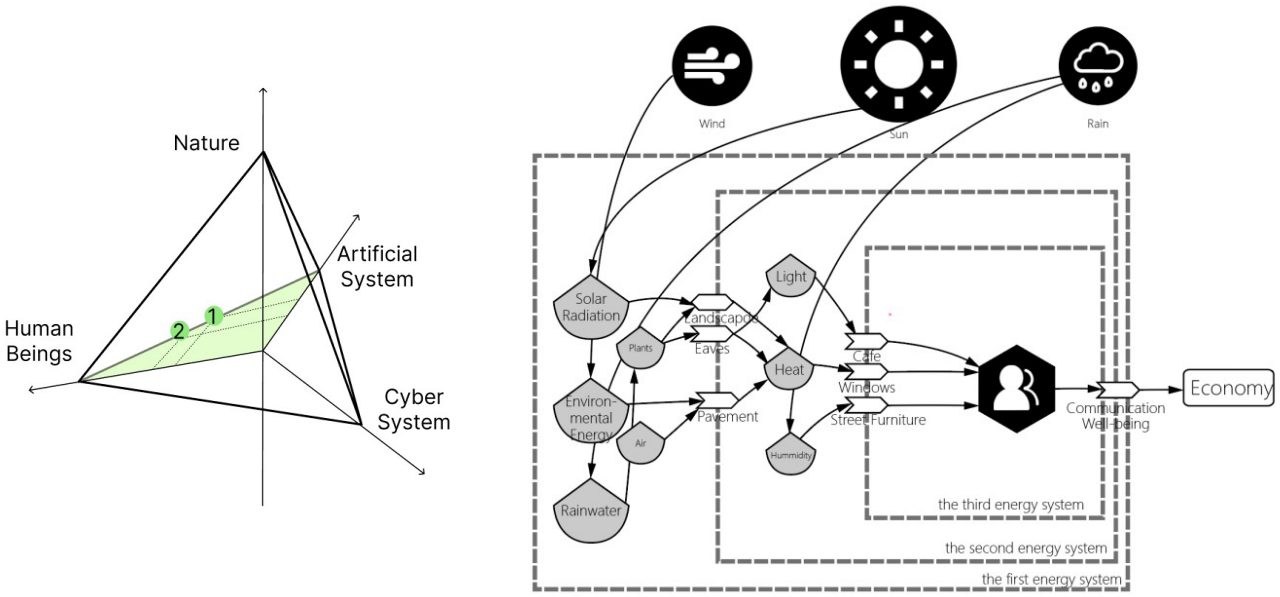

Figure 6. Left: The Positions of Case 1 and Case 2 in The Four Systems. Right: Thermodynamic diagram of Case 1 and Case 2.

Case 1 and Case 2 illustrate how improving artificial system designs can enhance the well-being of human systems. Case 1 investigates two communities in the center of Annaba, Algeria (Figure 7), assessing thermal comfort and walking facilities to derive the CWI (Comfort Walkability Index) values. The results indicate that the colonial center has a higher CWI value, offering a more comfortable walking environment, while the old town, with its inadequate walking facilities, shows a lower CWI value. This study emphasizes the importance of evaluating walkability at the community level and proposes specific measures to improve walking environment comfort (Labdaoui et al., 2021).

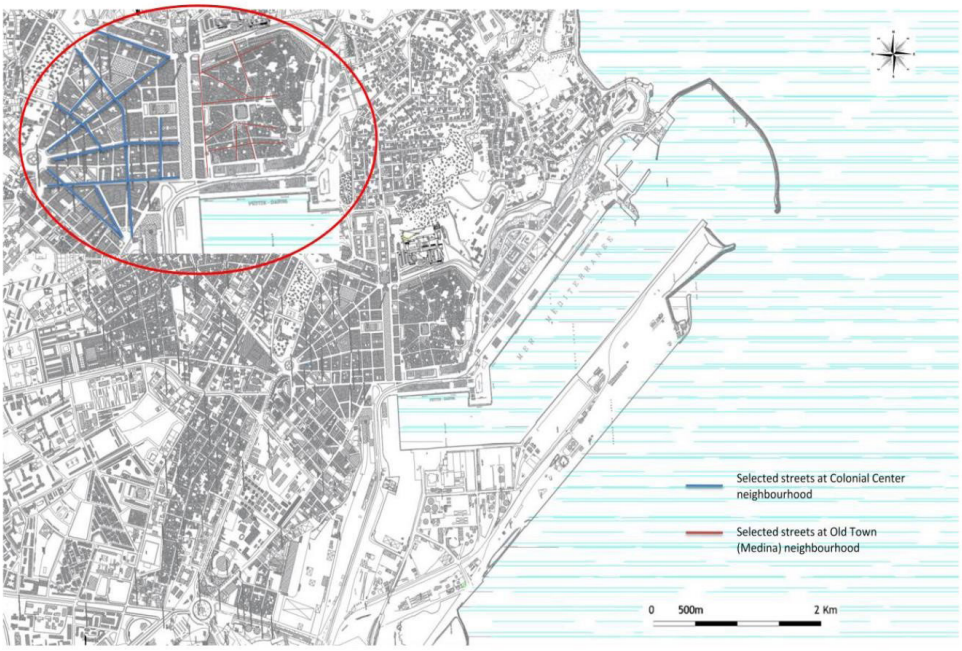

Figure 7. Selected streets at Colonial Center and Old Town in Annaba city center (image source: Labdaoui et al., 2021).

Case 2 compares two urban areas in Guangzhou: Yongqing Fang (a historic district) and Knowledge City (a new district). Using on-site monitoring and surveys, the study evaluates outdoor thermal comfort through PET (Physiologically Equivalent Temperature) and TCV (Thermal Comfort Vote). The results reveal significant differences in building environments and meteorological conditions between the old and new districts (Figure 8), which affect the perception of thermal comfort. The findings indicate that urban design strategies can significantly enhance pedestrian thermal comfort, demonstrating the interaction between artificial systems and human well-being(X. Deng et al., 2023).

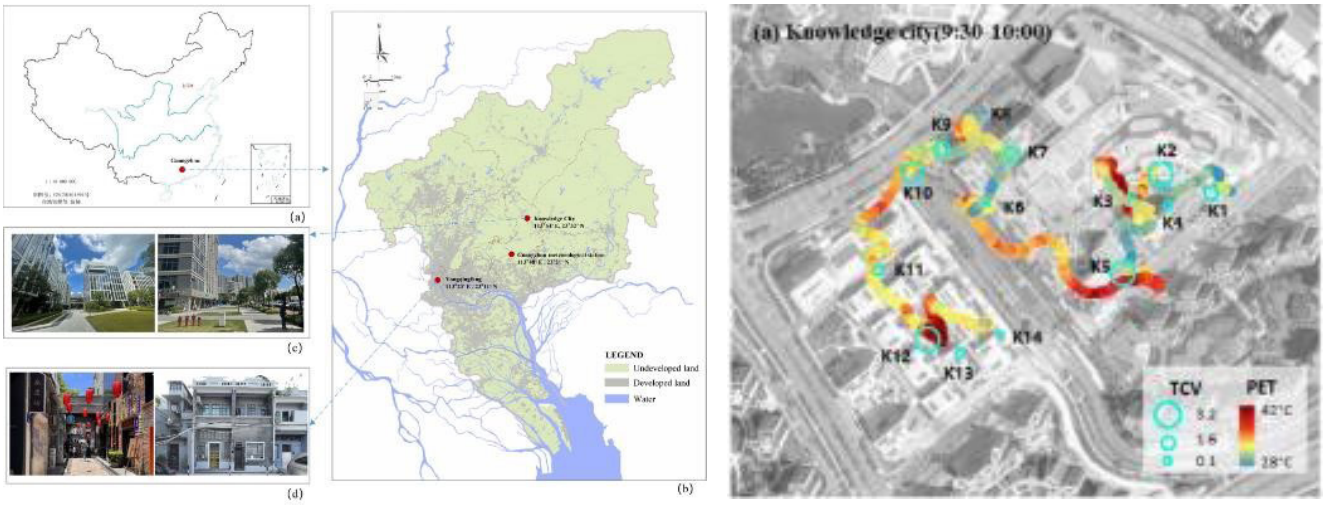

Figure 8. Left: Location of the study area. Right: Spatial distribution of PET for the routes and the corresponding TCV reported by subjects (image source: X. Deng et al., 2023, p.3).

Table 1. Comparison of Case 1 and Case 2 in the aspect of Human Beings & Artificial System.

Case No.	Human Beings	Artificial Systems
1	Walkability Comfort: Perception data from pedestrians were collected through questionnaires to understand the impact of different walking facilities on comfort.	Walking Infrastructure: The design elements such as sidewalk width, slope, shade, and seating influence the overall quality of the walking environment.
	Social Interaction: A comfortable walking environment can promote interactions among community members, enhancing social cohesion and overall well-being of residents.	Thermal Comfort: Using Physiologically Equivalent Temperature (PET) as an evaluation metric for thermal comfort, combined with microclimate data for assessment.
2	Thermal Comfort: The subjective evaluation of pedestrians regarding the thermal environment was studied using Physiologically Equivalent Temperature (PET) and Thermal Comfort Vote (TCV).	Urban Design and Morphology: How building height, density, and layout influence the local microclimate and pedestrian thermal comfort.
		Landscape Parameters: Factors such as greenery, water bodies, and building shading can impact the urban microclimate.

3.2 Artificial System & Cyber System: Case 3 and Case 4

Deploying Internet of Things (IoT) sensors in communities to gather real-time environmental parameters—such as indoor and outdoor surface temperatures, air temperature, and humidity—along with human body parameters and subjective comfort evaluations, combined with machine learning predictive models, can facilitate precise forecasting of building heating and cooling needs. Additionally, incorporating a real-time feedback control system with intelligent regulation models that dynamically adapt to environmental changes can minimize energy consumption while maintaining the comfort of community residents.

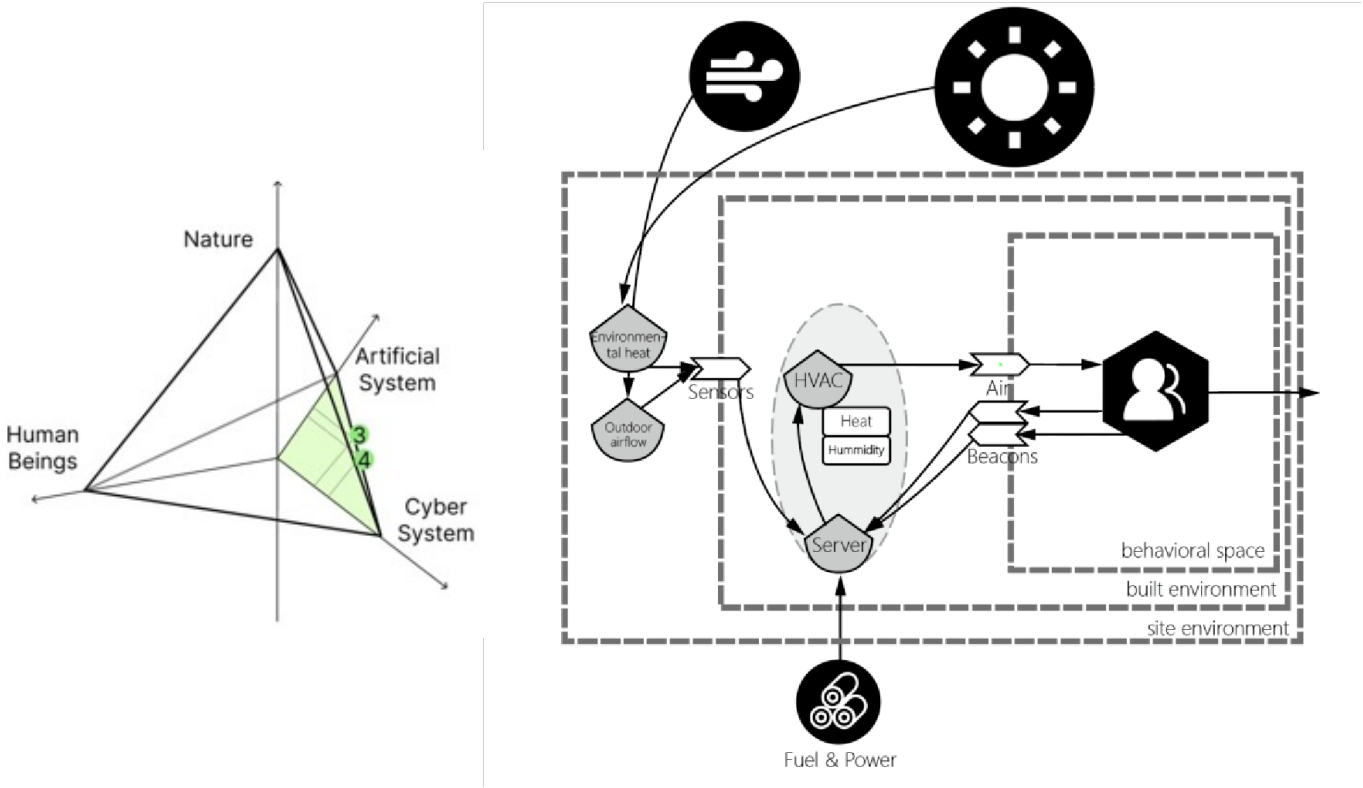

Figure 9. Left: The Positions of Case 3 and Case 4 in The Four Systems. Right: Thermodynamic diagram of Case 3 and Case 4.

Case 3 and Case 4 both demonstrate the importance of the involvement and feedback of cyber systems in optimizing performance within intelligent and data-driven artificial systems. Case 3 uses blockchain and Internet of Things (IoT) technologies to ensure the security and transparency of environmental data in buildings through Smart Contracts (Figure 10). The use of IoT enhances the sensitivity of building environment monitoring, and the study proposes incentive measures such as reward tokens to encourage users to reduce energy consumption, thereby achieving social participation in energy saving and emission reduction (Ma et al., 2023).

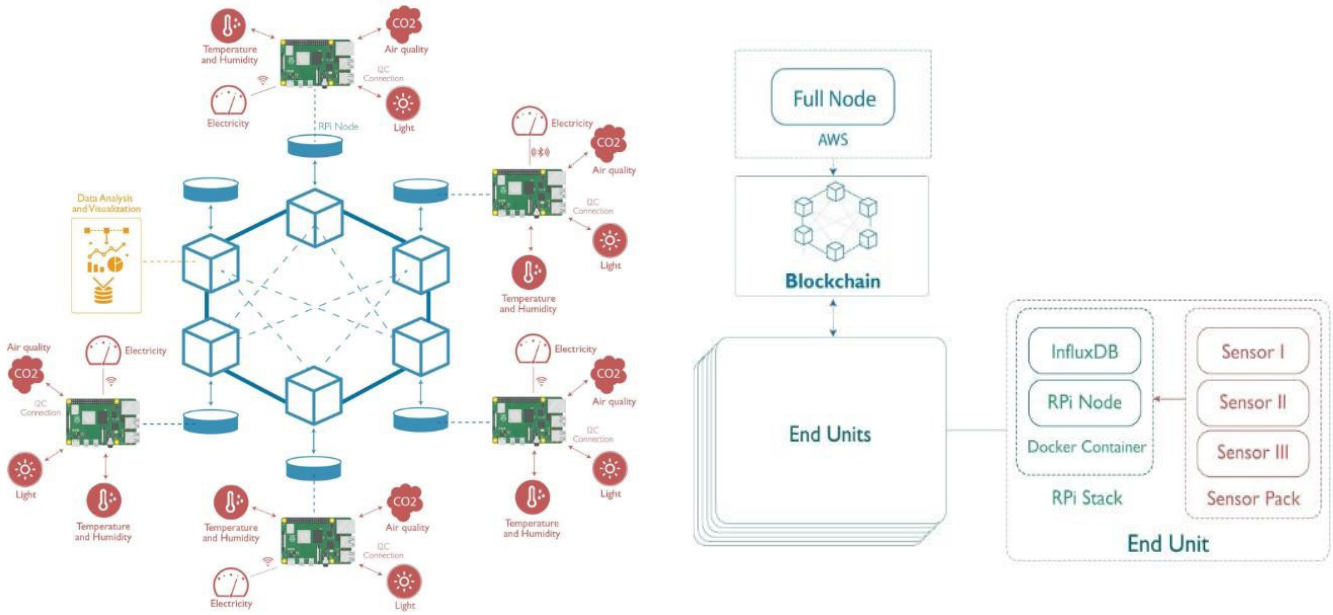

Figure 10. Schematic overview of the system infrastructure (image source: Ma et al., 2023, p.4)

Case 4 discusses a participatory sensing framework called TrojanSense, designed to manage thermal comfort in campus buildings. This system uses Bluetooth Low Energy (BLE) beacons and a mobile application to collect users' subjective feedback on indoor temperature through a combination of software and hardware (Figure 11). This approach aims to better understand and manage the thermal environment of buildings(Konis et al., 2020).

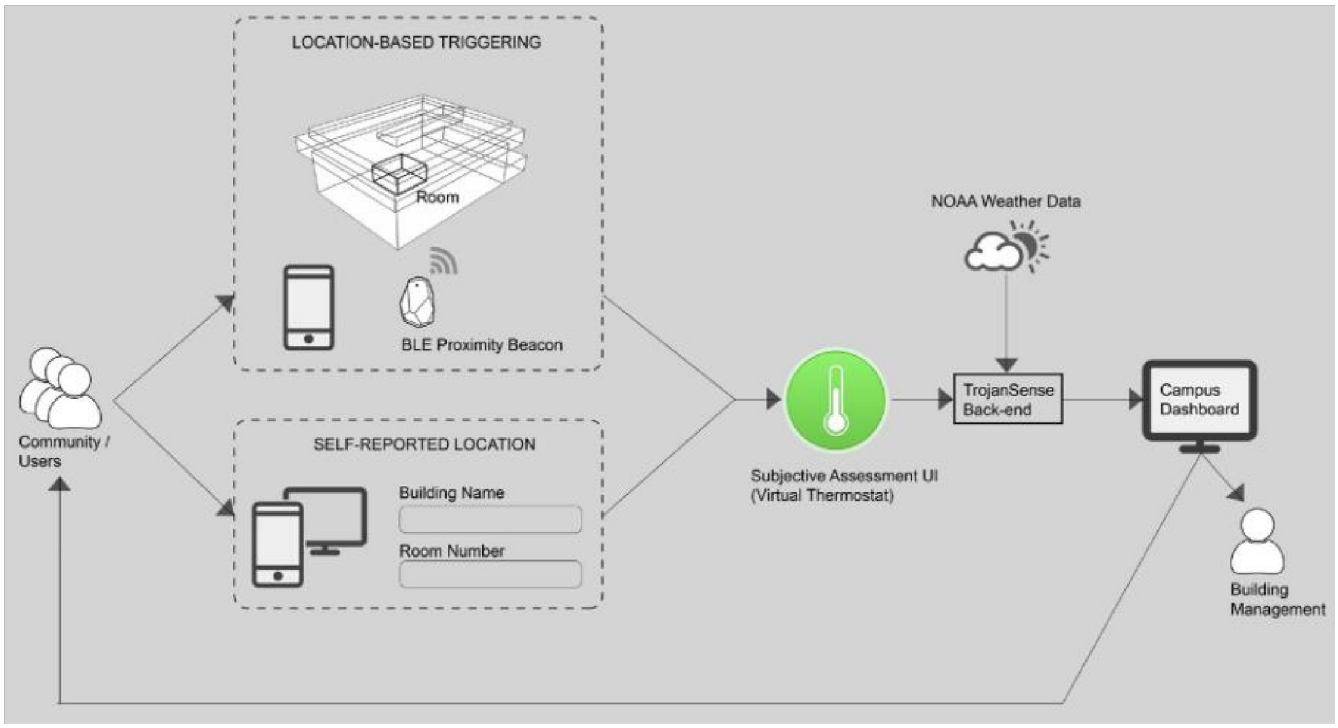

Figure 11. Framework of the TrojanSense open-loop feedback system (image source: Konis et al., 2020, p.4).

Table 2. Comparison of Case 3 and Case 4 in the aspect of Artificial System & Cyber System.

Case No.	Artificial Systems	Cyber Systems
3	Participation, Feedback, and Incentives: Through the IoT sensor network, users can access real-time environmental data and participate in providing feedback, which serves to incentivize energy-saving behaviors.	Blockchain and Smart Contracts: Blockchain technology provides a secure and transparent way to store and transmit sensor data. Due to the inherent characteristics of blockchain, users can more confidently rely on this data to make informed environmental decisions.
	Sensor Network: The study deployed a large number of IoT sensors within the campus, which monitor indoor environmental quality and energy consumption data in real time.	Internet of Things (IoT): IoT sensor networks collect environmental data in real time, which is then stored and verified using blockchain technology. Users can view real-time data through the platform and provide feedback, helping to improve environmental management strategies.
4	BLE Beacons and Sensor Network: The TrojanSense system deploys BLE beacons and a sensor network within buildings to monitor environmental parameters such as indoor temperature and humidity in real time.	Feedback Optimization: Utilizing participatory sensing technology, active user feedback is linked with real-time environmental parameters to establish a more interactive environmental control model.
		Thermal Comfort Management: User feedback helps building managers understand actual temperature needs, allowing them to adjust temperature control strategies by the micro-climate control systems.

3.3 Cyber System & Human Beings: Case 5 and Case 6

Wearable physiological sensors, such as ECG (electrocardiogram), EEG (electroencephalogram), SC (skin conductance), and respiration sensors, enable real-time acquisition of human perception data. These physiological data, combined with human comfort models, guide the assessment of group thermal sensations. This approach brings subconscious cognitions and feelings, which are difficult to perceive intuitively, to the forefront, facilitating the regulation and optimization of behavior and environmental design within communities.

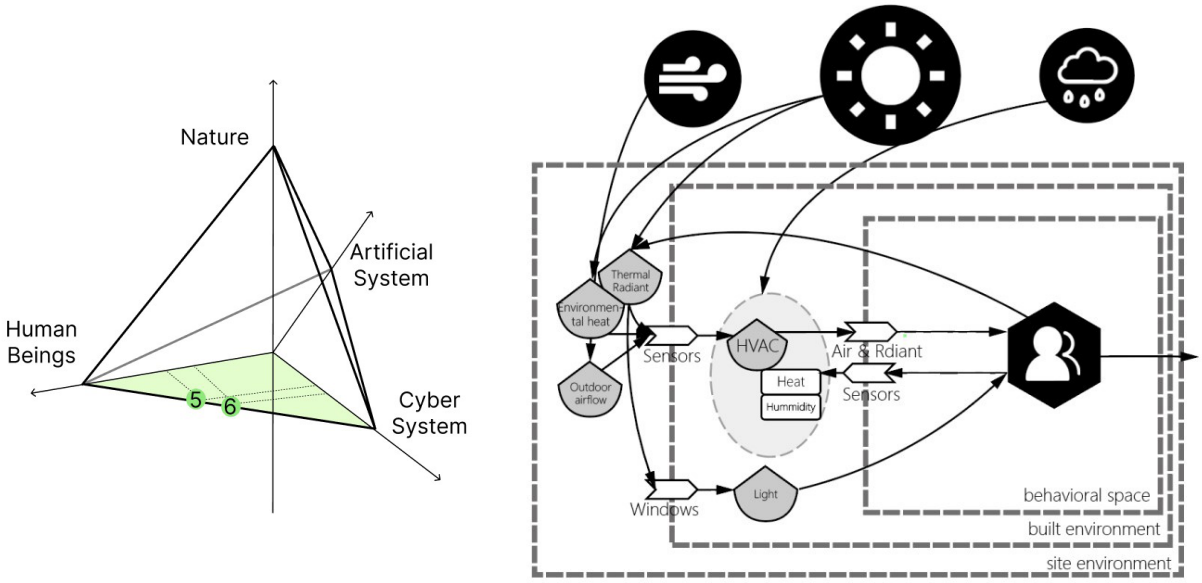

Figure 12. Left: The Positions of Case 5 and Case 6 in The Four Systems. Right: Thermodynamic diagram of Case 5 and Case 6.

Case 5 and Case 6 both demonstrate that the integration of natural and artificial systems is crucial for optimizing thermal comfort. Case 5 primarily investigates the potential impact of indoor radiant environments on human comfort and guides intelligent building design. Through a series of experiments conducted in a thermal laboratory, this study combines scanning and thermal imaging technologies with ray tracing simulations to provide high-resolution thermal models (Figure 13). These models comprehensively characterize longwave and shortwave radiant heat flows within a space and analyze their effects on Mean Radiant Temperature (MRT) (Hou et al., 2023).

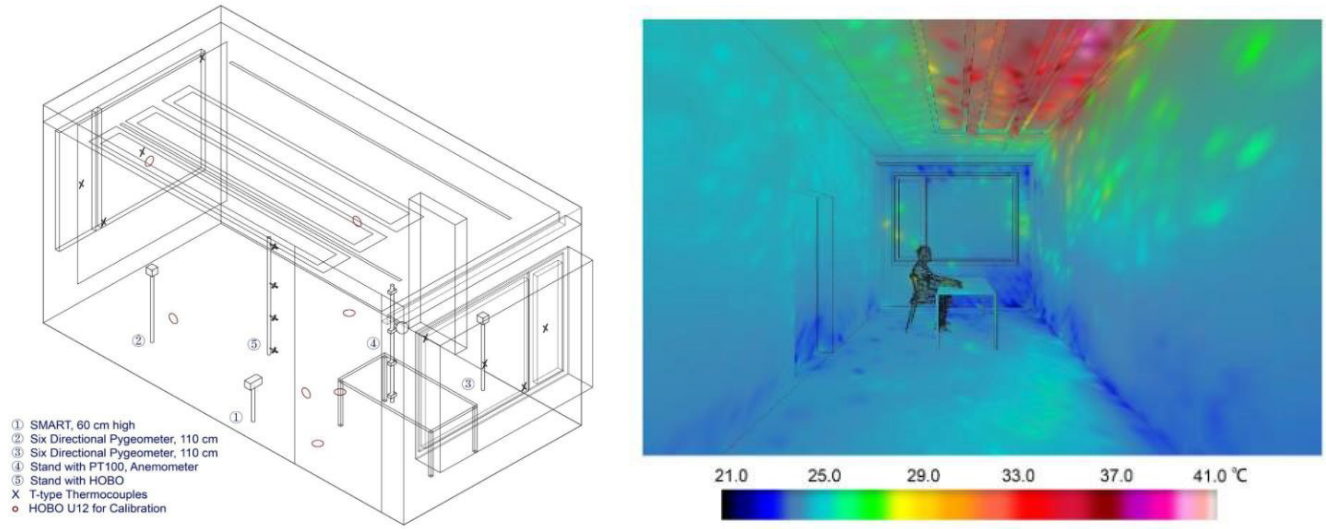

Figure 13. The sensors' layout in the experimental room and experimental room surfaces with the temperature mesh from the surface temperature data of SMART (image source: Hou et al., 2023, p. 6).

Case 6 aims to develop and validate an intelligent HVAC (Heating, Ventilation, and Air Conditioning) control system to improve thermal comfort in multi-user offices. This system uses wearable devices to collect users' physiological signals and predicts thermal sensations through an Artificial Neural Network (ANN) model (Figure 14), dynamically adjusting indoor temperature settings accordingly (Z. Deng & Chen, 2020).



Figure 14. Data collection devices used in this study. (a) thermostat on the wall, (b) data logger, (c) wristband (image source: Z. Deng & Chen, 2020, p. 2).

Table 4. Comparison of Case 5 and Case 6 in the aspect of Artificial System & Cyber System.

Case No.	Cyber Systems	Human Beings
5	Innovative Experimental Environment: The Smart Living Lab was established to simulate real building environments, utilizing a wide array of advanced sensors and wearable devices.	Human Thermal Comfort: The study assessed human thermal comfort in various radiant environments, focusing on the effects of shortwave and longwave radiation on different parts of the body.
	Smart Building Design: The research can provide design strategies for optimizing indoor environments, such as using reflective materials, adjusting window positions, and incorporating shading devices.	
6	Data Processing: The Artificial Neural Network (ANN) model predicts users' thermal sensations (Thermal Sensation Vote, TSV) based on the collected data. The model considers multiple input parameters, such as air temperature, relative humidity, and clothing insulation factor, and is trained and optimized using machine learning methods.	Wearable Devices: These devices enable users to participate in the regulation of building environment temperatures in a relatively unobtrusive manner. On one hand, they collect physiological data, and on the other hand, they make thermal sensation voting more convenient.
	Automated Control: The control system can automatically adjust temperature settings based on real-time physiological data, ensuring optimal thermal comfort in office environments across different seasons and varying numbers of occupants.	User Experience: The system is highly personalized, capable of providing individualized temperature control based on each user's specific physiological state, significantly enhancing user comfort.

3.4 Nature & Artificial System: Case 7 and Case 8

Climate is a natural phenomenon, and humans constantly engage in a struggle with it for survival. Architectural spaces are human creations that protect against the climate, acting as intermediaries between people and their environment. In modern times, artificial lighting has freed us from dependence on natural light, and air conditioning systems use mechanical energy to transfer indoor heat to the outdoors, creating a microclimate with suitable temperature and humidity for living spaces. The natural climate is both the external environment that artificial systems must adapt to and a source of external energy that they can utilize.

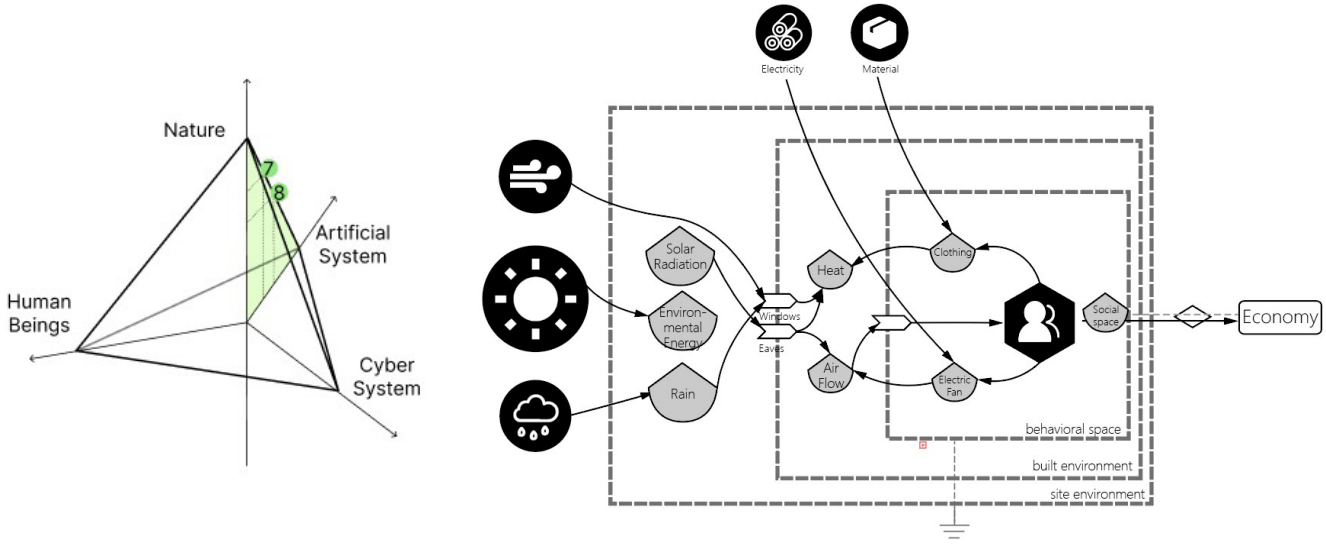

Figure 15. Left: The Positions of Case 7 and Case 8 in The Four Systems.
Right: Thermodynamic diagram of Case 7 and Case 8.

Case 7 and Case 8 demonstrate the immense potential of integrating natural elements and considering human needs in the design of artificial environments to enhance comfort and health. Case 7 explores methods to improve pedestrian thermal comfort in a hot desert climate through urban design strategies such as asymmetrical streets, high-reflectivity materials, and shading facilities (Figure 16). The study was conducted in Biskra, Algeria, and the results indicate that asymmetrical street designs, high-reflectivity materials, and effective shading strategies significantly improve pedestrian thermal comfort(Necira et al., 2024).

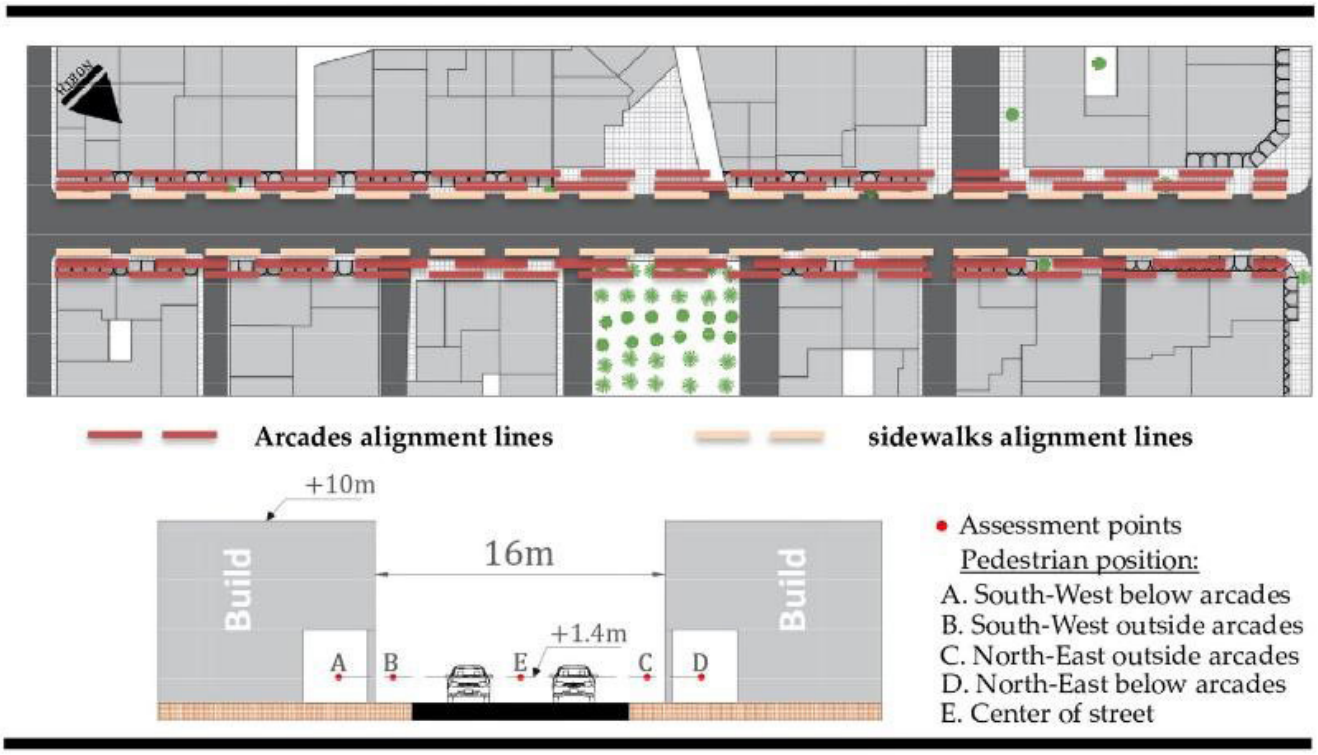

Figure 16 Modified parameters for the reference scenario. (image source: Necira et al., 2024, p. 12)

Case 8 analyzes the impact of climate on the thermal perception of residents (elderly) and non-residents (caregivers and therapists) in 18 nursing homes from three climatic zones. The study found that different climatic conditions affect the thermal comfort of nursing home occupants, with the neutral temperature for the elderly depending on the climate (Figure 17). This research is significant for regulatory agencies in developing design and operational guidelines for nursing homes under different climatic conditions (Baquero Larriva et al., 2022).

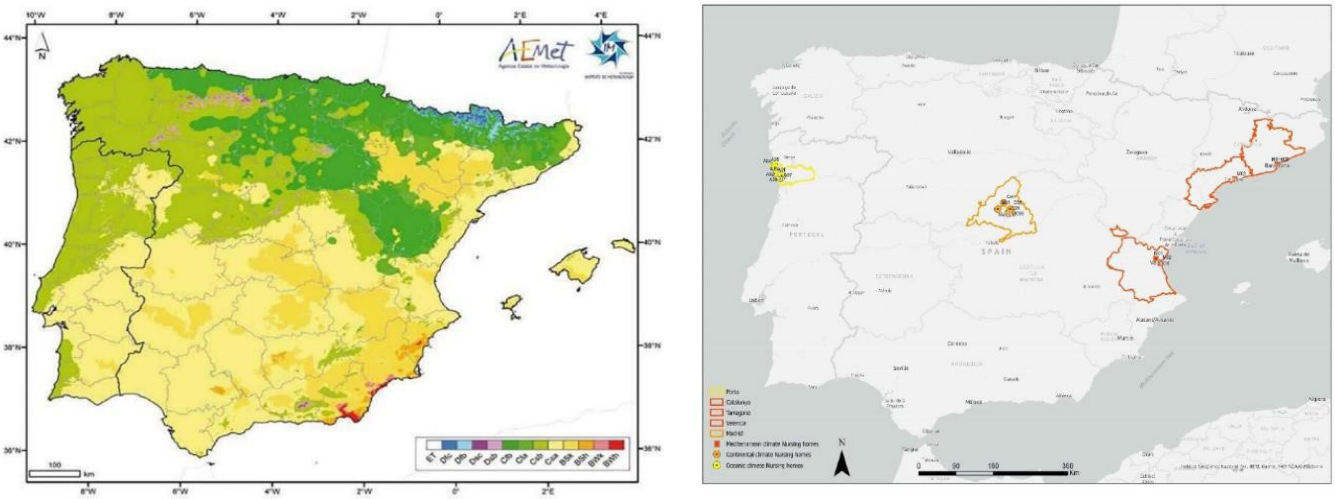

Figure 17. Left: Climate classification for the Iberian peninsula (image source: Iberian Climate Atlas) , Right: Distribution of the studied nursing homes (image source: Baquero Larriva et al., 2022, p. 4)

Table 5. Comparison of Case 7 and Case 8 in the aspect of Nature & Artificial System.

Case No.	Nature	Artificial Systems
7	Desert Climate: The study examined the outdoor physical environment of streets under specific climatic conditions, such as solar radiation, wind speed, and air humidity. These factors significantly impact pedestrian thermal comfort in hot desert environments.	Street Models: By measuring and simulating actual streets, the study explored strategies for improving pedestrian thermal comfort through artificial system interventions. These strategies included altering street geometry, using high-reflectivity materials, and designing shading structures.
	Natural Landscapes: The introduction of trees and green spaces is crucial for reducing the urban heat island effect and enhancing pedestrian thermal comfort. The study utilized asymmetrical street designs to optimize natural shading, leveraging natural landscapes to alleviate pedestrian heat stress.	
8	Climate-Adaptive Design: The study analyzed the impact of various climatic conditions in the Mediterranean region on indoor thermal environments and proposed building design strategies adapted to local climate conditions.	Smart Building Systems: The study found that occupants adopt various adaptive behaviors (such as adjusting clothing or using fans) when experiencing thermal discomfort. Building design can offer flexible solutions by incorporating features like automated window adjustments, shading devices, and air conditioning systems to enhance occupant comfort.
	Environmental Control: Prevailing wind directions vary across different regions. Through effective ventilation design, it is possible to achieve indoor comfort without relying on mechanical cooling systems.	

Discussion

"If we can build or enable a hybrid community combining the virtual and the real worlds, and at the same time, strengthen and enrich the interconnections among the human-nature-artificialcyber system, we will have an incubator for encouraging responsible behaviors and social interactions."(Lou, 2018) As Lou advocates, the community, being the center of urban residents' lives, requires systematic design as a sustainable and responsible practice. This paper combines historical research on building thermodynamics with cutting-edge studies on modern community environments to analyze the interactive elements that can be incorporated into community design. For example, variations in heat perception lead to different environmental temperature requirements. By studying the interactions among human sensation, incentive methods, and the Internet of Things (IoT), human-machine collaboration can achieve a balance between physical comfort and energy consumption, while also improving energy use through adjustments of human behavior . The neighborhood environment significantly impacts social interactions and social innovation potential. Therefore, research on natural climate, thermal environments, and building morphology can enhance thermal comfort in public community areas, transforming these spaces into true public areas that serve residents.

The cited cases all illustrate that community environments can be explained using thermodynamic systems. Every design action with a sustainable vision should comprehensively consider all involved elements and their systemic relationships. Braham once proposed, "We need a full energy accounting of the interaction between work and information in buildings."(Braham, 2015, p. 250) The scope of a community extends beyond buildings, involving more elements and having a closer relationship with the ecology system. Therefore, it is crucial to establish a universally applicable sustainability assessment for communities design and practice method. This paper provides preliminary ideas for sustainable community design, with the hope of studying more cases in the future and building a community design knowledge system based on thermodynamic principles through experiments and data.

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EXTENDED CURRICULUM PROGRAMMES IN SOUTH AFRICA: A FOCUS ON SOCIAL JUSTICE AND ARTS-BASED PEDAGOGIES

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Peninsula University of Technology (CPUT)

ABSTRACT | South Africa's historically segregated apartheid education system still affects students' academic performance in higher education. Extended Curriculum Programmes (ECPs) in South Africa (SA) attempt to bridge this gap by providing additional specialised support to prepare students from under-resourced high school backgrounds for success in their chosen fields. Many ECP students, however, struggle due to limited prior educational opportunities and language barriers, with English (which is often their second or third language) being the primary language of instruction. ECPs, as supported by the South African Government, present a valuable opportunity to integrate social justice principles and arts-based pedagogies to create inclusive learning environments. Arts-based pedagogies, offer alternative pathways to knowledge creation and are particularly valuable for students navigating language barriers. These pedagogies allow students to explore their experiences and engage with epistemological issues in a non-linguistic and accessible way. This paper explores Extended Curriculum Programmes (ECPs) in Design at a University of Technology in South Africa, focusing on social justice through arts-based pedagogies within these spaces. Collage as an arts-based pedagogy facilitates expression beyond language limitations and provide opportunities for students to explore and make meaning of their experiences of transitioning to university. Collages can foster dialogue and shared understanding within diverse learning communities and the collages generated by students who are part of this particular ECP generate rich data that help us understand the experiences of these students as they transition from school to university. Through a review of the literature and semiotic analysis of some of the collages created by students, this paper looks at how arts-based pedagogies such as collage can contribute to a more just and equitable higher education landscape in South Africa and be instrumental in students finding their voice while navigating their educational journeys.

KEYWORDS: SOCIAL JUSTICE, HIGHER EDUCATION,ARTS-BASED PEDAGOGIES, COLLAGE, EXTENDED CURRICULUM PROGRAMS

1. Introduction

This paper scopes literature related to Extended Curriculum Programmes (ECPs) in South Africa, social justice in higher education, using collage as an arts-based method of inquiry, and humanizing pedagogies. The paper opens with a discussion of ECPs' role in assisting students' transition from high school to university in South Africa. It dives into ECP students' demographics and many factors influencing their transition to higher education. The paper discusses the global background of social justice in higher education, referencing Palmer's paradoxes for establishing socially just learning environments and looks at Humanizing Pedagogies as the framework for the study. In addition, the paper explores the value of arts-based activities in these transitional spaces, with a special focus on collage as a tool of inquiry.

2. Extended Curriculum Programmes in South Africa

The continued effects of the apartheid basic education system in South Africa are one of the main contributors to the difference in the academic performance of students in Higher Education (HE) in South Africa (Shepherd, 2016). During Apartheid, an education department oversaw and supervised education for each ethnic and racial group independently. The apartheid government acknowledged four racial groups as per the nationalist government groupings: black Africans were all grouped under the term "Bantu" and eventually segregated along ethnic lines such as Zulus, Pedis, Tswanas, Sothos, Shangaan, Venda, and Ndebele, while those of Indian and Asian heritage were designated as "Indians". People of mixed ancestry, such as African, European, and Malay, were labelled as "coloured". People of Indian, Asian, and mixed races (Coloureds) had a poorer education than Whites but were considerably better off than the Bantu school system made available to Black South Africans. The apartheid government designed this system to segregate South

African education into the four perceived racial groups and in so doing designed inferior education for the non-white people to maintain the "subordinate and marginal status of the majority racial group of the country" (Thobejane, (Thobejane, 2013 p2). This narrative extended to language use in schools, where learners were taught in their mother tongue in the primary band and English and Afrikaans in high school. This left them with no high-level academic language ability in any of the languages. To this day Bantu languages as a mode of instruction are "associated with poor education" (Webb et al., 2010)

Foundation Provision (FP) also known in universities as Extended Curriculum Programs (ECPs) are an initiative of the Department of Higher Education and Training (DHET) in South Africa that aims to redress the academic inequalities caused by the apartheid history of South Africa. ECPs cater for students from designated groups who meet university requirements and gain admission, but, due to their initial educational and social disadvantage are less likely to complete their studies than those students who have access to schools that better prepare them for university (Garraway & Bozalek, 2019a). This is achieved by increasing the period by adding on an extra year and providing students with specialised support to succeed in their field of study.

According to FP policy, ECPs should focus on basic concepts, content and learning approaches that foster advanced learning. Initially in thinking about ECP, Garraway & Bozalek, (2019) refer to what Morrow, (2009) calls epistemological access. For Morrow, epistemological access entails "learning how to become a successful participant in an academic practice" and as not only depending on teaching but also the student's efforts. For epistemological access to be possible, Morrow (2009) states that students must have selfunderstanding and be able to relate this to their academic practice. As a result of South African history and more poignantly its educationally segregated history, ECP students, according to Furlong & Cartmel, (2009 p110), do not have "adequate background knowledge" to engage in mainstream studies yet. Students who form part of the first year of the ECPs in design, typically do not have a "classical" (Menon, 2003) art and design background and they come largely from rural and public schools that do not offer "the skills and competencies normally expected of a first-year post-matric university student" (Zulu, 2011 p447). The term "post-matric" (Zulu 2011, p447) here becomes key in highlighting ECP students' "proximity to high school level rather than second or third year" (Zulu, 2011 p447) at university. In their academic practice then as fist year design students it is difficult to relate their understanding of self, back to their practice as design students and by implication, makes epistemological access challenging for them.

Timmis et al. (2019 p78) highlight that research studies on young people migrating from rural areas to urban universities in South Africa show that whilst rurality itself is 'not

necessarily a disadvantage when it intersects with low income (rather than high income and historical privilege), it manifests as a challenge in students' lives and the making of their new identities as university students. Many different factors influence university transitions from rural areas, these include geography, financial resources, schooling, and language (Timmis et al., 2019). According to Timmis et al. (2019), geography relates to the high level of access urban areas typically must support, social services and infrastructure as opposed to their rural counterparts. These issues of access to resources often also apply to the basic education offerings in rural areas, putting ECP students on the back foot once they gain access to the university, where the systems and curricula tend to favour those with high income and historical privilege.

Timmis et al. (2019 p82.) stress that transitioning from one context to another inevitably means changes in the self and changing identities. The authors suggest that "transitions can be understood as identity making". During these transitions from school to university students make negotiations to access, participate and study and position themselves within the university. ECP students are often English second or third language speakers from rural areas. This fact adds to the complexity of their transitions into higher education, where the language of learning and teaching is English. Eisner, (2008 p5) states that it has become increasingly clear since the latter half of the 20th century that knowledge or understanding is not always reducible to language. He suggests that knowledge comes in different forms and the forms of its creation differ. Eisner says the idea of ineffable knowledge is not an oxymoron but suggests that the term knowledge should be liberated from the propositional, and birth what he calls the deliterization of knowledge. With words, according to Eisner (2008), defined as proxies for direct experiences, Eisner advocates for the deliterization of knowledge as it opens the door for multiple forms of knowing (Eisner 2008, p. 6) and knowledge building that is not dependent on a specific language for meaning making and is more inclusive. Within the ECP space in South Africa and more specifically in ECPs in Design, it is crucial that praxis that transcend linguistic barriers are explored, to create inclusive learning environments.

3. Collage as an Arts-Based Method of Inquiry and pedagogical tool

Arts-based inquiry as a pedagogical approach offers multiple forms of knowing. It includes activities such as creative writing, photography, music, poetry and visual art, as ways to engage with knowledge. These methods help users make the meaning that "eludes linguistic description" (Casey, 2009 p73) and has what Culshaw (2019, p. 268) calls "revelatory potential" as it unveils the things that people may not be able to communicate in words alone. This non-linguistic capability makes arts-based methods particularly useful in transitional environments like ECPs where individuals are learning a language other than their mother tongue. Art-based pedagogical experiences provide value for

both teacher and student. The student can explore their personal narrative and configure their experiences of particular subject matter into works of art. The viewer/teacher by engaging with the art is drawn into the art experience, which according to (Casey, 2009 p71) is a "dialogical process where the worlds of the artist and interpreter meet through experiencing the artwork". (Eisner, 2008 p7) describes art as enabling one to vicariously participate in a situation and thus allowing the viewer to "walk in the shoes of another" and understanding is gained through "empathic experience". "Collage creation allows a reflection on and the visual reconstruction of an experience to make that experience more familiar and, hopefully, understandable" (Culshaw, 2019 p271)

Kerry-Moran (2008) in Knowles & Cole, (2008 p500) expresses that "arts-related research links the emotional with the scholarly and places emotional learning on even ground with scientific understanding. This directly contradicts the notion that science, and by extension, good research, is devoid of emotion." One type of inquiry does not cancel out or replace the other, but rather, arts-based inquiry is seen to enrich and humanise scientific research. Cahnmann-Taylor & Siegesmund, (2018 p. 2) call arts-based research the next logical part in the shift to qualitative inquiry, which is causing a move from employing qualitative skills that emulate hard science paradigms to research that encourages "fearless academic and artistic border crossing".
Arts-based inquiry offers academic border crossers a variety of innovative apparatuses that bring about ongoing assemblages and mutations of the tools that can be used in research (Cahnmann-Taylor & Siegesmund, 2018). These tools create multi-sensory research and produce a permanent record of ideas. Arts-based inquiry also opens fresh discussions and allows for visual thinking rather than linguistic thinking (Culshaw, 2019)

Collage is a form of arts-based inquiry employed in various fields of study. The term collage originates from the French word collé which means glued. Pablo Picasso and Georges Braque used collage as a cubist technique, disrupting the notion that a painting represents a "uniform reality" (Gerstenblatt, 2013 p295). Collage "fragments space and repurposes objects to contextualise multiple realities" (Gerstenblatt, 2013 p295) and because of the ability of collage to consolidate multiple realities it is a good way to provide opportunities for inclusive communication and learning about or eliciting the different experiences of different people who now find themselves in the same context. Because of its non-linguistic nature, collage allows for narratives that are "silenced by the textual and linguistic" (Gerstenblatt, 2013 p295) to emerge. According to (Rose, 2016) collage can help in the discussion of identity and the mixing of subjects' own drawings with existing images can give insight into their visual culture. As an art-based inquiry method, collage is a means to include and hear the marginalised voices and encourage language-based, visual, textural, and non-verbal representations. Collages are an alternative

way to articulate authentic lived experiences and offer to us as researchers both a method of inquiry and analysis (Gerstenblatt, 2013).

4. Social Justice in Higher Education

"Education can change lives" (Rowan, 2019 p2) but education is not a "neutral act" (Rowan, 2019 p2). It can bring about conformity and render students invisible, or it can be the practice of freedom (Freire, 2000, p. 34). Hooks, (1994) claims that for education to be liberatory it should incite "mutual labour" (hooks, 1994 p14) in knowledge generation. This means that students are agents of knowledge building and creation and don't just use a "banking system" (hooks, 1994 p14) where knowledge building is a one-way street only imparted to them by the knowledgeable other. Zembylas, (2017, p37) calls this participatory way of knowledge building "curricular justice" as it considers how knowledge is generated in the colonial encounter while foregrounding higher education as public good.

Zembylas (2017) elaborates on the concept of higher education as public good and questions what this public good looks like in societies like South Africa, where gross inequalities have existed. He uses the idea of curricular justice (Connell, 1994) which places emphasis not only on the development of knowledge through the recognition of the interests of the least advantaged, but also emphasizes how this knowledge may be critical and useful to the communities of people that higher education (HE) seeks to address. Therefore, social justice in higher education is becoming critically aware (Sensoy & DiAngelo, 2012) of who the real communities of people that HE serves are, and making sure that their voices are heard, acknowledged, and affirmed in their classrooms. However, This acknowledgement and affirmation do not equate to equality but equity in terms of access to systems and structures that in HEIs are inherently unjust (Furlong & Cartmel, 2009). These unjust systems according to Sensoy & DiAngelo (2012) exercise unequal social power at both micro (individual) and macro (structural) levels, and it is therefore imperative that educators engaging with issues of social justice recognize this. Similarly, at a macro level, universities must implement policies and systems that promote equity rather than equality (Furlong & Cartmel, 2009). At a micro level, educators employ pedagogy and curriculum that facilitate equitable participation in knowledge formation. Additionally, larger institutions that want to contribute to the public good must prioritise graduates' need to be active citizens in a democracy that promotes social justice (Zembylas, 2017 p39). This entails making strategic choices around staffing and curriculum to empower such.

Rowan (2019 p98) advises that creating learning environments that are intellectually charged and demanding while recognising diversity and keeping students engaged are key in HE. This endeavour requires staff that "are confident in their ability to create

hospitable environments characterised by clear boundaries, high expectations, diverse forms of support, and opportunities for choice". Once staff members are confident in their ability to create such environments, the pursuit of "situated action in pursuit of educational and social justice" can begin (Rowan, 2019 p98). For example, academics wanting to implement socially just spaces in higher education must be aware of the "patterns of speech and silence that have been naturalised" (Rowan, 2019 p99). Rowan (2019) therefore suggests the employment of (Palmer, 2017 p76-77) paradoxes in creating socially just learning spaces. In Palmer (2017), paradoxes are described as ways teachers can induce creative tension. The space paradoxes are as follows:

1. **Bounded and open spaces:** Space of learning needs clear boundaries for learning to be clear and guided. However, according to Palmer (2017), openness in a learning space refers to the many ways in which the end result of learning/knowledge building can be achieved.

2. **Hospitable and charged spaces:** Learning spaces must have features that help students feel safe on their "educational expedition" but must also be charged so that students do not "fall asleep" but experience the risk of pursuing deep learning by engaging with topics of significance without trivializing them.

3. **Spaces that invite the voice of the individual and the group:** When students find their authentic voices rather than assimilating the educator's voice, they are more likely to learn (Palmer, 2017 p67) in a supported learning environment. However, in addition to having and voicing their own opinion, they should also show an ability to listen with care to the voice of their peers and then to consolidate the collective wisdom with their own and recognize its possible influence on their ideas and beliefs.

4. **Spaces that honour little and big stories:** According to Palmer (2017), learning spaces should not only be filled with the large abstract stories that inform learning but should also leave room for the "small but soulful realities that grow in our students' lives". The big stories should be used to frame the personal to make learning relatable.

5. **Spaces that support solitude and are surrounded by resources of community:** Learning spaces should provide opportunities for individual meaning-making and for the testing of such meaning by the larger group, which may be able to make the individual aware of those factors that impede their discernment.

6. **Spaces that welcome speech and silence:** Silence is a space of reflection and individual meaning-making, while when students speak they communicate the concrete meaning they have made. In this kind of space students may gain greater understanding by ascertaining the similarities and differences in the meaning they may have made in silence as individuals.

Sensoy & DiAngelo (2012) define socially constructed meaning as not inherently true but as agreed upon by society. If one were to use this definition in the making of socially just engagements or learning environments (especially for post-matric students transitioning into university) one could say that if the group agrees to particular ways of meaning-making and interaction, these become the norm in that community. In other words, we as educators have the power to create environments that are socially just by foregrounding particular values and creating particular kinds of spaces for learning as written by Rowan, (2019 p123) who says we as university educators have to "look well beyond familiar, common, rehearsed explanations regarding what effective or quality teaching is or looks like to investigate who benefits from our decisions" If we are to make sure that students entering university post-matric are fully benefiting from the transitional strategies that we employ we have to ensure that their voices are present and engaged in what we do in our classrooms.

5. Humanising Pedagogies

According to Freire, (2000), humanisation is the process of "becoming more fully human as social, historical, thinking, communicating, transformative, creative persons who participate in and with the world. Humanising pedagogies have at its heart Freire's notion that humans are motivated by a need to reason and engage in becoming (Salazar, 2013). According to Salazar (2013 p128) the philosophical, theoretical, and operational foundations of humanising pedagogy can be delineated into five essential tenets.

The first contends that the person's full development is essential for humanisation. The second argues that the denial of someone else's humanisation is a denial of one's own. The third tenet foregrounds how the journey for humanisation is an individual and collective endeavour toward critical consciousness. Following this, the fourth focuses on how critical reflection and action can transform structures that impede our and others' humanness, thus facilitating liberation for all. Finally, the fifth maintains that educators are responsible for promoting a more fully human world through their pedagogical principles and practices.

Cautioning against a narrow and dismissive view of educational theory and discourse, Fataar (2016) encourages a pedagogy based on recognition and engagement, including our students' social and subjective aspects. Engaging the ever-changing "humanity of people" (Fataar, 2016 p20) suggests rich thinking around humanizing pedagogies, which engages the participants in learning to the full by mapping the social aspects of their being onto the educational and pedagogical aspects. Thinking with Nancy Fraser (2009), Fataar explores humanising pedagogy as a three-dimensional conception of social justice. Fraser's (2008) three dimensional theory of social justice says that any work toward social justice require economic redistribution (equal share), cultural recognition (equal respect) and political representation (equal say).

Fataar argues that in addition to addressing how knowledge is distributed, a humanizing pedagogy must recognise students' knowledge, literacies, and identities. Fataar (2016 p19) highlights how, using Fraser's (2009) dimensions of social justice "schooling can be informed by vigorous and thoughtful interaction between school knowledge and the students' life knowledges". Fataar (2016) suggests that recognition of students' life knowledge would help them understand that their knowledge, thinking and world views are important in finding their place in society and that knowledge formation is generative as well as a matter of participation according to Fraser's (2009) participatory third dimension.

6. Methodology

1. Data collection

The data for this research project was gathered from individual written text and collages Data was collected in the second semester of the ECP in Design Foundation Year and was made up of artefact creation (collages) as well as written reflections on the artefacts created. In order to listen visually (Butler-Kisber, 2008) to students' experiences of their transition into higher education and design studies they were asked to create three collages. The three collage prompts are listed below and are framed in terms of Frasers (2008) framework for social justice:

1. How they see themselves including things they like to do and how they often feel (the individual collage)=(recognition)
2. How they see themselves as a university student including their life since they have been at university (university student collage)=(representation)
3. How they see themselves as designers (designer collage)=(redistribution)

After creating their collages students were asked to write a brief reflection on each of their collages. The reflections were an explication of the collages created and were used to further engage students in making meaning of the identities depicted in their collage. The written reflections were not focused on eloquent language and correct grammar and spelling but were rather a form of what Austin, (1975) calls performative definitions which are statements that define the state of things. These performative definitions give a subjective rather than objective description of the state of things and often a call to action. Ortlipp (2015) says that written reflections as a method of data collection provides reciprocity in research. The written reflections should provide the reciprocity Ortlipp (2015) speaks of by giving a conscious insight into what may have been unconscious decision-making while creating the collages.

2. Analysis

Semiotic document analysis was used to identify themes, inferences in the collages/ artefacts as well as the written reflections. The analysis of the collages attempted to excavate whether the collages allow for the three crucial parts of Fraser's Framework for social justice to emerge. The semiotic analysis utilizes what Butler-Kisber and Poldma (2010) identify as the three attributes of collage in qualitative research:

1. Collage as a form of elicitation – what are students collages saying about their identities? (recognition)
2. Collage as a reflective process – what are the similarities, recurring themes or links (if any) between the collages and what do they mean? (representation)
3. Collage as a way of conceptualizing ideas – what are students' aspirations around their university and designer identities? (redistribution)

7. Analysis and Discussion

In this section student collages will be analyzed semiotically. The three aspects of Nancy Fraser's Framework for social justice will be used to discuss the student collages and whether collage as arts-based pedagogy allow for socially just and humanizing expression of the experiences of ECP Design students at University.



Sometimes a person may feel that they have no purpose in life. Finding out who you are just takes the time of sitting down and thinking of the importance in your life. Who am I? I am [redacted] and I am a person with different personalities, characteristics, and identities. The are many ways, in which I identify myself, in fact, are the ways that define who I am. My Identity is something only I can fully define. I have a little sister, which makes me a sister; I have a loving parent, which makes me a daughter; I am in university studying graphic design, which makes me a student; and I have wonderful friends in desperate need of support, which makes me a wonderful best friend.

University is a competitive environment; in order to succeed in it a student needs certain skills. Those skills can only be learned. The are basic rules that we need to be follow in order to become a good student: study, do all the homework and the assigned reading, attend class, and, most importantly, develop self-discipline and time management. I learnt this the hard way when I was doing IT but I learnt my lesson.

During my information technology course we had a module called Multimedia we used to create logos, advertisement , this is were I fell in love with graphic design. When I go out to centres, supermarkets, the high streets around Cape Town I have seen lots of Graphics designs in advertising, Billboards companies for example in electronical products or any type of product the graphics advertising companies running around the world, just because of that I was inspired in the graphics designing and I was influence by the subject.

I was interested particularly in doing graphics design and the visual communication that I was inspired by combining images phrases and ideas to illustrate to the target and audience so that they would impact and react on those kind of illustrated for e.g. the billboards, poster, the product packaging and lots of more advertisement there. There are lots of elements on different types of media that I have already mentioned but there are also examples like Logos which really encourage people and make those people to think about logos

The are many ways a person identifiers themselves even beyond this. I am a very quiet person and art is a form of my speaking language.

Figure 1: Collage and Reflection 1

The imagery of books and technology in the collage can be interpreted as signifiers (in Saussure's terms) of educational and informational resources. The books, such as "What Colour is the Sun?" and "The Eye of the Reindeer," symbolize access to knowledge, suggesting an environment where educational resources are accessible and valued. The presence of digital devices implies a connection to modern technology, further indicating a space where technological resources are distributed in a way that facilitates learning and growth.

The collage features various elements that denote personal and cultural identity. For example, the word "family" and the image of hands holding a cut-out family represent the importance of familial bonds and social support systems. The central figure adorned with intricate patterns could symbolize individuality and uniqueness, suggesting a recognition of personal identity and self-expression. Additionally, the presence of plants and nature imagery can be interpreted as an appreciation for the environment and the natural world, further emphasizing the recognition of diverse forms of life and existence.

The collage does not explicitly depict political or civic engagement, but the word “winner” and the graduation cap symbolize achievement and success, hinting at the possibility of upward social mobility and empowerment. These elements suggest that individuals have the opportunity to excel and be recognized for their achievements, which is a form of representation in societal contexts.

Through the lens of Nancy Fraser’s social justice theory, the collage presents a narrative where resources (educational and technological) are accessible, diverse identities (personal, familial, and environmental) are recognized, and individuals are empowered to achieve and be acknowledged. This aligns with the principles of redistribution, recognition, and representation, reflecting a holistic approach to social justice.



1.How do you see yourself as an individual:

What I did in this collage was I combined all the things I’m interested in and how I see myself as an individual, me being a skateboarder and being really passionate about it ,as well as with my fashion.

I added many different colours and pieces of clothing instead of adding one complete outfit because my sense of fashion comes in a variety of different materials,colours and patterns. I added the scenery that I feel I would be most comfortable surrounded by ,and of course added a skateboard or two for I am always seen holding a board or skating on it.

This really helps to make it easier for people when they first see me or this collage ,it’s gives a slight look into the type of person I am ,with the scenery being a calm environment to it being a sunset in the streets ,it shows my sense of fashion and how I would dress myself and what I’m interested in. (163 words)

2. How do you see yourself as a university student:

What u did with this specific collage ,was I combined from bottom to top what I was accustomed to before entering university, and then as it goes up it shows the things I started getting interested in ,such as design and culture.

My clothing style has changed up a bit also ,wearing different colours. I have also dded more communication skills around my character ,like the microphone and “voice” by my head area.This indicates that I’m socialising, having my own voice and seeing how everyone is different and unique in their own way. Learning more about what I’m into. The top section of the collage has more vibrancy and colours to it.(112 words)

3.How do you see yourself as a designer:

I saw myself adapting and learning in a new way ,in this collage I added everything I got into and learnt.

From the bottom it shows a continued section from the previous collage ,how it started as a university student ,and then to the top it changes ,getting into art and design ,my fashion sense being more intense. Technique ,adapting my own style ,working different and my change in music.

This collage has the most colour and pictures added to it because it shows my current self and improving what I’m into and all about. I used the face disguise by the head area to show that I’m becoming a new person in my own way.(116 words)

Figure 2: Collage and Reflection 2

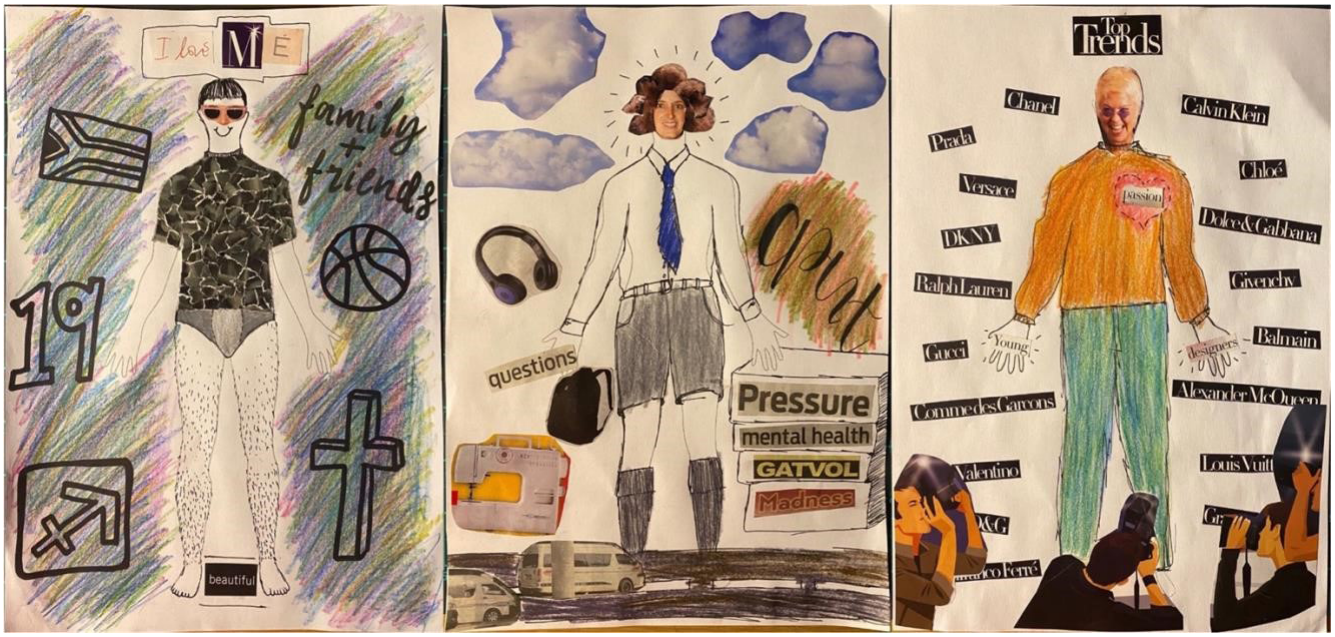
In the first panel, the figure holding a skateboard and wearing fashionable, eclectic clothing signifies access to cultural and recreational resources. The skateboard can be seen as a symbol of youth culture, freedom, and mobility, suggesting that these resources are available and valued within this societal framework. The presence of artistic and colourful backgrounds also implies a society rich in aesthetic and creative resources.

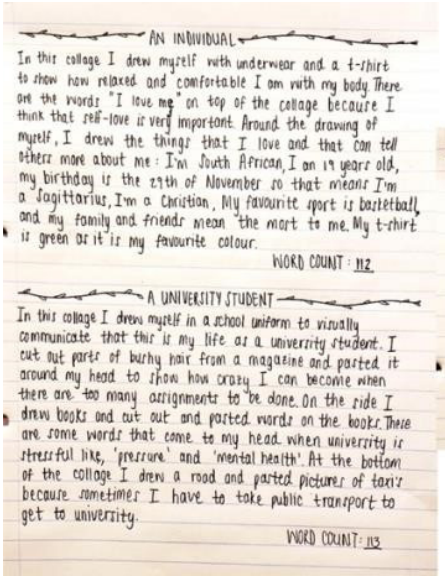
Each panel of the collage highlights different aspects of individuality and self-expression. The middle figure, with a megaphone and the word "VOICE" prominently displayed, represents the importance of having one's voice heard and acknowledged. This aligns with Fraser's dimension of recognition, emphasizing the need for individuals to be seen and respected in their uniqueness.

The third panel, with the phrase "WORK DIFFERENT" and the figure wearing a unique, bold outfit, underscores the value of diverse forms of work and expression. The inclusion of elements like the zebrapatterned hat and vibrant backgrounds signifies an embrace of diversity and unconventionality. The term "ALCHEMY" suggests a transformative process, acknowledging the ability to create and innovate in varied and personal ways.

The figure with the megaphone in the middle panel signifies advocacy and active participation. This element suggests that individuals are not only recognized but also have the platform to influence and contribute to societal discourse. The megaphone is a symbol of amplified voice and agency, reinforcing the idea of participatory democracy and representation.

Through the lens of Nancy Fraser's social justice theory, the collage presents a narrative where cultural and recreational resources are accessible (redistribution), diverse identities and forms of self-expression are celebrated (recognition), and individuals are empowered to voice their opinions and participate in societal structures (representation). The visual and textual elements work together to convey a society that values equity, diversity, and inclusion.





AN INDIVIDUAL

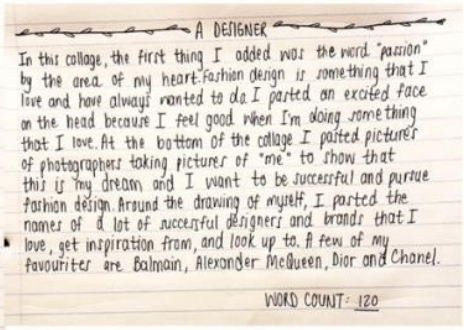
In this collage I drew myself with underwear and a t-shirt to show how relaxed and comfortable I am with my body There are the words "I love me" on top of the collage because I think that self-love is very important Around the drawing of myself, I drew the things that I love and that can tell others more about me: I'm South African, I am 19 years old, my birthday is the 29th of November so that means I'm a Sagittarius, I'm a Christian, My favourite sport is basketball and my family and friends mean the most to me. My t-shirt is green as it is my favourite colour.

WORD COUNT: 112

A UNIVERSITY STUDENT

In this collage I drew myself in a school uniform to visually communicate that this is my life as a university student. I cut out parts of curly hair from a magazine and pasted it around my head to show how crazy I can become when there are too many assignments to be done. On the side I drew books and cut out and pasted words on the books. These are some words that come to my head when university is stressful like, 'pressure' and 'mental health'. At the bottom of the collage I drew a road and pasted pictures of taxis because sometimes I have to take public transport to get to university.

WORD COUNT: 113



A DESIGNER

In this collage, the first thing I added was the word "passion" by the area of my heart Fashion design is something that I love and have always wanted to do I pasted an excited face on the head because I feel good when I'm doing something that I love. At the bottom of the collage I pasted pictures of photographers taking pictures of "me" to show that this is my dream and I want to be successful and pursue fashion design. Around the drawing of myself, I pasted the names of a lot of successful designers and brands that I love, get inspiration from, and look up to. A few of my favourites are Balmain, Alexander McQueen, Dior and Chanel.

WORD COUNT: 120

Figure 3: Collage and Reflection 3

The images in Collage 3 don't directly address economic inequality, but there are hints of class and resource distribution through the use of fashion brands (Gucci, Chanel, etc.) suggesting economic stratification. There is a contrast between high fashion and everyday items (sewing machine, basketball) pointing to differing access to resources

The recognition dimension is more prominently featured through diverse body types and styles that challenge traditional beauty norms. Mental health labels ("Pressure", "Madness") indicate a push for recognizing psychological struggles. "Family friends" suggests valuing diverse relationships and religious symbol (cross) implies recognition of faith identities

The triptych format gives equal space to different identities/issues such as fashion industry representation via brand names and “young designers”, youth culture represented through style and activities and mental health advocacy through explicit labelling.

Overall, the artwork seems to advocate for recognizing diverse identities (body types, styles, mental health experiences), representing various social groups and issues equally and questioning societal pressures (fashion, mental health stigma)

While economic redistribution is less explicit, the juxtaposition of high fashion with everyday elements hints at critiquing resource inequality. This analysis suggests the artwork aligns with Fraser’s multidimensional approach to social justice, emphasizing the interplay between cultural recognition and social representation, while subtly touching on economic factors.



1. INDIVIDUAL
   In this collage I used a lot of small images that describes me and the certain things that I like. E.g. The South African flag represents my country, fitness shows I am very active, I love to gym and the plant describes my growth etc. (45 words.)

2. STUDENT
   In this collage I tried to express my creative side. I am a university design student and I still have so much to learn and improve. I made sure to get images that represent what I am studying for my future career. (42 words.)

3. DESIGNER
   The last collage represents my dream career as a graphic designer. These pictures are examples of what life would be like when I am qualified. These images show how fun work life would be and how I will be able to be an independent woman and flourish in what I am good at (designing.) (54 words.)

Figure 4: Collage and Reflection 4

While economic redistribution isn't explicitly addressed, there are implications of resource access to education and self-improvement ("EDU", "IMPROVEMENT") which alludes to pathways to economic mobility. "BUSINESS" and entrepreneurship hints at economic opportunity while technology access (computer, smartphone icons) implies digital resource distribution

· The recognition dimension is prominently through the inclusion of "African chic" which acknowledges cultural diversity. "YOUTH" emphasis recognizes young people's identities and concerns while multiple languages and cultural references (e.g., "BTS") show multicultural recognition. Diverse interests (music, fitness, art) validate various forms of self-expression

· The triptych format gives equal space to representation of different aspects of identity. The Individual, Student, and Designer roles are given equal prominence while a variety of communication methods (social media icons, QR code) suggest diverse channels for voice and participation. "Make it Official" implies formalized representation or legitimacy

· The "REDISCOVER" theme suggests a process of reframing or reclaiming identities and roles while "Critical thinking" and "Problem-solving" emphasize empowerment through education. The focus on creativity, passion, and innovation points to valuing diverse contributions to society

· This analysis reveals alignment with Fraser's multidimensional approach to social justice as it emphasizes cultural recognition of diverse identities and interests, hints at pathways to economic participation and mobility and suggests multiple avenues for representation and voice in society

While economic redistribution is less explicit, the overall message promotes empowerment through education, creativity, and self-expression. This aligns with Fraser's idea that social justice requires addressing both cultural and economic dimensions of inequality.

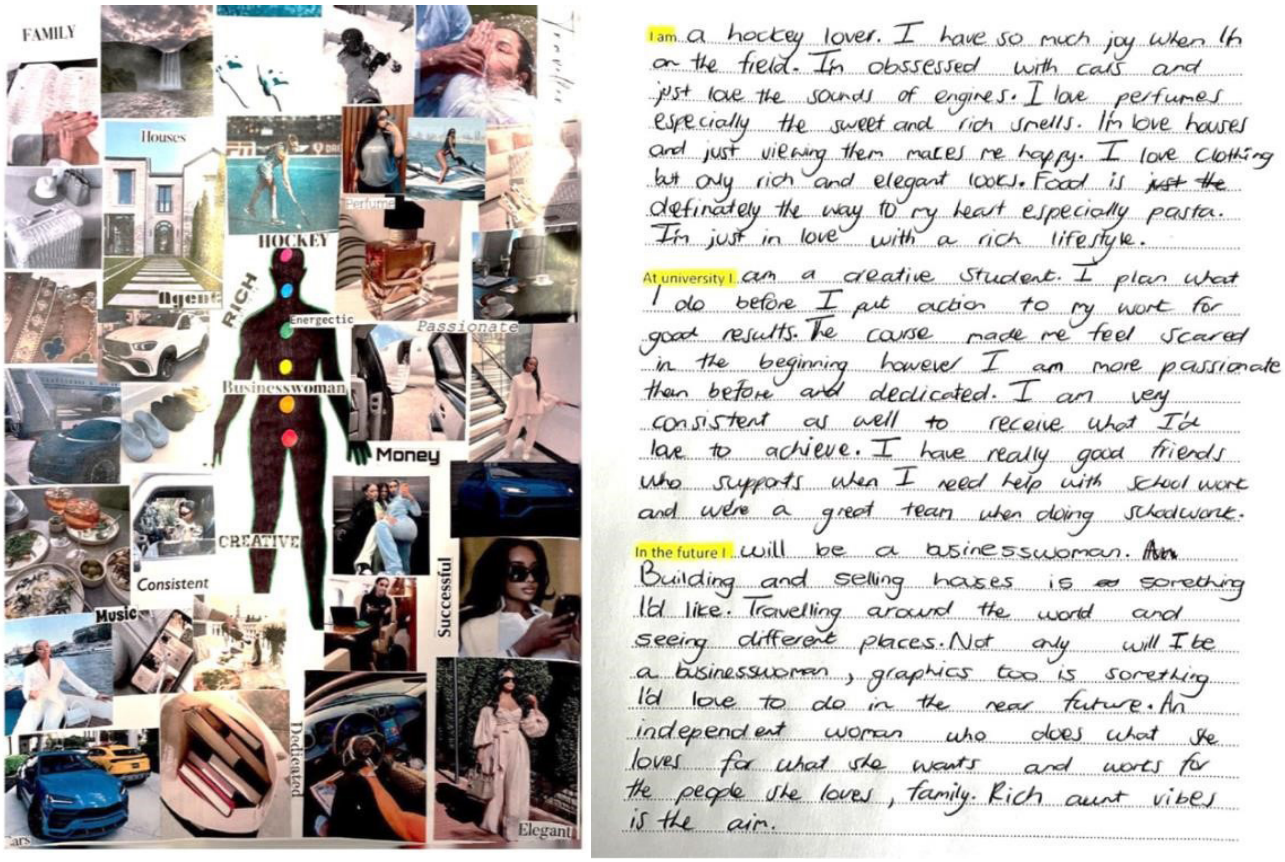


Figure 5: Collage and Reflection 5

The image contains several symbols of economic status and resource distribution:

- Luxury items: High-end cars, perfume, elegant clothing
- Property: Houses, implying home ownership
- “Money” explicitly mentioned
- “Businesswoman” suggesting economic participation and power

These symbols indicate a focus on affluence and economic success, which relates to Fraser’s concept of redistribution. However, the emphasis seems to be on individual achievement rather than equitable resource distribution across society.

The image presents a specific identity for recognition as it uses female-centric representation. Most human figures appear to be women. “Businesswoman” label emphasizes professional identity. There are diverse activities such as hockey, water skiing, creativity, family roles and personal attributes depicted, such as “Energetic,” “Passionate,” “Creative,” “Successful”.

This aligns with Fraser's idea of cultural recognition, particularly for women in professional and multifaceted roles. However, the representation appears limited in terms of diversity (e.g., body types, ethnicities, socioeconomic statuses).

The central figure of the businesswoman with chakra-like points suggests a holistic representation of a woman's life and roles. However, the representation is narrow and focused on a particular lifestyle associated with success and affluence. Ther is limited diversity in the types of women and lifestyles shown and an emphasis on individual success rather than collective voice or participation

The collage format suggests a complex, multifaceted identity and "Family" is included, indicating recognition of personal alongside professional life. The mix of luxury and everyday items (e.g., books, food) attempts to show a balanced lifestyle.

While the image does touch on aspects of Fraser's framework, it falls short of a comprehensive approach to social justice. It celebrates individual success within existing structures rather than challenging systemic inequalities or promoting broader societal change. The focus on affluence and a particular lifestyle may inadvertently reinforce economic and cultural disparities rather than addressing them in the holistic manner Fraser's framework suggests

6. Conclusion

The exploration of ECPs in South Africa, social justice in higher education, arts-based inquiry, and humanizing pedagogies reveals a profound need for inclusive and transformative educational practices. The historical context of ECPs underscores the significant impact of apartheid policies on education and, consequently, the ongoing disparities in academic preparedness. The role of ECPs in addressing these inequalities is evident, resonating with the fundamental concept of social justice in higher education.

The utilization of arts-based methods, particularly collage, as an innovative tool for inquiry and expression in transitional spaces like ECPs, demonstrates the potential for multidimensional learning experiences. Collage offers a non-linguistic means to amplify marginalized voices and enrich the academic environment, aligning with the principles of social justice and inclusivity. The pursuit of social justice in higher education calls for a multifaceted approach, integrating curricular justice and equitable participation. The creation of socially just learning environments means a recognition of diverse voices, critical reflection, and a deliberate effort to challenge unequal power dynamics.

At the heart of this effort to transform rather than bridge the perceived gap, lies the concept of humanizing pedagogies, emphasizing the full development of individuals, critical consciousness, and the

responsibility of educators to promote a more fully human world. This resonates with the drive to recognize students' knowledge, literacies, and identities, fostering an inclusive and participatory learning environment. In the future, it is imperative to continue advocating for educational practices that honor the diverse lived experiences of students, foreground critical consciousness, and strive for a more equitable and inclusive educational landscape. Embracing humanizing pedagogies and arts-based inquiry can contribute to fostering a transformative, equitable, and socially just higher education experience.

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MULTIDIMENSIONAL ARTISTIC PROCESSES AND STRATEGIES FOR CONVERSATIONAL PRACTICES BETWEEN WOMEN

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ABSTRACT | This paper explores how conversations through multidimensional artistic processes and strategies enable empowerment for women across borders, race, sexuality, and class. These conversations are not just daily interactions but integral to forming solidarity and supporting the collective fight against oppression. While conversations as method and methodology have been discussed in feminist research, the role of global justice for women within artistic research has been less explored. My aim is to interweave artistic and feminist practices, showing how female agents organize bottom-up resistance through spatial practices in conversations. The research draws on feminist theories and practices by Elke Krasny, Françoise Vergès, and Chandra Talpade Mohanty to highlight how conversations create shared meanings and address injustices. This study looks at historical shifts and feminist discourses, highlighting how claiming spaces through female interactions is crucial for collective empowerment. The research introduces *Multidimensional Conversational Processes and Strategies* to link individual experiences with collective action, dismantling oppressive structures and systemic injustices. Visual frameworks titled Entangled Video Setups and Mappings highlight the transformative power of conversations in art and design research. These processes and strategies encourage women to navigate and refine conversational practices. They contribute their own expertise and collectively grow their ability to engage with multidiverse perspectives. The study calls for engagement with *Imaginaries of Multidimensional Conversations* as an ongoing journey for sociopolitical transformation, building on contemporary art projects, feminist research and activism. This approach points to the importance of interweaving multidiverse voices and experiences to build global solidarity in the ongoing fight for global justice and liberation.

KEYWORDS | MULTIDIMENSIONAL CONVERSATIONS, FEMINIST SOLIDARITY, ARTISTIC AND FEMINIST RESEARCH, MULTIDIVERSE VOICES AND EXPERIENCES, INTERSECTIONAL EMPOWERMENT



“The social dimension of the conversational mode can be understood as a production of shared meaning. The political dimension of the conversational mode can be understood as a practice of giving equal importance to all speakers. Shared meaning, as we understand it, is connected to matters of public concern and common interest.“ — Elke Krasny, Jane da Mosto and Liza Fior (2017, p.160)

“A feminist cannot claim to possess the theory and the method; she seeks to be multidimensional and intersecting. She asks herself what she does not see, she seeks to deconstruct the malignance of school education that has taught her to not to see, feel, or know how to read, but to suffocate her senses, be divided within herself and be separated from her world.“ — Françoise Vergés (2019, p.20)

“I choose ’feminism without borders’, then, to stress that our most expansive and inclusive visions of feminism need to be attentive to borders while learning to transcend them.“ — Chandra Talpade Mohanty (2003, p.2)

1. Conversations as Everyday Feminist Practices

This contribution shares conversational processes and strategies to deconstruct power dynamics, prejudices, and systemic inequalities in neoliberal capitalist orders. Through conversations women explore differences and commonalities in their experiences of living under misogyny and patriarchy. Introduced conversational strategies enable learning and unlearning processes that promote an understanding of complex multidimensional challenges. I argue that sharing knowledge and experiences between women, while valuing the plurality of narratives and perspectives, engages in political action through collective artistic journeys. These conversations, which circulate between private and public spheres, intervene in urban environments and enable togetherness beyond categories of race, sexuality, and class. The idea is to tackle dominances through intersecting frameworks, interweaving voices of female agents organizing in bottom-up resistance as vibrant formations. I focus on sharing conversational processes rather than tools and techniques, seeing them as part of an ongoing project of interconnectedness between women. This contribution points out the potential of conversational research engaging with women's individual and collective struggles, while recognizing various lived realities.

As a female designer, artist, and researcher, conversational practices help me navigate experiences in my everyday life. I understand conversations as resilient bonds leading to interwoven resistance between women. These daily conversational practices create spaces for sharing thoughts and feelings that lead to alternative knowledge production. Everyday feminist practices form strength and resilience, sustaining meaningful relationships to which I contribute through artistic approaches and research. Drawing upon personal conversations, I examine how co-creating images with women catalyzes political action, with a focus on understanding struggles through an intersectional lens. Artistic and feminist research provide the opportunity to engage deeply with multidiverse realities as a multiplicity of global solidarity and empowerment. By dissolving the boundaries between private and political spheres, informal and formal notions, individual and collective actions, this research reshapes conversations into meaning for anti-discriminating, anti-racist, and anti-colonial learnings and unlearnings through creative processes and strategies. It investigates the potential of artistic and conversational interactions, examining how they shift between theoretical and practical frameworks, manifesting at the intersection within artistic, design, and feminist research.

My engagement lies in creating environments for conversations where women feel heard, seen, and understood, allowing space for softness, vulnerability, and emotions. The potential of these affective spaces embraces genuine connections in societies that often lack reflective practices and environments. Ann Cvetkovich looks into the transformation of public values through affect and how it can produce intellectual networks, such as relationships and kinship. She emphasizes the importance of the production of spaces that enable emotional energies to connect and think collectively. Cvetkovich argues for raising awareness for the entanglement of feelings, culture and, politics for alternative knowledge production (Cvetkovich, 2010, p. 1–12). Building on Cvetkovich's writings, I believe that integrating artistic research with conversational practices that embrace vulnerability, emotions, and feelings can be essential for dismantling oppressive structures and rethinking futures grounded in justice and equality. Similarly, Sara Ahmed investigates how emotions play a crucial role and are not just personal, but deeply social and political world making (Ahmed, 2004, p. 1–12). By creating spaces where emotional expressions are valued, women challenge existing power dynamics, generating transformative thoughts and actions. Referring to the strong emotional bonds between women, I center the role of emotions and feelings in conversational practices, particularly in daily encounters. Deeply connecting emotionally with diverse lived female experiences, conversations serve as a commitment to multiplicity for social change.

Examining the history of women's conversational practices shows how this powerful practice has always been systematically undermined and targeted as a means of oppression for centuries. The term 'gossip', originally derived from the Old English words 'god' and 'sibb' (meaning 'godparents'), initially referred to social bonds and close kinship. However, by the 16th century, official regulations began to prohibit gatherings of women and reinforcing patriarchal dominances. This shift punished any acts of independence and aimed to exclude women from communal activities, increasing the underrepresentation of women in public life. Silvia Federici examines how 'gossip' had been a form of interconnected communication and community building between women for centuries. She describes that, "It was in this context that 'gossip' turned from a word of friendship and affection into a word of denigration and ridicule" (Federici, 2018, p. 35–44). What was once a means of sharing knowledge, telling stories, and learning strategies for life became, under misogynistic pressures, a target for silencing women. Building on this historical context, I explore how women's conversations can bridge individual experiences to collective actions to address global injustices and discrimination in our global world. In Reina Gattuso's words, "… women and other marginalized people have to share information that formal systems—politics, education, and the media—often won't consider or share" (Gattuso, 2023). Oppressed communities can use their relationships and networks to develop an

ongoing journey to build spaces to grow together, which are essential for supportive environments. Gattuso observes, “At most revolutionary, we can understand gossip as ’weaponized intimacy‘“ (Gattuso, 2023). When personal conversations are transformed into public discourses, these interventions tackle systemic injustices as interconnected political actions and movements between women.

2. Multidimensional Approaches: Empowering Women Across Borders, Race, Sexuality, and Class

Following the argument of transformative empowerment for global justice and liberation for women, it is necessary to include decolonial and feminist theory to conversational research. To challenge existing narratives and to disrupt Eurocentric perspectives we must consider knowledge production from the Global North and Global South. Gloria Anzaldúa argues that a new way of understanding borders requires overcoming binary thinking and acknowledge complexity and fluidity. This shift is crucial for addressing and resolving cross-border conflicts effectively, as it allows us to challenge and transcend the rigid opposing frameworks that control our perceptions and interactions. The solution to global conflicts, she writes, “lies in healing the split that originates in the very foundation of our lives, our culture, our languages, our thoughts“ (Anzaldúa, 1987, p. 80). Even though global neoliberal capitalist systems often make borders invisible, they persist through deportations, segregation, marginalization, and criminalization. Recognizing and embracing the intersecting identities and experiences that shape our understanding of these boundaries is crucial for addressing the complexities of border thinking (Gržinić, 2018, p. 13–16). This concept of ’border thinking’ calls for moving beyond traditional approaches. It requires the development of inventive methods and political strategies that place awareness of social injustices at the center. Including ’border thinking’ into artistic research supports critical building of connections and relations. To transform dominant perspectives, we must integrate dimensions across borders with a critical lens on our intertwined histories and knowledge production. ’Border thinking’ rewrites and retells our entangled histories, embracing relationships that collectively resist capitalist and oppressive systems. It crosses both physical and non-physical boundaries through thought and involves people with international histories. Consequently, the research must address these complexities, challenge rigid biases, and promote anti-colonial and anti-racist liberation across borders.

The book Feminist Futures of Spatial Practice offers valuable insights that incorporate decolonial and feminist theory, presenting “new forms of activism, expanding dialogues, engaging materialisms, transforming pedagogies, and projecting alternatives.“ The research challenges social orders intervening in spaces through creativity and social engagement to imagine possible futures

(Schalk, Kristiansson, and Mazé, 2017, p. 13–23). The contribution by Liza Fior, Elke Krasny, and Jane da Mosto, titled Making Time for Conversations as Resistance, explores how conversational dimensions shape feminist futures and how collaboration evolves into a dialogue that engages in meaningful change“ (Fior, Krasny, and da Mosto, 2017, p. 159–168). They draw on Chandra Talpade Mohanty's concept of 'imagined communities', which suggests political action through building connections between women. Mohanty argues that resistance must be rooted in historical and political contexts and emphasizes challenging conventional categories of identity through nonhegemonic feminist practices across cultures, genders, nations, and classes (Mohanty, 2003, 10–24; 46). Mohanty's work offers the opportunity to develop a deeper understanding of how to think and act intersectional, "...feminism need to be attentive to border while learning to transcend them.“ She critiques white feminism and academic supremacy, highlighting struggles beyond borders, drawing from her own experiences of navigating boundaries that both excluded and empowered her. The politics of solidarity is one central focus of her work which "involves profound transformation of self, community, and governance structures“ (Mohanty, 1984, p. 333–358) (Mohanty, 2003, p. 1–13). Intertwining the described approaches inspires me to view conversations as a critical practice for rethinking and reshaping artistic research. Additionally, I take on the responsibility of critical self-reflection regarding my positionality. This encourages me to reflect my position as a white artist and researcher, addressing power dynamics and privileges in my work. These reflections navigate me toward refining a more transformative approach within the context of decolonial and feminist methodologies.

Afterall, multidiverse backgrounds, histories, and narratives unfold multidimensional links for building conversational practices and spaces for women beyond borders. Conversations are multilayered acts of empowerment that enable collective movements, challenging social problems and conflicts. Audre Lorde's writings highlight the importance of including interwoven interactions in feminist discourses, "Interdependency between women is the way to a freedom which allows the I to be, not to be used, but in order to be creative. This is a difference between the passive be and the active being“ (Lorde, 1984, p. 89–93). For organizing these feminist spatial conversations, I focus on a contemporary multidimensional approach, which addresses various spatial and dimensional aspects for complex reflexive practices. Françoise Vergès's contribution to decolonial feminism describes a multidimensional analysis that deconstructs links and connections that exist in heteronormative orders. Vergès writes, "Decolonial feminism is a feminism that offers a multidimensional analysis of oppression and refuses to divide race, sexuality, and class into mutually exclusive categories“ (Vergès, 2019, p. 19–20). Her approach enables new ways to address social injustices by supporting anti-imperial re-imaginaries.

She stresses the importance of dismantling capitalist and imperialist power structures illuminating "a kaleidoscopic narrative encompassing broad swathes of time and territory" (Vergès, 2019, p. ix). Working with Vergès's ideas helps to build frameworks for artistic approaches that engage with spatial, transnational, and multidiverse interactions. It allows relating with multidiverse contexts, making it particularly effective in artistic research. Dimensions beyond categories of race, sexuality, and class enrich artworks by adding complexity and depth, allowing for more meaningful reflective interactions of varied experiences. Multidimensionality navigates complex interdependencies, contributing kinships and allyships across borders with women. Feminist conversations as multidimensional practices across borders contribute to understanding women's lives by recognizing interconnected liberation.

3. Image Production for Future Visions: Engaging in Global Feminist Struggle and Justice

The question of how image production engages in global feminist struggle and global justice arises from the interest in past, present, and future conversations. During my research, I was deeply moved when I came across a historical photograph of three young female scholars – Esther Cooper, Alice Dritz, and Vidya Kanuga – involved in an intimate conversation during the 1945 World Federation of Democracy. Their meeting is marked by their collective fight against patriarchy, violence, and capitalism, highlighting their active role in global movements. Elisabeth Armstrong features the photograph in her article, questioning, "What does this memory mean for us now as we imagine our future?" Her question invites us to reflect not on the photograph's exemplary meaning but on its role in a particular moment in time. It challenges us to consider how we can shape our own gatherings and conversations in the present (Armstrong, 2023, 156–162). Armstrong's article, featured in *The Kohl Journal*, addresses Anticolonial Feminist Imaginaries, focusing on body and gender research in the Middle East, Southwest Asia, and North Africa. Under the framework of Speculative Conversation, how to 'fill the blank spaces of histories of revolution, and also re-imagine and re-capture lost, unheard, and erased voices' (Sajed & Salem, 2023, p. 1–8) is further explored. For my research, the term 'speculate' is particularly relevant, deriving from the Latin *specere* ('to observe, watch, look at'). I connect this notion of 'looking at' with past, present, and future narratives and the production of images. Artistic conversational practices are used to explore, challenge, and reshape these imaginaries, thereby rewriting of understanding interrelating global contexts of women.

Recognizing the importance of creating and maintaining spaces to share stories and experiences for women, I began exploring how my practical artistic work could connect with feminist and political action. By participating in symposia on 'Feminist Methodologies' organized by Elke Krasny

at the Academy of Fine Arts Vienna, I met feminist scholars from Austria, Italy, the Czech Republic, Russia, or Brazil. Despite our diverse backgrounds and fields, we shared feminist perspectives on various topics on care, solidarity, space, ecologies, decoloniality, or memory. During breaks from the presentations, talks, panel discussions, and workshops, we gathered in informal settings by sharing lunch at the market, sitting around a playground table, or relaxing in public spaces while drinking juice in the sun. This is where I began conceptualizing conversations using artistic, design, and feminist strategies. In these times, I conceptualized conversation and videos settings, seeing the potential to learn from personal stories and interactions. These experimental conversations reshaped my evolving research on how artistic environments could actively develop into transformative collective action. I discussed with feminist scholars how these conversational practices could be processed as feminist methods and methodologies, which are created, practiced, shared, and reshaped by women. The support I experienced deepened my commitment to feminist research. It strengthened my affirmation to build on existing feminist research, multiplying the transformative power of collective feminist action.

Through these research exchanges with scholars, I realized that my background in artistic approaches intertwined with conversational practices could contribute to feminist futures. Artistic and design practices highlight personal and subjective experiences that offer new possibilities to build multidiverse entanglements in depth. This intersectional approach has the power to provoke individual thought, build collective empathy, and mobilize shared action for women. Recent shifts in social and cultural research present an increasing focus on diverse methods, such as including the use of photographs, tape recorders, or anecdotes (Lury & Wakeford, 2012, p. 1–24). The implementation of alternative practices in research engages in an openness to creativity, challenging normative research methods. The field of artistic research, as an interdisciplinary approach, uses creative processes to generate new knowledge and insights. Emma Cocker's approach, for example, involves dialogue, transcription, distillation, and presentation, aligning with the research into how conversational practices in art can be a powerful tool. Cocker's concept of conversation-as-material specifically focuses on capturing and expressing aesthetic co-creation through dialogue in the context of a language-based artistic research practice and phenomenological writing (Cocker, 2022, p. 202–231). My contribution shows how artistic perspectives through image and multimedia-based formats can commit to multiplicity for conversation building multidiverse environments. It shows how artistic research can learn from feminist practices and theories and vice versa, highlighting how both forms of research can mutually benefit each other by challenging existing heteronormative norms and structures with openness to emotional and cognitive levels.

My research relies on diverse learning environments, including artworks, museums, and exhibitions, which play a key role in my research practice. By exploring global projects, I gain complex understandings that shape the creative and social actions within my work. For instance, in Pristina, Kosovo, the interdisciplinary artist Alicja Rogalska presents an alternative blueprint for the so-called 'Brother Houses' at *Manifesta*. By creating collaborative situations and processes, she offers a meeting place for local women to seek advice and support from experts on domestic violence. Her project, *Sister Flats*, is a hybrid installation showcasing videos, images, and objects created through group processes and dialogues (Rogalska, 2022). In Turkey, *Oda Projes*i, a feminist artist collaborative, aims to intervene in daily life through art practices, building connectivity between artists, non-artists, institutions, and communities in a three-room apartment in Istanbul's Galata district. They provide interactions that encourage dialogue and cooperation with neighbors, creating 'blank spaces' and 'holes' for social processes. As Claire Bishop writes, "By working directly with their neighbors to organize workshops and events, they evidently wished to produce a more creative and participatory social fabric" (Bishop, 2012, p. 20). In Germany, the *Fem_Arc* collective explores community work that exchanges personal struggles within urban transformations. The project *City of Gossip* deals with (informal) conversations as an urban strategy of resistance, presenting conversations from a feminist perspective in Berlin. Their window installation looks at caring participatory practice that "enables mutual help, exchanges goods and knowledge, and provides space" (ARCH+, 2023, p. 146). These interactions with artistic environments broaden my conversational practices within individual and collective feminist movements. Furthermore, I want to highlight the importance of conversations in women's fight for social change across diverse contexts within my artistic practices.

4. Sharing Processes and Strategies in the Intersection of Artistic and Feminist Research

Through conversational activities, experiences, and practices, I have expanded existing multidimensional feminist research with experimental approaches. Meeting women in my daily life has led me to evaluate spaces where women share struggles and empower each other to face challenges in collective meaning. These daily conversations have become sources of support, resilience, and strength, highlighting the importance of personal connections and growth for women in everyday environments. Additionally, participating in cultural and art spaces has allowed me to connect with women in creative discussions about past, present, and future thinking. In these settings, women learn new practices and experiment with creative ideas together. Lastly, building relationships through conversations with women from different countries through international workshops, journeys, and projects has been transformative for my feminist research. This plurality of interactions has been integral to

my approach to feminist actions, which aims to interweave women across various contexts. The shared experiences have enabled me to build global networks that acknowledge and overcome categories, boundaries, and borders. By participating in these multilayered interactions, both for this research and for myself as a woman, I aim to learn, unlearn, and build solidarity, growing my cross-border perspectives on women's struggles across race, sex, and class.

Conversational experiments practiced with women in everyday environments informed and enriched my research. Through critical reflexive practices and co-created conversations with women, I propose visualized frameworks for multimedia-based conversations rooted in intersecting artistic, design, and feminist research. I introduce *Multidimensional Conversational Processes and Strategies* that include *Entangled Video Setups and Mappings*, which transform the production of images and conversations into key elements for women to create interconnections and to increase awareness of multidiverse truths. The core of the project encourages individuals to rethink their own beliefs and build collective relations, resulting in interconnected meanings through conversational practices resulting in an ongoing process. This research aims to break the boundaries of normative thinking through speaking, listening, feeling, and participating to address the intersectional struggles of women. By discussing both differences and commonalities, this contribution provides mutual learning from diverse lived realities and cross-border experiences. The multimedia co-production of images highlights the transformative potential of artistic practices in challenging norms through inclusive thinking and dialogues. Through multimedia approaches, individuals represent themselves and become part of a collective understanding of entangled realities and the links between us. Multidimensional Conversational Processes and Strategies contributes to a broader understanding of how multidiverse worlds can be experienced across disciplines, fields, and borders, resulting in resistance and resilience for women.

In my practice-based research, I engage in multidimensional conversations with women across borders. These conversations lead me to share the following four visualized frameworks: (1) *Spatial Video Practices,* (2) *Interconnecting Fields*, (3) *Navigating Conversations*, and (4) *Interweaving Texts*. Figure 1 illustrates *Spatial Video Practices* to create a conversational environment without hierarchical dominance. In this setup, participants can operate the camera with shared responsibility and decide the image's composition and frame. The personal space provides women with a safe environment that supports personal interaction, with the overarching goal of togetherness as a figure. *Figure 2* presents *Interconnecting Fields*, which functions as an expandable map of related fields, terms, and discourses. This map allows women to select, connect, or rewrite concepts, contributing to the research framework. *Figure 3, Navigating Conversations*, outlines conversational learning frameworks that

empower women to practice conversation and to contribute their own insights. This map invites participants to navigate and refine conversational practices, growing their ability to engage with multidiverse perspectives. Finally, Figure 4, Interweaving Texts, presents an expanding text, which documents the notions and thoughts produced during conversations using an open keyword-based approach. The four processes and strategies developed together with women provide conversational practices useful for non-artists, artists, non-researchers and researchers and others. They result in Imaginaries of Multidimensional Conversations, inviting women to join in global justice practices, actions, and movements for women.

Figure 1, *Spatial Video Practices:* The setup presents a conversational environment without hierarchies

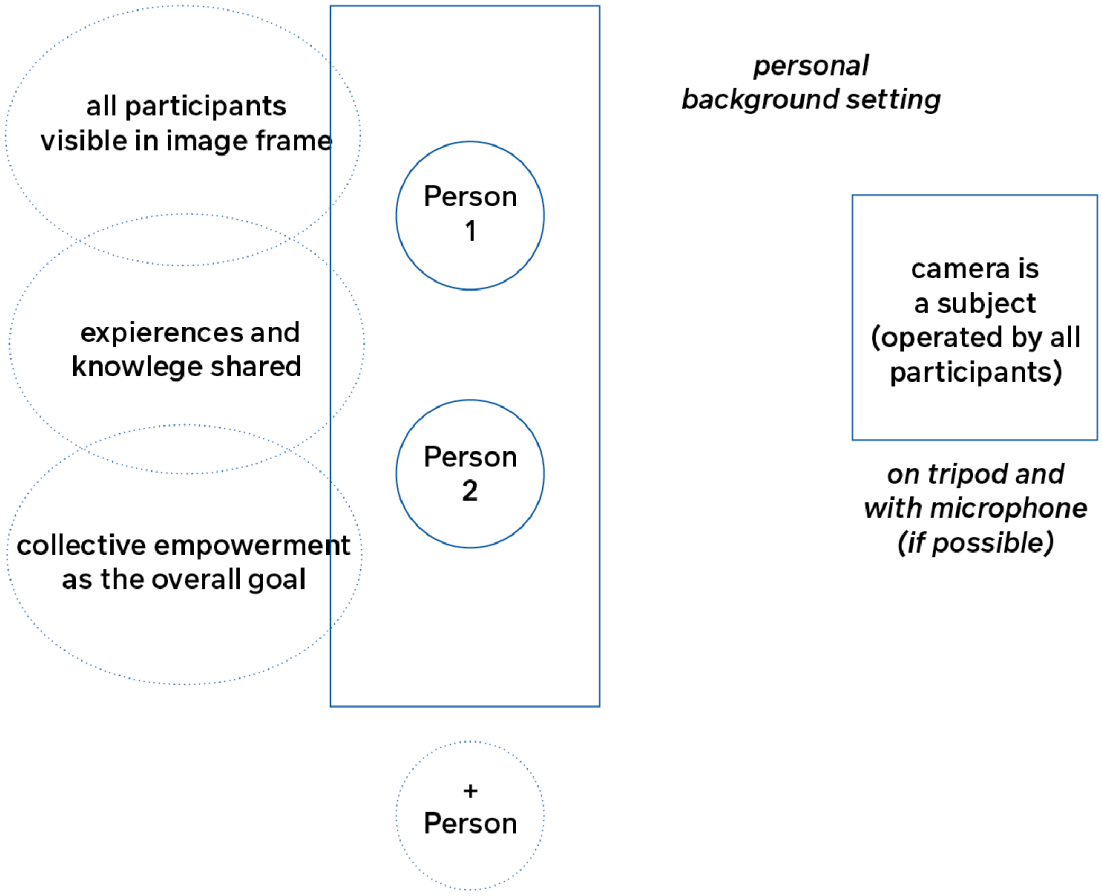

Figure 2, *Interconnecting Fields:* The map is an expandable field enabling participants to connect with

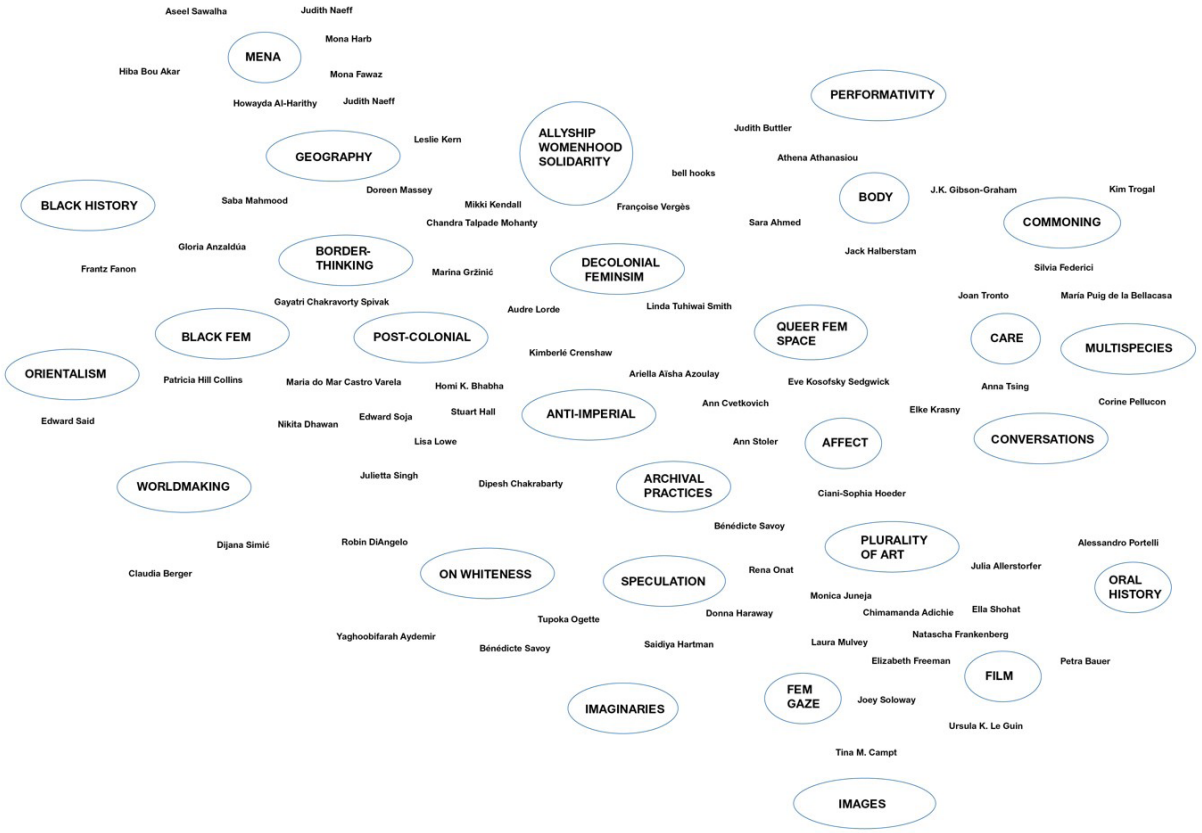

Figure 3, *Navigating Conversations:* The conversational framework engages with multidiverse perspectives

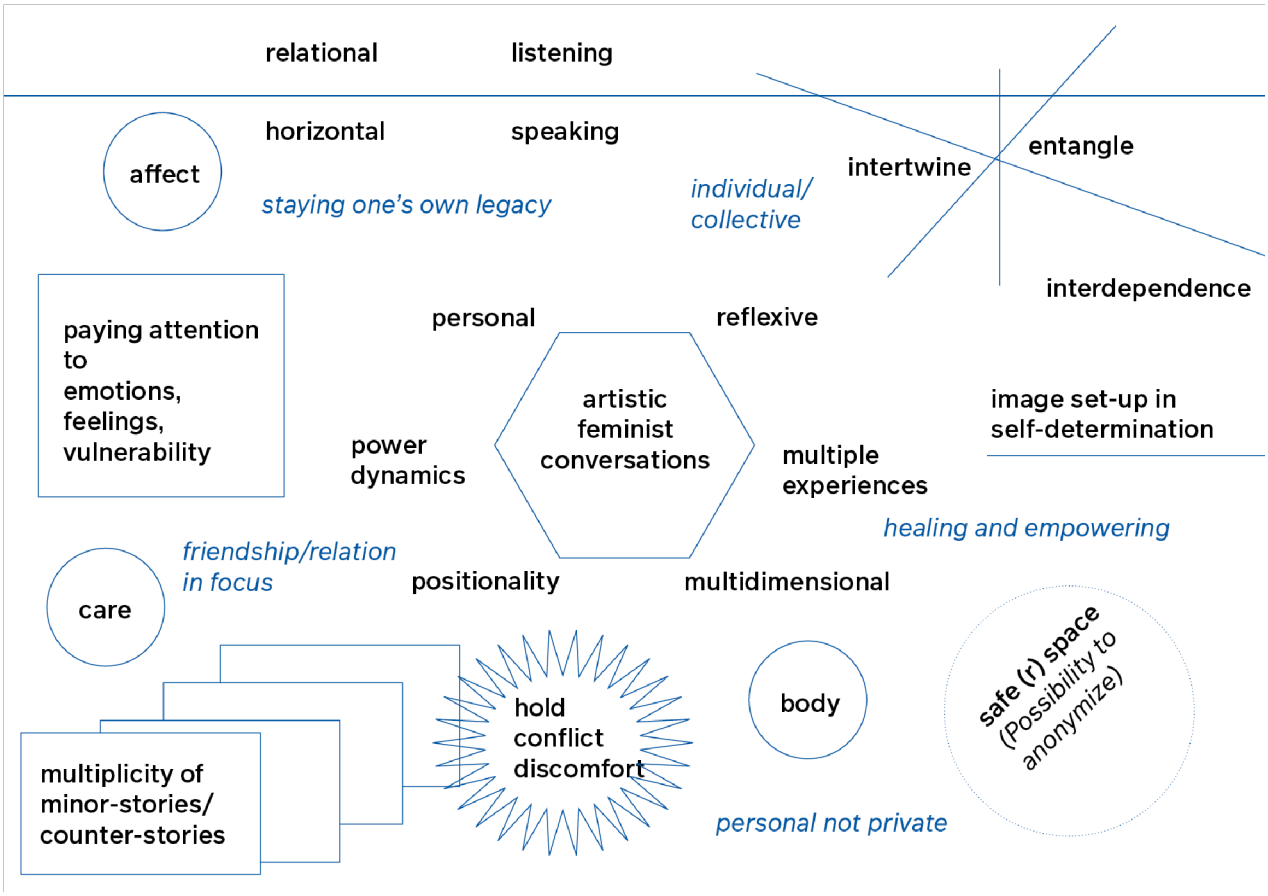

Figure 4, Interweaving Texts: The open keyword method documents new produced thoughts

#connections #conversations #togetherness #multiplicity #feminist #transnational #intersection #experience #relations #resistance #temporarily #space #entanglement #notions #interdependence #interwoven #care #affect #bodies #anti-colonial #decolonial #anti-racist #anti-capitalist #anti-sexist #space #multidimensional #dimensions #potential #resistance #commoning #transdimensional #troubling #uncomfortable #transborder #borderthinking #speculative #support #imaginaries #care #sensitivity #non-imperial #anti-imperial #responsibility #collective #collaborative #embodied #awareness #un/learning #reflection #self-reflection #engagement #activist #struggles #story #possibilities #travel #border #transborder #exploitation #discrimination #transnational #femalegaze #feministgaze #relational #tofeelseen #emotions #affect #engagement #legacies #agencies #carrierbag #anti-hero #fictional #queeringtime #time #vulnerability #healing #dissolving #troubling #courage #memories #gossip #resistance #vulnerability #artisticfilm #circulating #body #sphere #legacies #agencies #positionality #situatedness #newterm

4. Invitation in Imaginaries for Ongoing Multidimensional Conversations

This paper addresses the role of intersecting artistic, design, and feminist studies, focusing on the potential of how these fields provide empowerment for women. Conversational practices are central to my daily life, guiding personal experiences and interconnectedness between women across borders. They serve as resilient connections, shaping strategies and emotions as intertwined forms of resistance and togetherness. By integrating decolonial feminist approaches to artistic practices, I explore how conversational practices engage with multidiverse perspectives to provide global equity and collective processes for justice. Overall, this approach emphasizes the importance of engaging with cross-border experiences to support individual and collective resistance. In my research, conversational practices become political acts of solidarity centralizing feminist stories and their multiple meanings. The approach outlines the complex use of conversations as multimedia-based methods and methodologies that create learning environments in the fight for social justice. These conversational practices reconsider conventional methods by providing interwoven interactions between diverse groups that highlight personal experiences to find commonalities and differences. I pay attention to the transformative power of conversation, leading to societal change for living together. Through these moments of connection, I aim to build on existing feminist spaces of resistance, finding alternative environments for learning and togetherness.

This contribution interconnects multidimensional multimedia-based approaches with feminist research; it emerges as a powerful practice that makes visible the entanglements of women's voices. Firstly, the paper discusses how everyday conversations between women across borders promote solidarity, friendship, and empowerment. These interactions form resilient relations, allowing women to engage in strategies that provide mutual empowerment and resistance against oppressive structures. Secondly, the research presents feminist multidimensional

approaches that provide inclusivity and intersectionality while addressing feminist struggles and self-reflection through spatial conversational practices to transform perspectives across borders, race, sexuality, and class. It respects and transcends physical and non-physical borders, integrating perspectives from people with diverse international stories. Thirdly, the text draws out how conversations practiced through artistic research involve creating collective images that serve as resistance against dominant power dynamics. The artistic strategies harness the transformative power of conversations by enabling affective interactions that emphasize vulnerability and emotions, thus turning everyday encounters into opportunities for transformative thoughts and actions. Finally, the contribution points out visualized processes and strategies which invite women to engage in conversation with equal participation, trustbuilding, and empathy for various experiences. These processes and strategies are made accessible as visualized frameworks to organize conversational feminist practices and political actions – open to changes and revisions as an ongoing journey.

The project presents as an outcome visualized *Multidimensional Conversational Processes* and Strategies for practicing conversations between women. The conversational strategies are crucial for intervening in social structures and transformative processes. The frameworks emerge from *Entangled Video Setups and Mappings:* (1) *Spatial Video Practices,* (2) *Interconnecting Fields,* (3) *Navigating Conversations*, and (4) *Interweaving Text*s. These visualized frameworks demonstrate how conversations can act as powerful tactics for resistance, helping to navigate and challenge power dynamics. The artistic frameworks present how *Multidimensional Conversational Practices* commit to women's fight for social change and political transformation through shared meaning and alternative knowledge production. Focusing on the interconnection between individuals and communities necessitates traversing narratives for new forms of subjectivity and connection. The contribution invites women to be part of *Imaginaries of Multidimensional Conversations* as an ongoing journey of conversational practices for interconnected relations. Afterall, the project's focus on creating inclusive and intersectional spaces for women and advancing social justice for future-focused visions by sharing processes as an ongoing exploration of global solidarity and liberation.

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PACKAGING AND CULTURAL ACCESSIBILITY. DESIGNING PRODUCT COMPREHENSIBILITY FOR ALL USERS

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ABSTRACT | Our society is becoming increasingly complex and diversified, comprising individuals of diverse geographical origins, new first and second-generation citizens with their own cultures, and social groups diversified by age or specific physical and cognitive abilities.

The issue of accessibility to products, services and environments is therefore becoming increasingly visible and widespread issue, no longer confined to niches of users with specific needs. In this scenario, the aim of this contribution is to explore the accessibility of packaging, with particular reference to the dimension of cultural accessibility, which is more related to cognitive and communication design aspects.

To date, the topic of accessibility in the packaging industry has been the subject of considerable theoretical and experimental reflection in relation to its physical-sensory component. However, solutions that make packaging also cognitively inclusive for culturally differentiated audiences still deserve to be further investigated and explored.

The article proposes, through a comparative analysis of different attitudes and interpretations of accessibility in packaging, an in-depth exploration and categorisation of the communicative-informative characteristics. Particular attention is paid to the consideration of the cultural background of the target users, which we define as cultural accessibility.

This analysis specifically aims to implement an operational tool for the investigation and design of accessible packaging. The purpose of this tool is to provide an objective assessment of the level of accessibility of packaging, thereby guiding the designer in the identification of solutions to enhance existing packaging, increase its level of accessibility and sustainability, and ensure its social responsibility.

1. Introduction

Our society is becoming increasingly complex and diversified, with individuals from various geographical origins, new first and second-generation citizens with their own cultures, and social groups differentiated by age or specific physical and cognitive abilities (Figure 1). Indeed, over recent years, Europe's demographic structure has undergone significant changes due to strong migration flows and an aging population (Eurostat data, 2023). As a result, the issue of



accessibility to products, services, and environments is becoming more prevalent, extending

beyond niches of users with specific needs to encompass society as a whole.

Figure 1. Dimensions of diversity. Credits: authors.

In our era of globalization, multiculturalism is an integral part of modern societies (Cerrina Feroni & Federico, 2017). The interconnections between diverse cultures influence many aspects of daily life, from cuisine to fashion, education to design.

Designing for a multicultural world is not only about inclusion but also about innovation and sustainability. This approach allows for the creation of products, services, and spaces that meet the needs and desires of a diverse population, promoting social cohesion and valuing cultural diversity.

Social sustainability, which considers people's well-being as fundamental, can be achieved through an inclusive design approach, involving values such as equity, safety, participation, integration, well-being, and quality of life. It is also an area of focus for companies, as neglecting these aspects can lead to commercial repercussions (Fain, 2018).

In this context, the present contribution aims to introduce a recently started research project focused on the accessibility of packaging—an omnipresent, mass-produced item that accompanies almost all our consumption activities, from purchase to use and disposal. Packaging's functional and communicative attributes make it a particularly intriguing subject of study: it is a powerful communication tool, capable of conveying meanings related to brand values and significantly influences purchase decisions and consumer perceptions.

The research aims to explore packaging accessibility, with a specific emphasis on cultural accessibility[1], which mainly pertains to cognitive and communicative design aspects. While the topic of accessibility in the packaging industry has seen significant theoretical and experimental discussion regarding its physical-sensory components - such as readability, manageability, ease of opening, and usability (Yoxal et al., 2019)— there remains a need for further exploration of solutions that make packaging cognitively inclusive for culturally diverse audiences.

[1] Cultural accessibility refers to the design and provision of products, services, and environments in a way that ensures they are inclusive and usable by people from diverse cultural backgrounds. The goal of cultural accessibility is to eliminate cultural barriers and promote inclusivity, making sure that cultural differences do not hinder people's ability to access, understand, and benefit from a product, service, or environment.

[2] The Ethical Packaging Charter is a project by Politecnico di Milano and Edizioni Dativo. It is a set of principles and guidelines aimed at promoting responsible and sustainable practices in the packaging industry, promoted by the Packaging Ethical Charter Foundation. It encompasses various aspects of packaging design, production, and lifecycle management, with a focus on minimizing environmental impact, ensuring social responsibility, and enhancing consumer safety and satisfaction. (Source: https://fondazionecartaeticapackaging.org/)

As emphasizes in the Ethical Packaging Charter[2], packaging has evolved into a mature and essential product, necessitating collaborative reflection among industry stakeholders to ensure its development aligns with consumer, user, environmental, and societal needs (Baule & Bucchetti, 2015). In this context, the communicative and cultural accessibility of packaging has become increasingly significant, highlighting the importance of design awareness in influencing user interaction and comprehension.

Packaging inherently must fulfil multiple requirements, often forcing designers, producers, and distributors to balance different functions. Its primary role is to protect and preserve its contents throughout the supply chain—from production to storage, transportation, display, purchase, and final consumer use. Additionally, packaging must facilitate product sales by ensuring easy identification and clear communication of contents. It is also meant to establish a physical-sensory and cultural connection with users, allowing for intuitive and straightforward interaction. Moreover, legal requirements, such as environmental labelling and specific needs of producers or distributors, must be met (Goodman-Dean et al., 2016).

Packaging design should account for the wide range of human perceptual and cognitive processes, gestures, languages, and cultural backgrounds (International Standard, 2011). Each of these aspects influences design choices regarding shape, material, operational mechanisms, opening and closing systems, quantity, size, and placement of key information, among others. Recognizing that not all design needs can be perfectly aligned, it falls to the designer to prioritize which aspects to emphasize based on the specific context.

Extensive research in psychology and consumer behavior underscores the significant role of culture in shaping cognition, perception, behavior, and decision-making (De Mooij & Hofstede, 2011; Ji & Yap, 2016). The subjective relationship between packaging and the user can be explored through personal values, which can be categorized into three main areas: internal values (such as self-actualization, self-respect, and fulfilment), external values (like respect, security, and belonging), and pleasure-oriented values (including excitement, enjoyment, and pleasure). These values drive consumer behavior and are shaped by cultural influences (Limon et al., 2009). According to congruence theory[3], consumers are more inclined to choose products and

[3] In psychology it is a cognitive consistency theory that focuses on the role of persuasive communications in

brands that align with their personal values. Consequently, packaging that reflects both the cultural and personal values of consumers is more effective in shaping their purchase intentions (Ploom et al., 2019).

To support user and environmentally-conscious packaging design, several tools have been developed over the years, in order to assess the performances (both quantitative and qualitative) of existing packaging, evaluate their compliance with quality standards, and highlight project opportunities. For this research, some tools developed in the context of other research experiences were analyzed, which allowed for critical reflection on the interpretive keys adopted and the ultimate goals of these instruments: from environmental and social sustainability (Badalucco, 2011; De Giorgi, 2013; Barbero & Tamborrini, 2018), to design implications in terms of physical and sensory accessibility on both a qualitative (Badalucco, 2011; De Giorgi, 2013; Rossi, 2019) and quantitative/ performance level (Fain, 2018).

However, aspects concerning cultural accessibility in its communicative dimension appear to require further reflection (Van den Berg-Weitzel & Van de Laar, 2001) with specific reference to the design of information content to help users overcome socio-cultural barriers. These barriers are related, for instance, to cultural self-referentiality—such as the use of technical and specialized language (Gallavotti & Pistoi, 2007)—or the lack of adequate and/or shared languages, such as the limited use of information in English or other languages, or alternative languages like Braille, digital insights, etc. These aspects have design implications related to the expressiveness of packaging —through elements like colour, shape, typography, etc. — and how information is presented, either explicitly (by highlighting facts, images, and details) or implicitly (through symbolism and metaphors).

The central research question thus becomes: what specific tools and methodologies can be developed and applied to critically analyze and promote the effective design of culturally inclusive packaging?

This entails identifying strategies and tools that not only assess the cultural accessibility of packaging but also guide designers in creating packaging that respects and reflects diverse cultural perspectives and needs. The aim is to ensure that packaging is accessible and appealing to a broad spectrum of consumers from various cultural backgrounds, thereby enhancing user experience and fostering inclusivity.

2. Cultural accessibility and packaging: a methodological approach

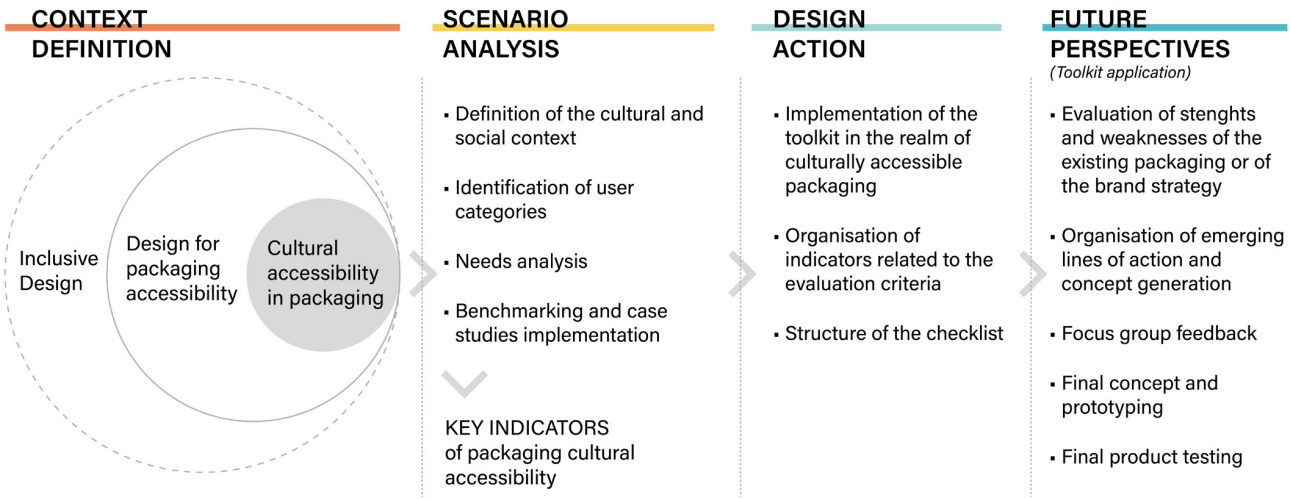
Designing the built environment, everyday objects, information, services, strategies, means necessarily having to take into account the variety of human beings, their different needs and capabilities in performing actions or achieving goals. A topic of social sustainability that looks at the component

of people's well-being as a fundamental fact, which can also be achieved through an inclusive approach.

Indeed, the central theme of *inclusive design* embraces various design approaches that aim to create products and services that are accessible to and usable by a wide range of people, regardless of their abilities or circumstances (Coleman, 1994). These approaches include, for example, design strategies that refer to the areas of *Universal design* (Mace, 1985), *Design for All* (EIDD - European Institute for Design and Disability, 2004) and *Human Centred Design* (ISO 9241-210:2010[4], point 2.7 - standard Ergonomics of human-system interaction).

The article proposes, through a comparative analysis of different attitudes and interpretations of cultural accessibility in packaging, an in-depth exploration and categorisation of the communicative-informative characteristics.

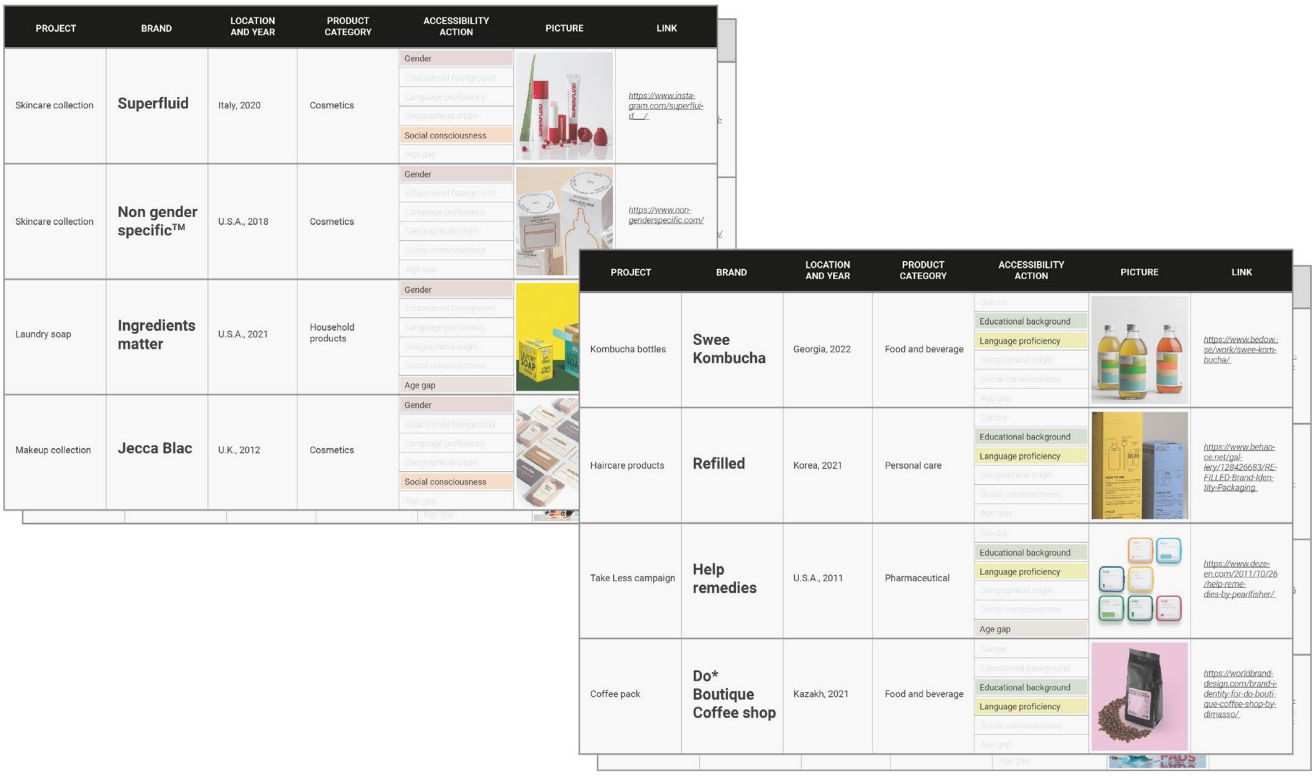
From a methodological perspective (Figure 2), the topic was initially approached through a literature review aimed at defining the design domain of Inclusive Design in packaging, which refers to the creation of packaging solutions that are accessible, usable, and appealing to the widest possible range of people, regardless of their age, ability, cultural background, or other characteristics (Waller et al., 2015). This activity allowed for the identification of the main categorizations and interpretations of cultural accessibility in packaging, which were useful for the



subsequent selection and analysis of case studies, which proved to be of interest in terms of

4 Definition of Human Centered Design available in "Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems", section 2.7.

inclusive solutions with respect to diverse user groups (gender identity, language proficiency, geographical origin, educational background, etc.).



PROJECT	BRAND	LOCATION AND YEAR	PRODUCT CATEGORY	ACCESSIBILITY ACTION	PICTURE	LINK
Skincare collection	Superfluid	Italy, 2020	Cosmetics	Gender, Social consciousness		https://www.instagram.com/superfluid__/
Skincare collection	Non gender specific™	U.S.A., 2018	Cosmetics	Gender		https://www.non-genderspecific.com/
Laundry soap	Ingredients matter	U.S.A., 2021	Household products	Gender, Age gap		
Makeup collection	Jecca Blac	U.K., 2012	Cosmetics	Gender, Social consciousness		
Kombucha bottles	Swee Kombucha	Georgia, 2022	Food and beverage	Educational background, Language proficiency		https://www.bedow.se/work/swee-kombucha/
Haircare products	Refilled	Korea, 2021	Personal care	Educational background, Language proficiency		https://www.behance.net/gallery/128426693/REFILLED-Brand-Identity-Packaging
Take Less campaign	Help remedies	U.S.A., 2011	Pharmaceutical	Educational background, Language proficiency, Age gap		https://www.dezeen.com/2011/10/26/help-remedies-by-pearlfisher/
Coffee pack	Do* Boutique Coffee shop	Kazakh, 2021	Food and beverage	Educational background, Language proficiency		https://worldbrand-design.com/brand-identity-for-do-boutique-coffee-shop-by-dimasso/

Figure 2. Methodological approach for the development of a cultural accessible packaging. Credits: authors.

A selection of 50 case studies of existing packaging (Figure 3), notable for their proposed cultural accessibility solutions, was conducted. These case studies span various product categories and were chosen based on the types of accessibility they address.

Figure 3. An extract of the case studies of cultural accessibility mapped and analysed. Credits: authors.

2.1 Gender

Gender neutrality in packaging – a topic extensively explored in recent studies - refers to designing and creating products that does not specifically target or appeal to any particular gender, aiming instead to be inclusive and appealing to all consumers regardless of their gender identity (Huang, 2023). This approach avoids using stereotypical colours, imagery, language, or iconic elements that are traditionally associated with a specific gender, focuses instead on neutral features that can appeal to a broader range of consumers (Dimaandal & Espineda, 2023).

From a gender inclusion perspective in packaging, it is evident that certain sectors, such as cosmetics and children's toys (Figure 4), have already made significant strides. These market areas have explored and implemented marketing and packaging design strategies that reflect greater sensitivity and inclusivity towards various genders. However, there are still sectors that could benefit from increased attention in this regard.
For instance, the household cleaning sector remains strongly rooted in gender stereotypes, often representing and targeting a predominantly female audience. This perpetuates the notion that domestic tasks are primarily a responsibility of women, overlooking the reality of a society where an increasing number of men share these duties. A change in packaging that reflects a more equitable and inclusive view could help break these patterns and promote a more modern and realistic image of household management.
Similarly, the alcoholic beverage sector tends to target a predominantly male audience, both through packaging design choices and advertising strategies. This trend not only excludes a significant portion of the female market but also reinforces limiting stereotypes that associate certain types of alcoholic drinks exclusively with men.
Promoting packaging that is gender-neutral or even celebrates consumer diversity could not only expand the market target but also contribute to a more balanced and inclusive representation of the consumers.

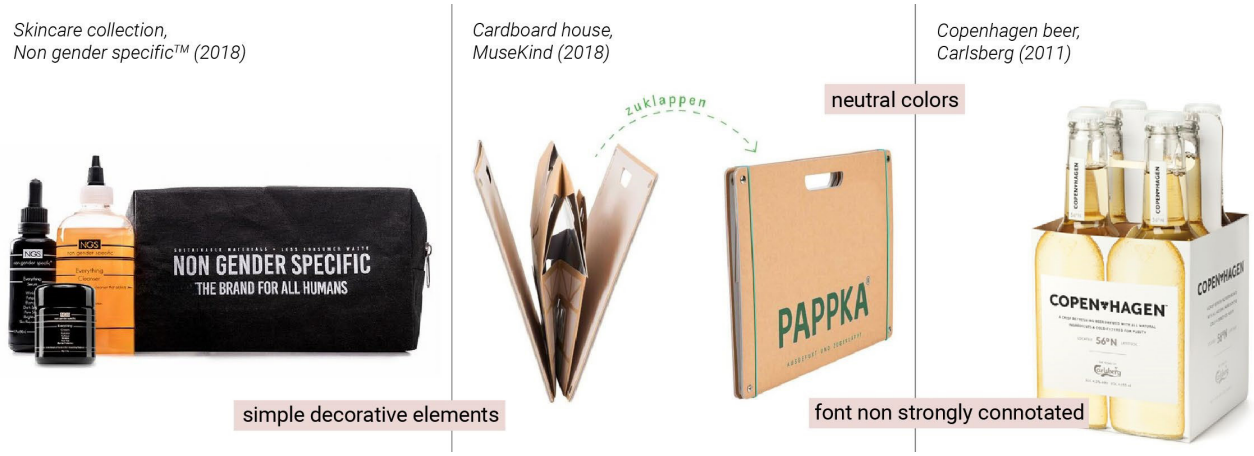


Figure 4. Some of the case studies collected in which design attentions related to gender accessibility can be identified. Credits: authors.

2.2 Educational background

From a design perspective it is essential to recognize that not all individuals have access to the same social and cultural resources. Therefore, communication must be straightforward and accessible to everyone: developing solutions that overcome socio-cultural barriers that often lead to feelings of cultural inadequacy is crucial.

Regarding the attention to the cultural background of target users, it is interesting to observe how packaging experimentation has made significant progress, particularly in the fields of personal care and pharmaceutical products (Figure 5). These areas have leveraged digital technologies and visual design techniques to facilitate access to detailed and comprehensible information about the usage and storage of products. For instance, QR codes and other interactive technologies allow consumers to access digital insights in various languages and formats, making information accessible to a culturally diverse audience. Additionally, visual simplifications, such as universal icons and intuitive illustrations, help overcome language barriers, ensuring that instructions are understood regardless of the users' cultural background.



Figure 5. Selected case studies in which some design attentions to people with different cultural backgrounds can be identified. Credits: authors.

2.3 Language proficiency

Linguistic accessibility in packaging is a topic of growing importance in the modern world, where globalization and cultural diversity have become the norm. Ensuring that product information is understandable to people from various linguistic backgrounds is crucial not only for enhancing the consumer experience but also for ensuring safety and compliance with international regulations, particularly in sensitive sectors such as food, pharmaceuticals, and cosmetics.

The use of images, symbols, and icons results in effective communication, particularly in contexts where language comprehension varies among users. These visual elements must be culturally relevant and easily recognizable to ensure that the intended message is universally understood. Incorporating digital and audio insights can further enhance comprehension; for instance, QR codes can link to multilingual websites or video descriptions, offering alternative ways to engage with textual content. Additionally, narration and verbal descriptions should be clear and engaging, ensuring that all users can access and understand the information being conveyed. This multi-faceted approach helps bridge language gaps and ensures effective communication across diverse audiences (Alley-Young, 2014).

One of the most innovative ways to enhance linguistic accessibility in packaging is through the use of digital technologies[5]. For instance, many companies are incorporating QR codes or digital insights into their packaging that redirect users to multilingual online content. This content can include video tutorials, detailed instructions, and nutritional or safety information.

Visual simplifications, such as the use of universal icons and intuitive illustrations, represent another effective approach to improving linguistic accessibility. These graphical elements can convey essential information without the need for text, overcoming language barriers (Figure 6).

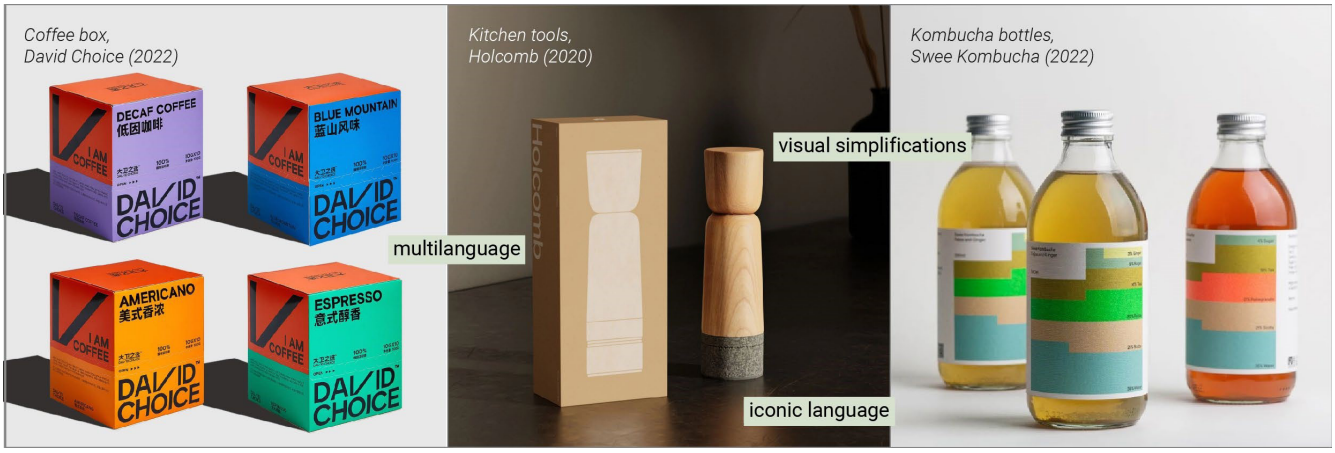


Figure 6. Some of the case studies where particular attention is given to linguistic accessibility. Credits: authors.

2.4 Geographical origin

When developing packaging that considers the geographic origin of end users, it is essential to adopt an approach that acknowledges and respects diverse cultural traditions, preferences, and regional sensitivities. This can be achieved through in-depth market research that analyses the demographic and cultural variety of consumers in different territories (Berg-Weitzel & Laar, 2001), for instance, adapting the use of colours, symbols, and graphics to reflect local aesthetics and positive cultural associations (Figure 7).

Among the strategies that might be interesting to adopt, the use of foreign lettering can be advantageous if it aligns with the origin of the product, thus improving perceived quality, especially for familiar products. Positive evaluations are further amplified when there is congruency between the lettering and the product category, as consumers tend to favour

[5] It is important to remember that some functions may improve accessibility for certain types of users but not for others. In fact, digital accessibility certainly represents a great opportunity for a large part of consumers, but at the same time it can be a limitation for older users. Therefore, a good accessible packaging project should still take into account providing the same cultural content through the structuring of differentiated experiences.

familiar products with unconventional lettering (Hornikx et al, 2013). Additionally, colour interpretation by different cultures plays a crucial role in brand perception. An example is the use of the colour green. While it is universally linked to nature and life, its specific meanings can differ significantly based on the religious, historical, and cultural influences of each region. For instance, in countries with Islamic traditions, green is associated with religion, prosperity, and elegance. Conversely, in China, green can also carry negative connotations related to infidelity and shame.

Effective packaging design should consider these cultural differences in colour preferences to avoid negative connotations and enhance appeal. Companies that skilfully utilize colour (as well as symbols and icons) in their packaging can significantly boost product appeal, increase profits, and achieve greater brand recognition, demonstrating that colours have different meanings across cultures and can profoundly affect product perception (Valdillez, 2012).



Figure 7. Some of the case studies in which attention is paid to cultural elements related to the different geographical origin of potential consumers. Credits: authors.

2.5 Social consciousness

Today's consumers are more informed, critical, and demanding, seeking trust, transparency, fairness, and social responsibility from companies. Marketers face the challenge of appealing to a generation that values immediacy, digital connectivity, and social consciousness. Large corporations are expected to contribute positively to society by addressing social and environmental issues, creating "shared value" and integrating ethical business practices and responsible investment, concerned with sustainable production and sourcing, and comprehensive environmental management (Kiygi-Calli, 2019).

Social activism in packaging (Figure 8) reflects a company's commitment to corporate social responsibility, demonstrating awareness of social and environmental concerns. This commitment not only enhances a brand's reputation and builds consumer trust but also aligns with growing consumer expectations for ethical and environmentally responsible practices. Sustainable and recyclable packaging helps reduce environmental impact, while inclusivity and diversity in design challenge stereotypes and promote equality. Brands that integrate these values into their packaging strategies often benefit from improved brand reputation, increased customer loyalty, attraction of new consumers, competitive advantage, and alignment with regulatory trends. Additionally, social activism in packaging can stimulate innovation, opening new business opportunities and fostering a more inclusive and sustainable world.

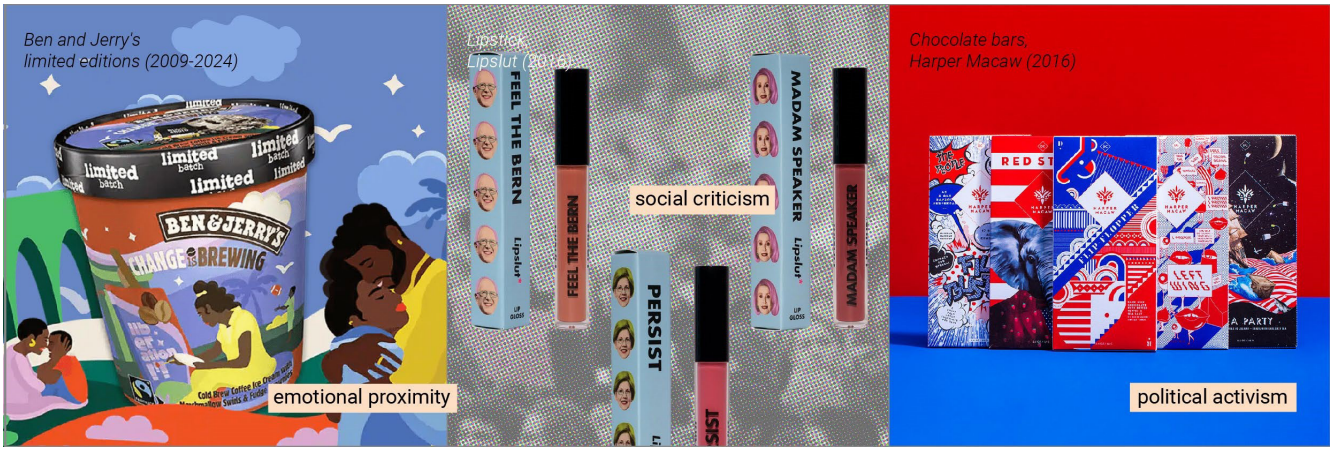


Figure 8. Some of the case studies where an explicit brand position on issues of social consciousness is evident. Credits: authors.

2.6 Age gap

In packaging design, taking into account the differences in age of the users is crucial in order to respond to very different needs in terms of physical, perceptual and cultural abilities, thus reaching as wide a market as possible. For instance, according to some studies (Świda et al, 2018; Guido et al, 2020; Banerjee et al, 2022) certain packaging types and designs, like glass bottles, straightforward logos, and muted colours, are generally preferred by older consumers. Additionally, they give priority to details like the product's composition, producer name, and expiration date.

To cater to this demographic, packaging must address physical challenges such as reduced hand strength, compromised vision, and difficulties in reading small text. It is therefore useful to adapt design precautions related primarily to the physical accessibility of the product.

On the other hand, developing attractive culturally appropriate packaging can attract younger consumers to products traditionally targeted at older demographics (Figure 9). This strategy offers several advantages such as broadening the consumer base and changing the perception of the products. Fresh and modern packaging can significantly enhance a product's appeal, particularly to young consumers. Attractive designs, vibrant colours, and innovative graphics can capture the attention of a younger audience who may not have previously considered the product. Incorporating current trends such as interactive technologies - like QR codes and augmented reality - or popular themes can make the product more relevant and engaging for this demographic. Interactive packaging experiences, such as games, quizzes, or exclusive content accessible via QR codes, can stimulate interest and encourage engagement. Additionally, packaging that tells a story or aligns with social causes important to young people, such as environmental or social issues, can further increase its appeal. Formats are youth-responsive, like single servings or portable containers, and a renewed brand identity incorporating elements of pop culture or youthful influences, can build a stronger emotional connection and make the product more appealing.

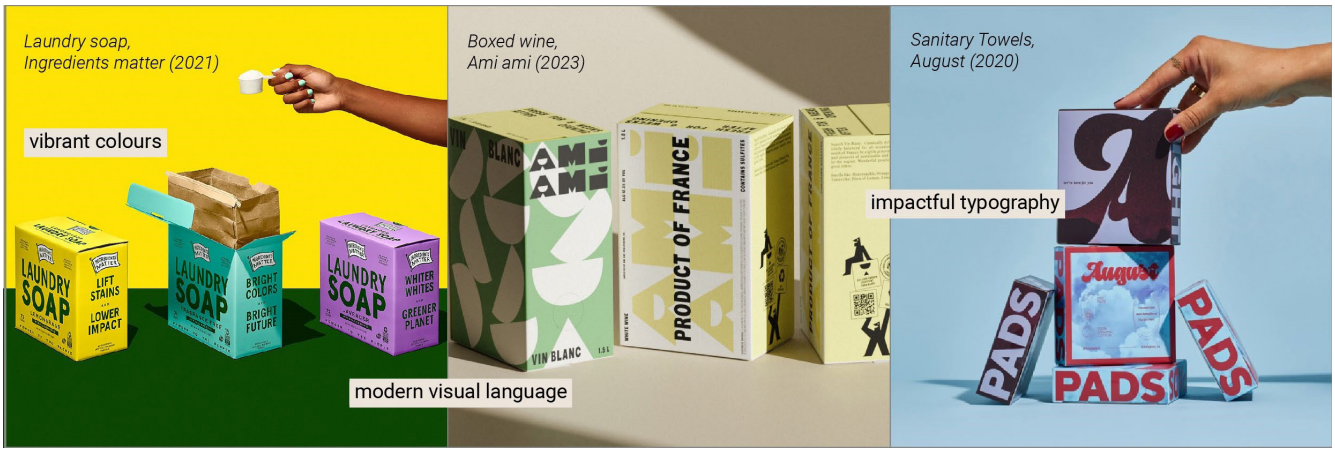


Figure 9. Some of the case studies in which specific design features open up the brand to new customer groups (with a focus on the age of the target audience). Credits: authors.

3. Future perspectives: implementation of an operational tool

Packaging transcends mere functionality; it acts as a visual storyteller, conveying emotions, values, and cultural narratives. Inclusive design principles form the cornerstone for creating packaging that appeals to a wide range of cultural backgrounds and identities. By incorporating diverse visual elements, designers can ensure that packaging speaks to a broad audience, fostering a sense of belonging and respect among consumers. This approach helps in building a positive brand image, as consumers are more likely to support brands that reflect their values and experiences.

Moreover, culturally sensitive packaging design can enhance the emotional connection between the product and the consumer. When consumers see themselves and their values reflected in a product's packaging, it creates a stronger emotional bond and can drive brand loyalty. This emotional connection is crucial for brands aiming to differentiate themselves in a competitive market.

The use of diverse cultural symbols and inclusive design elements also helps in breaking down stereotypes and promoting cultural understanding. For example, featuring a variety of skin tones and body types can challenge traditional beauty standards and promote a more inclusive notion of beauty. Similarly, using culturally significant symbols and colours can help in acknowledging and celebrating cultural heritage, thereby fostering a more inclusive society.

Incorporating these elements requires a deep understanding of the target market and a commitment to inclusivity. Brands must engage with cultural experts and diverse communities to ensure that their packaging design is not only inclusive but also respectful and authentic. This collaborative approach can lead to more innovative and culturally resonant packaging solutions.

The results of the analysis and mapping thus made it possible to critically assess the types of interventions that could contribute to a more culturally accessible packaging. Based on these reflections, the theoretical and methodological foundations were laid for the development of a tool capable of analysing the state of inclusivity of a packaging and monitoring its coherence in progress.

A brief description of the tool is therefore given below, which, in addition to the criteria of cultural accessibility, includes parameters of physical accessibility.

The development of the tool is therefore not the subject of the paper but a pre-existing element that can benefit from the outcomes of this new part of the research on cultural accessibility.

The tool consists of a detailed checklist organised by skill areas, each of which covers a different aspect of the physical or communicative accessibility of packaging. This tool has been designed to be used during specific action steps and with the involvement of different stakeholders, thus guaranteeing a systematic and collaborative approach to the process of evaluating and improving the product itself: this allows data and feedback to be gathered from different perspectives, ensuring that all skill areas are examined and improved in a coherent and integrated way.

The moment a company decides to take critical action regarding the accessibility (physical, sensory, communicative) of its packaging, the first step should be to interact with the designer expert in order to understand the scope and objectives of the project.: the specific products in question, current accessibility challenges and what the company hopes to achieve are discussed.

The next step should involve the designer gaining a deeper understanding of the products, the target market, and the social and cultural contexts of the area where the products will be sold. In a next phase, crucial in the methodological process, would be the organisation of dedicated focus groups with stakeholders, during which accessibility problems and points of specific design interest are noted. To guide this process, the designer can will use the checklist as an operational tool to support the critical analysis of specific aspects - examining both the physical, sensory, and cultural accessibility of the packaging - and to provide a general overview of the product, highlighting its strengths and identifying critical points, which can reveal new design opportunities. To go into more technical detail, this tool includes two specific devices: an evaluation form in the format of a checklist of criteria, useful as a pre-design tool (Badalucco, 2011), capable of returning the level of accessibility of the existing packaging analysed, and the indication of possible improvements related to the results of the analysis carried out. The purpose is to provide an objective assessment of packaging accessibility, guiding the designer in identifying solutions to enhance the packaging's accessibility, sustainability, and social responsibility, particularly concerning physical and cultural contexts.

The first form analyses physical accessibility characteristics, grouped into subcategories such as handling, opening, closing, and dispensing systems. It documents the presence or absence of these features and evaluates any complexities or difficulties in the physical interaction between the user and the packaging, considering factors like required force, number of movements needed, and the possibility of one-handed use, etc.

The second form considers the communicative accessibility characteristics divided into aspects of information, comprehension, identification, and cultural factors.

The forms (Figure 10) are graphically structured with four columns to enhance understanding and make completion more intuitive. The main column lists statements related to the characteristics being evaluated (e.g., "Cultural aspects"), offering specific references. To the left are the subcategory groupings, while the four evaluation parameters are to the right:

- "No" indicates the characteristic is not met for any user category.
- "In part" means the characteristic is met only for some user categories.
- "Yes" signifies the characteristic is met for most user categories, including people from various cultural and linguistic backgrounds, able-bodied individuals, individuals with physical limitations (e.g., motor disabilities, visual impairments, deafness, arthritis, colour blindness), individuals with cognitive limitations (e.g., neurobiological disorders, mild intellectual disabilities), and individuals with temporary

limitations (e.g., pregnant women, people with injured limbs).

· "N.A." (Not Applicable) applies if the characteristic cannot be evaluated for the specific type of packaging analysed.

The final column for notes is essential, as it allows for documenting observed criticalities, providing a useful basis for subsequent packaging improvement guidelines to be developed by the designer. The completion process can ideally be divided into two phases: after the initial analysis, which involves observing the packaging, filling out the various items, and writing notes, the number of ticks for each evaluation parameter is counted. This will highlight, using a "traffic light system", the subcategories that require more attention due to potential accessibility issues.

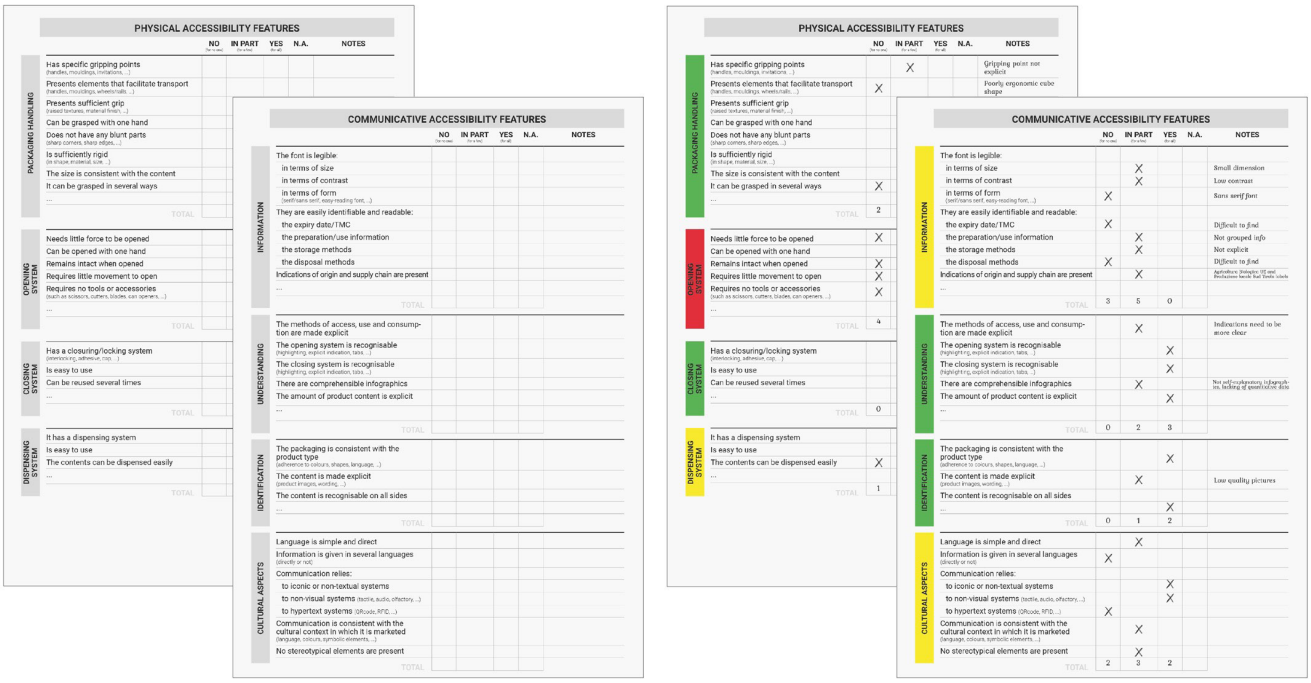


Figure 10. The structuring of the tool and an example of compilation. Credits: authors.

After this analytical session, the designer examines the results, extracting the critical issues related to the accessibility of the packaging under investigation and translating them into requirements for the re-design of the product. The designer then moves on to the creative phase, developing new design concepts that address the identified problems. These concepts are then discussed with stakeholders and technically developed until a design is achieved that best meets the needs expressed in the preliminary phase. These will be further tested through models, which are tested internally to ensure compliance with the required accessibility standards. After that, the company can develop prototypes based on the implementations proposed by the

designer. It would be essential to propose again at this stage a further heterogeneous focus group formed not only by the main stakeholders, but also by other subjects such as representatives from the company, cultural associations, accessibility experts, and other relevant entities that actively work on the topic of accessibility, in its different shades. The group members then evaluate the new packaging proposed by the designer - through the use of the checklist, which then takes on the function of a performance verification tool for the new product - providing valuable feedback on how well they meet cultural accessibility needs. Their insights should be carefully documented and analysed, leading to further refinements.

After incorporating the focus group's feedback, the designer finalizes the designs, and the company moves forward with production. But the process doesn't end there. Post-launch would be useful if the company and designer monitored the market response to ensure the new packaging effectively meets the cultural accessibility goals.

4. Conclusions

The explorations carried out lead in the first instance to the identification of two main project scenarios for increasing the cultural inclusiveness of packaging: (a) an approach according to which the packaging product can offer a differentiated experience to respond to different needs, even within the same object; (b) the definition of differentiated packaging, for instance different packaging solutions for the same sales content, thus able to adapt the performance provided to the specific cognitive needs of the user, through dedicated packaging.

In the context of the research, the implementation of the designed checklist is one of the main objectives, but it is not the only purpose of the work, that aims to enrich and expand the study and academic literature on a specific topic – that of cultural accessibility in packaging design - that, to date, has received a considerable lack of attention and feedback. This research theme follows the more central and debated strand of sustainable packaging design, which has been the main focus of study in recent decades, and from which it actually originates. In fact, accessibility is still a question of sustainability, where, however, the point of view varies from environmental to social.

The topic of packaging accessibility itself sees studies and insights, particularly into aspects of physical accessibility, less so into those of cultural accessibility, that, despite its relevance, has not been adequately explored in previous research. The aim is to contribute to a more comprehensive and detailed understanding of the topic of cultural accessibility in packaging design, providing new perspectives and information that can stimulate further academic studies and debates.

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RESEARCH ON THE EMOTIONAL VALUE OF TRADITIONAL RESIDENCES FROM THE PERSPECTIVE OF DAILY LIFE —— TAKE THE EXAMPLE OF THE EAGLE RIVER DIAOLOU GROUP

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ABSTRACT | In the context of the era of urban-rural integration in China, traditional residences have gradually faded from people's view, affecting their status in society. Influenced by urbanization and modern lifestyle, villagers' living needs have changed. They desire convenient living conditions and also hope to develop and renovate their homes to bring in income. Traditional residences face the dilemma of survival and development amid modernization. The urgent issue in the renewal of traditional residences is how to retain their architectural forms while continuing their spirit and culture, thereby preventing them from converging with urban architecture. This paper aims to explore the emotional value and modern significance of traditional residences from the perspective of daily life. The study will analyze aspects such as landscape protection, skill inheritance, cultural transmission, nostalgic memory and emotion, and adaptation to modern life. It seeks to understand how traditional residences can meet the residents' living needs while evoking their historical memory and emotional resonance through their unique spatial layout, architectural forms, and cultural symbols. It will explore the differences in emotional perceptions among different groups towards traditional residences and propose strategies for protecting and updating traditional residences during modernization, aiming to achieve their sustainable development and cultural inheritance.

KEYWORDS |URBAN-RURAL INTEGRATION; DAILY LIFE; TRADITIONAL RESIDENCES; EMOTIONAL VALUE

1. Introduction

Traditional residential houses are the physical carriers of regional culture and construction techniques, providing a daily function of place for local people to live in. Traditional residential buildings are closely linked to their surroundings, reflecting the influence of specific geographical and cultural features. As a result, traditional houses display unique characteristics in different regions and are often seen as a way of highlighting regional identity.

Under the impetus of rural urbanisation, traditional houses may face a number of problems in order to accommodate the needs of development. The uniformity of urban morphology has led to the homogenization of space, materials, and construction methods; the obstruction of cultural heritage has resulted in the gradual fading of local characteristics and historical memory. Traditional residential houses symbolize collective memory and nostalgia, but with the process of urbanization, the original village and community structures have been destroyed or rebuilt, causing residents to lose their emotional attachment and identification with their hometown, thereby exacerbating the disconnection of social rootedness. These challenges suggest the need to find sustainable development solutions while preserving traditional cultural and architectural features in order to promote social harmony and the continuity of cultural heritage.

2. Research on the emotional value of traditional houses: introduction of daily life perspective

In the context of China's fast economic development, rural architectural design has begun to adopt an orderly and symbolic approach similar to that of the city, making the architecture disconnected from the real life of village residents. With the change of time, the traditional concepts and lifestyles of villagers have changed, which has a great impact on 'daily life'.

Researching the emotional value of traditional residential houses from the perspective of daily life involves an in-depth exploration of the emotional connection and interaction between people and traditional living spaces. This connection is not only reflected in the comfort and practicality of the physical space, but also in the history, culture, customs and group memory carried by the houses. In the face of this problem, experts and scholars have beginning to think about how to start from the daily life, through the study of the regional characteristics of traditional houses and the living habits of local residents, so as to make the traditional houses and the people's 'daily life' more closely integrated, which is particularly important.

The perspective of daily life is a way to study and understand social phenomenon, which focuses on people's behaviours, habits, experiences and interactions in daily life. This perspective emphasises the details and micro-levels of life and explores how people construct and understand their world in daily life. Through observing and analysing daily activities, social interactions, family life and work scenarios, the researcher is able to gain a deeper understanding of the values, emotions and cultural identities of individuals and groups. The perspective of daily life focuses not only on macro-level social structures and institutions, but also on the specific practices and experiences of people in everyday situations, revealing how society and culture are concretised and manifested in everyday life.Henri Lefebvre is a French philosopher and social theorist known for his research on daily life, urban space and social production. The multiple origins and connotations of the concept of 'daily life' point to the fact that it not only distinguishes itself from the monotony of ordinary life, but also refers to the withdrawal and alienation of authenticity, which is characterised by repetition, triviality, and dullness, reflecting the reality of consumer and symbolic societies (Henri Lefebvre, 1964). In his definition of the basic connotation of 'daily life', Lefebvre also emphasises the repetitive, experiential and recurrent behavioural activities of 'daily life', and pays more attention to the real feelings of individuals and different groups of people towards the spatial place, focusing on the spatial The basic connotation of 'daily life' in reproduction (Gaoling, 2014). Domestic research on the theory of daily life started late, but with the attention and input of academics, this research field is gradually developing and maturing. Xiao Qunzhong's Ethics of Daily Life Behaviour highlights the importance of ethics in daily life through the ethical analysis of specific behaviours in daily life. Through in-depth theoretical expositions and rich case studies, Xiao Qunzhong demonstrates how to practice ethics in daily life to improve the morality of individuals and society. In the book, it is emphasised that ethics is not only a theoretical discussion but also a part of daily life (Xiao, 2018). He argues that ethics should focus on people's actual behaviour and moral choices in daily life, rather than just remaining at the abstract theoretical level.

In the habitat of traditional villages, there is a close connection between daily life and traditional residential houses. The shaping of architectural forms and the inheritance of regional culture in villages are of great significance, but there is not much research and practice on daily life perspectives and traditional residential houses. In the process of updating traditional residential areas, from the perspective of daily life, through the users of residential areas can better understand the specific realities and needs of the use of traditional residential areas, combined with regional characteristics, to carry out scientific and reasonable transformation and protection, not only to improve the quality of life of the residents, but also to effectively pass on and continue the traditional culture.

3.Research on the emotional value of traditional residential houses in Siwa village of the Qing Ethnic Group from the perspective of daily life

3.1 Overview of traditional residential houses

The Qiang

The Qiang are one of the oldest ethnic groups in Chinese history, mainly located in Aba Tibetan and Qiang Autonomous Prefecture and its surrounding areas in Sichuan Province. The history of the Qiang can be traced back to the 'Qiang people' in ancient literature, who were once a nomadic tribe active in the eastern part of the Tibetan Plateau and the western part of Sichuan. There are records of the Qiang people in such ancient texts as the Classic of Mountains and Seas and the Records of the Grand Historian, and these ancient Qiang people have a close historical connection with today's Qiang people. With the long historical process and the evolution of production activities, the Qiang people gradually formed a unique worldview and religious belief system.

The beliefs of the Qiang people are mainly based on multi-god worship, and the contents of deity worship are rich and diverse, covering nature gods, household gods, labour craft gods and village gods. Among them, the nature gods are the reverence and worship of nature, including the gods of mountains, water, wind and other natural forces; the family gods are the worship of ancestors and the prayers for family peace and the safety of future generations; the gods of labour and craftsmanship have symbols that are closely related to daily production and life, such as the gods responsible for the construction of houses, the gods in charge of stonemasonry and blacksmithing skills, which represent the Qiang people's respect for and belief in craftsmanship; while the village gods are worshiped through the village gods, which are the gods of the Qiang people. The village gods, on the other hand, exist in the form of 'sacred groves', protecting the safety and harmony of the entire village.

This belief system not only reflects the Qiang people's respect for their ancestors and the importance they attach to their families, but also expresses their worship of the power of nature and their concept of coexistence with nature. In Qiang culture, the ideas of honouring ancestors, praying for peace, and worshipping and harmonising with nature have taken deep root and become an inseparable part of their culture.

Heihu Qiang Village

Heihu Qiang Village is located in the mountains in the northwest of Mao County, Aba Tibetan and Qiang Autonomous Prefecture, Sichuan Province, China. Heihu Village is a well-preserved ancient Qiang village in Mao County. (Figure 1) The Eagle River Diaolou Group the most famous in Heihu Village, is located at the top of a half-mountain slope, with cliffs on both sides. (Figure 2) in the past, such a geographical location is conducive to resist foreign intrusion, play a collective defence role. Most of the watchtower clusters are located on the north-south trending ridge, with an altitude of 2,277 metres above sea level and a vertical distance of about 300 metres from the valley of the Heihu River, covering an area of about 15,000 square metres. The villagers' way of life is based on ploughing and herding. Although herding was once also an important economic pillar, due to policy adjustments, they now rely mainly on ploughing for their livelihood. Most of the villagers grow plum trees and corn, which have become their main economic sources. In such an ecological environment, agricultural activities not only sustain the livelihood of the village, but also protect the traditional way of life.



Figure 1 Heihu Qiang Village Architecture Complex



Figure 2 The Eagle River Diaolou Group

Traditional residential houses

The traditional residential houses of the Qiang Village are famous for their unique architectural style and structural design, which are not only adapted to the natural environment of the high mountain terrain, but also contain rich cultural connotations. The phrase 'living on the mountain and building a house of stone' describes the Qiang architectural form of choosing the site and using materials locally. Qiang residential houses are mainly built of stone and wood, reflecting the concept of harmonious coexistence with nature. These buildings are usually located on mountain slopes or ridges, built on the mountains, forming a patchwork of village patterns.

The original architectural texture of the Eagle River Diaolou Group is well-preserved, mainly constructed with stone as the material, demonstrating the traditional architectural style of the Qiang people, with the functions of earthquake-proof, wind-proof, fire-proof, and foreign enemy-proof. The traditional residential houses of the Qiang are composed of Zhuang houses, towers, watchtowers or boarding houses (Figure 3). Zhuang house is a common Qiang residential buildings, generally two to three floors, the ground floor for raising livestock and storage rooms, two or three floors for living space, the top floor is the 'photo floor', for the 'God' living place; towers are the main function of defence against foreign enemies, combined with

the function of the beacon, about 20-40 meters, in a trapezoidal shape, with the function of the beacon. 20-40 metres, in a trapezoidal shape. Distributed here a total of 12 stone masonry towers, so far, these towers in the basic intact existing 5; watchtower is a combination of Zhuang Fang and towers, has a strong defensive function at the same time can live; boarding house form and similar to the footstools, a layer of aerial raising livestock, the first floor is the living space. Zhuangfang, Diaolou, Diaofang structure for most of the stone and wood structure, the use of stone, yellow mud, wood and other materials to build.

Figure 3 Zhuangfang Diaolou Diaofang (from left to right)



In addition to the unique natural scenery and profound cultural traditions, Heihu Qiang Village is also facing a series of challenges and opportunities. With the acceleration of urbanisation and the penetration of modern lifestyles, the villagers' life needs are changing. They are not only eager to improve the convenience of their lives, such as obtaining more modern housing infrastructure and more convenient transport conditions, but also hope that the development and renovation of their houses can bring economic benefits and improve their living standards.

However, the village is located in a geographic location that is significantly different from that of the city. The complexity of the terrain and the remoteness of the location make the transport of building materials and construction more difficult. The introduction of modern facilities also needs to overcome the constraints of the natural environment, especially among the mountains and cliffs, making construction and renovation works challenging. In addition, although Heihu Heihu Qiang Village has the potential to develop tourism, the development of tourism faces uncertainty due to the village's remote location and the limited number of travellers. How to attract more tourists and improve the living conditions of the villagers while preserving the traditional culture and natural ecology has become an important issue for the development of Heihu Qiang Village.

3.2 The influence of village space on people's daily life in a daily perspective

In the daily life perspective, apart from the building itself, other spatial elements play a key role in creating the residents' emotions and sense of identity with the traditional village. By combining the five senses of perception (sight, hearing, smell, touch and taste) and the five elements of Kevin Lynch's Urban Imagery (paths, boundaries, zones, nodes and landmarks), these spaces profoundly affect the quality of life and cultural identity of the residents through their daily use and interaction.

Paths are the main access routes for residents' daily activities, and their design and layout directly affect the visual experience. Paths in traditional villages are often meandering, combining with the natural terrain to form a unique visual landscape (Figure 4). The design of the paths in Heihu Qiang Village follows the mountainous terrain, presenting a staggered landscape. Residents walking along these paths can appreciate the integration of traditional architecture and natural scenery, which enhances the visual identity of the village.

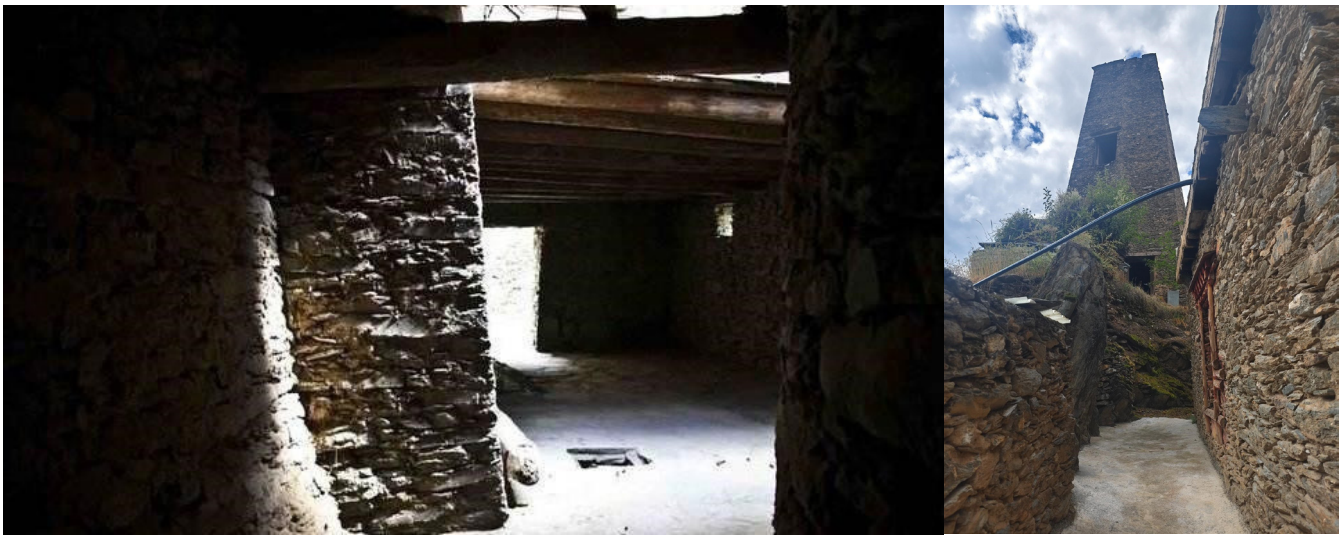
Figure 4 Roads in the Eagle River Diaolou Group



Boundaries play a role in dividing different areas in traditional villages. The stone walls commonly

found in Qiang villages are carefully stacked with local stones, which are not only sturdy and durable, but also have a good sound insulation effect. (Figure 5) These walls not only effectively separate different functional areas within the village, such as residential areas, farmland, places of worship, etc., but also form a natural sound barrier, effectively blocking the intrusion of outside noise. In a typical Qiang village such as the Eagle River Diaolou Group, the clever layout of the stone masonry walls keeps the living areas of the residents away from the hustle and bustle, and maintains tranquillity and peace, providing the villagers with a quality living environment.

Figure 5 a stone wall



Zone division in traditional villages not only clarifies the distribution of different functional areas, but also affects the olfactory experience of the inhabitants. Different areas, such as living areas, farmland areas and public activity areas, emit their own unique smells. The living area of the Eagle River Diaolou Group is filled with the warm texture of wood and the rising smoke of cooking, and these smells are a symbol of home, giving people a sense of warmth and tranquillity. The aroma of wood may stem from the natural properties of the building materials, while the cooking smoke is directly related to the villagers' food culture and daily life habits, and the farmland area is filled with the fresh scent of soil and plants, which constitute an important part of the residents' daily life.(Figure 6)

Figure 6 Smells emanating from different areas. For example, When the inhabitants cook, they still burn wood as their main source of fuel. As the smoke rises, the air is filled with the distinctive aroma of burning wood, and this odour, mixed with the warmth of the cooking smoke, emanates throughout the village, becoming an integral part of the daily



life of the village.

Nodes are the main places for socialising, trading and cultural activities of the village inhabitants, and the materials and design of these places have a significant impact on the tactile experience.

The nodes in Heihu qiang village, such as watchtowers and ritual platforms (Figure 7), each carry a different 'taste function'. The watchtower gives the building a 'spicy' level of protection and strengthens the safety of the building with its defensive nature; while the sacrificial platform symbolises the 'sweet' harmony and faith with its spiritual function, which maintains the emotional bond of the society. The two together constitute the core nodes of Qiang architecture, reflecting the complex relationship between material and spiritual, reality and faith. Therefore, the nodes of a building can be compared to the 'seasoning points' in cooking, and each node is like the seasoning in a dish, giving the building a unique 'taste'.

Figure 7 Diaolou (left) and Sacrificial platform (right)

Landmarks are buildings or objects in villages with distinctive features and identities, which can be experienced by linking the physical characteristics of landmarks with human



senses, especially the sense of touch that can directly perceive the material, texture and space

of the buildings. The Qiang Diaolou, as an important defence building of the Qiang village, is high and strong, usually made of stone, with a rough and heavy appearance (Figure 8). Touching the stone walls of the towers, people can feel the stone cold and hard, this tactile experience intuitively conveys the towers in the defence against invasion of foreign enemies in the role of defence. Tactile towers symbolise the towers in the village defence system in the core position, its towering form and solid materials together to convey a sense of strength and security, into the Qiang architecture of the 'tactile perception of the starting point'. People close to the towers, touch the roughness of the wall, as touching the deposition of time, stone erosion through the wind and rain left behind the texture, conveying a sense of history and the toughness of the old building. For the Qiang people, towers are not only fortifications, but also the wisdom of our ancestors and the witness of life, the sense of touch strengthens the link between history and culture.

Figure 8 Stone materials from different periods

3.3 Emotional value of traditional residential houses based on daily life

Traditional residential houses carry rich



emotional values in daily life, which are not only reflected on the material level, but also deeply affect the occupants on the spiritual and cultural levels.

The traditional residential houses of the Qiang people focus on the harmonious coexistence with nature in their location and construction. Most of the Qiang villages are built on high mountains or halfway up the hillside, and they are good at using the terrain to construct houses in a staggered and falling manner. This kind of layout is not only conducive to saving land and resources, but also helps to maintain ecological balance and reduce the impact of natural disasters. The Qiang inhabitants believe that traditional residential houses are an important link for them to live in harmony with nature, reflecting their reverence and love for the natural environment. Traditional residential houses are characterised by stone masonry buildings and quadrangle layouts, which are not only beautiful and sturdy, but also adapted to the local natural environment. The Qiang Diaolou, Walled Villages and residential houses all use local stone and clay, which ensures the stability of the buildings and also complements the surrounding natural environment. Protecting these features will preserve the historical appearance and unique charm of the village, enabling residents and visitors to experience the unique architectural culture of the Qiang.

Traditional Qiang architectural skills are the crystallisation of the wisdom of our ancestors, and passing on these skills is not only a continuation of the techniques, but also a sign of respect for our ancestors and culture. In the process of skills inheritance, the interaction between masters and disciples and the co-operation between family members are important ways of

emotional communication. The passing on of skills is in itself a transmission of culture and emotion that enhances cohesion within the group. In recent decades, however, traditional construction techniques may be gradually lost, and the younger generation prefers modern construction techniques to traditional ones. The research found that the people who mastered the traditional building skills in Chinese villages today are generally older, around 80 years old and above, and they are no longer able to build houses. This phenomenon may also lead to the loss of traditional building skills.

In order to realise the sustainable development of traditional Qiang residential houses, they need to be adapted to the needs of modern life on the basis of maintaining the traditional style and cultural connotations. At the same time, emphasis should be placed on the transmission of skills to avoid the loss of these skills.

3.4 Emotional perception of Qiang residential houses by different groups

There are significant differences in the emotional perception of Qiang residential houses among different groups. For local residents, traditional residential houses are the core of their lives, carrying rich emotional and cultural values. Foreign tourists feel the unique charm of traditional residential houses more from the perspective of appreciation and experience, and their cognition of traditional residential houses is more complicated.

Different groups have significant differences in their emotional perceptions of Qiang residential houses, and local residents have deep nostalgia for traditional residential houses. These buildings are not only their homes, but also the places where they live and grow up. The scene at the entrance of the village, the village paths, the traditional customs and activities, all these images carry the historical memories of the family and the community. Living in traditional residential houses for a long time has created a strong emotional bond between them and these buildings. Every detail in traditional residential houses records their life moments and family stories, and leaving these places will make them feel lost and nostalgic. The nostalgia of foreign tourists for traditional residential houses is mainly a romanticised and idealised emotion, and they hope to feel a way of life different from modern life through visiting and experiencing traditional residential houses. When visiting traditional residential houses, they are more interested in appreciating their unique aesthetics and cultural charms and experiencing a novel and unusual way of life. Traditional residential houses offer a unique travel experience for foreign travellers. Unlike modern hotels or flats, traditional residential houses provide travellers with the opportunity to experience first-hand the lifestyle and living environment of local people, and thus get closer to the local culture and life. Some travellers have emotional resonance when visiting traditional residential houses and are infected by their

simple and peaceful atmosphere. Such resonance may stem from admiration for traditional culture, nostalgia for history or a desire for a peaceful life.

3.5 Challenges facing the Qiang residential house in the context of modernisation

With the advancement of globalization and urbanization, traditional villages and residential houses are facing the risk of disappearance. Modern lifestyles and architectural styles are gradually permeating the Qiang areas, significantly impacting traditional Qiang residential houses. Additionally, many Qiang settlements are located in earthquake-prone regions, where natural disasters have severely damaged these residential houses (Yang, 2022). For example, the Wenchuan earthquake highlighted the limitations of traditional building materials; materials like adobe walls are prone to collapse during earthquakes, failing to provide adequate safety. Consequently, residents have chosen more cost-effective new building materials over traditional ones to adapt to modern life, sometimes resulting in the loss of the unique regional characteristics of traditional architecture.

In contemporary society, the phenomenon of residents converting their houses into homestays is increasingly common. The primary purposes include promoting local economic development, increasing residents' income, facilitating cultural exchange and heritage, and meeting diverse accommodation needs. As an emerging form of tourism accommodation, homestays not only attract tourists and boost local tourism and related industries but also provide a means for homeowners to increase their income, especially in areas rich in tourism resources, where the returns are more significant. The regional characteristics and cultural atmosphere of homestays offer an important window for showcasing and preserving local culture. Tourists can gain a deeper understanding of local history and lifestyles by staying in homestays, thereby promoting cultural exchange.

4. A discussion of the emotional value of traditional residential houses from the perspective of daily life

Qiang traditional dwellings hold significant emotional value in daily life, which is not only reflected in their practicality and defensiveness but also in their social, cultural, aesthetic, and spiritual symbolism. The preservation and inheritance of these traditional dwellings are of profound significance for maintaining the cultural identity and emotional belonging of the Qiang people.

By analyzing the emotional value of Qiang traditional dwellings for both local residents and outside tourists, we can comprehensively understand the multiple meanings of traditional architecture in modern society. In terms of common emotional value, both

local residents and outside tourists have deep emotional connections with Qiang traditional dwellings. For the former, this connection is more rooted in cultural heritage and practical living, while for the latter, it is derived from cultural experience and aesthetic enjoyment. Regarding differences in emotional value, local residents' emotional value is more focused on long-term living memories and cultural identity, with a strong desire to protect and inherit these traditional dwellings. In contrast, outside tourists' emotional value is more about temporary experience and appreciation, gaining spiritual satisfaction and cultural education through tourism. As for complementary roles, the economic benefits and social attention brought by outside tourists help local residents protect and inherit traditional dwellings. Meanwhile, the hospitality and cultural heritage of the residents enhance tourists' travel experiences and cultural understanding.

Through the emotional value analysis of these two groups, it is evident that Qiang traditional dwellings hold multiple meanings in modern society. They are not only cultural heritage but also a bridge connecting the past and the future, promoting cultural exchange and economic development.

Concluding

In the wave of globalisation and urbanisation, the traditional residential houses of Qiang Siwa Village are facing unprecedented challenges and opportunities. These ancient and simple residential houses are not only the space where the Qiang people have lived for generations, but also a deep carrier of emotion and culture. Built on the mountains and integrated into nature, they embody the wisdom of the Qiang people and the concept of harmonious coexistence, carry family memories and historical inheritance, and become an emotional link between the past and the present. From the perspective of daily life, it has an important and positive guiding effect on the protection and renewal of traditional villages, which can not only create better activity space and stimulate spatial vitality according to the needs of the villagers, but also better excavate the rural folklore and protect the regional vernacular culture. This paper summarises the current situation and problems of traditional residential houses at the present stage by understanding the daily behavioural activities of villagers through the research on Sihua Village. By analysing the different views and emotional analyses of local residents and foreign tourists in the Qiang residential houses, it explores the possibilities of the Qiang nationality in the modern society, triggers the designers' attention to the daily life of the rural residents, and is helpful to promote the inheritance and development of the Qiang culture and to maintain the ethnic diversity and ecological balance.

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“BLOCKCHAIN APPLIED TO SYSTEMIC DESIGN: ENSURING PROJECT AUTHENTICITY THROUGH QUANTITATIVE REPORT VERIFICATION”

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ABSTRACT | Systemic design encompasses a wide range of sectors and projects related to technology, people, and the environment. A common element is the production of detailed and analytical documents and reports on the design development carried out. However, at present, methods of verification and protection for systemic projects have not been identified, representing a lack of safeguarding for designers and all involved parties. The study conducted in Italy by the Polytechnic University of Turin addresses this lack of protection and focuses on the treatment of such reports from a quantitative data perspective, namely through their verification using blockchain technology. Blockchain was chosen over other verification methods because it is a decentralized and cost-free technology that can be adapted to various social contexts and conditions. Blockchain offers two main tools for verification: notarization and smart contracts. Notarization is a process that allows the document to be notarized and subsequently locked with all the information contained within it. In this context, notarization is used to increase designers’ attention to the entered data because it cannot be overwritten. On the other hand, smart contracts are autonomous programs that execute contracts recorded on the blockchain. These contracts can be used to automate the verification of data contained in project reports. The combined use of notarization and smart contracts on the blockchain provides greater security for documents produced in the field of systemic design. This not only increases confidence in the validity of the documents, thereby avoiding cases of greenwashing and speculation, but also offers greater protection to designers. As a symbol of this verification, a Non-Fungible Token (NFT) is issued.

An NFT is a type of cryptographic token that represents a unique object. In this case, the NFT is inserted into a node of the blockchain to attest to the project’s verification. This provides tangible and immutable proof of the verification that has taken place. The project has been implemented in three different contexts: wineries in southern Spain, a facility management company, and the post-university education sector. The verification process enables the protection of small local entities and the scaling of business processes, involving the local community and individuals. The application of blockchain technology in systemic design offers a new experimental method for decentralized verification and protection of projects and the data contained within them.

KEYWORDS | SYSTEMIC REPORTS, DATA VERIFICATION, PROTECTION SUSTINABILITY, NO GREENWASHING, BLOCKCHIAIN VERIFICATION, NOTARIZATION

1. Introduction to the Topic: Prelude to the Research Method

In the context of systemic design, an area that encompasses a wide range of sectors and projects, the generation of comprehensive documentation and textual reports detailing and analyzing the work carried out emerges as a common element. However, we face a significant challenge: the need to limit the production of documents that, while oriented towards sustainability, present inaccurate data, thus constituting a form of environmental deception. In this context, accurate data verification represents a crucial aspect. Although established control procedures already exist, such systems often adopt a centralized perspective. The real design challenge lies in implementing a decentralized and cost-effective approach to data verification, thus ensuring the integrity and reliability of information within the scope of systemic design (Ryan, 2014). The research methodology is based on the integration of blockchain into systemic design for validating sustainability reports. This approach merges the principles of systemic design with blockchain technology, combining the ability to delineate material flows aimed at reducing the ecological footprint with the blockchain's capacity to ensure data transparency and immunity to manipulation (Sevaldson, Jones, 2019). The research process follows an iterative approach, characterized by phases of research on current and past conditions, design, implementation, and repeated testing to refine the proposed solution. During development, blockchain has been integrated as a key tool for validation and assurance of data integrity. This integration involved the development of smart contracts, notarization, and NFTs that ensure the immutable recording of environmental, social, and economic information. The methodology also includes a phase of thorough testing and validation, where the design system is subjected to a series of simulated scenarios and real situations to assess its effectiveness, scalability, security, and adaptability to the needs of the business context and stakeholders. A fundamental element of the methodology has been the active participation of stakeholders, including representatives of companies, who have chosen to actively apply the project. This involvement has ensured a comprehensive analysis of the needs

and constraints of the operational context, contributing to ensuring the effectiveness and adaptability of the proposed solution.

1.2 The Most Well-Known Applications of Blockchain

The idea of applying blockchain to systemic design stems from the study of its applications carried out in recent years, starting from its inception in the financial world (Tapscott, & Tapscott, 2016). Blockchain technology, thanks to its versatility, has involved numerous sectors worldwide, addressing various issues. Among the many applications of blockchain, one of the most promising is its ability to improve data verification and traceability in a wide range of areas. Firstly, in the financial sector where its application originally emerged in 2008, as part of the Bitcoin whitepaper, written by an individual or group of individuals under the pseudonym Satoshi Nakamoto, blockchain has revolutionized the way economic transactions occur (Nakamoto, 2008). Cryptocurrencies like Bitcoin and Ethereum utilize blockchain technology to enable secure and transparent financial transactions, eliminating the need for traditional financial intermediaries (Wood, 2014). But it's not only in the financial world that blockchain has made its presence felt; in the logistics and supply chain management sector, companies worldwide are adopting blockchain to trace the origin and path of products along the entire distribution and supply chain. This not only ensures greater transparency but also helps prevent fraud and counterfeiting (Puthal, Malik, Mohanty, Kougianos, & Das, 2018). The use of blockchain technology for managing counterfeits in the world of art has gradually expanded, allowing a revolutionary change in both the creative industry and among collectors (Whitaker, 2019). In addition to the aforementioned sectors, blockchain has also found applications in digital identity management, copyright protection, and even in EU-funded electronic voting systems (Netservice, 2024). In all these contexts, blockchain offers an unprecedented level of security and reliability, enabling the creation of transparent and decentralized systems (Zyskind, Nathan, & Pentland, 2015).

1.3 Current Parameters for Verification Environmental Data in Reports

Starting from these examples of applications developed since 2008, the analysis delves into exploring the current verification criteria implemented on documents and reports focused on environmental development initiatives for businesses and organizations. In this context, practical scrutiny methods emerge, such as ISAE 3000, an international standard issued by the International Auditing and Assurance Standards Board (IAASB). This directive, originally conceived for assurance engagements not related to financial information, has recently been adopted as a reference for sustainability reporting examinations and assessments (Stern, 2020). This choice is due to its ability to provide a comprehensive view when analyzing the reliability and accuracy of non-

financial data communicated by companies. It should be noted, however, that ISAE 3000 is commonly employed by auditors who, due to their predominant expertise in financial matters, may not be as adept at scrutinizing sustainability-related data in detail. To outline specific parameters related to sustainability data, the Global Reporting Initiative (GRI) was established in 2007, an independent international entity that developed and promoted a reporting framework for sustainability (El Alfy, Weber, 2019). Founded in Amsterdam in 1997, GRI formulated the GRI Standards with the aim of facilitating clear, comprehensive, and reliable environmental, social, and economic reporting. These standards are structured into various categories, each dedicated to specific aspects of sustainability reporting. For example, the GRI Standards Series includes the main guidelines for preparing sustainability documents, covering topics such as governance, human rights, labor, environment, procurement, and anticorruption, among others. The GRI Taxonomy, on the other hand, defines a standardized structure for the presentation and analysis of sustainability data, facilitating comparability and analysis of reports (Thistlethwaite, Menzies, 2016). This series establishes a standardized framework for presenting and analyzing sustainability data, facilitating comparability and analysis of sustainability reports. These parameters represent guidelines for companies but not verifications for the data that are reported in the documents, but parameters to adhere to in the representation of quantitative data.

Another prominent method for controlling environmental data included in systemic reports is represented by audits conducted by centralized certifiers. In this context, ISO standards are widely used, recognized, and adopted globally, which establish specific parameters for various business areas. Analyzing the main cases dealing with environmental issues, there is ISO 14001, which not only defines the requirements for establishing an Environmental Management System (EMS) but also, through its provisions, requires the acquisition and monitoring of environmental data to assess organizational performance (Boiral , 2007). Similarly, ISO 14064 plays a crucial role in managing greenhouse gas emissions, providing detailed guidelines for the quantification, monitoring, and reporting of such emissions (Dunlop, Hawkins, Levick, Orozco, Vernoit, Wright, 2019). Its provisions provide a framework for external verification of information, ensuring compliance with established standards. To accurately assess their environmental performance, companies can rely on ISO 14031, which offers specific guidelines for implementing internal environmental performance assessments. Finally, ISO 14020 focuses on environmental labeling and declarations, promoting transparency and reliability of environmental information reported on products and services. However, it is worth noting that obtaining ISO certifications requires verification by a centralized entity and entails a fee for certification, which can be a limitation for small businesses and may encourage a decrease in attention to the presented

documents. It can therefore be summarized that the technologies involved in verifying environmental data often involve third-party users or certifying entities, which provide guidelines and support for checking such data or providing punctual verification. However, it has emerged that such processes are not uniform and decentralized or scalable on a global level. In response to these challenges, the proposal to adopt blockchain technology in this context also emerges. This approach aims to overcome the current limitations of the cases analyzed, providing a transparent and decentralized verification system for environmental data, thereby enhancing the reliability and consistency of reported information and promoting scalability in environmental data control.

2. Use of Blockchain and IT Systems for Data Verification

The blockchain, with its notarization capability and implementation of smart contracts, emerges as a revolutionary solution for verifying environmental data reported in systemic reports. This innovative approach is based on a computer system that transforms documents into code and transactions that become part of the enormous chain of blocks continuously mined by miners, hence blockchain (Tapscott, Tapscott, 2016). At the core of blockchain operation lies the cryptographic hashing algorithm, which transforms data into a unique fixed-length cryptographic hash. This process is irreversible, meaning that it is not possible to trace back to the original data from the generated hash. This ensures the integrity and security of the data recorded on the blockchain (Kalendzhian, 2021).

Furthermore, blockchain utilizes a distributed consensus system to validate and accept new transaction blocks in the chain. This process involves a network of nodes or participants working together to verify the authenticity of transactions and reach a consensus on their inclusion in the blockchain. This ensures that all network nodes agree on the current state of the blockchain and prevents any attempt at manipulation by a single malicious actor (William, 2016).

Notarization represents one of the main advantages of blockchain for verifying environmental data, considering the officialization of a document and thus all the information contained therein. A crucial aspect of blockchain is the concept of "verification digest" or "block hash." This is a unique value generated for each blockchain block using the cryptographic hashing algorithm. The verification digest is calculated taking into account all the data contained in the block, including transaction data and the hash of the previous block. This ensures that even the slightest modification to the block data would generate a completely different hash, immediately revealing any attempted manipulation. With blockchain, it is possible to securely and permanently record environmental information, such as greenhouse gas emissions, natural resource consumption, and environmental impacts of industrial activities, which is what the project

aims to do in the tested application fields. This information is stored in cryptographically protected blocks, which serves as undeniable proof of their authenticity and origin, recorded down to the day, hour, minute, and second.

While notarization commits data providers and involved to declare the truth as a public act, smart contracts, on the other hand, are self-executing computer programs that allow the automation and automatic execution of specific actions once certain conditions written in JavaScript code are met (Buterin, 2021), (Buterin, 2013). These smart contracts can be used to automate a range of processes related to environmental data management, such as verifying greenhouse gas emissions concerning time and size, monitoring energy consumption based on usage, and distributing environmental credits as in a specific case of application analyzed below (Bellassen, Leguet, 2007).

After obtaining data verification through blockchain technology or through notarization or smart contracts, the option to incorporate the verified digest into an NFT (Non-Fungible Token) image represents a next step in the project; to ensure the authenticity and integrity of certified data, the NFT offers an additional level of security and authenticity, making the certification symbol visually distinctive and easily recognisable, a logo. Using an NFT image as a certification symbol offers several practical advantages. First, NFTs are unique and immutable digital objects, registered on a blockchain, making them extremely secure and resistant to counterfeiting, as it is not possible to generate a copy of the issued certification. Incorporating the verified digest into an NFT image thus creates a digital seal confirming the authenticity of certified data and prevents manipulation or falsification (Mullings, 2022). Secondly, the NFT image can be easily shared and viewed on various digital platforms, making the symbol usable in different contexts. This helps promote transparency and trust in certified data, as companies and other stakeholders can easily verify the authenticity of the certification symbol through the blockchain. Furthermore, using an NFT image as a certification symbol adds an element of prestige and exclusivity to the certification itself. This confers a sense of importance and recognition to certified data while being generatable at low cost and therefore accessible to all economic strata.

This can encourage greater adoption of blockchain technology by companies, as they see the tangible benefits it can offer in terms of security and usability (Taylor, 2022). Thanks to the transparency and immutability of blockchain, recorded environmental information can be easily verified by any stakeholder, and personnel can verify what is stated, ensuring greater trust and transparency in the environmental reporting process. For example, years later, it is possible to review a past document and check for inconsistencies compared to subsequently published data, thus avoiding instances of greenwashing.

Undoubtedly, the use of blockchain technology for verifying environmental data offers several distinct advantages over

traditional approaches adopted by the Global Reporting Initiative (GRI), ISO standards, and ISAE 3000, which are just some of the existing verification methods but represent the chosen comparison panel in the initial analysis as the most widespread.

Therefore, thanks to the transparency and easy accessibility of data guaranteed by the public and transparent nature of blockchain (Antonopoulos, 2022). Another key feature of blockchain is data security against current privacy concerns, although potential attempts at malicious manipulation are not to be excluded (Antonopoulos, & Wood, 2019). Finally, the use of blockchain can contribute to reducing the costs associated with managing and validating environmental data, which represent an annual expenditure for companies or entities. By eliminating the need for intermediaries and streaming verification processes, this technology can help reduce both actual and overall operating costs of organizations. In comparison, the Global Reporting Initiative (GRI) provides free guidelines but requires subsequent levels to be paid for, ISO standards, and ISAE 3000 are subject to annual review by releasing companies and chartered accountants; therefore, continuous expenditure is required to keep up with market demands and public and private tenders. Blockchain, with its decentralized, immutable, and transparent nature, overcomes these limitations by providing an advanced technological solution for environmental data verification (Maupin, 2017).

2.1 Project Application Cases

The project research has yielded significant results in applications, demonstrating the effectiveness of blockchain technology in the realm of corporate environmental management in various domains. Through the use of practical simulations, a clear positive impact on environmental practices and data transparency has emerged. The project was successfully applied at the Antigua Real Fabrica de Hojalata, a highly sustainable winery located in Juzcar, southern Spain, in the province of Malaga. Here, smart contracts were utilized to verify the company's CO2 emissions related to the transportation of annually produced wine bottles and calculate the CO2 absorption of vineyards over the course of a year. This innovative approach allowed the company to accurately and reliably assess its environmental impact and identify opportunities to improve its sustainability practices. Additionally, the project addressed the challenge of wastewater discharged into the nearby Genal River, situated adjacent to the winery. Through the notarization process, an official verification of the actions undertaken by the company since 2023 to reduce the impact of wastewater on the surrounding environment, pursuing the 6th and 12th development goals, it will be possible to compare the project's progress in the coming years and avoid retroactive changes to feign fallacious improvements. This notation has provided an additional level of transparency and authenticity to the company's sustainability

actions, providing a solid foundation for its reputation and credibility in the industry. As the subject of the master's thesis project, the case study has also shown the potential scalability to all wineries in the area (Schilling & Liboni, 2023). It is important to note that Antigua Real Fabrica de Hojalata was the first company involved in this in-depth analysis, holding the verification digest of its actions. However, it was chosen not to include this digest in an NFT as a public symbol, as it was the initial experimentation phase. The verification of the proposed project's functionality was then applied to Reber S.r.l., based in Turin, which benefited from notarization verification for environmental data present in the 2023 sustainability report and in the development report prepared according to systemic flow analysis covering the company's emissions for the same year and aiming for a reduction by 2030.

This approach allowed the company to ensure the integrity and authenticity of information regarding water consumption, CO2 emissions, waste impact, and harmful particles to water, as a waste producer REA (Reber, 2023); in this case as well, the company's commitment can be monitored by comparing data annually. This provided an additional level of security and reliability, eliminating the risk of manipulation or alteration of environmental data being provided, published, and verified in public digital act. Additionally, the use of blockchain made the verification process more efficient and accurate; although the company holds ISO 14001 and the certificate provided by EcoVadis, it chose this verification method to attest to public documents (Reber, 2024). As recognition of passing the verification, Reber S.r.l. received an NFT (Non-Fungible Token) as a symbol of successful certification. This NFT contains the digest representing a cryptographic imprint of the verified data, confirming the authenticity and integrity of the information uploaded in today's public documents. This certification further strengthened the company's reputation and credibility in the facility management sector. The project application has expanded to the world of post-university training; the adoption of blockchain technology by SIAT (Italian Society of Technical Analysis) represents a significant example of the growing adoption of this technology in business operations. SIAT recognized the potential of blockchain to enhance the integrity and reliability of its processes by implementing a notarization system to verify CO2 emissions from company events and for issuing exam certifications. Notarization via blockchain allows SIAT to register and store immutable and verifiable records of every CO2 emission linked to company events, such as seminars, conferences, and workshops during the second half of 2024; the project is currently in development. This will ensure that each event is traceable and that related data cannot be retroactively altered. For each event, SIAT will record details such as date, time, location, and presented content with the respective CO2 calculation and the products chosen for compensation, carbon credits, but will also implement increasingly sustainable resource usage methods. This information will then be "notarized" on the

blockchain, creating a permanent record that can be easily verified by third parties involved in the events. This process increases confidence in the services offered by SIAT, as participants and stakeholders can be certain of the authenticity and accuracy of the information. In addition to notarizing emissions from company events, SIAT will use blockchain by 2025 for issuing certifications for exams. After passing an exam, the candidate's details and results are notarized on the blockchain. This provides tangible and indisputable evidence of acquired skills, facilitating the recognition of qualifications by employers and other institutions and reducing the production of paper documentation.
The analysis of environmental data and its verification represent a crucial component for organizations aiming to demonstrate their concrete commitment to sustainability without perpetrating greenwashing. In this scenario, blockchain has proven to be an innovative solution that can bridge these possibilities. As demonstrated by the case studies of Antigua Real Fabrica de Hojalata, Reber S.r.l., and SIAT Società Italiana di Analysis Tecnica, the application of blockchain has allowed for accurate and indisputable verification of environmental data. This has led to increased confidence in the reported information and facilitated the recognition of sustainability initiatives by companies.

2.2 Evaluation of the Results Obtained and the Critical Issues

It is essential to approach the chosen design process with a critical eye, recognizing not only the benefits that have been widely reported but also the challenges and limitations inherent in this technology. The technological complexity of blockchain represents one of the main barriers to adoption, due to the low level of understanding. This complexity can be daunting for organizations that do not have the necessary resources to invest in training and technological and computer updates. Furthermore, scalability issues arise when transaction volume increases, potentially leading to delays and higher costs that could compromise system efficiency. The lack of interoperability between different blockchains, some dedicated to economic transactions and others to verify transactions like Cardano, may limit data sharing and the effectiveness of the technology on a larger scale.

Additionally, the energy consumption of some blockchain implementations, especially those based on Proof of Work, may conflict with environmental sustainability goals. Some blockchains are transitioning from high-energy consensus mechanisms, such as Proof of Work (PoW), to more efficient protocols like Proof of Stake (PoS) or variants thereof, which require significantly less energy to operate (Schilling & Liboni, 2023). Another critical aspect is the quality of data entered into the blockchain. While the technology ensures the integrity of data once registered, it cannot guarantee the possibility of duplication. This means that errors or repetitions in the initial data will be perpetuated in the system. Furthermore, the need for transparency must be balanced with compliance with data privacy regulations, creating tension between information

accessibility and protection of personal information (Kulhari, 2018). The challenges do not stop at the technology itself. Adoption and acceptance of blockchain can be slowed down by distrust of new technologies or confusion in considering Bitcoin and blockchain as the same tool. It is therefore crucial for organizations to work to promote understanding and the benefits of blockchain to overcome resistance to change. Additionally, organizations must navigate an uncertain regulatory environment in Italian legislation, which can pose legal and operational risks. Despite these challenges, blockchain, analyzed since the late 1990s, has the potential to become a revolutionary tool in the field of environmental reporting (Szabo, 1997). Organizations adopting this technology position themselves as leaders in the field of sustainability, ready to respond to the growing demands for accountability and traceability from stakeholders, consumers, and financial entities. To fully harness the potential of blockchain, a critical and aware approach is needed that takes into account its limitations and actively works to mitigate associated risks.

3. Conclusions and Future Challenges

In the context of promoting environmental sustainability through blockchain technological innovation, the project aims to establish itself as a reference point for future sustainable practices. Looking ahead, a series of evolutions capable of revolutionizing how we address environmental and social challenges are outlined below.

The future prospects of blockchain will project towards a horizon of significant transformations that could revolutionize not only how we interact with data but also how we approach sustainability and technological innovation. The widespread implementation of blockchain, thanks to the work of miners who will further develop it from financial and computer science perspectives, will allow its application in key sectors such as manufacturing, sustainable agriculture, and ecological construction, where the need for transparency and traceability will increasingly become urgent to demonstrate. This expansion could lead to a reduction in environmental impact and an increase in operational efficiency.

The advent of Artificial Intelligence (AI) and the Internet of Things (IoT) will enrich the project with advanced analytical capabilities and more sophisticated data collection (European Investment Bank, 2021). AI can offer predictive insights based on data collected through blockchain, while IoT can provide real-time environmental monitoring, enhancing responsiveness and measurement accuracy. This synergy between technologies could lead to smarter resource management and a greater understanding of implemented environmental dynamics, allowing for realistic long-term predictions. The involvement of local communities will be crucial for the project's success. Through active participation in data collection and evaluation, communities can gain greater environmental awareness and become active protagonists in promoting sustainability. This bottom-up approach

could stimulate behavioral change and greater collective responsibility towards the environment (European Investment Bank, 2021). The standardization of blockchain protocols for sustainability and international collaboration will be necessary steps to ensure consistency and effectiveness of data verification practices on a global scale, in addition to the production of specific laws and regulations. This could facilitate the adoption of public policies and regulations that promote transparency and accountability in the sustainability sector; many steps forward have already been taken in 2024 with Bitcoin operating on blockchain computing.

Moreover, the provision of economic incentives and tokenization can play a crucial role in encouraging the adoption of sustainable practices. Sustainability-linked tokens can be used to reward companies and communities that contribute to generating reliable data and adopt environmentally respectful behaviors. This rewards system could stimulate broader commitment to sustainability and innovation. Education and public awareness of the importance of sustainability and environmental data verification will be essential for the project's progress. Awareness campaigns and educational programs can be implemented to engage the public and promote a cultural shift towards more sustainable behaviors.

Interdisciplinary collaborations with fields such as sociology, behavioral economics, and environmental psychology can provide a deeper understanding of the human factors influencing sustainability-related decisions. This integration of knowledge can lead to more effective solutions and more targeted engagement strategies. Finally, by promoting transparency and accountability, blockchain can become a key tool in encouraging the adoption of evidence-based practices and guiding policy decisions towards a more sustainable future. In conclusion, blockchain is emerging as a key technology for the future, with the potential to radically transform our approach to sustainability, innovation, and social responsibility. As we approach this future, it will be crucial to continue exploring and developing its applications to maximize benefits for society and the environment.

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UNTOLD STORIES: THE GRAPHIC DESIGN OF MARIA KEIL AND CRISTINA REIS DURING THE PORTUGUESE DICTATORSHIP AND THE PATH TOWARDS INCLUSIVENESS

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ABSTRACT | The history of Portuguese graphic design is intertwined with the history of the country that, between 1933 and 1974, lived under a harsh dictatorship called Estado Novo (New State). The stories of women working in the design field, then male-dominated, are even more constrained by the Portuguese social context of that period, marked by gender inequality and lack of inclusiveness. The purpose of this paper is to unveil the role of Maria Keil and Cristina Reis, who, despite difficult conditions, contributed to the development of the design practice in Portugal before and after its official establishment in the 1960s. Literature review, documentary research, and content analysis reveal how their work is still fairly unknown to the public, even inside graphic design classrooms. The research also shows how the lack of women's visibility in graphic design is more accentuated in Portugal due to its sociocultural context under the regime, which also censored some of their works. Uncovering their heritage in today's Portuguese graphic design allows us to walk in the direction of more inclusive graphic design history and practice.

KEYWORDS | INCLUSIVE GRAPHIC DESIGN, WOMEN DESIGNERS, PORTUGUESE DESIGN, MARIA KEIL, CRISTINA REIS

1. Introduction

The lack of visibility of women in Portuguese Graphic Design during the Military Dictatorship and Estado Novo regime (1926-1974) stems from several social, political, and cultural factors. Portugal had one of the longest dictatorships in Europe, spanning a total of 48 years, with some scars still noticeable today. Led by António de Oliveira Salazar (1889-1970) from 1933 to 1968, the authoritarian regime ended with his successor, Marcello Caetano (1906-1980). During that period, the state persecuted all forms of thought that diverged from the official discourse (Fragoso, 2010). Only the Carnation Revolution of April 25th, 1974 – which celebrated its 50th anniversary in 2024 – effectively managed to end it.

The regime invariably shaped the sociocultural conditions of a country that, even before the coup d'état of 1926, was already behind other European and North American countries. In the words of Barbosa (2015, p.2), it "further contaminated the political and economic situation that it had inherited by cultivating a backward-looking philosophy of 'being Portuguese', which led to further stagnation and cultural decline". During the 1960s, while places such as the United States and the United Kingdom were experimenting with countercultural forms of graphic design against the dominant culture and the establishment, Portugal was still undermined by propaganda. As Souto (2018) reminds us, the history of Portuguese design itself seems to have been conditioned by the dictatorship, with the late start of industry and education.

This study aims to unveil the contributions of Maria Keil (1914-2012) and Cristina Reis (1945) to graphic design during and after Estado Novo and to analyze their little presence in the records of Portuguese design history. Buckley stated that, although women have been involved with design in a variety of ways, "a survey of the literature of design history, theory, and practice would lead one to believe otherwise" (1986, p.3). Authors such as Scotford (1991), Thomson (1994), Clegg & Mayfield (1999), Skyes (2017), and Guida (2020) agree with this perspective.

Rawsthorn (2018) also acknowledges the privileged position of white men. For Franchini and Garda (2016), this lack of knowledge goes beyond the public, being shared by students, academics, and professionals. The reasons for such a situation include an array of social contexts, gender stereotypes, education, work environment, and recruitment processes (Trauth, Quesenberry, & Huang, 2006; Yue, 2018).

Women contemporary of Keil and Reis were especially subjected to discrimination and difficulties. Guida (2020, p. 607) considers that for them, working was an "almost heroic result, if the profession had to be accompanied by conventional social and cultural roles: being a wife, being a mother, taking care of the family home, looking after the offspring". This reality seems accentuated in the Portuguese context, whose prolonged regime made it even harder for women to access education and the job market, confining them in their social role of dedicated wives and mothers. This chronic dysfunction, according to Meer (2012), has led to women being less encouraged to consider their lives and work as worthy of historical attention. It was in this complex framework that Maria Keil and Cristina Reis lived and worked.

2. Method

This study proposes an analysis of the work of Maria Keil and Cristina Reis, while also discussing their traces and heritage in Portuguese design history. The choice of the two designers as case studies derives from the fact that Keil was the first woman to work in an advertising studio in Portugal and that Reis was one of the first two Portuguese women with a degree in graphic design – meaning they both had pioneering roles in the field. Having two people from different generations (one born in 1914 and the other in 1945) provides an ampler look into the role of women in the history of Portuguese design and its parallel with the evolution of the profession – even before its official establishment in the country.

Thomson (1994, p.30) tells us that "to understand the positions women found in the graphic design profession, we must turn to documentary sources that provide a broader picture of the profession and its history". Accordingly, the first step of this research is the literature review on the Portuguese sociocultural, political, and economic context during the regime, with an emphasis on the life and stereotypical roles of women; the growth and establishment of graphic design in Portugal; the work of Maria Keil and Cristina Reis; the overall lack of visibility and representation of women in design history, with the Portuguese case. This approach provided a detailed view of the intricate relations between the topics.

Then, documentary research is followed, focusing on materials of the period, such as newspaper articles, laws and decrees, videos, and interviews, to grant a deeper understanding of all mentioned circumstances. This phase includes an immersion into the work of both designers,

to comprehend their practices: how they worked, who they worked for, what they did, and the possible constraints. Then, a search and analysis of Design History programs in Portuguese universities was carried out. Finally, the exploratory analysis aims at understanding the invisibility of women designers in Portuguese design history, not only to gasp this lack of representation and inaccurate perceptions about their roles but also to discuss possible answers.

3. The (slow) progression of graphic design in Portugal

Graphic design in Portugal had a slow rise and progress compared to other European and American countries, where it developed earlier and more quickly. For Thomson (1994, p.28), "the concept of graphic design and the professional graphic designer evolved in the United States during the second half of the 19th century". In Portugal, this situation does not occur or does not find similar terms. According to Barbosa (2011), texts on the history of Portuguese design appeared late and sporadically, a likely consequence of the little importance attributed to this field in Portugal during the 20th century.

First, as mentioned by Almeida (2009), the absence of an industrial revolution in Portugal contributed to an apparent lack of need to reformulate the design process associated with industrial production and, consequently, did not allow any thoughts on design whatsoever. This difficulty in affirming the design practice has naturally impacted how its story is written, interpreted, and told. At the same time, and perhaps due to its recent rise and development in historical terms, graphic design is sometimes regarded as something "supplementary or additional to other projects" (Walker, 2017, p.1). Thus, the history of this field, as well as that of its agents, deepens and becomes even more complex.

The delay felt in Portugal regarding design also resulted from education itself, still tied to 19thcentury academism, stubbornly focused on the division between major and minor arts, with painting and sculpture in the front row. In this sense, it was up to the ateliers to find ways to mitigate the gap between artistic practice and knowledge (Almeida, 2009). Mantas (2012) states that there was a lack of graphic consciousness and, therefore, the average quality of the work was low – from an artistic point of view, project development, and printing process. In 1934, António Ferro (1895-1956) lamented the crisis of the graphic arts in Portugal, pointing out the absence of a professional graphic school as a symptom of a worrying cultural weakness (Ferro, 1934). Other authors of the time, including Adolfo de Mendonça and Luiz Moita, drew attention to the need for Portugal to invest in the development of graphic arts through education and the regulation of the sector (Mantas, 2012).

Within a stagnant country, practically closed to external inputs, the development of graphic design in Portugal finally got out of the impasse with the arrival of Swiss artist Fred Kradolfer (1903-1968) in 1924 (Fragoso, 2012).

Kradolfer, who had studied at the School of Applied Arts in Zurich, brought a new sense of modernity, with which Portuguese artists had not had previous contact. Still, the public was yet to get familiar with this field. According to Barbosa (2015), it is through architecture that design acquired some value in the Portuguese lexicon: the magazine Arquitectura (1952) is the first place where we can find the use of the word 'designers' – although combining industrial and graphic design. That is why, as Manaças (2005) reminds us, it was only from the 1960s onwards that people began to talk about design in Portugal. The 1965 International Exhibition of Industrial Design was responsible for the official recognition of the term 'design' by including it in the title and catalogs (Souto, 2017). Still, these words "were only applied in contexts referring to the professional activity in the 1970s, usually beneath a signature" (Barbosa, 2015, p.10). According to Almeida (2014), by the 1970s, the design praxis was still unaltered and under the control of its main agents.

Formal design education in Portugal also came late and rather slowly. For a long time, the Fine Arts schools insisted on not recognizing the importance of this area. Some professors opposed the inclusion of design in their programs because they argued that the institutions would suffer, with painting and sculpture losing prestige (Rafael 2006; Almeida, 2009). As a result, the first higher education course in design was implemented only in 1969, with the founding of the Institute of Art and Decoration (IADE) in Lisbon – today the oldest design faculty in the country. The first design courses in public institutions appeared in 1974, after the revolution (Barbosa et al. 2015). Later, it was the reform of those public courses at the Fine Arts schools of Porto and Lisbon, between 1975-78, that finally validated design as an autonomous discipline (Santos, 2001).

In terms of showcasing, it is worth noting the Graphic Arts Exhibition, held by the National Society of Fine Arts (SNBA) in 1941 – an early attempt to legitimize graphic design in Portugal. The exhibition's presentation text highlighted the proximity of graphic arts with fine arts, as an effort to bring design into the artistic sphere. However, the first major design exhibitions were the Portuguese Design Exhibitions that took place in 1971 and 1973, proposing an overview of the panorama of this field and the professionals of the period (Almeida, 2015). Those exhibitions ended up being a provocation to the context of design in Portugal, revealing the public and state ignorance regarding this subject (Pinheiro & Franqueira, 2022). From the catalog of both exhibitions, one can easily spot another problem in the history of Portuguese graphic design: a clear predominance of industrial design. The latter was already more developed and studied, and as the initial agents worked in both areas, there was an imbalance in its favor. That is why today it is easier to find references in industrial design and, oftentimes, when seeing the word 'design', it is not related to graphic production.

The Portuguese Design Association (APD), founded in 1976, is the first representative

of the profession in the country. However, the professional activity of 'designer' was only incorporated into the personal income tax code (IRS) in 2007 and recognized and published in the Portuguese Classification of Professions in 2011 (Pinheiro & Franqueira, 2022). Clearly, as stated by Agapito et al. (2015), design is still defining itself and seeking its position in Portuguese society, through its expansion and progression.

4. The condition of women during the regime

The recent and complex history of graphic design in Portugal is not the only factor contributing to the invisibility of women designers. If that were the case, then the stories of male designers would also be hidden in the corners of the slow and somewhat confusing process of affirmation of this field. In part, the explanation for this persistent invisibility lies in the condition of Portuguese women during the regime, resulting from the sociocultural conjuncture of the country.

Article 5 of the 1933 Constitution stated that citizens were equal before the law, "except for women, the differences resulting from their nature and the wellbeing of the family" (PT Const. 1933, art. 5). Even before the consecration of this discriminatory discourse, the 1930 censuses already considered women as less important citizens, including them in the category of "family members assisting their respective heads" (Cova & Pinto, 1997). The 1940 census maintained that view, adjusting the designation to "domestic" (Cova & Pinto, 1997). The expression "head of the family", intended for men, remained until 1981 (Casimiro, 2003). Decree-law 23:048 of September 1933 stated that the work of women and minors, outside the home, would be regulated by special provisions by the requirements of morality, physical defense, motherhood, education, and social good (Decreto-Lei nº 23:048, 1933). The 1968 Civil Code defined men as the leader of the family and responsible for all decisions regarding all family members (Hargreaves, 2020). Once again, we can see that women had fewer rights than men, as Sousa highlights (2019). However, to obtain a broader perspective on the condition of Portuguese women during the dictatorship, we must also look at the country's social, political, cultural, and economic context.

In 1970, close to the end of the regime, only 47% of Portuguese houses had running water, 58% had access to sewage, and electricity was present in only 63% (Almeida, 2009). At the beginning of this decade, 32% of the population worked in the primary sector, and 30% did not have proper homes, with around 21.000 families living in slums in the Lisbon area (50 anos 25 de abril, 2024). Additionally, education rates remained low throughout the period (Almeida, 2009). In 1960, the illiteracy rate was still 33.1%, much higher than in other southern European countries like Spain (14%) or Italy (8,3%). For Melo & Benavente (1978) and Cavaco (2018), illiteracy rates were persistently high, in a strategy of programmed obscurantism, with only slight improvements

due to international pressure. Access to universities was, of course, restricted, with a rate of just 5% also in 1960 (Almeida, 2009). The main victims of those rates were the women, whose access to education until the 1960s was even more limited (Adão, 2012; Sousa, 2019). The obligation for girls to attend at least four years of schooling was only legislated at the dawn of that decade (Mantas, 2012). From this point on, we can finally observe what Sousa (2019) calls the "feminization" of education, especially in secondary education. This phenomenon demonstrates a slow but growing awareness of the importance of education – something that worried the state, which did not want women to deviate from their natural destiny (Sousa, 2019).

The 48 years of dictatorship were marked by the crushing of fundamental civil and political liberties, with committees and censorship acting in all social areas (Samara & Rosas, 2021). Political parties and expressions of discontent were banned. Topics such as war, racism, and even family relationships were subject to censorship (Mantas, 2012). There was greater oppression against women who, for example, could not leave the country, open bank accounts, or even take contraceptives without their husband's consent (Pinto et al., 2014). Also, they could not vote, and some professions, such as judge, diplomat, military, or police officer were offlimits (Pinto et al., 2014). For the regime, female work was fatal to the birth rate, disrupting the home and promoting demoralization (Vaquinhas, 2011). Those who were able to work earned, on average, half the salary paid to men (Pinto et al., 2014). The salary gap was legislated, with the promulgation of decree-law 32:749 of April 15, 1943, which determined that salaries should meet the 'normal needs' of the worker, in harmony with age, sex, professional category, and local living conditions (Melo, 2017). Divorce was illegal for church marriages until 1975, and the penal code provided mitigating circumstances for men who killed women for adultery (RTP, 2014). Women were expected to be obedient to their husbands and dedicated to the home (Pimentel, 2012). Ultimately, the guardianship exercised by husbands created a form of dependence that nullified the legal capacity of women (Cardoso, 2023). The press also participated in the stereotypical social construction of women (Marques et al., 2019).

Stereotyping a certain group is characteristic of propaganda speeches, contributing to the perpetuation of discrimination (Van Dijk, 1995). Still, according to Samara and Rosas (2021), women did not stop participating and trying to have an active role in society. The case studies of this research, Maria Keil and Cristina Reis, reflect this fight well.

5. The design of Maria Keil and Cristina Reis

Although both Maria Keil and Cristina Reis have worked as graphic designers during the Portuguese regime, they are from different generations and have thus experienced different work practices and sociocultural constraints. Those experiences seem to have invariably shaped their career paths and design praxis. Maria Keil, the older of the two, is from the second generation of Portuguese Modernists (Fragoso, 2012; Souto, 2018) – before the establishment of graphic design as a profession or study area in Portugal, and before the word 'design' came around in the country. Like many artists of the time, she worked within several artistic areas, including painting, tile design, illustration, and graphic design – the latter known at the time as 'graphic art', 'graphic arrangement', or 'decoration'. When asked about her position within the artistic context, she defined herself as a "blue-collar worker of the arts" (Leitão, 2005). Keil was the first woman in Portugal to have worked in an advertising studio: the ETP - Estúdio Técnico de Publicidade, founded by José Rocha (1907-1982) in 1936, alongside artists such as Fred Kradolfer (Souto, 2018). In her design career, she also experimented with editorial design, poster design, illustration, and postage stamps.

The separation of 'high' and 'low' arts, rooted in the Portuguese artistic context of the time, brought discrimination and prejudice to those working within the 'minor' fields. Keil suffered prejudice while working as a 'graphic artist' because people did not consider such activity proper or worthy for painters, due to being commercial based (Cotrim, 2004). She had started the Painting course at the Fine Arts School of Lisbon, later dropping it when she got married to fellow student and architect Francisco Keil do Amaral (1910-1975). About her time at the Fine Arts School, Keil referred to how little she learned there, due to its chronic stagnation, and how much she learned outside (Mantas, 2012). With a different design view, the American magazine Arts and Industry included her in the 1939 article Pioneers for Publicity, about Portuguese graphic design (Mantas, 2012).

In the 1930s and 1940s, she, along with most artists of that period, worked for the state, despite being opposed to the regime. Several projects were made for Secretariado da Propaganda Nacional (SPN)/Secretariado Nacional de Informação (SNI), while António Ferro was in charge (Quintas, 2014). This apparent oxymoron results from a symbiosis between the state and the anti-regime artists: one side needed the money to live and the other needed artists with quality work. However, from 1949 onwards, the volume of state orders diminished considerably, after Ferro was removed from office due to incompatibilities with Salazar.

The inclusion of Keil in the 1942 Graphic Arts Exhibition was the first public recognition of the quality of her design (Mantas, 2012). Still, although acclaimed from the beginning,

one cannot but notice the adjectives usually employed when talking about women's achievements. At the time, the work of women was usually described with words such as 'gracious', 'delicate', 'sentimental', 'sensible', 'enchanting', 'lyric', or 'feminine' (Hargreaves, 2020). Adriano de Gusmão (1908-1993), described Keil's work as a "nice effort, where one can notice some interesting details, in drawing and color, even betraying her feminine nature" (1947, p.23). We can observe something similar in what Roberto Nobre (1903-1969) wrote in 1957, stating that "one of the aspects that makes the work of Maria Keil unique is the richness and variety of her art, indeed rare in a woman" (1957, p.117). Mariac Dimbla (n.d.), another woman, avoids the use of stereotypical adjectives, focusing instead on the harmony achieved between tradition and modernity. Dimbla's article was written for a magazine called Modas e Bordados (Fashions and Embroidery), subtly revealing the impossibility of escaping stereotypical images of women.

Additionally, most comments, according to Mantas (2012), are made about painting (even though Keil did not consider herself a painter), confirming once again the superiority of this area in the Portuguese context.

In a very conservative country, Maria Keil defended the women's cause, having joined the Women's Democratic Movement (MDM), the Democratic Unity Movement (MUD), and the National Council for Portuguese Women (CNMP) (Mantas, 2012). Along with her husband, she worked for the anti-regime publication Seara Nova (1921-). In 1947, some works exhibited at the SNBA, including Keil's Regresso à Terra, were apprehended by the state (Mantas, 2012). She was arrested in 1953 by the political police (PIDE) for getting Maria Lamas (1893-1983) – a Portuguese anti-regime writer and feminist activist – at the airport. About her opposition to the regime, Keil said that they all did what they could because the important thing was to participate somehow (Cruz, 2002). She described herself and her inner circle as "a few but all anti-regime" (Leitão, 2005). In 1969, she designed the poster "Por um Portugal Livre e Melhor" (For a Better and Free Portugal), for the Electoral Commission of Democratic Unity (CEUD). She also designed the poster for the exhibition Women Writers of the World, held at the SNBA and organized by CNMP. In 1980, Keil received the rank of Commander of the Military Order of Santiago de Espada, in recognition of her work.



Figure 1. Works of Maria Keil. From left to right: Pompadour advertisement (c. 1940), Vignette for Seara Nova (1941), Page from agricultural production campaign (1946), For a Free and Better Portugal Poster (1969). Source: Biblioteca Nacional de Portugal.

Cristina Reis was born in Lisbon in 1945. In the 31 years between the birth of the two designers, the role of women in Portuguese society remained almost stagnant. Still, Reis had the opportunity to study graphic design at the Ravensbourne College of Art and Design in London, being one of the first women in Portugal with a higher education in the field. Before going abroad, she undertook the Basic Design Course at the studio of Daciano da Costa (1930-2005), due to the absence of such courses in universities. Daciano da Costa, prevented from teaching in the Fine Arts school by the regime, decided to create this course on his own premises (Fragoso, 2010). For Reis, this was a pioneering experience that only a few lucky people had the opportunity to participate in (Reis, 2014). While there, she had access to a problem-solving education, learning about the Bauhaus and the Ulm School (Souto & Brízio, 2014).

Her studies in London, funded by a scholarship from Calouste Gulbenkian Foundation, were also influenced by the condition of women in that period, who even in other European countries were not on par with men. The field she intended to study in England was, in fact, cinema, having abandoned it in favor of design when she realized that as a woman, she would not have been able to go beyond becoming a 'script girl' (Lisboa, 2020).

Back in Portugal in 1970, together with fellow designer Alda Rosa (1936), Reis organized the 1st Exhibition in Portuguese Design (1a Exposição de Design Português) and designed the graphic identity and catalog. She repeated the experience in the same role for the second exhibition in 1973. In 1974, she opened the cooperative DEZ with affirmed designer, architect, and artist Sena da Silva (1926-2001) - an indicator of her prominent

role in the Portuguese Design context. Censorship reached the work of Cristina Reis when the book O Mundo é a Nossa Casa, by Júlio Moreira (1929-2014), for which she worked with Margarida D'Orey, was seized and destroyed, as it was considered subversive (Lisboa, 2020; Barata,2023). The book, which appeals to an innovative environmental consciousness and change toward more sustainable futures, is now part of the national reading plan for schools.

From 1975 on, Reis starts working with Teatro Cornucópia, bringing graphic design into the theatrical sphere. Most of the work she did for this theatre company is now part of the collection of MUDE – Museum of Design and Fashion in Lisbon – donated when the theatre closed in 2016. Between 1979 and 1981, she went abroad again, this time to the Schaubühne Am Halleschen Ufer in Berlin, further experimenting with the crossing of design and theatre. Later, she became the director of Cornucópia, alongside Luís Miguel Cintra (1949). She also collaborated with Teatro Nacional D. Maria II, Teatro São Luiz, and Culturgest, among others. In 1994, the Portuguese Association of Design (APD) organized a series of exhibitions under the title Design & Designers, including Cristina Reis. She won the Career Award from the Portuguese Design Center in 2000 and the Gulbenkian Arts Award in 2010. For Coutinho (2020), even though Cristina Reis has been honored several times with awards and other recognitions, her work has not been properly studied, analyzed, and disclosed in a cohesive way. For Costa (2019), although women were working as graphic designers, there was no discursive practice on the subject. Still, as Duarte & Martins (2021) point out, she is and will be a reference for women designers to question their own practice.

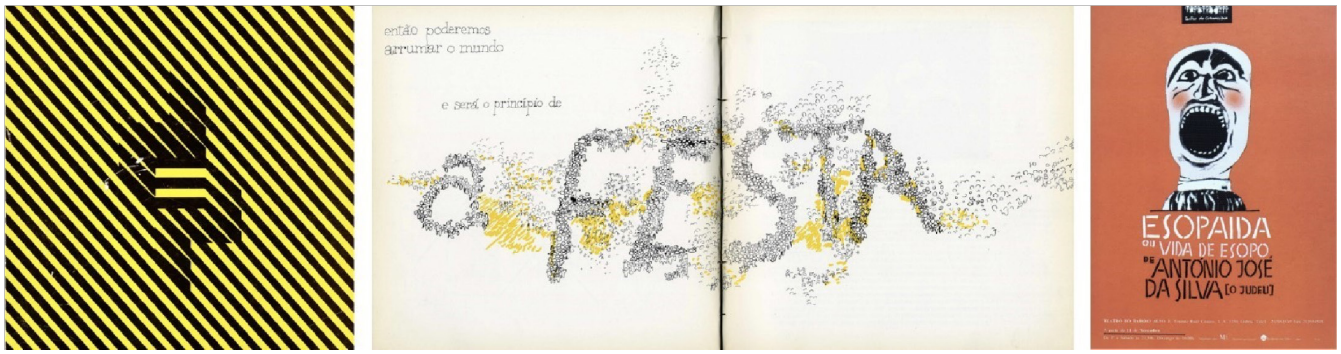

Figure 2. Works of Cristina Reis. From left to right: Cover for 2ª Exposição do Design Português (1973), interior from O Mundo é a nossa Casa (1973), poster for Cornucópia Theather (2004). Source: FCG/Biblioteca Nacional de Portugal.

6. (Lack of) Visibility

Despite their prominent roles in the development of graphic design in Portugal, Maria Keil and Cristina Reis remain fairly unknown to the public. This situation seems to reflect the chronic lack of inclusiveness in design publications and university curricula. A simple search on Portuguese design leads us to male names such as Daciano da Costa, Victor Palla, Sena da Silva, Sebastião Rodrigues, or António Garcia. According to Moura (2018), in the chronologies of the evolution of design in Portugal, with the intention of understanding each era and identifying its main actors, we only see the names of male designers. The same happens with the history of design ateliers, where there is a deficit of female representation (Moura, 2018).

The First Exhibition of Portuguese Design (1971) provides us with a major hint at this reality. Looking at the catalog, one can see that of all the fifty participating designers, only ten were women. Also, the first texts on Portuguese design (1974) – included in A Arte em Portugal no séc. XX by José Augusto França (1922-2021) – follow this trend. As a sign of possible upcoming change, Cristina Reis was recently included in Coleção D - Design by Jorge Silva (1958), published in September 2023 – a collection that up to that point was made only of male designers. Still, apart from this exception, references to women tend to be sporadic and usually synthetic, acknowledging their presence, but avoiding further discussion (Mantas, 2012). It is only natural that international publications follow this scenario. For instance, Novin's A History of Graphic Design (n.d.), in the chapter The Portuguese School of Graphic Design, does not include women. Bigger publications, such as The History of Graphic Design, by Müller (2022), favor Portuguese male designers. This seems to be in line with the perspective of Falcão (2015), for whom history was created by those who were able to work and remain working for an extended timeframe. Considering the Portuguese sociocultural context during this patronizing regime, it is no wonder that women faced more difficulties career-wise.

As Barbosa (2011) discloses, the research on the beginnings of design in Portugal, as well as some book collections, reveal a tendency to favor industrial design. This situation further compromises the visibility of women who worked at the time in the field of graphic design. Such a reality stands out even more by looking at design history programs included in graphic design bachelor's from different Portuguese Universities. For this purpose, we looked into IADE (Universidade Europeia), Faculdade de Belas-Artes da Universidade de Lisboa, Faculdade de Belas-Artes da Universidade do Porto, Universidade de Aveiro, Universidade de Coimbra, Universidade do Algarve, Politécnico de Leiria, ESAD Porto, Politécnico de Castelo Branco, Politécnico de Coimbra, Escola Superior Artística do Porto, and Universidade Lusófona. At the moment, there aren't specific programs on Portuguese graphic design

history, although there are on industrial design history, such as at Faculdade de Belas-Artes da Universidade de Lisboa. Despite all these bachelor's including Design History in their study plans, only IADE and Universidade de Aveiro have specific programs in Portuguese Design History. The analysis of the syllabus of both programs reveals a combination of Industrial and Graphic Design, without references to women in the descriptions provided to the students. Such reality makes us believe that there are no women worthy of mention, or that they did not provide enough quality or consistency to be studied. One can argue, as Costa (2019) states, that the absence of discourse on the work of Portuguese women designers at the time, also contributed to their later invisibility in historical studies. For Meer (2012), this is because women are considered less productive than men, meaning that the surrounding circumstances, namely oppressive sociocultural situations, are ignored. That is why Buckley (1986) states that this invisibility is also a consequence of historiographic methods.

Additionally, "the few women who make it into the literature of design are accounted for within the framework of patriarchy", defined as "designers or users of feminine products", or "under the name of husband, lover, father, or brother" (Buckley, 1986, p.3). We can observe a similar situation in both cases. Maria Keil often credited her husband and his guidance as the reason why she was able to work as an artist – that is especially true for women of her generation, with the few other women artists being also married to established male artists. In the case of Cristina Reis, one can rapidly associate her with the time she spent in the studio of Daciano da Costa or the work with Sena da Silva for DEZ. We must also take into consideration that the opportunity to work within this field during such a hard period is due to Maria Keil marrying into an artistic family and Cristina Reis being born into one.

Mantas (2012) points out the existence of a double prejudice: being a woman and having dedicated herself to areas that were then considered minor, such as graphic design. That is the case for both women whose stories were told here, especially Keil. The fact that these stories are still not properly told perpetuates an array of misrepresentations, misunderstandings, and undervaluation, making it difficult for teachers and students to find sources that reveal a more complete picture of Portuguese graphic design, thus creating a vicious cycle. Students, when faced with exercises in which they must choose designers from a list, might opt for those they already know better or can find more information about. Educators play an important role in the search for not-so-well-known designers, including women designers.

7. Conclusions: The path towards inclusiveness

The history of Portuguese design focuses on those who seem to have been the most fruitful figures, had the most work opportunities during the dictatorship period, and, in parallel, suffered fewer impositions from the state. The results show that women such as Maria Keil and Cristina Reis, who had fewer rights and, consequently, less visibility in society, are granted smaller places in texts, classrooms, and, ultimately, in history. It is necessary, to achieve any meaningful change, to deconstruct the discourses of design history, making them more inclusive.

The analysis suggests that the state of graphic design history in Portugal is deeply related to the tumultuous and complex past of the country, in which the profession struggled to grow and to get established as a respected field – separated from the pressure of fine arts and from the strength of fast developing industrial design. Together with the image of women during the regime, this factor heavily plays a role in the relevance of female designers, who faced a double prejudice. However, despite these limitations, we can observe that both designers took part in different but defining moments for Portuguese design.

In the first case, Keil's work unveils the role of Modernism in a country that, at the time, was everything but modern. The fact that she was the first woman working inside an advertising studio in Portugal goes against the bias of the period, in which women could only dedicate themselves to 'feminine' activities such as embroidery, jewelry, or painting – namely still life and portraits of children or other women – leaving the more serious subjects to men. Her role in modernizing graphic design in Portugal emerges through her synthetic and stylized style – innovative in that period and place.

The second case reveals that Reis, although three decades younger, suffered equally from the oppression of the regime, which still saw women as less important citizens. However, as one of the first Portuguese citizens with a higher education in graphic design, she took part in the organization of the first two design exhibitions in Portugal and worked with major brands and institutions of the period. She is also the symbol of a design transition towards a more democratic reality, finally embracing the field of graphic design. Moreover, her experiments with topics such as sustainability and ecology in the early 1970s put her at the vanguard of design discourse in Portugal.

In conclusion, the first step towards equity in design history involves contextualizing the realities in which women lived to understand how their surroundings shaped their career paths, in opposition to their male counterparts. In the Portuguese case, the following step is to include these women in design history programs, with more than simple mentions, promoting reflections and analysis about their design processes and outcome materials. It is worth noting that the

Portuguese context must also deal with the remnants of the historical supremacy of fine arts over design and industrial design over graphic design.

Although we have come far with women's rights over time, there is still plenty of work to do, including in the field of design. Today, women are still not granted the same visibility or opportunities. Just a few years ago, the 2019 AIGA Census revealed that 61% of designers were women, but only around 29% were creative directors (Design Census 2019; Larsen, 2021). The battles we now face to tell the stories of women designers are just another symptom of a deep need for change.

The bottom line of this exploration is that a more inclusive design history can contribute to a more inclusive design practice, which in turn can produce more equity and fairness in future design histories – a positive circular dynamic. It is, therefore, crucial to change design programs to make them more inclusive from the start. Encouraging students to learn inclusively is fundamental to creating future healthier practices and promoting positive change in graphic design.

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CULTURAL DIMENSIONS IN DESIGN: RESEARCH ON THE SHIFTS OF INTERACTIVE RELATIONS

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ABSTRACT | Design, as an important creative activity in the process of human survival and development, is essentially a cultural creation activity of humanity. On the one hand, the power of culture deeply influences design, and design trend expresses and reflects the dynamic culture. On the other hand, design is also involved in the construction process of culture through multiple methods, becoming the main driving force for promoting cultural innovation. With the continuous development of people's awareness and understanding of culture, the interaction between design and culture has also changed simultaneously. The investigation of the relations between design and culture aims to fundamentally reveal the motivations, purposes, and principles of human design activities. In this paper, we discuss the changes of relation types between culture and design when they interact and interplay. According to the degree to which culture plays a central role in the design process, the scope of intervention, and the ways of participation, relation types can be divided into culture-oriented design, culturedriven design, and culture-as-tool design. The research discusses the differences among three relation types through summarizing their features and methods respectively, and highlights their influences on design practice, so as to assist designers to create more meaningful, diverse, innovative, and inclusive designs in an interconnected global context.

KEYWORDS | CULTURAL INTEGRATION, DESIGN PROCESS, DIVERSITY, SUSTAINABILITY, RELATION

1. Introduction

For decades, culture has been a crucial and essential topic of debate in various research fields. Tylor (1871), widely credited with providing the first formal definition of culture, holds culture as a "complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society". Williams (1976) states culture is one of the most complicated words that can be divided into three types of meanings: a particular way of human life, works and practices of art and intelligence, and signifying or symbolic systems. UNESCO (2001) defines culture as "the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, that encompasses, not only art and literature but lifestyles, ways of living together, value systems, traditions and beliefs".

Globalization has made culture the most important asset to work with (Lee, 2004), and various fields emphasize the significant role of culture. The characteristic of contemporary society can be described as a "society of design" (Zhou, 2013), and design, as the product of human practice, is positioned as a cultural phenomenon (Sparke, 2013). The relations between design and culture are dynamic and bidirectional, and the modifications in the former's evolution both reflect and determine the developments in the latter (Röse, 2004; Moalosi et al., 2005). Design can be seen as the integration, transformation, and manifestation of tangible and intangible codes through various encoding methods, and all design processes should proceed under a counderstanding cultural context, so that designers, users and other participants can communicate, interact and empathize with each other through design practice.

The intertwined and ambiguous relations between design and culture are the subjects of continuous investigation by numerous design scholars, and they have explored the interaction between design and culture from an interdisciplinary perspective, believing that the two constantly evolve through mutual influence and jointly shape the material and spiritual world of humanity. However, these studies emphasize more how the

design process can better apply, protect, or promote culture by practice, and there is limited research on the changing relation types between design and culture, there is not much literature available for reference. We will analyze the core role, intervention scope, and participation methods of culture in the design process based on people's continuous understanding of the mutual influence and interaction between design and culture in design practice and suggest three types of relations between design and culture: culture-oriented design, culture-driven design and culture-as-tool design. In the next three sections, we will attempt to describe their content, features, and methods respectively, and differentiate them subsequently. The contribution concludes with a summary of the previously discussed points.

2. Collisions between cultural levels and design characteristics

Cultural issues are complicated and multi-faceted, scholars attempt to develop multiple levels or layers of culture to understand its complexity and the different dimensions it encompasses. Malinowski (1944) indicates that there are three cardinal constituents of cultural reality, physical basis and equipment of artifacts as material elements, norms, customs, traditions, and rules as institutional elements, ideas and values, interests and beliefs, and magic or religion as spiritual elements. Schein (1985) offers three levels of culture containing artifacts, espoused values and shared tacit assumptions. By combining Schein's theory with ideas drawn from symbolicinterpretive perspectives, Hatch (1993) raises a model called cultural dynamics and symbols are introduced as a new element into the levels of culture, the components of this cultural model are assumptions, values, artifacts, and symbols.

In the field of design, there is also a constant stream of thinking about cultural levels, and related research has been widely approved over the years. The cultural elements we use in design have no direct correlation with spiritual contents, it is we who give meanings to these elements, for example, the meaning of color is culturally mediated (Raskin, 1999). He (1992) divides "cultural space" into three structural levels like an inverted pyramid: the external, tangible and visible "outer level"; the behavioral "middle level" including human behavior rites, and regulations in the form of words and language; and the intangible "inner level" involving the manifestation of human ideologies. Leong (2003) develops a matrix model to replace He's pyramid (1992), consisting of material/design and style, behavior, institutions and customs, philosophy or ideology in each quadrant. Summing up the theories above, Lin (2006) states culture can be classified into physical or material layer which include daily related objects and tools, social or behavioral layer which include human-related rituals and customs, and spiritual or ideal layer which include emotion reflected art and religion. The consideration of the interactive relations between design and culture begins with linking cultural levels with their corresponding design characteristics.

3. Culture-oriented design

With the increase in global trade, communication, and migration, cultural integration and injection will inevitably become an essential force for design innovation. Concerned with design competitiveness in global markets, designers should demonstrate more responsibility for their designs when considering the impact of their designs, not only by meeting the demands of customers but also by preserving cultural variety and values. Globalization creates a more interconnected and multicultural world, design first needs to face two urgent problems: on the one hand, globalization leads to cultural homogeneity by denying or ignoring cultural identity, or abstracting cultural identity into universal identity, and in the process destroys cultural diversity and heterogeneity (Moalosi et al., 2007; Yao & Lu, 2016); on the other hand, it is necessary for global design to adapt to different local cultures, designers should know how to disrupt or support the local cultural system of society (Popovic, 2002). Culture-oriented design emerges in response to the proper time and conditions when it comes to culture-related basic issues.

3. 1 Design for culture: Crafting creative solutions with cultural significance

Culture-oriented design aims not only to embed unique cultural features into the design outcomes that assist in enhancing its added value, strengthening its identity attributes, and attracting a wider range of consumers, but also to create relevant, acceptable and significant designs to provide products, services, and environments that resonate with the cultural context of the target audiences. Culture-oriented products are employed as the basis for competitive advantage or product differentiation, as they can be used to mark the boundaries between groups, and create and divide differences or commonalities between figurations of people (Farr, 1966; Featherstone, 1995). Röse and Züblke (2001) propose that culture-oriented design is a design that integrates the cultural characteristics of product users, namely internationalized products with “cultural modules” and localized products that adopt specific cultural needs. Cultural features are regarded as unique characteristics that can be incorporated into the design to enhance its identity in the global market and to improve the individual consumer experience (Heskett, 2005).

Enhancing diversity and adding extra value to design, which are necessary for the improvement of design performance and experience, are the most significant features of culture-oriented design (Hsu et al., 2011). The key issue to injecting culture into design depends on the choice of cultural elements, such as functional, aesthetic and symbolic attributes (Leong, 2003; Lee, 2004). By drawing inspiration from certain cultures, designers integrate or transit cultural elements and insights into the design process, not only enhances the aesthetic and emotional appeal of the design but

also increases its relevance and usability in specific cultural contexts, helping to enrich the variation of the design, differentiate designs in the highly homogenized global market, add unique selling points that attract a broader audience to bring about the development of new market opportunities and cultural revitalization (Shin et al., 2015).

Another crucial feature of culture-oriented design is the user-centered idea that arises from the inevitable process of acculturation (Lee, 2004). Cultural experience affects user's response to design and customer's interpretation of visual artifacts, and an acculturated design method is needed to correct and control potential biases and mistakes caused by differences in cultural contexts and perspectives (Kostelnick, 1995; Dervin, 1999). As user's preferences for product forms are much driven by non-physical cultural factors, the employment of user-centered design concepts is required to connect design to a specific socio-cultural context (Bloch, 1995; Rosenman & Gero, 1998). Culture-oriented design creates stronger bonds with users, it can not only reflect users' identity, but also provide more insights on creating new designs that are effective and efficient, play a role in the intuitive use of designs, and meet the users' needs and expectations (Razzaghi & Ramirez, 2005; Prameswari et al., 2017). To align the design with the customers' background, designers naturally seamlessly integrate relevant cultural elements into the design, ensuring that the designed product, service, or environment resonates deeply with the customers, thereby improving their overall experience and satisfaction.

3.2 Culture-oriented design methods

Culture-oriented design produces products, services or experiences, and scenes or environments that are understandable, acceptable, and resonant to users through acknowledging and incorporating cultural plurality. Many scholars and designers have proposed various methods and theories of culture-oriented design, among which the most representative and frequently used are Moalosi and Lin.

Moalosi and others (Moalosi et al., 2005; Moalosi et al., 2007; Moalosi et al., 2008) define a culture-oriented design which states culture can be integrated into product design by assessing users' needs and activities, combining technological advancements or evaluating existing designs, and the process is developed into three interrelated phases. The first phase involves identifying the sources of socio-cultural factors that contain user needs in the user domain and their categorization, which is composed of social practice factors, emotional factors, material factors and technology/design factors. The second phase is about the integration of cultural factors and design features in the designer domain in which designers can discover the attributes of designs through different social interaction modes, and socio-cultural factors thus can be transformed into characteristics of functional, meaningful, knowledge, intermediary, gender, and aesthetics features, so that design expression matches the acceptance characteristics of user culture. The last phase focuses on creating novel design ideas that

align with the needs of users and design ideas that have a distinct and recognizable product image in the product domain, embedded with narrative abstract features of product that improve the product acceptance, construct differentiated lifestyle modes, and express personal identities for users. Moalosi's culture-oriented design method provides a culturally innovative structure of design, which adds value to design, meets user's true needs, and offers meaningful experiences.

Lin (2007) proposes a framework for correspondence between cultural layers and design features, and suggests three design features that correspond to the cultural levels mentioned earlier (spiritual/ideal level, social/behavioral level, and physical/material level) respectively when cultural objects are incorporated into cultural design: the inner level of reflective design with storytelling, affection and cultural meaning; the mid level of behavioral design with function, operation, usability, safety; the outer level of visceral design with colors, pattern, form, texture, decoration, lines and other appearance elements. Lin and others (Lin, 2006; Lin, 2007; Lin et al., 2007; Hsu, 2011) assume that the culture-oriented design model consists of three sections: conceptual model, research method, and design process. The focus of conceptual model is how to extract cultural features from cultural objects, followed by transforming these features into design models to design cultural outputs. There are three phases of research method: identification phase that extracts cultural features from original cultural objects, translation phase that transfers the extracted cultural features to design information and elements, and implementation phase that eventually designs the cultural outputs. Four steps are used in design process to design the cultural outcomes by using scenario and storytelling: investigation that sets a scenario to fit the three cultural levels; interaction that tells a story to describe user's needs and the features of outcomes; development that writes a script to confirm why consumers need the outcomes and how to design the outcomes to meet their needs; implementation that design the outcomes through creating, evaluating and modifying. Lin provides designers with the specified procedures for integrating culture into design for cultureoriented design patterns.

According to the investigation of theoretical research, Moalosi and Lin's culture-oriented design methods can complement each other and be widely recognized by design scholars. The approaches that inject culture into design practice in the design field, such as cultural product design, cultural creative design and culture-inspired design, can all be classified as cultureoriented design essentially because design is regarded as their core. In general, culture-oriented design involves a process of identifying and extracting cultural characteristics, transforming them into design elements, and then applying the transformed design elements appropriately in the design, which results in promoting the richness and diversity of design categories and achieving common understanding with users to arouse users' interests of culture, as well as generate economic value.

4. Culture-driven design

With the mass production of design and the spread of mass consumption, problems such as resource waste, environmental challenges, social inequality, and cultural erosion have emerged one after another. Intentions of modernism are making the world a better place through design (Julier, 1990), contemporary designers must be aware of their social and cultural responsibilities and carry out creative, sustainable, responsible, ethical, and cross-cultural design production. Papanek (1971) observes that the large-scale design in developing countries by outsiders has never worked. Similarly, Krippendorff (2005) states design strategies that go against the ecological wisdom of a culture are likely to fail. In other words, problems such as cultural barriers, cultural insensitivity and cultural inadaptability will inevitably arise without a deep understanding of the local culture. From these perspectives, culture-oriented design that serves commercial purposes cannot achieve fundamental transformation in the lives of the cultural groups to which people belong or meet their real cultural sensitivity needs, resulting in the emergence of culture-driven design.

4.1 Design with culture: Collaborative innovation in culture-centered practice

Culture-centered practice is a fundamental aspect of culture-driven design. By understanding and respecting cultural contexts, engaging local cultural communities, and integrating multiple stakeholders to support local actors and embed cultural narratives, designers can create designs that resonate deeply with users, thereby promoting cultural protection, preservation and continuation. The role of designers has changed, their ultimate goal is defining solutions instead of product production, and they should consider new actors and stakeholders in the design system, including service providers, local organizations, institutions and associations, as well as individuals (Morelli, 2007; Sangiorgi, 2011). Designers' creative skills can be utilized to help develop an inspiring, long-lasting, repairable, and worth-repairing cultural innovation, but it must be based on local capabilities, as only solutions developed in the local environment can meet cultural appropriateness, effectively promote local cultural relations and community flourishing, and environmental impacts can be recognized and alleviated (Walker, 2018).

Cultural sensitivity should be concerned, Lee and Sayed (2008) develop three principles of culturally sensitive design that may be used to understand the cultural other and are associated with innovative culture-centered design methods. The first principle states that local characterization of the past and future requires an understanding of cultural locales within the context of history and future aspirations rather than current "exotic snapshots" (Berk, 2013). The second principle emphasizes localization of global process, which asks for understanding globalization as a local response to modernity, rather than

a local Westernization. The third principle is a reflexive gaze which involves strong involvement, sympathy, and empathy from designers in the design process. In the era of globalization, designers must be aware that a "cultural design solution of goodwill" that has not undergone comprehensive understanding, research, communication, and coordination could seem insensitive and sometimes even rude to local users (Sun, 2012).

In contemporary society, the challenge of cultural sustainability is critically connected to culturedriven design, which is considered another significant feature. Sustainable development solutions at the cultural level are the most comprehensive, by understanding the cultural context, social and cultural results with long-term cultural durability can be designed (Manzini, 1994). As Loach et al. (2017) mention, culture is described as the fourth pillar of sustainable development, situated alongside social, economic, and environmental concerns, thus requiring more strategic approaches to encourage cultural vitality and manage cultural heritage.

Sustainability requires the integration of ethical and spiritual considerations, a sense of responsibility towards culture and environment, and the fulfillment of practical requirements throughout the entire design process, and is expressed as a deeper beauty that transcends surface and style (Walker, 2014).

4.2 Culture-driven design methods

Through studying and analyzing the research of numerous design institutions and scholars, we summarize related methods of culture-driven design. The culture-driven design method takes culture-centered design as the main framework, and some steps come from communitycentered design, co-design, sustainable design, transformation design, cross-cultural design, and so on. The culture-driven design method is divided into two main parts: predesign phase and design phase.

The predesign phase is composed of the background setup stage, presupposition awareness stage, and access stage, during which preliminary design research and planning are required. The background set-up stage includes collecting secondary sources to propose basic design problems and address the challenge of cultural competence, which requires: cultural awareness that realizes the bias towards other cultures may arise based on one's own culture; cultural skills about learning and applying specific cultural expertise; cultural encounters that involve a process encourage cross-cultural interaction; cultural desire about individual's motivation for interacting with other cultures; cultural knowledge in terms of seeking and acquiring a solid learning foundation about other cultures (Berk, 2013; Garran & Rozas, 2013). The presupposition awareness stage deals with the risk of cultural imposition in culture-driven design (Berk, 2013), designers must be vigilant against cognitive biases to avoid various forms of assumptions,

stereotypes, or prejudices toward other cultures. Furthermore, creating a design team with plural cultural backgrounds can bring multiple perspectives to reduce the barriers brought by cultural imposition (Page et al., 2016). The access stage is an intermediate stage between predesign phase and design phase, its primary targets include building organizational and personal networks, and differing cultural roles and norms as well (Berk, 2013). This transition stage provides access to another culture during the design phase, helping to bridge cultural divides and foster respect for diversity, and emphasizes inclusivity by allowing users from various cultural backgrounds to engage with the design while ensuring acceptance and support within the cultural context (Dutta, 2020).

The design phase involves actual design work and consists of four parts: cultural immersion stage, reflective integration stage, co-design and implementation stage, and evaluation stage. The cultural immersion stage is the process of deeply engaging and participating in a culture different from one's own (Berk, 2013), which maintains cultural sensitivity to both relation construction with other cultures and the otherness factors. Role negotiation is demanded to establish equal, honest, and open relationships among designers, users, and other participants. Additionally, complex cultural issues need to be mediated through different perspectives, and the design process creates a neutral space (Burns et al., 2006).

The reflective integration stage involves communicating and interacting with other stakeholders about different forms of design insights and initial design ideas through reflection and integration (Berk, 2013). The brief should be defined and redefied at this stage, the UK Design Council suggests designers conduct this operation at the beginning (Burns et al., 2006), we believe that in this cross-cultural context, however, it will be better for designers to deal with after a deep understanding, communication, and experience of the local culture. Furthermore, design proposals should be localized and achieve users' sensitive goals of comprehensive system contexts (Perkins, 2008), which entail conveying insights and knowledge to other participants with varying cultural competencies and obtaining their feedback and recognition.

The co-design and implementation stage contains direct and indirect involvement. Co-design means that cross-cultural and interdisciplinary actors participate, interact, and even directly provide creativity, in other words, their roles get mixed up and play important roles together in knowledge acquisition, idea generation and concept development (Sander, 2006; Sander & Stappers, 2008), which concerns a process of empowering local people (Meroni, 2008; CostanzaChoc; 2020). Moreover, designers' awareness of cultural sensitivity is a significant factor in preventing assumptions that may cause misunderstanding, offense, or harm to certain cultural groups (Van Boeijen & Zijlstra, 2020). In terms of design implementation,

cultural sustainability should be prioritized in culture-driven design to ensure co-created, long-term, and desirable outcomes. Various overlapping elements such as tradition, contextual factors, shared beliefs, values, and meanings, and specialized knowledge valued by local communities, are incorporated into culturally significant designs that consider practical, social, personal, and economic issues, forming the "quadruple bottom line of sustainability" (Walker, 2011; 2014; 2018).

The evaluation stage includes evaluation, modification, and distribution. Given the complexity and evolving nature of culture, periodic follow-ups, revisions, and evaluations guarantee that the design evolves in harmony with local cultural shifts, maintaining its flexibility, effectiveness and long-term relevance. Continuous attention and care toward the design scheme reflects designer's responsibility, ensuring that culturally tailored solutions truly achieve sustainability. Distribution is another criterion for assessing cultural design solutions by estimating their replicability across different cultures and promoting scalability to broaden the designs' reach and impact, allowing sustainable cultural design to be effectively delivered to a wider audience (Manzini, 2015). The evaluation stage is a long-term process that always connects with predesign phase to form a cycle of design patterns.

Rooted in a profound understanding of long-term concepts and the significance of culture, a sustainable, inclusive, interdisciplinary, and cooperative culture-driven design approach has emerged. The focus of design evolves from "objects" (such as appearance and experience) toward "ways of thinking and doing" (such as thinking patterns and design systems) (Cagan & Vogel, 2012; Manzini, 2016). The core of culture-driven design is culture, offering a new solution when traditional design or technological innovation fails to manage complicated social and cultural problems. The shift from culture-oriented to culture-driven approach marks a transition from consumerist, user-centered commercial design to sustainable, culture-centered social design. Papanek (1971) advocates that responsible designers should design for human "needs" rather than "wants" or artificially created wants, culture-driven design, likewise, is precisely built on cultural expressions that come from genuine origin and resonate with the audience.

5. Culture-as-tool design

The development trends of globalization, internetization, and digitalization gradually make the world a more interconnected whole. The breakthrough development of intelligent and digital technology has accelerated the arrival of the Singularity, and the technological wave marked by artificial intelligence (AI) has brought profound changes to the role of culture. It is obvious that we are living in a transitional period that embodied cultural instability. On the one hand, these changes help to expand the global dissemination of local cultures and enhance cultural plurality. Nevertheless, on the other hand, local culture may be invaded by powerful foreign cultures,

resulting in the loss of local culture, namely cultural displacement and erosion. These cultural issues are not only related to culture itself, but also closely connected with non-cultural realities such as ideology, power, identity, and economy. Culture-as-tool design aims to maximize the social and economic benefits of cultural activities and policies in the context of digital transformation, making culture a key instrument in responding to national strategies and achieving a better future.

5.1 Design through culture: The instrumentalization wave in the AI era

The various aspects of modernization promote the diversified development of culture, but yet exacerbate the tension and conflicts between cultures. Culture-as-tool design highlights the instrumentality of culture, referring to using culture as a means or instrument for attaining goals in non-cultural areas. Culture can only be entered when members of a group reach a common understanding of it and master its equipment and content (Du Guy, 1997; SpencerOatey, 2000). Culture is more like a "toolkit" or repertoire, as Hannerz (1969) put it, from which actors choose different segments to construct their lines of action. Swedler (1986) compares modern pluralistic society to a collection of cultural "toolkits", and culture influences actions by shaping a series of habits, skills, and styles, from which people construct action strategies. Culture-as-tool design emerges as a strategic approach, which takes culture not merely as a passive expression of human creativity and identity but as an active strategy of controlling and managing cultural repertoires that can be shaped and utilized to serve a wider range of needs.

The focus of culture-as-tool design is to embed intelligent and digital technologies, especially AI technologies, to support the construction of physical and virtual cultural platforms, thereby promotingsustainableandinnovativedevelopment of culture. The *Boundless Creativity Report* (UK Government,2021)pointsoutthattheaccelerated shiftofculturalcontenttowardsdigitalpresentation modes after the pandemic has provided opportunitiestoreachnewglobalaudiencesaswell asnewhyper-localaudiences.Thisextendedreach not only brings financial benefits by promoting online cultural consumption but also expands cultural influence through taking advantage of thesenewdigitalaudiencestopromotetheirrich culturalcontentinternationallyduringperiodsof restrictedphysicalparticipation.Duetotherise of AI,cognificationbecomesthemainculturaltrendof digitaltransformation,andtheintelligentcognified environment mediates human interaction and evenparticipatesininteraction(Levin&Mamlok, 2021). Algorithms and big data as paradigmatic innovationscannotonlydrivescientificprogress, butalsoshapesocialvaluesandnorms(Lazzeretti, 2023).

Policy integration is one of the prominent features of culture-as-tool design. The focus on culture has shifted from direct use value to more instrumentalized versions of policy worth, instrumentalization regards cultural policy as the means to acquire non-

cultural results, but cultural content provides meaning for it (Hadley & Gray, 2017). *France 2030* includes concern about cultural and creative content as one of the societal objectives (French Governmental Information Department, 2024), and a call for projects aimed at developing immersive technologies for the future to ensure France's cultural sovereignty has been launched (France Ministry of Culture, 2024). In recent years, the impact of globalization has made the trend towards the instrumentalization of cultural policies increasingly apparent (Gray, 2007). The policy integration in culture-as-tool design prevents treating culture in isolation, but combines cultural initiatives with economic, social, and political agendas, ensuring collaboration with more departments, disciplines, and stakeholders to implement cultural policies (Drew et al., 2021).

Economic focus is another important feature, emphasizing the role of culture as a catalyst for economic development. This approach recognizes the enormous potential of culture in driving economic growth and development in the process of digitalization, and fully exploits the economic value of cultural products and services by promoting innovative transformation in manufacturing, information and communication, and retail industries. Culture-as-tool design encourages participation and promotion in cultural tourism design, enriching innovative content and cultural activities of cultural heritage (Sheldon, 2020), thereby attracting more consumers to achieve the dual effect of expanding cultural dissemination and creating economic value. Besides, cultural projects that combine culture with broader consumption and strategies can help create employment opportunities, generate multiplicate economic benefits, and accelerate local development. Culture-as-tool design highlights the important role of culture in promoting economic prosperity, enhancing overall social well-being, and improving national strength.

5.2 Culture-as-tool design methods

Culture-as-tool design refers to the foresight strategic use of cultural repertoires to produce practical outcomes, respond to digital transformation and social changes, and promote the achievement of specific political and economic objectives. Design approaches that involve cultural actions such as strategy design, policy design, transition design, digital, virtual and immersive design, and AI-generated design can be regarded as culture-as-tool design in this case, and we divide its process into planning phase, design phase, and delivery and evaluation phase.

The planning phase requires participation and research of various actors to lay a solid foundation for subsequent design practice. Cross-sector dialogue is the first stage that brings together all designers, users, experts, cultural-related sectors, technical sectors and other stakeholders to define design issues jointly through communication and negotiation and develop insight in this process to turn intuition and observation into visions or action plans (Bason, 2014; Van Buuren et al, 2023). New forms of alliances should be

set up at this stage, and designers should identify the position of their design and themselves within the group. The second stage is intent and vision setting, and it aims to build a shared understanding of a broader vision through the integration of cultural policies and consumption goals in digital age. Scenario construction can help intent and vision transform into a plausible hypothesis by producing structure and motivation (Meroni, 2008). This stage describes the desired outcomes from multiple perspectives of actors and provides a conceptual sketch of the whole design process, and even can serve as a framework for evaluating and designing moves (Irwin et al., 2022). Discovery and placement, the third stage, includes various forms of research exploration and investigation through gathering cultural information and resources that help the design team generate ideas, and gain insights into users, organizations, markets, relevant policies, and other sectors. Additionally, user issues should be considered related to their utilization and interaction in design, as well as manufacturer issues, concerning influences of production technology, tools, materials, and broader industry analysis on design (Carlopio, 2010). To make design meaningful, culture-as-tool design requires designers to have a wealth of knowledge and insight into the relevant content system and the workings of specific departments involved (Walker et al., 2001).

The design phase involves the practice process of culture-as-tool design. Firstly, the development stage puts the research from planning phase into real design practice. It requires the creative ideation of numerous design proposals that respond to the vision of cultural intervention. Moreover, the prototype of the design outcome, selected from previous ideations, should be produced with appropriate intelligent and digital technical support to represent and concretize the design concept. The second stage, calibration and standardization, is the key section of whole culture-as-tool design, which demands that we own and master the cultural repertoire to ensure effective understanding and engagement within a shared cultural context (Milkie, et al., 2014), thus preventing the occurrence of “cultural lag”. Technology is not a good traveler unless it is culturally calibrated (Kaplan, 2004), and this perspective also applies to design. Culture is recognized as both constraining and empowering, through calibration and localized standardization, culture can serve as a catalyst for local entry into the global market and a defensive tool for resisting foreign ideological invasion in the wave of global cultural turbulence. Hence, culture-as-tool design could ensure the unity of guidance and directions for cultural actions in the rise of generative AI and help establish a consistent and firm cultural identity externally. Lastly, implementation stage illustrates the ultimate production of design outcome. It involves cooperation among designers, end users, external experts, interest groups, and other stakeholders, leading to envisioning and approaching the desirable outcome together (Irwin et al., 2022). Culture-as-tool design supports cultural policies through the alignment of

cultural repertoires, creates multimodal and crossmodal human-AI generative, interconnective, integrative, and collaborative cultural content and application scenarios, and promotes innovative cultural production to drive consumption, thereby stimulating the flourishing of politics and the economy.

The delivery and evaluation phase involves putting the design outcomes into use and evaluating them afterward, as well as making revisions as needed. Design outcomes are delivered to a wider range of users, and the key point of this phase is that while users are using or participating, the design outcome is also iterating simultaneously. Von Hippel (2005) uses the term "democratization of innovation" to refer to the increasing tendency of users of products and services to innovate on their own, as for many users, it will be easier to obtain what they want by designing for themselves. As digital society is characterized by its dynamic nature and the ability of people to be both consumers and content creators (Levin & Mamlok, 2021), the design outcome is like an adaptive system, which is open and interactive, and able to organize or reorganize itself based on changes that occur (Meroni, 2008; Sudjic, 2024). Generally, cultureas-tool design is an automatically iterating system in this phase, as it involves the participation and interaction of many new users, whose actions will help to continuously expand the content of the design results. Nevertheless, the design team still needs to regularly evaluate the design results and intervene and adjust them as necessary to ensure that the design outcomes constantly meet the needs and preferences of cultural policies and consumption in the overall direction.

The emergence of culture-as-tool design is to serve cultural policies and cultural consumption in the digital age, in response to the turbulent social landscape brought about by technologies such as AI in the contemporary world. This design treats culture not merely as an end in itself but as a means to drive economic development, promote social cohesion, and enhance political stability. It integrates cultural initiatives with a wider policy agenda through cross-sector collaboration and interdisciplinary strategies, ensuring that cultural activities can bring tangible benefits such as creating employment opportunities, supporting local development, promoting economic growth, and fostering cultural identity. This approach balances the instrumental and intrinsic values of culture, helping people establish a common understanding of cultural vision through the interaction between the two, responds to the constantly changing needs of digital transformation, and maximizes the social impact of cultural investment and initiatives.

6. Discussion

Design is taken as a culturally specific practice

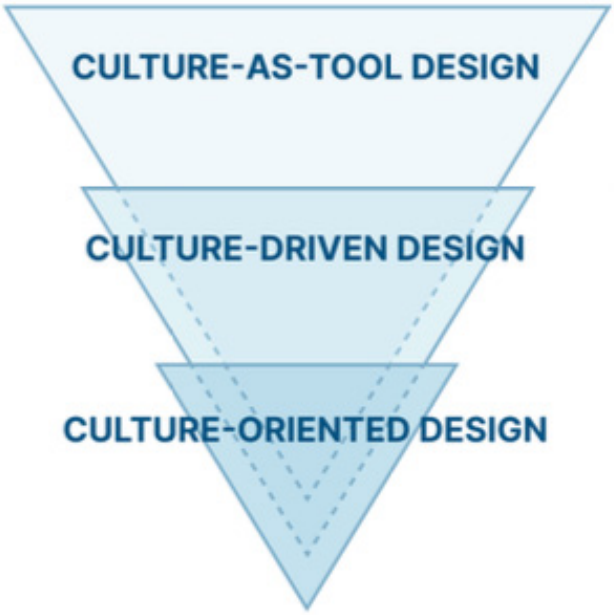
that is driven almost entirely by strategies of differentiation (Julier, 2000). According to the analysis above, the relation between design and culture can be divided into design for culture, design with culture, and design through culture, corresponding to culture-oriented design, culture-driven design, and culture-as-tool design respectively. By summarizing three relation types between design and culture, a classification with multiple parameters is provided to demonstrate their differences (Table 1). These three design approaches do not conflict with each other and sometimes appear together in design practice because there is an inclusive relation among them (Figure 1): culture-oriented design is included in culture-driven design, while the latter is included in culture-as-tool design.

Figure 1. The inclusive relation among three design approaches.

7. Conclusion and future work

Table 1. Classification of three relation types between design and culture.

	Culture-oriented design	Culture-driven design	Culture-as-tool design
Relation	Design for culture	Design with culture	Design through culture
Design participation	Translate and transform	Collaborate and empower	Integrate and manage
Role of designer	Leader	Promoter	Coordinator
Culture intervention	Added value	Resonated expression	Shared cultural repertoire
Design subjects	Designer	Designer, user, and stakeholder	Designer, public, industry expert, cultural sector, technical sector, and stakeholder
Keywords	Diversified, acculturated, and user-centered	Sustainable, collaborated, and culture-centered	Instrumentalized, co-created, and strategic
Design aim	User needs; diversity of design; commercialization	Real cultural needs; social responsibility; cultural diversity	Digital transformation; social change; social and economic good
Design theories	Product design; service design; user experience design; etc.	Participatory design; co-design; transformation design; etc.	Strategy design; policy design; transition design; AI-generated design; etc.



When exploring the types of interactive relations between design and culture that constantly change, we classify them into culture-oriented design, culture-driven design, and culture-as-tool design. We found that these three design approaches have changed people's understanding of cultural content and exploration of design practices deepened. Each approach has different backgrounds, features and aims, but all provide unique design perspectives for the diverse, innovative, and sustainable development of culture. A deep understanding of the integration of culture and design is crucial for addressing contemporary globalization challenges, as it can help designers, industry experts, and more participants create meaningful, inclusive, and transformative design outcomes in the context of cultural turbulence.

The relation between design and culture is an eternal and dynamic research topic, and with the development and changes in society, research in this field will continue to deepen and expand, attracting scholars, experts, and designers to further collaborate to explore and address the challenges and opportunities at the intersection of the two through interdisciplinary research and practice. This research mainly examines the changes in the interactive relations between design and culture through the analysis and summary of design theories related to culture, which limits the scope of the findings to a conceptual level, without extensive empirical validation through practical examples. In the future, we will explore various design practices and case studies, as well as conduct specific analyses and thorough discussions based on particular cultural contexts to further explain and supplement the research content.

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NAVIGATING CHALLENGES IN PARTICIPATORY DESIGN: EXPLORING HANDOVER TOOLS WHEN DESIGNING FOR PEOPLE WITH DEMENTIA.

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ABSTRACT | The rising number of people worldwide living with dementia necessitates designers' involvement in addressing their needs. Participatory design is a practice that advocates involving people with dementia (PwD) in the design process to ensure their voices are heard and their needs and wishes are reflected in the designed outcomes. However, challenges such as emotional strain on PwD and designers, limited time and resources, and organisational efforts hinder participation. This paper explores "handover tools" as a means to transfer dementia-related insights to designers when direct involvement of PwD is not feasible. The paper first describes and defines "handover tools". Secondly, handover tools were selected and categorised. Third, a total of 45 handover tools were discussed during one-on-one interviews with professional designers. The data gathered during these interviews were clustered resulting in five overarching needs that designers expressed for implementing handover tools in the design process. This paper reports on these five needs and situates them within different design contexts and existing literature. This research underscores the potential of handover tools in design practice, contributing to the accessibility of designing for PwD.

KEYWORDS | DEMENTIA DESIGN, HANDOVER TOOLS, EMPATHY IN DESIGN, DESIGN PROCESS, DESIGNER NEEDS

1. Introduction

More than 55 million people worldwide are living with dementia (PwD) (WHO, 2023), a neurodegenerative condition causing progressive cognitive, psychiatric and physical changes, frequently accompanied by stigmatisation and social isolation (Cerejeira et al., 2012). Given the ageing population and the absence of a cure, the number of PwD will continue to rise. Designers can be part of those who respond to this growing need. To design for people whose lived experience differs from that of the designer, active participation by individuals representing that group is required (Pullin, 2009). Recent years witnessed a shift towards participatory design, involving PwD in the design process (Novek & Wilkinson, 2022; Liddle et al. 2022). Participation leads to more inclusive products that foster expressions of personhood and social engagement, supporting a positive transition from the medicalised understanding of dementia towards a more holistic understanding of the condition (Wilkinson, 2002; Hodge et al. 2023). Participation not only leads to products that prioritise the wishes and needs of PwD but also enriches designers' understanding of how to design inclusively (Kowe et al., 2022).

Despite the benefits, participatory design poses significant challenges for grounded implementation in design practice due to the nature of dementia (Hellstrom et al., 2007; Vink et al. 2016). Emotional strain and stress can arise for both participants and designers, negatively influencing the project (e.g. designers lacking empathy and adaptability towards participants' abilities or getting emotionally overwhelmed) (Kowe et al., 2022; Suijkerbuijk et al., 2022). Although Hendriks (2019) states that it is essential for designers to fully immerse themselves in the lives of PwD to build a designer-participant connection, these connections require time and demand effort from the designer, while time and resources are often limited in design projects (Smeenk, 2019). Moreover, the organisational efforts to involve PwD in the design process (e.g. recruitment, ethical approvals, adapting design methods) can present challenges, especially for designers lacking an understanding of the reality of working with PwD (Vink et al. 2016).

While participatory design should always be prioritised, there is a need to explore alternative approaches in cases where the involvement of PwD in the design process is not feasible. This paper explores 'handover tools' to facilitate the focused transfer of an understanding of PwD as unique individuals, based on interactions with PwD, in the early exploratory stages of the design process. Through a scoping review, handover tools were selected and categorised according to Pratte et al.'s framework (2021). A total of 45 handover tools responding to the framework were discussed during twelve, one-on-one, semi-structured interviews with professional designers. The interviews acted as open spaces for exploring the ability of handover tools to transfer dementia insights and their suitability in design practice. The interview transcripts were analysed to identify common themes, resulting in five overarching needs that designers expressed for using handover tools in the design process. This paper reports on these five needs and situates them within different design contexts and existing literature. To conclude, several challenges and considerations regarding these needs are addressed.

This paper contributes to a growing understanding of the use of handover tools. By addressing the challenges of participatory design and investigating alternative approaches from the designers' perspective, the research aims to stimulate accessibility for PwD-oriented design practices.

2. Method

Designers are interviewed to grasp opinions, needs and preferences regarding the use of handover tools when the involvement of PwD in the design process is not feasible. To guide these interviews, 45 handover tools were selected through a dual approach: a literature review to refine the definition of 'handover tools' and a scoping review to select the 45 tools.

2.1 A literature review: defining handover tools

A rapid literature review was conducted into the terminology used to describe tools to transfer dementia insights and participants' experiences. The pragmatic choice for a rapid literature review was made based on its ability to produce information in a timely manner (Khangura et al. 2021). Google Scholar and snowball sampling (i.e. forward and backwards citations) were used to identify papers reporting on approaches, methods, tools and artefacts to transfer dementia insights and participants' experiences to other designers. Included sources evaluated, compared, or described an approach, method, tool or artefact to transfer information about PwD. Studies on participants other than PwD were excluded, since designing for PwD requires a specific sensitivity to be reflected in the tool (Branco et al. 2015). In total 21 papers reporting on transferring dementia insights were included in the review and three categories of tools were identified:

1. Participatory design tools facilitate the participation of PwD in the design process and enable direct contact between the

designer and PwD (Lazar et al., 2017; Brankaert et al., 2019; Foley et al. 2019). These tools are even more relevant when designing for PwD, where collaboration with those with the condition often requires additional effort due to cognitive impairments, communication restrictions, and behavioural changes.

2. Awareness tools to support dementia awareness and understanding for PwD, often by altering stigmatised and stereotyped views that live within the general population (Lee, Tsang & Hendriks, 2017; Kouprie & Sleeswijk-Visser, 2009).

3. Empathy tools evoke empathy for PwD, often by taking on the PwD's perspective and thereby experiencing aspects of dementia (Lindsay et al. 2012; Hattink et al., 2015).

However, these three categories do not correspond with the aim of this research.

1. Participatory design tools require the presence of PwD, whereas this research seeks alternatives when including PwD in the design process is not feasible.

2. Awareness tools aim at creating a public understanding for PwD, while this research looks into tools creating a 'designers' understanding of PwD.

3. Empathy tools partially correspond with this research, however, empathy tools often focus on the physical experiences of impairments rather than the broader cognitive, mental, or social consequences of conditions like dementia. This research advocates for the transfer of empathy as a broader understanding of, being aware of, and being sensitive to the feelings, thoughts, and experiences of PwD (Lee, Tsang & Hendriks, 2017; Smeenk et al., 2017). So instead of referring to the transfer of empathy as an emotional response, handover tools transfer an empathic understanding for PwD, aiming to convey an emotional understanding and informed comprehension of what PwD go through.

Based on the rapid literature review, the term 'handover tool' will be used, referring to tools transferring an empathic understanding for PwD to designers when the involvement of PwD is not feasible. 'Handover' corresponds to the process of transferring insights and experiences and originates from the 'Empathic Handover Approach' that enables experienced designers to hand over dementia insights to design team members (Smeenk et al., 2017).

2.2 A scoping review: categorising and selecting handover tools

To access the scope of available handover tools, literature and other design-related media were searched, using keywords like 'empathy tool' and 'information transfer'. These handover tools were categorised according to Pratte et al.'s descriptive framework (2021). This framework was chosen since it focuses on tools designed to create an empathic response similar to handover tools. The framework

describes tools according to the different audiences; designers, caregivers and the public, and along three dimensions;

1. First, the amount of agency the tool allows during the experience. Limiting agency can help users to feel the frustrations and challenges of PwD (Pratte et al. 2021). For example, documentaries like 'Wei. Zorgen voor pap' (Lenssen, 2019) restricts viewers' narrative agency to elicit the desired emotional effect. Similarly, the 'Into D'mentia simulation cabin' (Hattink et al., 2015) strategically limits the user's interaction agency with objects in the cabin, to simulate challenges of PwD. On the other hand, providing more agency with the tool can allow the user to gain a deeper understanding through exploration as an active participant. 'Through the D'mentia Lens' is an ecourse and VR simulation for users to engage with at their convenience (Wijma et al. 2018).

2. The second dimension is the perspective of the tool. For example, the VR experience a 'Walk Through Dementia' provides users with a first-person perspective to experience what PwD go through (Hicks et al., 2023). 'The Visit' uses a second-person perspective, inviting viewers to interact with Viv, a realistic and responsive virtual character with dementia (Papadopoulos et al., 2021). An example of a tool using the third-person perspective is 'dementiadiaries.org' (Innovations in Dementia, 2024). A blog on which PwD share real and raw accounts of life with dementia for others to read and observe (Skog et al. 2000).

3. The third dimension refers to the augmentation or limiting of mobility, perception, psyche and tangible elements (Pratte et al. 2021). An example of a handover tool to experience mobility limitations is the 'AGNES Age Suit' for wearers to experience physical sensations of an elderly person (Lavallière et al., 2017). Perceptual limitations and augmentations affect senses like hearing, vision, speech, smell, and touch. For example, the 'Alzheimer's Eye Challenge' is a mixed reality game for users to complete tasks while experiencing visual impairments (Kroma & Lachman, 2018). Physiological sensations involve biosignals such as breathing and heart rate. The Breeze Pendant measures and transmits breathing patterns for the users breathing to match, creating a shared reaction (Frey & Cauchard, 2018). Tangible handover tools influence sensations through physicality. For example, 'The Demented Objects' let users experience symptoms of dementia (Lee, Tsang & Hendriks, 2017). The 'Ok Dementia Jacket' is one of the Demented Objects leaving wearers to feel frustrated and desperate for it is impossible to close in a normal manner (Lee, 2019).

Handover tools were categorised along one or more of the three dimensions to select tools representing the framework. A total of 45 handover tools were included in the final selection for the expert interviews, detailed in the next section.

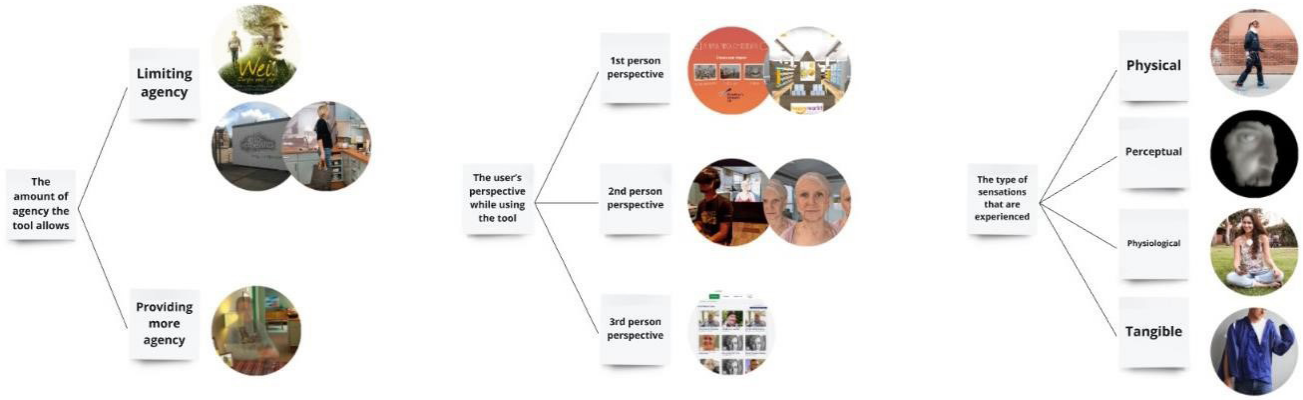

Figure 1. Referenced tools categorised according to Pratte et al.'s descriptive framework (Lenaerts, 2024)

2.3 Material Speculations: Expert interviews to reflect on handover tools

Semi-structured, one-on-one interview sessions were held with twelve professional designers to gain designers' perspectives on handover tools. Designers were recruited via the authors' network using direct communication and chain referral sampling. The interviewees included an equal mix of independent designers and those working in small design studios or large agencies, spanning industry and education, with both junior and senior profiles. Their experience with dementia ranged from extensive to limited or none.

Each session began with a three-minute introduction video, followed by a semi-structured interview. The goal was to capture the designer's expert opinion on using handover tools in design practice. A physical quadrant scheme was used to visually guide the conversation and capture the designer's output. Designers were asked to place the 45 handover tools along two axes of the quadrant while stating their perspectives on the strengths and weaknesses of each tool. The vertical axe represented the tool's potential to transfer dementia insights and experiences for designers to foster an empathic understanding for PwD. The horizontal axe indicated the tool's applicability in design practice, considering time and budget constraints, technology limitations, artistic decisions and designers' personal preferences.

The three-hour interview sessions provided time and space to explore handover tools and optimise recall from the designer's perspective. Three questions guided the interviews for designers to reflect on their practice, their views on participant involvement and tools to represent participants, and their preferences regarding the 45 handover tools. Recognising designers' struggle to articulate tacit knowledge, the first author posed open-ended questions like, "What insights do you need in your

design process?" and "What tools would support your way of working?" intended to uncover designers' attitudes and values and to elicit unexpected insights. All twelve interviews were recorded with permission and transcribed in full.



Figure 2. Designer placing a handover tool on the physical quadrant scheme (Lenaerts, 2023)

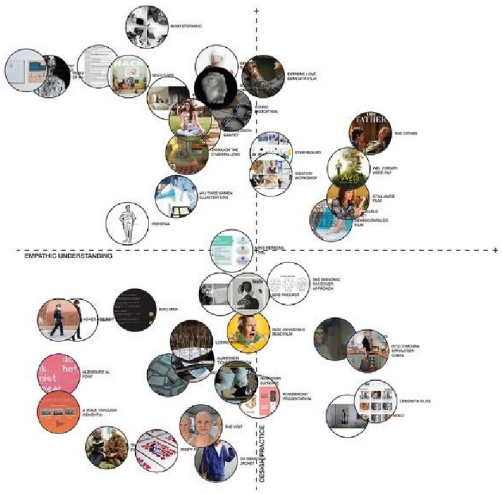

Figure 3. Final quadrant scheme of one designer (Lenaerts, 2023)

2.4 Clustering findings: Identifying designers' handover needs

The interview transcripts were analysed to gain a deeper understanding of the twelve interviews. The first author identified quotations and statements regarding the effectiveness, ease of use, satisfaction, and acceptability of handover tools. These were organised into themes using a Miroboard. Together with the co-authors of this paper (i.e. senior designer-researchers with over 10 years of experience in design involving PwD), these themes were discussed, identifying five key needs for using handover tools in design practice: (1) the need to capture the true experience of PwD, (2) the need to bridge the gap between designers and PwD, (3) the need to transfer both an emotional and cognitive understanding, (4) the need for reflection to enhance an understanding of dementia, and (5) the need to address designers' specific needs and contexts.



Figure 4. Organising themes and identifying five needs in Miro

3. Findings

The following section reports on the five identified needs and, when possible, situates them within different design contexts and existing literature.

3.1 Capturing the True Experience of PwD: Involvement and Transparency

During the interviews, designers expressed concerns about the authenticity of handover tools. For the acceptance of these tools, designers emphasised the need for them to be grounded in real and true experiences of PwD and be transparent on their origins. Designers showed a strong preference for tools that are perceived as genuine and free from bias. For instance, one designer expressed appreciation for a testimonial video on 'dementiadiaries.org' (Innovations in Dementia, 2024), noting, "You're not there, but you have the first person narrative, so you know that is not made up, you hear a real person telling a story of their life."

Although authenticity and representativeness are highly valued, the spectrum of dementia is broad. Each PwD is unique, with distinct thoughts, emotions, wishes and needs (Kitwood, 1997). Additionally, 'dementia' is an umbrella term and given the wide variety of types, each individual is affected differently. As the disease progresses, PwD may experience cognitive changes (e.g.

memory deterioration, language difficulties, disorientation in time and space), psychiatric changes (e.g. personality changes, depression, hallucinations) and physical changes (e.g. impaired movement, eyesight, hearing) (APA, 2000; Lobo et al., 2000). Moreover, each PwD exists within a unique social context. The network of formal and informal caregivers surrounding the PwD plays a crucial role in understanding the individual PwD, particularly, since the diagnosis is frequently accompanied by social isolation (Cerejeira et al., 2012).

During the interview, one designer stated, "If I've learned anything, it's that every PwD is different." Handover tools must encompass the uniqueness of PwD, which can be achieved by involving PwD in the development of these tools. For example, the use of personas is often criticised for representing stereotyped versions of PwD, so in the research by Jais et al. (2016), PwD and other stakeholders were actively involved in the development of personas to avoid such stereotypes.

However, some tools capture only single aspects of dementia. For example, the 'Alzheimer's Eye Challenge' risks stereotyping PwD as universally experiencing visual challenges (Kroma & Lachman, 2018; Hodge et al., 2023). Additionally, literature refers to the risk of giving minimal utterances too much importance (Lindsay et al. 2012; Hendriks et al., 2014). During the interviews, one designer shared the story of her grandfather who stole objects when residing in a care home. She stated, "You can assign meaning to these stolen objects, but it is dangerous as a designer to attach too much importance to them." Presenting a single aspect of the disease must be properly framed to avoid narrowing designers' perspectives on PwD.

Designers expressed an overall need for transparency regarding the origins of handover tools. For example, the VR experience 'The Visit' is accompanied by a website and academic paper detailing how the main character, Viv, was developed from verbatim interviews with five women with dementia (Papadopoulos et al. 2021). Such transparency on the tool's origins and development often increases designers' trust in the handover tool.

3.2 Bridging the Gap Between Designers and PwD: The Handover Facilitator

For Handover tools to authentically represent the experiences of real PwD, someone has to engage directly with PwD gathering insights into their complex and multifaceted experiences. In 'the Empathic Handover approach', a designated member of the design team 'harvests' dementia-related insights through personal interactions with PwD to afterwards 'hand over' these insights to the other members of the design team (Smeenk et al., 2017). One designer was experienced with 'the Empathic Handover approach' and valued having "an expert there" during the handover activities.

Designers often face challenges fully understanding the handover process and grasping dementia-related insights. In a study

by Hodge et al. (2023), designers working with 'dementiainspiration packs' sometimes struggled to understand the material. In these cases, they could seek assistance from experienced facilitators.

Thus, a second need for effective handover tools is the involvement of a facilitator who engages directly with PwD, translates these insights into handover tools, provides guidance when designers encounter difficulties during the handover process, and represents PwD throughout the design process. The role of the 'handover facilitator' is crucial in bridging the gap between designers and PwD and facilitating the handover process.

3.3 The empathising process: an emotional and cognitive understanding

The notion of empathy in design has been extensively examined and recognised as a way for designers to internalise participant requirements (Sustar & Mattelmäki, 2017; Koskinen et al., 2003; Lindsay et al., 2012). During the interviews, designers expressed a clear need for handover tools to transfer an empathic understanding for PwD, encompassing both an emotional response towards PwD and an informed comprehension of dementia. To address this need, it is essential to explore the principles of empathy that can be integrated into handover tools.

Empathy in design encompasses two facets; affective and cognitive empathy (Hattink et al., 2015). Affective empathy involves the ability to emotionally resonate with another's feelings, often facilitated by identifying perceived similarities between the designer and the PwD, such as gender, race, or personal experiences (Hunt, 2019). The 'Through the D'mentia Lens' VR simulation enhances affective empathy by aligning the user's gender to that of the virtual character with dementia. Another example is 'the ideation workshop', where designers recall their personal experiences to compare them with those of PwD, to deepen their understanding of PwD's experiences (Sleeswijk Visser & Kouprie, 2008).

Cognitive empathy, on the other hand, involves understanding another's perspective and emotional state by imagining oneself in their situation. For example, when trying to close the 'Ok Dementia Jacket', users can experience the frustration and desperation of being unable to close it normally, simulating PwD's struggles when performing simple daily tasks (Lee, 2019). According to Plumm and Terrance (2009), affective empathy can facilitate cognitive empathy, when individuals share similarities with PwD, they are more likely to imagine themselves in their circumstances. Therefore, handover tools should integrate cognitive and affective aspects to convey an empathic understanding of PwD.

Furthermore, empathy is not a state but a dynamic, evolving process (Sleeswijk Visser & Koupri, 2008). Designers expressed the need for a general understanding of dementia before using certain handover tools. For example, the film 'The Father' (Zeller, 2020)

was referred to as hard to follow and fully grasp without prior knowledge of dementia. This need aligns with the four phases of empathy of Kouprie and Sleeswijk-Visser (2009): discovery, immersion, connection, and detachment. Going through these four phases builds an empathic understanding for PwD. A designer envisioned that "at different points in the design process, different handover tools will help you." In the 'ideation workshop', designers go through these four phases, using specific handover tools in each phase and building upon the previous one (Visser & Kouprie, 2008). Moreover, literature states that a person's empathic abilities can grow and develop (Sleeswijk Visser & Koupri, 2008; Sustar & Mattelmäki, 2017). Thus, handover tools should facilitate an 'empathising process', progressively building the designers' empathic understanding of dementia.

3.4 Enhancing Dementia Understanding through Reflection

Reflection is a critical component of the design process (Carlson & Dobson, 2020; Turner, 2021). Designers expressed the need to organise thoughts, gain an individual understanding of dementia, and develop a shared understanding of dementia within the design team.

When utilising handover tools, designers must navigate layers of information, from objective data to subjective insights. Individual research and reflection provide insight into dementia. However, group interactions bring unique benefits, enabling the processing of complex information collaboratively (Turner, 2021). During the interviews, one designer expressed the value of both individual and shared moments of reflection, "I do see benefits in executing parts of the design process in group, but at certain moments, I think researching things on your own still has a lot of value."

Engaging in reflection and discussion, whether individually or within a group, helps designers critically assess and synthesise information (Carlson & Dobson, 2020). This need for reflection is also highlighted in empathic design, where guided discussions enhance the understanding of participants' experiences (Alzayed et al., 2021). For example, when using 'the Demented Objects,' some take on the role of the PwD while others respond to the PwD's behaviour. Afterwards, a guided discussion between those performing and those observing allows for a deeper analysis of the experiences, fostering a more empathic understanding of dementia (Lee, Tsang & Hendriks, 2017).

3.5 Tools for designers: Specific Needs and contexts

One designer identified two phases when designing for PwD, "one in which you get an understanding of dementia and one in which you gain insights as a designer".

The interviews revealed that 'design-specific insights' can be gained through a wide variety of information capturing unique and true aspects of dementia, for example photographs,

drawings, handwriting, recordings, quotes, personal objects, and artefacts made by PwD. These thick descriptions are perceived as informational and inspirational for designers to gain insights into PwD's preferences, abilities, way of interacting, movement and intonation. A designer noted after viewing a short video on 'dementiadiaries.org', "I also see the chair the man is sitting on, tiles and lighting. Those things are super important for me to know."

The interviews and literature indicates that designers prefer highly visual tools (Lee, 2008; McGinley & Dong, 2011). In the research of Jais et al. (2016), more visual methods of presenting personas were explored. One designer stated a preference for highly visual tools, since they often use minimal text, stating, "I don't want to read."

Designers also expressed a preference for tangible handover tools. One designer described tangible tools as providing "a physical connection, even if you haven't been in contact." Additionally, tangibility can enhance memory by linking information to physical objects (Hornecker & Buur, 2019). For example, Foley et al. (2020) developed 'Life Story Boxes' including physical objects representing different aspects of PwD's lives. One designer emphasised the value of exploration and attention regarding tangible tools, noting that picking up a physical cone representing bowling, provides a different level of engagement, compared to reading the word 'bowling'.

Furthermore, handover tools must align with the design project and its desired outcomes to be effective and relevant. Most handover tools will be used in the early, exploratory stages of the design process where efficiency is crucial. One designer mentioned his preference for easy-toaccess, online tools, like dementia blogs (e.g. dementiadiaries.org), since "a designer's job is 90% behind a computer." In comparison, the 'Empathic Handover approach' (Smeenk et al., 2017) was seen as time-consuming and challenging to organise. Designers were also hesitant towards VR tools (e.g. The Visit, a Walk Through Dementia and Through the D'mentia Lens), describing them as "cumbersome" and "distracting" due to the equipment itself getting in the way of the experience.

Additionally, the diversity of design projects shows the need for handover tools to be adaptable, providing designers agency to freely use and reshape them as needed (Hodge et al., 2023). One designer stated, "Suppose I have to design a cup holder, then I'll watch the parts of a documentary when PwD are eating or preparing food".

Moreover, diverse design contexts necessitate flexible handover tools. In educational settings, for example, tools should accommodate designers' emotional needs, as student designers are more prone to become emotionally overwhelmed (Baldner & McGinley, 2014; Guillemin & Gillam, 2015). In professional contexts, projects are often constrained by time and resources, requiring intuitive and easy-to-use tools (Lee, 2008;

McGinley & Dong, 2011). Tools like 'personas' have the advantage of being commonly accepted in design practice (Jais et al., 2016). In contrast, designers were hesitant to use the Empathic Handover Approach (Smeenk et al. 2017), since roleplay was perceived as unprofessional.

Moreover, handover tools corresponding to a design studio's or agency's identity are more likely to be implemented. Aesthetic and interesting-looking handover tools can motivate initial use. As one designer noted, "If it were just a dry text about the person [PwD], we [design studio] would be much less inclined to engage with it than something designed in a cool way." This preference was echoed by others, mentioning the importance of aesthetic tools during meetings with clients and other stakeholders, reflecting the designer.

4. Discussion

Challenges and considerations concerning the five needs will be discussed and situated within existing literature. A sixth consideration was added concerning the lack of direct engagement with PwD.

4.1 Challenges considering the True Experience of PwD

Basing handover tools on true experiences of PwD can cause challenges in grasping a PwD's true experiences and selecting which insights to hand over.

First, the interaction itself can be 'untrue'. A designer noted, "PwD can overperform because they feel observed and want to show that they're doing great." Additionally, due to dementia, PwD can bend the truth, overestimate their capacities or deny having difficulties (Hendriks et al., 2014). As well as caregivers having a hard time accepting the diagnosis and over- or underestimating the PwD (Hendriks et al., 2014). On the other hand, due to the progression of dementia, preferences and abilities of PwD can change, highlighting the importance of taking many perspectives into account. For example, one designer shared an experience where family members of the PwD stated he never spoke about the war, however, when interacting with the designer he kept referring to the war.

Another designer referred to "aspects you don't want to talk about like the undesirable sexual behaviour", further raising the question of which insights have to be transferred.

4.2 Facilitating the Handover: Multiple Facilitators and Skill Requirements

Some designers expressed that they would take on the role of handover facilitator, considering their commitment to the project, willingness to interact with participants, personal experience or interest. A designer will interact with PwD from a design perspective. This knowledge and understanding of the design process is seen by designers as beneficial and "makes it possible to take more concrete steps more

quickly". One designer expressed her trust in handover tools made by colleagues, "If a colleague has created a persona, I can use that. I don't necessarily have to do it myself". Additionally, Littlechild et al. (2015) indicate that designers view data collected by other designers not as superior or inferior but as 'merely different' from their own data. In practice, designers often divide the work, as a designer mentioned, "sometimes only one person [of the design team] goes [to the participants] and then we follow the [design] process with his experiences". Choosing a handover facilitator from the design team can be beneficial in comparison to someone external, because of their understanding of the team structure and atmosphere to tailor tools to the context and way of working (Zingoni, 2019). However, very few designers who are working in the high stress design field have the time or inclination to take on this role (Kowe et al., 2022). Can the participation with PwD be executed by others, unburdening the designer?

First, PwD can choose to share and capture their experiences through handover tools, for example the dementia blog 'dementiadiaries.org' (Skog et al. 2000; Innovations in Dementia, 2024). Second, in design practice, often the client takes on a similar role. A designer stated, "It is the responsibility of the client to qualitatively explain something." Another designer mentioned that in their social design studio, they make use of personas provided by clients, for example "hospitals have a fixed set of personas". She also commented how she finds it useful to create handover tools together with the client, "because they often have the knowledge and can provide those background stories." A third group to consider are formal and informal caregivers. Caregivers often spend the most time with PwD, especially when involved in the primary care of the PwD. A designer-educator explained how her students only involve caregivers in the design process, since the lack of ethical approval to work with PwD. Lastly, more research regarding dementia is being conducted by other experts (e.g. psychologists, sociologists, anthropologists) (Lee, 2007). Dementia experts often have years of experience on the topic of dementia, which can provide designers with valuable insights during the design process (Hodge et al. 2023).

However, designers agreed that the handover facilitator needs certain skills to successfully support the design process. PwD, caregivers and other experts often lack a design perspective. A designer noted, "Somebody working in healthcare has a completely different perspective. They often don't understand what we do or how we work."

4.3 Aspects of the Empathising Process: Time and Personal Ability

During the empathising process, time is needed to reflect and internalise an empathic understanding. For example, Sleeswijk Visser & Kouprie (2008) highlight how sufficient time is a key element of the 'ideation workshop'.

Another aspect to consider regarding the empathising process is a designer's ability

to empathise. Literature refers to designers' intuitive ability to identify others' thoughts, feelings, motivations, emotions, values, priorities, preferences, and inner conflicts (Fulton Suri, 2003). As one designer stated, "Agencies just end up in a completely new context each time they enter a competition, so they're used to that". Another designer, highlighted an empathic increase due to years of experience as a designer, stating, "If you're a designer for a few years, you can empathise enough with what that [dementia] is going to be like."

Literature agrees that a person's empathy level is hard to measure, however, it is proven that an empathic understanding can grow and further develop, requiring the ability and willingness of the designer (Battarbee et al., 2003; Alzayed et al.; 2021). Handover tools have to take into account differing empathic levels of designers and the time needed to grow empathy levels.

4.4 Factors Influencing Reflection

The handover facilitator can support designers through dialogue and discussion, fostering designers to actively question and reflect on themselves and the design project in relation to PwD. This aligns with the concept of social constructivism, which posits that design emerges through conversation and interaction (Bucciarelli, 1994; Fleming, 1996; Luck & McDonnell, 2006). For example, 'the ideation workshop' emphasizes reflecting on the insights and experiences gathered through the handover tool, rather than simply receiving processed data (Sleeswijk-visser & Kouprie, 2008). One designer shared this perspective stating, "Engaging in the research and putting together a persona yourself, will do more than just receiving a persona."

Moreover, handover tools often necessitate a debriefing moment to ask for questions and clarification from the facilitator and to contextualise experiences (Sustar & Mattelmäki, 2017). A designer expressed how a debriefing session after the 'Through the D'mentia Lens VR experience' (Wijma et al. 2018) positively contributed to her understanding of dementia.

Multiple factors can influence the designer's reflective process, for example, the lack of time or a safe space for reflection. Additionally, trust is needed from the design team towards the handover facilitator. One designer stated, "To make a tool work, a necessary condition is to create an environment where your team or designer has that trust, which the handover facilitator transfers." However, this trust is hard to guarantee and depends largely on designers personalities, team atmosphere, and group dynamic.

4.5 Designing for Diversity: Designer Needs and Contexts

Designers should not be considered as a homogeneous group. Designers have different ways of working. For example, one designer "would just find it super interesting to see a ton of examples of what has already been

made", yet another designer preferred not to see other examples "to not get influenced by other designs and stay original".

Furthermore, each designer has personal preferences regarding tools that often outweigh other criteria. One designer stated on the 'Ok Dementia jacket' (Lee, 2019) "I think it has the potential to provide a lot of insight, but I myself would never use it." Especially experienced designers expressed clear personal preferences towards certain handover tools, corresponding to their way of working. A designer shared her preference for the Bob podcast on dementia (Audiocollectief Schik, 2017), "I just like to listen to podcasts and I find it a very good way to take in stories."

Moreover, designers come from diverse cultural backgrounds, which can result in varying values and perspectives on dementia, as well as differences in work settings and access to technologies (Peter et al., 2020). While one approach is to make handover tools more abstract and adaptable to be applicable in different cultures and settings, Peter et al. (2020) suggest tools to be more "consciously culturally tailored" requiring stakeholder involvement in their creation and customisation.

4.6 Facing actual reality: motivating for Direct Engagement

During the interviews, experienced designers acknowledged the necessity of tools to transfer dementia insights when the involvement of PwD in the design process is not feasible. However, they consistently emphasised the importance of direct engagement with PwD, providing designers with unique insights that are difficult to capture through other means. As one designer noted, "The things I learned while talking to PwD and observing them isn't something you can correctly grasp with only a handover tool." This sentiment was echoed by another designer, stating, "You see more, you can look around, you can touch, that works better than seeing someone else's perspective." Additionally, literature confirms that designers prefer to gather their own data (McGinley & Dong, 2011).

However, designers with limited to no experience with PwD revealed that handover tools sparked their interest in designing for PwD. They viewed handover tools as valuable for introducing and preparing designers to interact with PwD.

Conclusion

This paper explored the critical role of handover tools in bridging the gap between designers and PwD when direct engagement is not feasible. Handover tools carry out the process of transferring dementia-related insights and experiences to designers, fostering an empathic understanding for PwD. Through interview sessions with professional designers, this study has identified five overarching needs for effective handover tools: (1) the need for participant involvement and tool transparency to capture the true experience of PwD, (2) the need for a handover facilitator with dementia expertise to bridge the gap between designers and PwD, (3) the need to transfer both an emotional and cognitive understanding through an empathising process, (4) the need for individual and group reflection to enhance an understanding of dementia, and (5) the need to address designers' specific needs and contexts.

While emphasising the importance of aligning handover tools with these five needs, the paper also addresses several challenges considering their development and implementation. The complexity of dementia and the diversity of design contexts show the need for further research into the adaptability of handover tools since there is no one-size-fits-all solution.

This paper highlights the value of handover tools as actionable formats for capturing and conveying dementia insights and experiences. By defining the needs for their development and addressing the challenges of their implementation from the designers' perspective, it aims to contribute to a growing understanding of the use of handover tools in design practice, thereby contributing to the accessibility of designing for PwD.

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TIME FOR (S)HEROES TO ENHANCE CIRCULAR FASHION AND COSTUME, ART INSTALLATIONS, DEVISING FOR DESIGN, STATE-OF-THE-ART TECHNOLOGY, INCLUSION AND DIVERSITY

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ABSTRACT | Time for (s)heroes is a capacity-building project for young fashion and costume designers and artists together with local youngsters engaged through drama activities, impacting sustainability, green shift, inclusion, and diversity. This paper addresses the cross-fertilization of theatre theories, drama pedagogies, and the design world via a pedagogical and operational model producing art installations and digital and tangible fashion and costume for (S)hero characterization. It applies reflective drama methods to engage local young people to voice what they think about being role models for inclusion, diversity, sustainability, and the green transition.

The interconnectedness of fashion and costume design with art installations is explored in the digital and tangible representations of (S)heroes. The study is relevant to art and design forms with characters, such as performing arts, theatre, metaverse with avatars, and digital games. Impact is pursued on both designers in sustainable material usage, reduction of left-over materials and circular approach, as well as manufacturers together with policymakers in reference to processes.

KEYWORDS | DIGITAL DESIGN, FASHION AND COSTUME, ART INSTALLATIONS, THEATRE, INTERDISCIPLINARITY

1. Introduction

Please Time for (S)heroes is an international research, design, and innovation (RDI) collaboration between a consortium of six organizations from five countries Finland, Estonia, Latvia, Germany, and Spain funded by the European Union Creative Europe with a duration of 48 months and a total budget of 1,425M€. Time for (S)heroes addresses sustainability, co-design, and lifelong learning in state-of-the-art technology for digital and material fashion and costume design and art installation with digital elements. Capacity building is also provided in terms of business mindset and entrepreneurial skills.

Time for (S)heroes is based on locally devised but globally relevant (S)hero stories by reinterpreting hero narratives critically in the framework of sustainable design, inclusion, and diversity. The focus is on every day, sometimes mundane realities; ethical leadership for gradual social change and the values, commitment, strength, and transformation it requires.

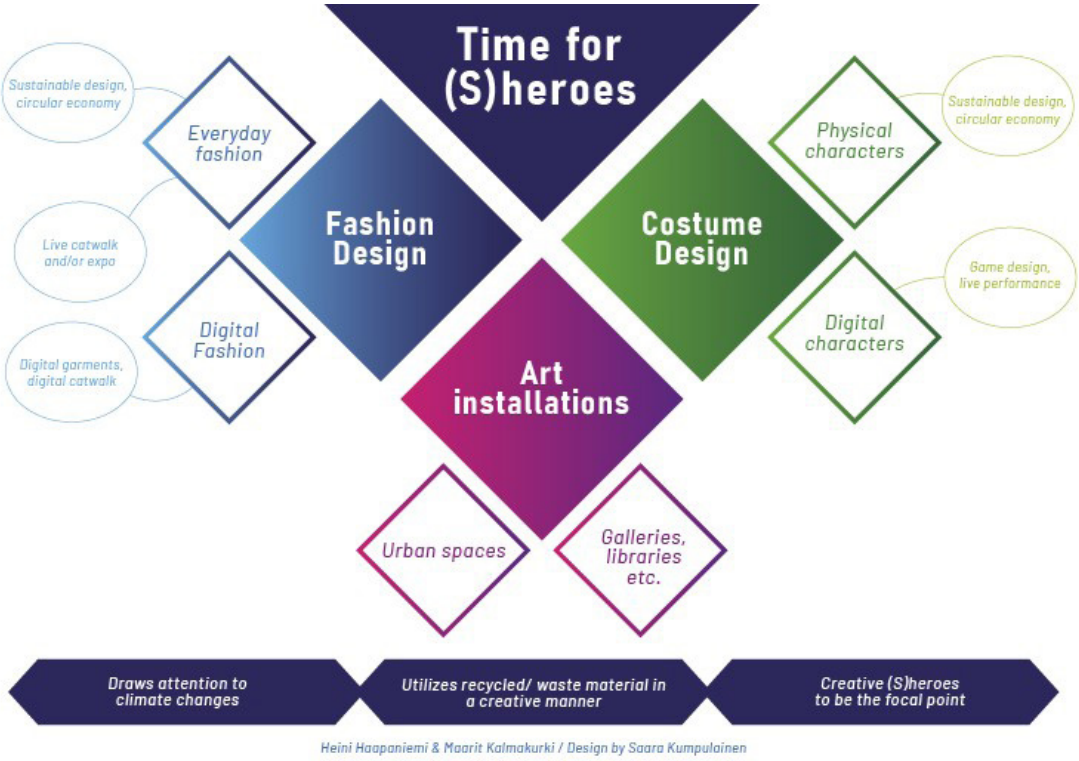


Figure 1. Interconnectedness of character-related art and design forms by Haapaniemi and Kalmakurki, visualisation by graphic designer Kumpulainen

The first phase of the (S)hero rethought is conducted via devising and drama methods in local schools. The gathered narratives are about to inspire and inform the iterative design processes. Engaging youngsters in critical discourse is fueled via drama methods: the spotlight is given to collectively formulating positive future scenarios and alleviating climate change anxiety by co-creating fictive characters called (S)heroes. Through integrity and everyday action, young people are empowered to become every day (S)heroes within their social group. Engagement and dialogue between young people and designers empower them both by focusing on sustainable and ethical design, everyday choices, and validating values and identity through action.

A collective mindscape is created by offering impactful co-design experiences in four categories via design briefs:

1. CIRCULAR ECONOMY—DESIGNS AND ART INSTALLATIONS:

   Reusing materials, converting discarded items into products, and giving them a new life.

2. (S)HERO REVISITED:

   The local patriarchal hero myth is reimagined and turned into artworks and design products, inviting deconstruction, investigation, and awareness of the antiquated process of creating legends and heroes.

3. FASHION AND COSTUME - THE REIMAGINED (S)HERO:

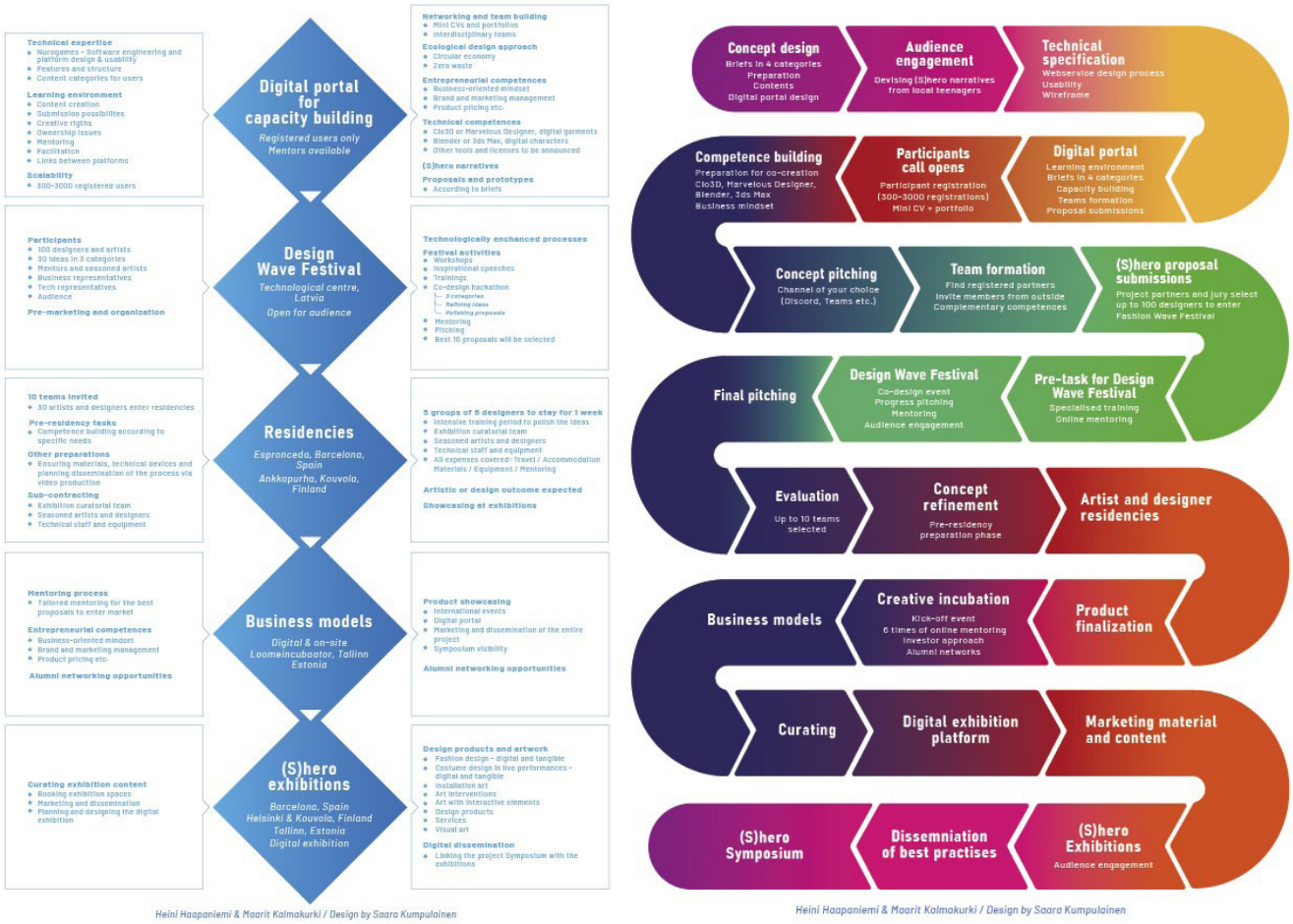
   Directing attention to fashion and costume, allowing digital and physical artifacts and characters to be created.

4. HERO ARCHETYPE TRANSFORMED:

   Reconstructing the new (S)hero and deploying it in digital and tangible forms in the performing arts.

The nature of design inquiry is experiential and iterative and benefits from relative creative freedom. Yet, it will be constrained and predisposed to the selected genre, form, purpose, modality, and material dedicated to the product (Ledin, Machin, 2020).

The visualisations below demonstrate the steps of the design process. The diamond visualisation illustrates from top to bottom the five main phases and demonstrate what is the required input on the left to the expected outcomes on the right. The ribbon visualisation gives each step equal emphasis and celebrates diversity in color and form.



Figures 2. and 3. Design of the timeline in two different formats by Haapaniemi and Kalmakurki with visualisations by graphic designer Kumpulainen.

Fashion and costume designers are regarded as the (S)heroes of the day for leading the green shift, advancing sustainability, reducing material waste, and spreading best practices for circular, sustainable design. Aligned with lifelong learning, competences are built in various capacity-building modules, from state-of-the-art technology to circular design and entrepreneurial skills. Digital tools mentorships are provided to co-design holograms, characters in physical space, installation art with digital elements, animations, soundscapes, visuals, and interactive content in visceral design ethos to elicit wanted emotions from audiences (Kamil, Abidin, 2013).

Broader social participation is facilitated through exhibitions in urban spaces, galleries, libraries, theatres, and performing arts centers to advance both a sense of belonging and mediate versatile identities in a digital era (Moujan, 2020).

2. Pedagogical and operational model to advance knowledge transfer between four co-design inquiries

University pedagogy functions traditionally at the limits of disciplines. Yet, interdisciplinary crossfertilization offers an opportunity for knowledge construction, knowledge transfer, and activities that are beneficial both for learning and future working life (Tavin, Tervo, Löytönen, 2018). Each new initiative requires that the prevalent understanding of especially art and design is problematized and transformed by other disciplines to enable completely new areas of inquiry and practice to emerge in between the disciplines, also referred to as radical creativity (Tavin, Tervo, Löytönen, 2018; Björklund et al., 2022).

The transdisciplinary pedagogical and operational model with "parallel inquiry cycles" and "performative inquiry for character-related design," acknowledges that drama inquiry can inform design processes (Haapaniemi, Leinonen, 2023). The model connects state-of-the-technology, participatory design and ethnography with practice-based, art-based, and performative inquiry fostering shared reflection, creativity and co-design for artists, designers, engineers, and youngsters to enhance collaborative learning, sustainability, and inclusion (Haapaniemi, Leinonen, 2023; Wagner et al. 2021; Leavy 2020; Travis 2020; Fels 2015; Blomberg, Karasti 2012; Fels, Belliveau 2008). The model is applied and adjusted to meet the needs of the four design briefs in time for (S)heroes.

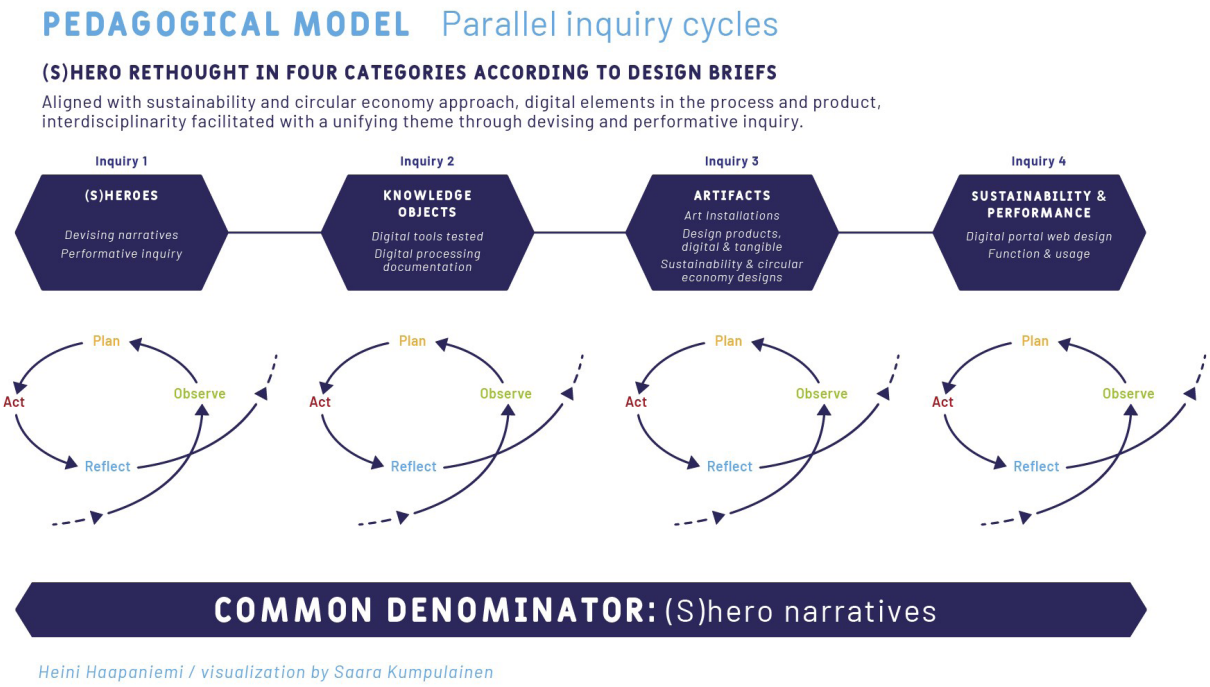


Figure 4. Time for (S)heroes pedagogical and operational model with parallel co-design inquiries by Haapaniemi, graphic design and visualisation by graphic designer Kumpulainen.

The pattern of Observe–Plan–Act–Reflect is an iterative cycle format in the model (Heron, Reason, 2002; Khaner, Linds, 2015; Haapaniemi, Leinonen, 2023). The more time and competency are invested in the iterative cycle format, the more detailed and refined the product and outcome are. Lingering in shared reflection has a crucial role as it enables informed decision-making (Schön, 2017; Dalsgaard, Halskov, 2012). Knowledge transfer between the four inquiries in the model can become successful only with the reciprocity of sharing based on trust that leads to action (Ståhle, 2004). In the parallel co-design inquiries, various optional solutions are reflected, assessed, negotiated, and tested, which equips the participants to solve unanticipated, interdisciplinary design challenges also in the future and feed information to the other parallel inquiries when shared reflection between the four inquiries takes place (Marton, Trigwell, 2000; Tyler 2021; Muukkonen, Kajamaa, 2024).

The model distinguishes two types of knowledge vessels, namely knowledge objects, which are abstractions that condense knowledge, and knowledge artifacts, which are concrete art and design items in both digital and tangible formats (Bereiter, Scardamalia, 2003; Merrill, 2000; Niedderer, 2013; Schatzki, Knorr-Cetina, Von Savigny, 2001; Khazraee, Gasson, 2015; Cetina, 2016). Advancing and articulating knowledge objects is facilitated by the co-designing community's collective efforts and resources (Schatzki, Knorr-Cetina, Savigny 2001; Bereiter, 2002; Bereiter, Scardamalia, 2003; Hakkarainen, Palonen, Paavola, Lehtinen, 2004). Knowledge objects evolve over time, are constantly in progress, incomplete, and in their nature open-ended (Knorr-Cetina, 2001; Cetina, 2016). Since knowledge objects are always in the process of being materially defined, they "continually acquire new properties and change the ones they have" thus generating questions (Knorr-Cetina, 2001, 181). They can be used at any stage to analyze the current stage of the progress of an inquiry (Merrill, 2000). Similarly, from a narrative point of view in negotiating shared meaning and value within the codesign process, an epistemic object embeds a story that enlists the support of others within the same inquiry and results in some form of collaborative understanding through either accepting or disputing the shared narrative (Khazraee, Gasson, 2015, 140; Haapaniemi, Leinonen, 2023).

Transformative (S)heroes with ecological touch equip the digital and tangible knowledge objects with associations, meanings, and cultural codes. Knowledge objects include a variety of digital contents and abstractions: the design drivers for each design brief realization, concept maps, (S) hero character personality trait lists, early prototypes, modifications and reports, visual learning diaries, and sketches done individually and produced as more time and competency is allocated to the iterative co-design process. Design artifacts refer to both digital and tangible costumes and fashion; recycled objects and material given new functions and meanings as part of the art installations with integrated thematic elements.

3. Knowledge construction through art and design

Depending on the purpose for which knowledge is produced, whether it is systemic knowledge enhancing understanding; target knowledge providing sustainable direction; or transformation knowledge, the methodology for research may be different (Hadorn, 2008). Vision is important for the (S)hero and transformation knowledge guides visions (Ibid.). Bruner distinguishes two different ways of knowing: paradigmatic and narrative knowing; the former refers to scientific, logical, and tested knowledge, while the latter aims at meaning-making and understanding others and one's own stories (Bruner, 2017). Narrative analysis of the hero trope refers to a qualitative method used to understand what kinds of stories are told including various media and modalities such as drama, texts, media texts, images, or environments, which are understood as narratives or narrative-like structures (Bruner, 2017; Flick, 2013). In the pedagogical model, the narratives are the very source that are examined through performative inquiry, process drama, devising and four parallel research design inquiries.

Art-Based Research (ABR) is "rich, complex, often unpredictable, and mostly unspeakable, leading researchers to areas of knowledge that have not yet been classified and restricted by words and logic (Kallio-Tavin et al., 2017, 103). Additionally, in design, procedural knowledge is largely experiential and tacit and is not usually made explicit. Thus, while creative practice may well be linked to the generation of new knowledge, art, design, and research appear to have "a number of opposing tendencies concerning the format and communication of this knowledge, which must be resolved in order to conduct satisfactory creative research" (Niedderer, 2013, 3). Kallio-Tavin et al. (2017) claim there prevails a challenge of articulating and analyzing the element of aesthetics representation in art with the notion "artistic, visual, multisensorial, and practice- based knowledge are difficult to articulate, especially in terms of what sort of knowledge they formulate or introduce to research" (Kallio-Tavin et al., 2017, 103).

Research in art and design problematizes the practices of art, design, and research, their relationships, and their respective processes and products (Niedderer, 2013). According to Niedderer this problem is three-fold: ontological, considering which questions could or should be asked in art and design research that are appropriate and worthwhile; epistemological, considering which perspectives or approaches could or should be incorporated into the inquiry; and methodological in considering how any inquiry could or should be undertaken from the point of pragmatic conduct (Biggs 2002, 2004; Niedderer 2009; 2013).

4. Amplified existence, the meaningful—meaningless spectrum of art, and liminality as a fruitful transitory place

Youth participating in art and design practices for rethinking the (S)hero are offered an amplified existence. According to Gilbert, art, design, and creativity refer to broader awareness, awakening for openings, and living a life driven more strongly by curiosity than fear (Gilbert, 2016, 9). When starting the adventure, the critical voice that tells participating is self-indulgent or preposterous needs to be ignored (Gilbert, 2016, 11). Embracing freedom in foolery replaces the feelings of extreme selfconsciousness, the need to control and know where the process leads, to enjoy shared self-discovery and awareness of the ways of inquiry and meaning-making for reciprocity, dialogue, and amplified existence (Gilbert, 2016, 11-12). Collaborative creativity is connected to the embodied body-mind-soul connection, which cannot be accessed in any other manner (Snowber, 2012; 2022).

The central paradox of any art form denotes it is meaningless. However, art is also deeply meaningful for individuals, communities, and ecosystems as artists possess the capacity to participate in the meaning structure formation (Gilbert, 2016, 134.). The paradox invites one to be comfortably inhabited with a balance of one's own creative expression being the most important in the whole world and simultaneously, it must not matter at all or might be ridiculous, e.g., sometimes a leap from one end of the paradoxical spectrum to the other extreme in a matter of minutes is a lifeline for artists, designers, and creatives (Ibid.).

Intellectual curiosity combined with artistic endeavor may lead to liminal, transitory learning and processes that are simultaneously fruitful and chaotic. Liminal space refers to a transformative state in which there is a reformulation of the participants' meaning frame and an accompanying shift in ontology or subjectivity (Land, Rattray, & Vivian, 2014). The liminal state can also refer to the inbetweenness of disciplines, modalities, and art forms. Liminality functions invite the participant to encounter something new, consisting of integrating the acquired knowledge and experience into the already existing knowledge schemas (Land, Rattray, Vivian, 2014; Morrison, 2008; Meyer, Land,2003).
According to Land et al., the liminal space entails a discursive shift, e.g., the acquisition and use of new forms of written and spoken discourse and internalizing these (Land, Rattray, Vivian, 2014).

Dewie and Herbard speak about the in-between space as consisting of struggle, uncertainty, and doubt - a place of frustration, discomfort, and possible negativity (Howard p. 141 as cited in Hatt, 2022). In this liminal space, from a pedagogical perspective, the participants begin to "learn how to learn," and their knowledge schemas start to change (Mayer, 2008). Learning, by its very nature,

means beginning from a place of *not* knowing, similar to starting a process of art that has enabling constraints such as material, media, or form (Fogarty, 2022, 65). This is particularly true in co-design and interdisciplinary contexts. The reflective collaborative lingering in the liminal stage, the edge of chaos and structure, needs to be scaffolded and supported to enable growth (Morrison, 2008). Yet, the stage of multiple directions, opportunities, and windows of possibility, which can appear chaotic, provides the needed creative challenge toward informed decision-making and meaningful change (Ibid.).

5. Installation art reducing climate anxiety

Voicing shared values provides a platform for dialogue in the realization of art installations and design artifacts as well as in the process of drama structure (Thompson, 2022; Gervais, 2006; Schwartz, 1994). Meaningful action and participation in installation art constitute a meaningful experience (Tian, 2023; Nelson et al., 2010). Time for (S)heroes asks whether co-designing installation art and digital characters based on the values and actions of (S)heroes is meaningful and why. What kind of actions meet the criteria for (S)heroism, e.g., is taking part in protesting in a large demonstration, which is at its core a value-based act, an act of (S)heroism? In terms of the environment, true climate work might be planting seedlings in a forest. Still, the role of the artistdesigner in the communities they live is not only aesthetic pleasure or entertainment but also connecting with the community, providing tools for critical thinking, exploring, and envisioning a better future.

Art can offer solace for climate anxiety when it promotes values, content, and even spirituality, which can soothe the viewer in the complexities of climate change and motivate positive everyday decisions and actions. Regarding the emotional impact of artistic expression – art can evoke emotions, spark introspection, and create a deep sense of connection to the earth and ecosystems. By fostering this emotional connection, art can motivate individuals to take meaningful action against climate change in their everyday choices. Art can also be a powerful vessel to explore narratives of healing and recovery in the evolving climate conversation.

Climate change is one of the wicked problems our societies face. Among young people, climate anxiety often manifests as sadness, fear, general anxiety, and anger (Thompson, 2021; Hickman, 2021). This emotional spectrum can also include feelings of powerlessness, frustration, and uncertainty (Ibid.). The overall climate issue is so broad and significant that it is nearly impossible for an individual, especially a young person, to fully comprehend it, as young people are still learning to understand large-scale issues, multilayered challenges, and how to manage their emotions related to them (Cefai et al., 2021; Thompson, 2021; Hickman, 2021). Nevertheless, climate anxiety can provide fuel and transform into a resource for change.

This is a positive outcome scenario for climate anxiety, and it resonates with action and hope for both today and the future. Climate anxiety can be replaced by dreams, visions, hope, and practical actions at the level of everyday life and within one's spheres of influence. Individual consumption decisions and recycling practices become important in everyday life, allowing individuals to become role models in larger recycling and consumption trends.

Alleviating anxiety through emphasis on listening skills, active dialogue, and collaboration helps young people understand that they are not alone with their feelings and are not responsible for the world's events either—yet, cultivating the ability to collaborate, even when dealing with wicked problems, can lead to successful solutions (McCune et al., 2023; McCune et al., 2024; Cefai et al., 2021).

6. Applied theatre: drama pedagogy and interpreting new (S) hero narratives

Drama methods are suitable tools to evoke focused inquiry and collaborative creativity across disciplines in higher education. Drama methods have gained popularity both in phenomena-based learning and in communication and language learning in secondary education but are still relatively little explored in interdisciplinary co-design or transdisciplinary design initiatives beyond Academia (Dunn 2016; Bowell, Heap 2012; Schneider, Crumpler, Rogers 2006; Cawthon, Dawson, Ihorn, 2011). Drama and bodily expression have been utilized in participatory and user-centered design for collaborative generation and exploration of *design* ideas to help designers achieve greater empathy and user understanding in the given context (Brandt, Grunnet, 2000).

The transition from expression to experience through drama evokes collective creativity. The link between intellectual understanding and the body can promote embodied learning through communicating with and through the body which is crucially important in dramatic exploration (Thompson, 2022; Fells, 2018; Brauer, 2002; Neelands, 2000). Drama, which has a kinesthetic, action orientation, provides a strong social context for learning and motivates students' desire to communicate about the characters, their relations, values, and actions (Haapaniemi, Leinonen, 2023; Winston, Stinson, 2011; Norman, 2002).

Experimenting with the fictive (S)hero characters and what constitutes their values are focal in process drama and devising workshops with youngsters (Gervais, 2006; Schwartz, 1994). Aristotle (384 – 322 BCE) divides the character types into three categories according to their status: superior to the audience, inferior, and at the same level – all of which influence how the audience reacts to them (Aristotle, 2006). Temperament dictates whether the character is easily irritated, optimistic, talkative, open-minded, reserved, introverted, extrovert, elegant, arrogant, or well-mannered. The constitution of the character is revealed by action and

moral choices (Ibid.). The co-designed characters are stored in value maps with character traits, and their interrelatedness is explained to contribute as rich source material for designers (Bruner, 2017; Flick, 2013; Gervais, 2006).

The drama method is built on shared reflection within the scenario – similar to the role of reflection in design iteration – including a collective stepping out of it, providing a special feature of simultaneous observation and action, research, and exploration of the fictive world to create understanding, negotiate meaning as well as experience empathy towards the fictive characters or end users in design (Haapaniemi, Leinonen, 2023; Schön, 2017; O'Toole, 2003, Owens, Barber, 2001; Neelands, 2000; Jackson, 1993). Lingering in shared reflection is an integral part of both drama pedagogy and enables informed decision-making for a group of designers in an interdisciplinary co-design context (Bowell, Heap, 2013; Schneider et al., 2006; Schön, 2017; Cavagnaro, 2023; Noel, 2023). Drama worlds are potential spaces for growth as they enable critical reflection within participatory and sociocultural learning (Piazzoli, 2018). This provides tools for prospective designers to become reflective practitioners before, during, and after each iterative design loop
(Schön, 2017).

6.1 Devising to transform the hero trope

Devised theatre offers a site for productive critical pedagogies as it enables integrating polyphonic voices with a result much greater than writing a script by oneself (Perry, 2011; Oddey, 2013).

Devising empowers the participants to choose and influence the perspectives that gain attention (Oddey, 2013). Devised narratives ensure meaning is communicated as the process challenges every group member to confront the theme and engage with it individually at different levels, as well as develop a sense of group cooperation, affiliation, and unity at the same time (Ibid.).

Devising is based on a passion and desire to say something, a need to question or make sense of a theme, cultural phenomenon, or other starting point that encourages the group to investigate further. Devising begins with the interaction between the members of a group and the starting point or stimulus chosen. Possible barriers at the individual and group levels need to be tackled. The group absorbs the source material and responds to it, and the drama pedagogue generates a method of working appropriate to the initial aims of the project. The devising process challenges every group member to confront the work, engage with it individually at different levels, and develop a sense of group cooperation, affiliation, and unity simultaneously. All groups are different as personalities change the group dynamics and impetus of the work. Thus, ultimately, devising is about the group discovering a relationship between itself and the theme it engages with (Oddey, 2013).

In a meaningful continuum, the process becomes the product: script, narrative, characterization map, or dramaturgical item.

6.2 Process drama informing design

Process drama is a genre of applied theatre in which the participants, together with the facilitator, engage in the co-construction of a fictive world. As an improvised dramatic form, it encourages the negotiation of meaning through the process of experience and reflection. A drama pedagogue is a facilitator from within a role within the same fictive world with the purpose of engaging rather than entertaining (Dunn, Stinson 2011). Cecily O'Neill, the founder of process drama, refers to the form as a thematic exploration with no intention of creating a performance for the audience, instead facilitating the shared exploration and reflection (Taylor, Warner, 2006; O'Neill, 1995). Drama pedagogue participates in the action from within a role with attention to status - lower, same, or higher and thus becomes an "active participant in the unfolding of events" and the social networks within the fictive world (Kao and O'Neill 1998: 26 as cited in Piazzoli, 2018). The facilitator is a coequal performing team member capable of analyzing power structures within the created scenarios and between the characters (Haapaniemi, Leinonen, 2023; Thompson, 2022).
Process drama inquiry easily integrates other art forms as pre-text, a starting point. Different art forms, such as visual arts, images, and photography, as well as poems, textual reference, or sound, can be used as stimuli for process drama (O'Neill 1995). In the (S)heroes process drama workshops with young people, an initial stimulus launches the dramatic world, the shared fiction, based on visual and perceptual modes of thinking and relates to opening access to skills participants already have but that are simply waiting to be released (Edwards, 2012, 7).

Rose explores the relationship between the performative approach, visual research methods, and contemporary visual culture, characterized by convergence (Rose, 2014). She suggests that images tend to be deployed as communicational tools rather than representational texts to produce sociological knowledge in the wider social field (Ibid.). Thus, visual prompts, e.g., visual pre-texts, supplement the kinesthetic, embodied drama process well. Visuals open access by *conscious volition* to the visual, perceptual mode of thinking to experience a focus in awareness and seeing things in a different way (Edwards, 2012, 89). The modes of knowing, whether rational or artistic, can be integrated into the process of drama scenarios. Bringing in visual prompts to process drama advances information processing, as the ways of knowing through art, in this case, visual art, bring information to the rationale (Edwards, 2012, 38).

After launching the pre-text, the process drama structure can be divided into three phases: the *initiation* phase, where

participants create their roles and become immersed in the dramatic situation; the *experiential* phase, where participants explore the dramatic world through several strategies, or 'conventions'; and a *reflective* phase, where participants reflect on the learning, making their own meanings explicit (O'Toole, Dunn, 2002).

Process drama consists of several scenarios that are not interconnected in a linear, chronological sequence but follow a non-linear narrative. It plays with spatial and temporal dimensions to explore a theme within the realm of human emotions and behavior (Piazzoli, 2012, 28).

6.3 (S)hero qualities, values, and behavior informing

What makes a hero a (S)hero is originality, but not always. A (S)hero does not follow the mainstream in situations where heroic qualities are needed, yet they do not oppose norms or resort to anarchy at the expense of credibility. A (S)hero dares to see things differently, a quality that artists and designers treasure. (S)hero turns attention from oneself to others with a positive impact through sharing. (S)heroism is considered from the perspective of integrity, resilience, and consistency. Thus, it is a deeper quality in a person, anchored in the ability to live with integrity according to (S)heroic values as part of a community (Gervais, 2006; Schwartz, 1994). (S)heroes live in a mental atmosphere that entails small gestures of attention to others. The (S)hero succeeds only through trusting relationships and interacting with others. This collaboration encouraged through co-design, breaks the prevailing traditional myth of loneliness in the concept of heroism. Heroism in one area, such as leadership or political power, can turn against itself if one does not align with ethical and responsible behavior, adjust, and regulate their actions. War zones, difficult circumstances, survival, and managing in everyday life are typically regarded as the traditional hero quests. Also, overcoming a serious illness or that of a close family member is often seen as heroism because mental commitment to well-being and recovery is regarded as crucial—the attitude of not giving up. This type of heroism and capability is linked to selfsufficiency and even a desperate rise – a hero for surviving and sustaining. Similarly, sports champions center their energies around winning over other contestants and accomplishing one achievement after another.

The focus in (S)heroes is on recasting the heroes – the transformation of the hero archetype and providing more variety to the interpretations of (S)heroes of today and the future (Pearson, 1989). The visionary transformation and reframing of the hero trope takes place through design and characterization both in everyday life (fashion design), in live performance (costume design), and in urban spaces (installation art). Campbell distilled the hero's journey into three main steps, namely Separation, Initiation, and Return, when analyzing the great classic stories (Campbell, 2008). The

universal pattern includes a hero who receives a call and - after reflection - leaves his known world. Within this quest, the suffering on a physical and psychological level leads to solutions for dangers that threaten communities to which the transformed (S) heroes return. Transformational (S)heroes are driven by ideals, while transactional heroes prefer instrumental action and seek pragmatic solutions. Both types keep the dream alive that collective happiness can be achieved. Because they possess admirable qualities, audiences want to emulate them. The new (S)hero is archetypal and universal, yet simultaneously has a thousand faces, celebrating incompleteness, vulnerabilities, and flaws as crucial for renewal, being humane, and regarding them even as success factors.

The need to mirror oneself in (S)heroes is strong, but the role and face of the contemporary hero have become thoroughly problematic. Thus, exploring which faces or *personae* the (S)hero must put on to appeal to the present and future generations is important. To what extent can a critical approach to the concepts of (S)hero and (S) hero's journey inspire students through drama methods and co-designing to reflect and create and shape the future by providing an alternative view to the existing norms and forms? A balanced approach is nurtured: all are encouraged to be strong, proactive, accomplished, and determined. Many academics are rather critical of the hero because of his prototypical manliness or as an exponent of a meritocratic worldview.

7. Characterization and costumes for sustainability with integrated theories

Costume and fashion relate to the character as outfits, garments, accessories, and other symbolic emblems express the value sets of their bearers (Dean, 2016). Costume design conveys a strong message in performing arts—not only in theatre but also regarding artists as performing idols and young people interested in cosplay or live-action roleplay (Ibid.).

Costumes are powerful in visually portraying a character's personality and fictional histories in live performance and digital media, such as computer animation (Kalmakurki, 2021). Character trades influence their attire, and how they are dressed and depicted in visual format. Performance and staging of a play create an illusion that is often more real or penetrating than reality. A vision the director wishes to convey to the audience becomes elevated existence, the director's interpretation of the version of some investigated theme, topic, or truth brought forth by the playwright (Cunningham, 2019, 10). Set and costume design are part of this overall artistic vision. Costume design involves a process of thinking about human character and representation using garment(s) as its main visual, but not sole, means (Ibid.). Pantouvaki argues designing costume is often thought of as 'in service' to performance-making, as either a direct response to the director's vision or a creative team's interpretation of a text or theme (2020). However, in (S)heroes, the costume itself

is a product of an artistic-research-design inquiry. Contemporary thinking in costume practice expands beyond storytelling and embraces substantial characteristics of life within diverse social frames (Pantouvaki, 2020). It involves understanding and accepting others' personalities, practicing empathy and observation, and improving interpersonal and intercultural communication (Ibid.). In this line of thought (S)heroes fashion and costume design processes invite us to think *with* and *through* costume by proposing costume as a tool for analysis, negotiation, communication, experimentation, and expression of ideas and behaviors (Ibid).

Aligned with the European Green Deal and EU Strategy for Sustainable and Circular Textiles (S)heroes foster digital and green transition in fashion and design industries in Europe by reducing material and textile waste through digital design, recycling, and circular economy. The fashion industry accounts for 10% of CO2 emissions and 25% of chemical emissions and is second only to agriculture as a consumer of water (Cheng, Charter, 2023). It is also largely in its infancy in terms of sustainability and circularity policy development despite being considered one of the most polluting industries, with 1.92 million tons of textile waste produced yearly. Fast fashion is increasingly coming under the policy spotlight. It has been specifically highlighted in the EU Strategy for Sustainable and Circular Textiles with a stated goal of taking fast fashion out of fashion. However, previous research shows that companies in fashion, clothing, and textiles (FCT) are at a basic level of awareness in relation to product circularity (PC). In addition, the research by Cheng and Charter highlights that most PC tools are designed for advanced users and are not product-specific, thus requiring adaptations to meet industry needs (Cheng, Charter, 2023).

In (S)heroes, interdisciplinary co-design teams aim to investigate sustainable and ecological methods with a practice-led methodology approach (see Groth, 2016; Mäkelä, 2007) to design fashion collections and costumes for live performance to allow the engagement with physical materials to lead the design process and undecided product outcomes. Sustainable methods consider both sustainable materials, circular economy, and zero waste design. One of the concepts for the (s)herowear is ecological materialism and innovative ideas which also focus on the ways how materials are recycled in the future.

Sustainable design is investigated via a unique and artistic "upcycling" process and via digital garment making process. Using the long tradition in the field of costume to recycle clothing from one production to another through designers' adjustments will benefit both fields. On the other hand, digital garment making has expanded in the fashion industry to reduce the need for garment sample making, strengthening sustainable industry practice. However, digital tools are still slowly emerging in costume design practice and can therefore learn from the fashion field. Participants experiment with clothing made from leftover industry materials, with zero waste, creating recycled

items, and explore the possibilities of digital garment making to create costume and fashion design. Working with digital tools has a strong ecological impact, supporting sustainable garment creation by minimizing fabric waste. In practice, this is visible through testing garments' fit, design style, colors, and prints digitally prior to making them with physical fabrics. We propose that this method can also be useful for costume making in live performance. In addition, digital costume making proposes new ways of presenting costumes and characters on stage entirely digitally in a live event, which promotes sustainability, as the costumes are not physically made. Hence, another concept for (S)heroes is to expand digital design from its traditional use and create digital characters with costume, art installations and fashion and present them in public spaces interacting with physical people or actors.

8. Conclusions

The (S)heroes promote the green transition, ethical leadership, sustainability, and inclusion by inviting polyphonic voices to speak and participate in the project. Ethical leadership and integrity are grounded in well-defined values that empower (S)heroes to act with dignity (Schwartz, 1994). In this line of thought, even small actions that encourage each other to proliferate and multiply into a movement of hope for the future.

(S)heroes to become ethical future leaders requires equipping them with tools and anchoring them in hope and resiliency. Discernment, even in the smallest action and in decision-making, is a capability that requires not only knowledge but fostering, cherishing, rehearsing, and being applied prior to it is a built-in quality. Shortly, if (S)heroes' actions are not responsible, their future activity will not be successful. Nowadays, success in entrepreneurial terms means ethical dimensions, responsibility, sustainability, integrity, and the establishment and nurturing of trusting relationships.

The pedagogical model suggests that embodied learning, drama methods, and reflection play an integral role in the four design research inquiries (Haapaniemi, Leinonen, 2023). The model uses a vigorous synthesis of approaches in an interdisciplinary manner, which means integrating knowledge and methods from different disciplines to address common denominators and themes – such as the (S)heroes – in beneficial. The model can be applied to structuring interdisciplinary case studies, design challenges, and advance higher education curriculum development, especially with a central role of characters.

Interdisciplinarity in the model brings technological advancement, sociology, social science, design, and art together, referring to a combination of knowledge construction methods to find synergy, creative solutions, and new perspectives. Interdisciplinarity relates to more than one branch of knowledge involving two or more academic, scientific, or artistic disciplines. Interdisciplinarity creates

socially-robust knowledge with stakeholders, in this case young people, by building on established methods to produce reliable knowledge and goes even beyond that generate new connections with societal impact (Nowotny et al., 2003; Caniglia et al. 2017).

In applying the model, higher education institution with its stakeholders, takes part in the shared construction of knowledge and cognitive processes. To accomplish cutting-edge innovations, higher education institutes need to resort to transdisciplinary approaches (Hadorn, 2008). The greatest challenges globally can only be resolved by working together in a collaborative, interdisciplinary manner. Technology and research-based innovations play an important role in solving joint global challenges, so-called wicked problems, such as climate change, healthcare, clean energy, and other wicked systemic challenges (McCune et al., 2023; 2024).

Participating in new types of initiatives and consortiums that focus on the relationships between interdependent parts is crucial. A more resilient future is enabled by collaboration based on different ways of knowledge construction, empathy to understand and accept differences, and focus on otherness and togetherness (Vita, 2023, 180). Co-designing requires flexibility, adaptability, and access to resources that support diverse perspective integration as successful outcomes of an innovation process consider interdisciplinary approaches with a shared vision from the start (Ibid.). Wicked problems have similarities with systems thinking and complex systems, which can be changed through interactions within the ecosystem, e.g., instead of trying to change mindsets, the entire context needs to be rethought and changed (McCune et al., 2023; 2024; Ståhle, 2004; Luhmann, 1995). Considering multiple ways of knowing and collaborating in acting with responsibility is crucial both for society and the planet (Vita, 2023).

Successful design processes require constant reflection with oneself, other co-designers, as well as the materials and methods employed to lead to informed decision-making (Stickdorn et al., 2018; Schön, 2017; Dalsgaard, Halskov, 2012). Decision-making is enhanced by testing the prototypes at each stage with authentic audiences. Communication and reflection on the process development stage, challenges, setbacks, and successes need to be well articulated at regular intervals (Ståhle, 2004). Dialogue includes testing, reflecting, questioning, and discussing whether the product and its features are relevant from the end user perspective when added value is sought in the spheres of technological innovation, aesthetics, and usability.

Testing the suitability of drama methods to design initiatives provides important knowledge as drama inquiry integrates imagination, perception, spatial skills, creativity, intuition, inventiveness, embodied presence, and communication skills. The values being promoted through drama pedagogy include openness, empathy, and engagement, simultaneously competences

enhanced include reflection, metacognitive and communication skills, as well as creativity and teamwork skills (Haapaniemi, Leinonen, 2023). Further consideration for research includes testing and validating the applicability of the model in curriculum development in HEI through evidence gathered and coded according to Grounded Theory principles (Thornberg, Charmaz, 2013; Compton, Barrett, 2016).

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DATA SONIFICATION AND THE POWER OF AUDIO: BREAKING BOUNDARIES OF INFORMATION DESIGN WITH CREATIVITY, ACCESSIBILITY, AND INNOVATION

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ABSTRACT | Data sonification, the practice of representing data through sound, has great potential to (1) expand the way we engage with information and experience learning, (2) offer a more inclusive avenue for design projects, and (3) break the boundaries of traditional design through innovative expression. This speculative paper explores the potential for data sonification to advance and transform the field of design through several avenues, with particular focus on shifting information consumption modalities and expectations, improving accessibility in design, and the design-oriented nature of sonification processes. The realms of design and data sonification are each powerful in their own right, yet there is ample room and need for these practices to support and influence each other. In fact, this synergy is needed for both fields to advance. This paper first acknowledges existing research around design-conscious data sonification, and explores the limitations of visual traditions in design.. It then discusses the powerful link between data sonification and design, exploring sonification as a design problem to be solved. It then presents two categorical arguments for why data sonification can help expand the world of design. The first is that data sonification shifts expectations and boundaries of design by propelling designers out of their comfort zone and introducing audiences to an unfamiliar format that is emotionally stirring. The second is that sonification is an excellent solution for inclusivity and accessibility limitations, welcoming individuals who might be excluded by purely visual modalities. This paper concludes by recommending practical starting points for designers, addressing next steps for the community, discussing existing challenges (user experience and technological limitations), and encouraging creators to engage with this unique method.

KEYWORDS | DATA SONIFICATION, INFORMATION DESIGN, AUDIO, FUTURE OF DESIGN, DATA VISUALIZATION, MULTIMODAL, DATA CONSUMPTION, DATA, AUDIO-DRIVEN DESIGN, EDUCATIONAL STORYTELLING, DATA-DRIVEN ART

1. Introduction

In the space of information design and data representation, there is heavy reliance on visual elements to convey an idea or message. Culturally, we are quite attached to this modality — but what would it be like to integrate audio as a more widely-used format for information design? There is broad familiarity with charts and graphs as a means of communicating data, whether that be in journalism, the classroom, or research. While visuals are powerful, they have certain limitations in that they are often presented in static format, are overused or misused, and lack a certain emotionality. Furthermore, they are exclusive to the sense of sight. Data sonification, the practice of using sound to communicate data, is a method that activates the under-appreciated sense of hearing and is beneficial to information design in at least two significant ways. First, expressing data in the form of audio makes data accessible to people who are visually impaired or blind. There is a heavy reliance on visualization as a tool for tasks like data analysis and developing educational content, but by integrating sonification into these realms, data can be consumed without reliance on sight. Second, data sonification is beneficial for engagement, sparking curiosity, and stirring emotion within someone. A sound composition may have the power to activate a poignant reaction more than a static data visualization can.

There is a great opportunity for designers of multiple disciplines to use information-driven audio to shift their own practices, strengthen the impact on their audiences, and ultimately expand the field of design as a whole. The field of information design is well-explored, and marked by strong theories around concepts like visual aesthetics, harmony, hierarchy, information structure, and so on (Pettersson, 2014). These principles are generally vision-oriented, and there seems to be less focus on design theory around sound. Designers could transform their work by embracing this lesser-explored modality. This speculative paper argues for the need to integrate data sonification into the world of design, as part of a movement towards more inclusive and intriguing methods for communicating information, educational storytelling, exploratory research, and beyond.

The subsequent sections of this paper will proceed as follows. Section 2 acknowledges previous research done to examine the relationship between design perspectives and data sonification. Section 3 reviews traditional forms of design through brief historical acknowledgment of heavily visual media in information design, addressing its benefits and limitations. Section 4 introduces the concept of data sonification, framing data sonification as a design problem and discussing examples of design-conscious sonification. Section 5 presents the argument that data sonification can shift expectations for audiences and designers by sparking curiosity around the unfamiliar, stirring emotional response, and invoking underexplored creative methods. Section 6 presents the argument that data sonification helps contribute to improved design inclusivity by providing an accessible medium for people who are visually impaired or blind. Both Sections 5 and 6 argue that these respective benefits of design-oriented sonification can ultimately break boundaries of informative design and expand the field as a whole. Finally, Section 7 presents practical recommendations for designers to start implementing sonification, addresses current challenges to integrating the practice broadly, and calls for further research in the future.

2. Previous Work

The Sonification Handbook (2011) contains a chapter by Barrass and Vickers called, "Sonification Design and Aesthetics," which expounds on the evolving relationship between design principles and data sonification theory, and the varying perspectives about appropriate design goals for sonification. Not long before the book's publication, the community of sonification began to witness a call for awareness around aesthetics in creating sonification compositions, with greater receptiveness to the idea that "the field is currently focused on applications and techniques, and there is a need to consider users, environments and contextual issues more in the future" (p. 151). Additionally, there have been more calls for interdisciplinary contributions to the field of data sonification, noting "a false dichotomy predicated upon the assumption that art and science are somehow incompatible bedfellows," when in reality they are incredibly supportive to one another as innovative dominions (p. 158). This early research shows interest in pushing sonification practices beyond niche research and into a broader, more relatable context.

The realm of Human Computer Interaction (HCI) has also demonstrated significant cross-section between data sonification and design. Sonification falls under the umbrella of auditory display, which arises consistently in the design of devices and technologies that we use on a daily basis. It is important for devices to emit well-designed sound in communicating with the intended user, whether that be in systems such as cars, phones, computers, voice assistant devices, or any other interactive technology. In an early overall assessment of the field,

"Sonification Report: Status of the Field and Research Agenda," authors Kramer et al. address applications of sonification from a design lens and propose a research agenda for how these applications could be built out into the future (ICAD Proceedings, 1997; updated 2010). They emphasize that problem-driven projects would be an optimal application of sonification, and state that a "design challenge" would be particularly useful for unveiling the "unpublicized efforts" of sonification designers (22-23). But there are also gaps in the design theory of sonification, and more research is needed to establish a solid theoretical foundation. So while we see gradual concessions over the years that data sonification and design need each other, the implementation has been slow to manifest, and it is well past time that the sonification welcomes design and that designers embrace sonification as a practice.

In more recent years, we have seen various explorations of the intersection between data sonification and design. Jordan Wirfs-Brock discusses the value of integrating multiple sensory expressions like sound, taste, and touch into the process of brainstorming about the potential expression of data (Wirfs-Brock et al., 2022). Through "sketching across the senses," including the translation of information into sound, various design-focused practitioners can generate iterations of unique data translations which can aid them in their development processes. This reflects the strong link between auditory display and human computer interaction, through the mechanism of interaction design processes and methods. In further research uniting interaction design and sonification, Wirfs-Brock examines "narrative sonifications" – the process of presenting data sonification to audiences with the aid of narrative and providing steps for "training the listeners ears," thereby crafting the design of the final sonification presentation to be most impactful and meaningful for audiences (Wirfs-Brock et al., 2021). This narrative approach can be particularly useful for information designers to ensure that their intended audiences genuinely understand the intended message. Sara Lenzi, Paolo Ciuccarelli, and contributing founders of The Data Sonification Archive (https://sonification.design/) have investigated the relationship between design and sonification, including the implementation of intentional design when it comes to the communication of social issues in journalism (Lenzi, Ciuccarelli, 2020). They have also developed a framework for implementing a design-driven approach to data sonification with the "Data Sonification Canvas" (2024). They call for the active application of design research methodologies to improve "an iterative process which would lead from ideation through prototyping to production of sonification as a real-world application," and propel sonification in a direction where it could be widely embraced and implemented societally (Lenzi, Ciuccarelli, 2020). With greater fusion between the practices of sonification and design, we are sure to experience mutually interesting developments in both fields.

3. Traditions in Design, Prioritizing the Visual Mode

3.1 Visual Emphasis in Information Design

Practitioners of information design may be well aware of the typical focus on the visual modality by their peers and in the field more broadly. Even the curriculum at Northeastern University, which maintains an impressive and unique informational design program, consists of much required coursework that is firmly centered around design as a visual modality, such as "Visual Cognition," "Visualization Technologies," and "Visual Communication for Information Design" (Northeastern University Academic Catalog 2024-2025). The title of the graduate program, "Information Design and Data Visualization," indeed demonstrates the anchored focal point on visualization in the study and practice of design. Early on in their careers, information designers are reliably exposed to the theories of Edward R. Tufte, statistician and professor best known for his books such as The Visual Display of Quantitative Information (1983) and Envisioning Information (1990) (© by Edward R. Tufte). While perhaps antiquated and rigid in some ways, his work still shares some groundbreaking concepts, like the idea of "escaping flatland," integrating depth, and eliminating superfluities in visual representations of information (Envisioning Information, p. 13). In an article about global information design, Paul Kahn presents historical frameworks of information design, all of which are specifically defined under an umbrella of visual communication; while Kahn calls for an expansion of the practice, audio is not mentioned ("Global Information Design, Part 1: A New Framework for Understanding Data Visualization" 2019). Even in fields submerged in the act of communicating information, such as data-driven journalism, "visual design plays a major role in data stories and in multimodal artifacts in general" (Weber et al, 2018).

3.2 Benefits and Limitations of the Purely Visual Mode

The purpose of examining traditional design tendencies is not to dismiss or downplay the value of visualization in design, but rather to point out the lack of focus on other sensory modalities like auditory perception. Of course, the visual modality is incredibly powerful and visual design is brimming with an array of beneficial qualities. Visual information design has the power to be highly specific and detailed, and effectively communicate ideas. It is also non-temporal; the eye can navigate nonlinearly around an image, unconstrained by a start and end time. Yet it has a long history of challenges and gradual adaptation with evolving technology, expanding from the highly scientific to the more artistic and experimental. Sonification theorists can benefit from this history – they can "learn from the visualization community's mistakes and embrace cross-disciplinary interactions from the outset, including those with cognitive scientists and artists" (Kramer et al., 2010). This calls for a synergy between data sonification

and design practice, and an opportunity for both fields to grow and improve.

Adhering to the purely visual has its limitations, and faces potential pitfalls in applications such as data visualization. Common problems include disproportionately scaling the data, unclear labeling, missing context, and oversimplification, leading to "false representations of the data and incorrect conclusions" (Webber et al., 2019). But researchers are beginning to explore the potential of multimodal information representation more often. It is possible that integrating additional sensory formats in information design can spur a more memorable and engaging experience. In a study by Saktheeswaran et al. measuring the impact of integrating multisensory interaction in visual network exploration, researchers found that interaction design involving speech, touch, and audio was preferred by participants (Saktheeswaran et al., 2020). Reasons for this included "freedom of expression" in task performance, being more direct and natural, as well as the modalities being quite "complementary" in nature. Additionally, user experience (UX) designers are beginning to think about how to integrate multiple senses in design to enhance informational experiences; historically, designers have approached design as exclusively unimodal, which does not reflect our actual multisensory day-to-day experience (Content Science Review, 2022). Changing attitudes towards information design invite the opportunity for data sonification to be implemented among these practitioners.

4. The Vital Link Between Design and Data Sonification

4.1 A Conceptual Overview: What is Data Sonification?

Data sonification is the practice of representing data through sound. It falls under a broader category of auditory display, which examines "how the human auditory system can be used as the primary interface channel for communicating and transmitting information" (The Sonification Handbook, 2011: p. 1). Within this domain, sonification is specifically the "technique of rendering sound in response to data and interactions." While the use of non-speech sounds (software instruments, etc.) to convey data is more widely practiced, speech and the voice are also valid mechanisms to present a sonification. The most common approach to data sonification is called "parameter mapping," which is the process of associating data or information with auditory parameters such as pitch, volume, timbre, tempo, etc. Parameter mapping is the form of sonification to which this paper is primarily referring. While some of these definitions have become more established over time, the field of data sonification is ever-evolving, and practitioners have debated about more granular details of best practices and principles. A tangible design theory for data sonification remains in development, and further undertakings of design-oriented sonification would help to clarify and expand current efforts.

4.2 Approaching Data Sonification as a Design Problem

Data sonification is, by its very nature, a design problem. The goal of a data sonification creator is to convey information contained within a data set through clear and (possibly) aesthetically-pleasant sound composition. This creator, in effect a designer of information and sound, will consider factors such as targeted audience, presentation format, and chosen narrative in crafting a composition. If the aim of an information designer is to communicate information so that it is easy to understand and memorable, it can then be said that sonification developers are information designers, tackling that very problem through sound. Indeed, sonification requires design: Grond and Berger present a framework for the design process of parameter mapping sonification which involves the "data domain" (data features such as events, polarity, and dimensions) and the "perceptual domain" (sound synthesis aspects such as frequency, gain, time, brightness, harmony, texture) (The Sonification Handbook, 2011: p. 366). Iterating between these domains, the sonification designer adjusts the mapping function which takes features from the data domain and produces sonic output. This design process is characterized by "listening, tuning, and thinking," in which the designer makes creative adjustments for an optimized outcome.

There is information design embedded in our daily sonic environment. Design considerations live within the notifications from our smartphones that indicate a message arrival, in the sirens that whir down city streets communicating emergency, in the bell tower that tolls with the passing of each hour. But sonic applications of design are not widely discussed in the field of design, as visual solutions take the main stage. The historically expected applications of information design solutions are "infographics," "wayfinding systems," "data visualizations" or even intangible products like "strategies" or "stories," (Sheila Pontis, Northeastern University) and it is rare to find audio as a cited design solution. A perspective shift is needed to expand upon existing instances of information display; with additional creativity and analysis, designers who experiment with audio may find it to be a particularly viable and communicative medium.

4.3 The Impact of Design-Conscious Sonification Development

Sonification projects generated with a design-oriented mentality have potential to touch listeners in a more impactful way than outcomes of systematic approaches. If an information designer truly considers the clarity, emotional tone, and aesthetic of the audio narrative, choices made in development are likely to resonate with audiences hearing the final product. Recent research has been done by Sara Lenzi and Paolo Ciuccarelli to explore the value of a design-driven approach to sonification, emphasizing "intentionality" and deliberate decision-making to produce meaningful narratives (2020). They question the extent to which sonification practitioners

are aware of the communicative potential their work may have, and whether they carefully consider the effect of their design choices. Lenzi and Ciuccarelli encourage this thoughtful awareness, stating that "intentionality has been considered an indicator of a 'designerly' approach that can position sonification as a meaning-making medium of its own," rather than only for scientific purposes (2). They explore a series of case studies to demonstrate this, specifically in the field of data journalism. One example they explore is a 2013 collaborative project called Egypt Building Collapses, by the Tactical Technology Collective, the Shadow Ministry of Housing and the Egyptian Initiative for Personal Rights. Due to poor public policy and construction regulation, Egyptian urban areas have experienced a number of building collapses, leading to numerous casualties and families left homeless. The web-based project powerfully combines visual animation with sound, tracking the number of building collapses, the outcome of the collapse, and the reason for the collapse (https://egyptbuildingcollapses.org/). With each building that falls, one can hear a destructive, mechanical, crumbling sound effect, representing each unfortunate occurrence, the sound compounding with higher rates. This project exemplifies highly intentional design because it takes an issue of social injustice and makes it viscerally present for the listener; the use of destructive sound samples causes the listener to "associate the sound directly with its source" (3). Rather than opt to make this sonification benign, neutral, or even pleasant, the creators purposefully design a jarring, emotional piece which calls for policy change.

Intentionally-designed sonification compositions reflect a keen awareness around social context and intended audience. An information designer may often encounter the challenge of presenting a particularly sensitive social issue, or solemn material, such as death rates, crime patterns, or human rights violations. Designers have the responsibility to both clearly articulate the content and remain conscious of the listener. Another example of intentional sonification design around a sensitive topic is a project called "London Under the Microscope," by D'Efilippo, Ray, and Geere (https://vimeo.com/571217327). Representing Covid-19 cases and deaths in London spanning one year, the piece pulses ominously, gradually building in intensity as the death toll increases. At first, the listener can hear individual instances of Covid-19 deaths, but as the numbers increase the sonification culminates into droning layers, powerfully symbolizing the pandemic's magnitude. The designers' subtle yet powerful choices for this sonification both memorialize lives lost and inform listeners of the data. The effect of intentional design is that the listener deeply connects with the material. Rather than being tasked with the work of drawing meaning from the audio, designers can embed contextual cues, metaphors, and creative indicators into their work to communicate a meaningful message.

5. Breaking Boundaries with Sonification: Expectations, Innovation, and Creativity

5.1 Shifting Audience Expectations through Novelty and Emotional Impact

Data sonification is a relatively new method of representing information, with limited acknowledgement among research communities and the public. While this has generally been noted as a downside to the method of sonification (Barrass an Vickers, 2011), it may be worth considering an alternate perspective. The fact that sonification is not yet well known could potentially be beneficial to information designers, as its novelty offers a format that may be unexpected and intriguing for audiences. Well-designed sonification tends to be bespoke, as data-driven narratives are highly context-dependent, and systematic approaches do not always work well with audio synthesis. Designers have the opportunity to bask in the dearth of sonification design norms, gifted with a blank slate in this emerging field. Examples of excessively codified information design techniques, such as graphical visualizations or "scrollytelling" projects, have seen broad application across numerous platforms, and users have become well-familiar with (if not jaded by) these presentation methods. Sonification, on the other hand, still remains protected from the threat of systematization, and its uniqueness may prompt engaged and curious listening.

Initial impressions of data sonification may cast it as a dry, scientific method lacking enjoyment, but that is where designers may play a role in transforming this assumption. Innovative creators can leverage design and aesthetic to direct the presentation of sonified data towards "an audience with expectations of a functional and aesthetically satisfying experience" (Barrass an Vickers, 2011, 2011: p. 165). Recent public-facing sonification projects have cropped up frequently in the field of astronomy, largely from the part of NASA. The organization has created a series of sonifications mapping digital imagery data from the James Webb Space Telescope to layered, ethereal sounds. Users can thus "hear the stars," absorbing soundscapes which are "designed to be captivating to anyone who tunes in" (NASA: Webb Sonifications, 2024). The reach of NASA is wide, and compositions like these are contributing to a shift in audience awareness and interest in sonification, exemplifying artfully-designed sonic arrangements which are calming and enjoyable. However, these sonifications are problematic in ways, because they can mislead listeners to believe that stars are actually emitting sound, or that sound is possible in space, which it is not. The infrared light observed by the Webb telescope is the data that is eventually mapped to sound, but that may not be clear to the listener. Perhaps an ideal equilibrium between data clarity and auditory aesthetic is achievable, allowing audiences to have both a pleasant experience and walk away having learned something new.

Beyond novelty, the variable of emotion may contribute greatly to shifting audience expectations in information design. The relationship between sound and emotion warrants significant acknowledgement within any discussion on design and data sonification. Duncan Geere, information designer and creator of the Loud Numbers Podcast (in partnership with Miriam Quick), makes a compelling argument for the capacity of audio to drive emotional response in ways that pure visuals may not ("Telling Stories With Data & Music," 2020). As a case study, he references a sonification piece memorializing individuals killed in the 2016 Orlando Pulse nightclub (Reveal from The Center for Investigative Reporting, 2016). This piece sonifies the life spans of the victims who lost their lives with cycling bell tones that end in unison, the suddenness creating a powerful effect. He states: "This would make a boring visualization — merely the lifespans of some people. But it makes a powerful sonification. Because the sound is experienced through time, you're lulled into a sense of security by the calming repeated rhythms, then comes the shock of all those lives ending at the same time." One can imagine numerous applications for which a simple data visualization simply doesn't have much sentimental punch, where a sonic rendering might do better. Geere explains how an emotional effect can be especially leveraged when a designer takes advantage of the meaning we associate with sound. For example, a designer might use literal sound effects to indicate events occurring, such as a thunder clap or a building collapsing, or use solemn musical tone to indicate data that is perhaps tragic or unfortunate. It has been shown that audio, particularly when it contains characteristics of musicality, has the ability to affect the emotional state of an individual (Bhatti et al., 2016). With design-driven elements, a sonification can convey a message that may last longer in a listener's mind due to the emotional resonance it causes. There are endless ways to embed meaning and association into a data sonification track, and this is something designers should consider with listeners in mind.

5.2 Expanding the Designer's Mindset through Innovative Sonification

As mentioned, data sonification creation is truly a design-oriented process. While designers may feel hesitant to experiment with data-driven audio, they may also find that their training in solution-focused strategy, user experience, iterative testing, and observation will aid them greatly when trying out sonification. With well-established theory and literature on visual design, individuals with this background may feel attached to the visual mode, but also well-armed to try something new to grow their practice. So if visual design theory is well established, what of sonification design theory? As discussed in Section 4, sonification design theory is still in flux, and its goals are still being debated and pondered. Some practitioners state that the goal should could be to convey the overall shape or trend of a data set through

sound composition that equally reflects this informational contour (Campo, 2007), others consider the goal of engaging with listeners in an interactive way, encouraging them to explore the data themselves (Walker and Nees, The Sonification Handbook, 2011: p. 20), and still others offer up the goal of simply catalyzing curiosity about the informational content. But ultimately the hope is to convey a message in a clear and interesting manner. There are innumerable avenues for accomplishing this through audio, and this is where the designer's intuition, expertise, and creativity come in handy.

How can designers begin to open their minds to sonification? There are some existing design frameworks available to aspiring sonification developers. For example, Campo offers a systematic design space map for sonification by defining three axes which need to be identified: x, the number of data points; y, the number of data dimensions; and z, the number of sonic parameters (Campo, 2007). Another tool for sonification design is the Data Sonification Canvas, developed by Lenzi and Ciuccarelli (2024), which defines a set of building blocks to tackle a data sonification composition. This canvas consists of of four primary areas to be identified: (1) Use Case – who are the users and what is the goal; (2) Mapping Choices – the mapping of data to sound; (3) Sonification Approach – does the presentation lean more analytical or narrative; and (4) Listening Experience – how will users listen to the sonification (Lenzi & Ciuccarelli, 2024). Designers may also look to the field of Human Computer Interaction (HCI) for reference, which is deeply immersed in product design processes and has employed sound techniques for innovation. "Sonic sketching" in interaction design offers an alternative to visual brainstorming; designers can use their own voices to convey the nature of data and capture their ideas in sound (Explorations in Sonic Interaction Designs, Rocchesso, 2011). These frameworks provide useful thought processes for approaching data sonification without being so defined as to risk rigidity. Furthermore, they may change and evolve as more designers from multiple disciplines contribute to the data sonification lexicon. Designers can use these schemas to begin thinking about data sonification and develop a new mindset about the possibilities of information communication.

5.3 Unifying Sonification and Design to Break Boundaries and Mutually Advance

The field of data sonification is undergoing a shift towards greater receptivity of design theory, producing an apt juncture for traditionally-trained designers to enter the community. The historically niche and academia-focused field of sonification is broadening to include more design-conscious output, and this change is necessary for a transition towards a more "widely adopted medium" (Lenzi et al., 2020). In the Open Sonifications manifesto, authors Wirfs-Brock, Perera, and Geere call for the expansion of sonification as a creative, exploratory practice, breaking beyond the conventions which have become rigid in dominant sonification

communities (2024). They point out that the conventional goal of sonification has been to provide "analytical insight," and call for an expansion of goals beyond this tradition. These goals include: (1) transform our views and assumptions about the world, (2) engage us in activism, and (3) understand data through self-expression (p. 4). This alternative offering to sonification design is groundbreaking because it dispels the barriers of previous conceptions about the practice, and initiates a perfect moment for designers, artists, and storytellers to embrace sonification as an open, creative form of expression. From the perspective of designers, the use of sonification presents an opportunity for exploration, creativity, and innovation that should not be limited by rigid convention or protocol. The planted seeds of shifting sonification practices are sure to flourish into an unexpected and diverse garden of design outcomes in the near future.

A possible avenue for building a bridge between information design and the unfamiliar realm of data sonification is by combining it with visual methods. Audiences may find comfort in the experiential grounding of an image or physical artifact, bringing their preexisting acquaintance with visual navigation to the experience. With this familiar framework, one may then be inclined to lean further into the piece, absorbing its sonic quality as well. Furthermore, "audio-visual congruent presentation" of information may be particularly impactful on cognitive processing and eliciting emotional response (Pan et al., 2019). While this approach may be tempting to a seasoned visual editor, it runs the risk of limiting a designer's willingness to branch away from techniques familiar to them. Designers should question whether they are truly employing their own creativity and expanding their own concept of information design methodologies.

The synergy between data sonification and design perspective is absolutely essential. Design can benefit from data sonification as a compelling tool of information communication, and data sonification can benefit from design through intentional aesthetic craft. Information designers wield the power to impact audiences with their craft, and this has social and cultural weight. Furthermore, there is an unbreakable link that exists between design and innovation, and the language inherent to design naturally pushes industries forward (Hernandez et al., 2018). Designers seek product solutions with curiosity, implementing new approaches consistently; as such, design-driven output can produce interesting new forms of communication and data representation. Channeling this curiosity towards data sonification can expand the designer's toolbox of iterative, performative, and exploratory design methods. From a user experience perspective, there is great benefit as well – experiencing information through multiple modalities can actually be beneficial for memory retention and an association of distinctiveness (Matusz et al., 2017). Additionally, just as changing one's typical routine can activate the brain in a helpful way, consuming information through

diversified modalities that include audio could ultimately be a more colorful and fulfilling way to experience the world. If designers choose to leverage the power of audio, wielding it with great intention and thoughtfulness, their creative output can certainly help to fortify the synergy of sonification and design.

6. Inclusivity and Accessibility Solutions with Sonification

6.1 The Problem of Exclusivity in Traditional Design

Most often, products are designed with good intent, educational resources are crafted with high hopes, and research projects are shared with enthusiasm – yet almost just as often, these manifestations of design processes are ultimately made without keeping a wide enough range of potential audiences in mind. Conventionally, designers have viewed accessible design as a separate, isolated process for a specific slice of the population. Designers may often fall into intuitive tunnel vision of creating for able-bodied users without fully considering different capabilities across user groups. In discussing a practical approach to inclusive design, Keates et al. point out that even when designers create accessibility-focused products, they focus on disabilities – but for better inclusivity, "principal concern for a designer should be physical capabilities, irrespective of cause" (Keates et al., 2000).

The problem of exclusivity is further exacerbated by evolving technologies, for example when changing user interfaces generate new challenges to users that could get missed in the design phase. In this environment of ever-changing technology, designers might need to further research the subtleties of features and devices that become paired with their product. It could be that designers are creating for the user rather than with the user; exclusivity often arises from a non-participatory process, rather than "a design process where the end user contributes to the development and life cycle of the product or system, through his/her perspectives and needs" (Moreira da Silva, F. 2023). A positive aspect of changing technologies is that more avenues of accessibility are introduced, as we are given access to higher quality screens, speakers, automation mechanisms, materials, communication devices, and beyond. However, with a broader range of possibilities comes the challenge of finding an optimized solution in a potentially overwhelming design space.

As information design outcomes are so often visual, it could be the case that creators are building projects with the assumption that consumers of this information are endowed with sight, or simply presume that solutions for individuals outside of the sighted population are not an option. Where visual representation of information may be exclusive, data sonification can offer a helping hand.

6.2 Sonification for Improved Inclusivity in Design

Data sonification as an accessibility solution can act either as a replacement to visual design or an augmentation of visual design. Approaching the integration of sonification as an augmentation of design may have successful effects for more inclusive solutions, as it considers the extension of design features to welcome in an additional swath of users in addition to pre-existing users. With the lens of design augmentation rather than replacement, and sonification in mind, the powerful combination of audio and visual components should be considered. Auditory graphs, which simultaneously contain both a data visualization component and an accompanying sonic representation of the data, provide an apt example. Imagine a digitally embedded time-series line graph with a call-to-action component that initiates a sonification composition reflecting the same temporal trend. In a 2010 study comparing sighted and non-sighted user interaction with auditory graphs, Walker et al. found that both groups of study participants were able to effectively derive understanding of the data, sharing many preferences in graph design, with certain exceptions across the groups (Walker et. al 2010). This offers another reminder to include users of varying abilities in the design process.

Another example of potential sonification solutions arises in the challenging case of geographical navigation aids and digital cartography design: “Google Maps and ESRI products are the standard mapping solutions for governments, schools, and other institutions (Cal fire, 2019), and they are completely visual,” with highly-limited and expensive auditory alternatives (Biggs, 2019). Biggs discusses a series of studies testing audio-based and tactile map navigation solutions, finding that there is potential to develop truly inclusive “nonvisual navigation experiences,” by combining a “turn by turn navigation solution with a detailed cross-sensory map” (Biggs, 2019). Bigg’s subsequent work features Audiom, “an auditory and text-based dynamic web-based digital map, [which] can be embedded into almost any application or website” (https://www.audiom.net/). Data sonification is applied here as the user navigates the auditory map with keyboard arrows, receiving sonic feedback about geographical placement, directionality, and proximal entities.

Sonification can also be used in the context of science and education to provide accessible, audio-based tools for researchers or students who may not be able to rely on sight to conduct their work. Take the example of the Accessible Oceans project, from the Woods Hole Oceanographic Institution. Senior scientist Amy Bower and a collaborative team of researchers are exploring the ways in which auditory perception and data sonification can be harnessed to improve accessibility in science education and research. In creating several prototypes combining auditory display, sonification, narration, and music,

a goal of their efforts is to “enhance the perception and understanding of ocean data for visitors to museums, aquariums and science centers, including those who are blind or have low vision” (Accessible Oceans, WHOI, 2024). Designing user experiences to include sound is vital to transforming educational environments for improved inclusivity, and data sonification is being used here to achieve that needed change.

Whether one considers inclusivity solutions through the lens of sonification as a replacement for the purely-visual design or an extension of it, the auditory representation of data can transform the outcome of design in a multitude of contexts. Multi-sensory sonification solutions are highly inclusive and ideal in many contexts, as we find with the mentioned examples of audio-visual graphs, multimodal geographical maps, and sonified oceanographic data. But there are also plenty of possible applications for sonification to be used in radio, podcasts, and voice-assistive technology, which can be purely auditory. The goal is to reduce exclusivity in how we design, communicate, and share information. Data sonification achieves this beautifully by including users who are visually impaired or blind.

7. Practical Starting Points, Challenges to Integration, and Future Work

7.1 How Designers Can Get Started with Data Sonification

For designers and communicators interested in getting started with data sonification, it’s best to start simply. It’s helpful to pick a topic that is of personal interest to the designer, and start with a data set that contains just two columns for the x- and y-axis. Due to the fact that the act of listening is inherently temporal, with a beginning and ending (unless an application allows for user interaction and/or navigation), time-based data often works quite well for intuitive sonic output. Thus x will be mapped temporally, and y will be sonified based on the creator’s choices for sound synthesis. However, this is in no way a rule; data can be derived from textual documents, geographical patterns, or other sources that are not linked to time. A designer will also want to think about the characteristics of their sound synthesis; perhaps the sounds implemented will relate directly to the data narrative through metaphor, or perhaps the numbers are mapped to pitch or volume to show a trend. The sonification may be temporally condensed or stretched out over time. It may be calming, or jarring, or musical, or neutral. It may also be helpful for designers to refer to the existing sonification design schemas mentioned in Section 5.2, such as The Data Sonification Canvas, which provides a conceptual framework for solving a sonification design problem.

There are a handful of easy-to-use web tools which allow a user to upload a data set, and adjust parameters to automatically sonify their data. Some of these include TwoTone.io (https://twotone-midiout-beta.netlify.app/), Highcharts Sonification Studio (https://sonification.highcharts.com/#/app), and DataSonifyer (https://studio.datasonifyer.de/en). There are also tools which do require some code but which offer abundant documentation, such as Sonic Pi (https://sonic-pi.net/), Supercollider (https://supercollider.github.io/), Highcharts (https://www.highcharts.com/), and Tone.js (https://tonejs.github.io/). If one is already comfortable using digital audio workstations (DAWs) and audio editors, such as Logic Pro X, Adobe Audition, Audacity, or GarageBand, sonification can be done manually in these editors, or by using a MIDI-generating tool such as csv-to-midi (https://csv-to-midi.evanking.io/) and importing the MIDI file into a DAW.

However, one myth that should be dispelled up front is the idea that "sonification requires computer skills" or even a traditional data set – in actuality, there are plenty of analog and manual techniques for creating sonification projects. In the Open Sonifications manifesto, authors Wirfs-Brock, Perera, and Geere offer up a sonification that only requires one's physical hand and voice: place your hand in front of you, and assign a base note to your thumb that you can sing or hum aloud; then, according to the heights of your other fingers, extrapolate the higher pitched notes; sing each finger in succession and hear how it sounds (2024). Their method highlights the progressive idea that "anything can be a dataset," allowing the sonifier to have a sense of "agency" and empowerment (p. 8).

Finding inspiration by browsing sonification examples also has substantial merit; by gaining more exposure to the work of other sonification designers, it becomes easier to wrap one's mind around what is possible to sonify, and even spark new project ideas. An exceptionally useful resource is the Data Sonification Archive (https://sonification.design/), which currently lists 452 sonification project examples across multiple disciplines. For more artistic applications, one can also explore the Sonification Art blog (https://sonificationart.wordpress.com/). Scouring the internet is also encouraged, as there will always be new examples emerging.

Another helpful step to take in familiarizing oneself with sonification is by connecting with existing communities of practitioners. If more information designers engage with these interdisciplinary communities of scientists, coders, artists, journalists, and beyond, the culture around sonification methodology will inevitably expand and improve. Some currently active communities include the Decibels Community (https://decibels.community/), a Discord-based group sharing ideas and tips about sonification; the International Community for Auditory Display (https://icad.org/), a well-established organization with ample conference proceedings to explore; and the Sonification World Chat (https://sonificationworldchat.org/). The Decibels Community in particular

has also published documentation about how to get started with data sonification. In a domain where paths are not always defined, these groups of sonification enthusiasts provide a welcoming anchor.

7.2 Current Challenges and Limitations Regarding User Experience and Technology

A primary challenge regarding sonification and user experience is that audiences may desire comfort and familiarity when it comes to information consumption. Social media scrolling has become a highly-familiar method of engaging with content, and users may not always have the patience or interest to listen through a data sonification. Many users also consume informative content in public, not necessarily wearing headphones or earbuds, and keeping their phone on silent. In this mode, they might miss a sonification entirely. This also highlights the attachment to the visual modality – most social media platforms are highly focused on visual presentation, which would require the combination of audio and visual components for sonifications to be shared on these platforms. What would make audiences more interested in and comfortable with listening to sonified data? It may come back to the hands of the designer to make the content fun, interesting, and even surprising in order to engage the user. Additionally, as social network platforms continue to evolve, there may be more opportunities for audio-focused content. The domain of podcasting also presents a promising opportunity for sonification to become more familiar for audiences, as more and more people listen to news, interviews, stories, and more in podcast form.

Another challenge for the sonification community is the transition out of the highly academic, analytical approach that dominates sonification practices at this juncture. Many sonification projects have been made by and for listeners within academia, and this excludes a wider population of artists, researchers, and communicators from other disciplines who could make great contributions to the field. The language around sonification needs to evolve, so that it can become more relatable to a wider audience. It could be helpful to develop more analogies to help people understand what sonification is, and adjust the definitions of sonification to be more welcoming to a wider range of creators.

Another challenge to the sonification creator is the transition from tool output to final presentation. For example, tools such as TwoTone.io, DataSonifyer and Sonic Pi require that the designer record or export an audio file, but then it is up to the designer to integrate this file into their final project. This adds another layer to the process which requires more effort and creativity. Creators who are comfortable with audio editing may easily weave an audio file into a podcast or sound art piece, but there are limited options when it comes to deciding how to embed audio into a webpage, for example. Audio-visual tools such as the Highcharts Sonification Studio allow for video export,

but lack the feature of embeddable code for chart integration into a webpage, requiring the user to find a workaround. The full Highcharts library allows users to embed audio charts directly into a webpage and endlessly customize dimensions and visuals, but this requires knowledge of front-end web development, which designers may not necessarily have in their skillset.

Another challenge for user experience is related to the quality of audio that is emitted from technological devices. It is common to listen to audio through phone or laptop speakers, but these may not always capture the subtleties of a sonification composition. Headphones are ideal in order to notice adjustments in audio parameters such as stereo image movement, variations in tone and texture, and so on. Designers may feel constrained around sound synthesis choices if they expect their targeted audiences' method of content consumption to have subpar audio quality. As the caliber of speakers, headphones, and earbuds continue to improve, this may be less of an issue in the future.

Additional tool development is needed to make sonification easier to integrate with a wide range of digital platforms. The existing web applications have limited features for exporting projects, and this presents a significant obstacle for accessibility and platform integration. Tools need to be relatively easy to use, while still maintaining customizable features for creating a unique sonification. Tools need improved integration features so that designers can more easily embed their projects into web pages and social media platforms. Designers may also need to try a variety of methods that do not depend on web applications. For example, they could include their own acoustic recordings, define their own parameter mapping functions, and/or use digital audio workstations to edit sound manually. In this respect, the current limitations can be considered beneficial, incentivizing creators to use more creative methods for data-driven audio.

7.3 Future Work and Applications of Multimodal Design

Data sonification practitioners and researchers are exploring what the future could sound like, and how data sonification may arise in our world of emerging technologies which are ultimately intertwined with design practice. For example, Jordan Wirfs-Brock points to voice assistant technology as a pertinent application for data sonification, exploring the prospect of voice assistant devices help you to sonify one's emotional states, log them over time, and reflect back to cultivate a deeper understanding a data set derived from personal experience (Wirfs-Brock, 2021). Wirfs-Brock's research also explores design prospects for voice assistant technologies to interpret personal music streaming behavior through data-as-sound, revealing possible personal informatics insights and new design solutions (Wirfs-Brock, 2020). Another future application of data sonification in the realm of design could be

in the context of educational art museum experiences. Through implementations of augmented reality, researchers Dam et al. have examined the effects of sonification as a supplement to the visual art experience; generating an algorithm-created sonification to accompany a series of paintings from the genres of Abstract, Impressionist, Realist, and Renaissance (Dam et al., 2024). They found that the experience produced the most positive user feedback, improving sentimental reaction and increasing engagement. A particularly promising future (and present) application of sonification is in the realm of data journalism, which has already witnessed an array of impactful sonification examples in publications, podcasts, and radio shows. In publication form, consider "Nine Rounds a Second: How the Las Vegas Gunman Outfitted a Rifle to Fire Faster" from The New York Times (https://nyti.ms/3D8Ie4A). This data sonification shows the speed of the 2017 Las Vegas shooter's outfitted weapon, as compared with a fully automatic weapon . In podcasting, consider "The Natural Lottery: Betting on climate change at the end of the Earth," from Loud Numbers: A data sonification podcast (Geere and Quick, 2021: https://www.loudnumbers.net/). This data sonification takes foreboding climate data and turns it into a techno track. And in radio, consider "What sound does a volatile stock market make?" from Marketplace (Wirfs-Brock, Ryssdal, and Fam, 2020: https://www.marketplace.org/2020/03/31/the-sounds-of-a-volatile-stock-market/). This piece is a 12-second sonification of the stock market from Jan. 2, 2020 to March 27, 2020, where each second represents a week of trading. These examples demonstrate how effective sonification can be for a method of data-driven storytelling.

Further research and discussion is needed to understand how design and data sonification can mesh further, with particular need to study the impact of design-oriented data sonification on listeners. As the small field of data sonification expands, and designers continue contributing to this field, there will be more diverse and expansive access to a range of sonification projects whose success can be studied. Designers should explore the relationship that their intended audience have with audio as a format for information consumption and communication, keeping it in mind as they explore the realm of data-driven audio. This paper addresses a selection of previous research endeavors investigating the link between design and sonification, and calls for these research efforts to continue. It addresses the excessive reliance on visual modalities in the field of design, which has created a rigid attachment to this format. It calls for a shift away from the purely-visual, pointing out the power of design-conscious audio arrangement to stir audience emotion and idea retention, encouraging designers to apply their expertise to the method of sonification. It argues that data sonification has the power to shift audience expectations, expand the designer's mindset, and break boundaries in the realm of design through innovative practices. It addresses the benefit of sonification for accessibility and inclusivity, and the capacity

for this method to break down existing barriers of exclusivity in design. Finally, this paper offers practical starting points for designers to start creating sonifications, including theory, tools, and community; it also addresses distinct challenges of sonification and speculates about future work in the field. Data sonification is an emerging method that requires design-conscious thought, creativity, and experimentation. As shown in previous work, it has the power to resonate with audiences and to convey profound meaning. Information designers are sure to benefit from using this unique method, and in doing so can expand the field of design as a whole.

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“PLACES TO LEARN — CULTURAL HERITAGE ENRICHMENT MODEL (CHEM) FOR TRANSFORMATION AND INNOVATION THROUGH ART AND DESIGN”

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ABSTRACT | Places to Learn - Cultural Heritage Enrichment Model (CHEM) is a conceptualisation, a practical design tool to enrich the cultural heritage features and narratives of selected places through art direction, digital and tangible design, and Culture and Creative Industries (CCI) involvement. In addition, CHEM offers a solution towards better-functioning places that are aligned with the regenerative, e.g., ecological approach in design; vibrant places filled with design and art that are citizen and user friendly.

CHEM consists of four parallel digital and tangible design-research inquiries, based on culture-led innovation methods: first, to identify and analyse cultural heritage and shared values as constitutive elements of the vision of the place, and second to understand, interact, co-design and transform with a process of culture-led regeneration.

CHEM is replicable, transferrable and scalable to different contexts and cultures on small, medium and grand scales. It enables sustainable growth with CCIs and invites investment and tourism in the revitalisation of cultural parks, urban spaces and other sites of interest characterised as Places to Learn (P2L), enabling them to flourish.

KEYWORDS | PARTICIPATORY DESIGN, CREATIVE INDUSTRIES, SUSTAINABILITY, DIGITAL NARRATIVES, COMMUNITY ART, CULTURAL HERITAGE, TRANSDISCIPLINARITY

1. Introduction

CHEM design-research inquiries focus on unique regional cultural heritage narratives and items, converting them into digital and tangible design artefacts, which engage both the local citizens and entire ecosystem of CCI. CHEM enhances the attractiveness of heritage sites, urban districts and other Places to Learn (P2L) to visitors and investors. It also increases the sense of belonging and social inclusion among local citizens; furthermore, it integrates P2L into local ecosystems as vibrant places for cultural activity, learning, socialising, exercising and spending time with others through culture-led regeneration (Della Spina, Giorno, Galati Casmiro, 2019). These places become vibrant places to enjoy and to experience the four realms: namely, adding aspects of aesthetics, entertainment, education and, to a certain extent, art, as an imaginary escapism value to the places in a balanced and appealing manner (Pine, Gilmore, 2011). Each of the four specific design-research inquiries in CHEM produce tangible and digital artefacts, such as murals, active design elements, public art, installation art spiced with digital elements, digital narratives and characters in physical space, mixed reality production, cultural heritage routes with augmented and mixed reality elements and other innovative outputs that have a state-of-the-art quality.

When the art and design direction provided by CHEM is applied to its full potential, various actors and stakeholders benefit from the mutual flourishing of P2L. In many places and settings, CCI possess a tremendous unused potential in their capacity to offer meaningful contents for each place, regardless of the places' socioeconomical status (Della Spina, Giorno, Galati Casmiro, 2019). Cultural institutions, together with associations, cooperatives and design universities, can enhance the originality of places by advancing enriched cultural heritage that is visible on urban sites, inside art institutions and museums, as well as in outreach programmes and site-specific projects by museums and other cultural institutions (Stylianou-Lambert, Boukas, Christodoulou-Yerali, 2014).

By Places to Learn (P2L), CHEM refers to any public places that can manifest the cultural heritage lineage and legacy, e.g., libraries, shopping centres, parks and any heritage sites of interest. By adding public art, regenerative approach and active design to P2L, new forms of art intervention and functional design products with artistic touch emerge, such as drinking water fountains and electrical cabinets with decorations, any informative boards that can be enriched by artistic designs' visualisations, icons and symbols. Building facades invite art in the form of murals or digital art, especially in the dark months of the year; public parks and marketplaces can become playgrounds for young designers, performing artists and visual artists through collaborations and open competitions.

2. CHEM model transmitting cultural meaning, increasing attractiveness and strengthening the sense of belonging

The four lines of inquiries are based on the latest knowledge, and they enable achieving the expected outcomes within the timeframe of four years (48 months). The purpose is to engage local communities and citizens, especially youth – representatives of the limitless generation, who live and work in the mixed hybrid online-offline setting, through invitation to participate in community arts, drama-based pedagogical and service design workshop. This engagement aims to produce, devise and gather data that inform the four innovative design-research inquiries (sub-objectives, cultural-led innovation, models).

Design-research inquiries refer to complex design processes that are grounded in transdisciplinary research and culture-led innovation:

1. Active design elements in urban spaces aligned with regenerative design principles.
2. Cultural modular design inquiry realised with circular materials in urban spaces.
3. Re-imagining the past through digital storytelling (VR, AR, MR).
4. Installation art with digital elements (digital & physical interact).

CHEM integrates the three core principles of the New European Bauhaus (NEB), sustainability, inclusion and aesthetics, into the design-research inquiries. NEB is an EU policy and funding initiative launched by the European Commission in 2021. It fosters sustainable solutions for transforming the built environment and lifestyles under the green transition (European Union, 2021).

CHEM structure is based on a pedagogical model which consists of several interlinked inquiry processes and ways of knowing, in which the participants co-design by processing information and data to generate artefacts, knowledge objects and design products in both digital and tangible format (Haapaniemi, Leinonen, 2023). In the original model, all the inquiry types, the art-based, design-based, drama-based and technology-augmented inquiry processes, together contribute to the collaborative knowledge construction,

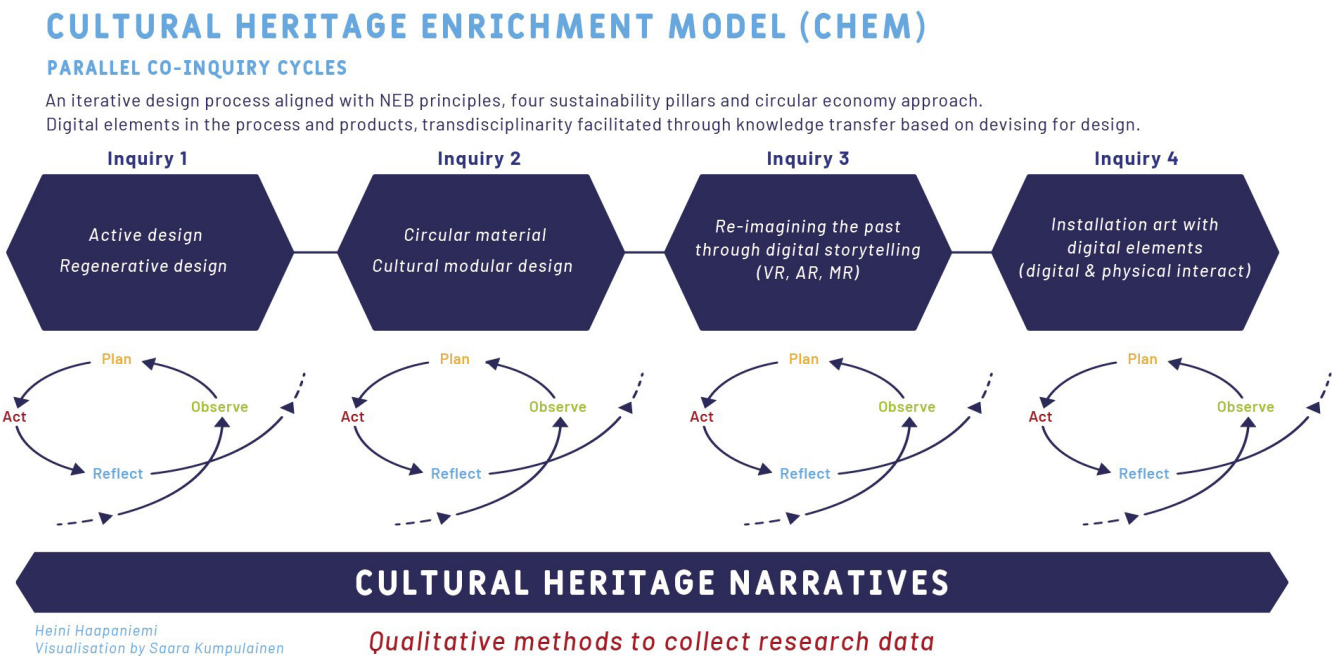

Figure 1. CHEM Parallel Inquiries, preliminary model modified from Haapaniemi and Leinonen (2023).

similar to the definition of progressive inquiry, "a pedagogical model for structuring and supporting a group of learners in a deepening questionexplanation process", peculiar to academic research groups (Haapaniemi, Leinonen, 2023; Hakkarainen, 2009). The separate, yet parallel and simultaneous, inquiries have dynamic influence on each other, yet they are four distinguished ways of constructing knowledge and co-designing: first, acquiring and processing knowledge and second, co-designing in a participatory and interdisciplinary manner (Haapaniemi, Leinonen, 2023). CHEM employs collaborative, participatory and art-based methodologies to inform design. Utilising a non-linear and iterative approach to address complex design challenges enables reflective practice in three dimensions of reflection-inaction: first, prior to designing; second, while designing; and third, after the design action, before the next loop begins (Haapaniemi, Leinonen, 2023; Schön, 2017).

Recurring iterations are characteristic of design processes. As explained in Author's model, each single co-inquiry cycle has, in reference to Heron and Reason, a pattern of Observe–Plan–Act–Reflect (Heron, Reason, 2002, p. 167 as cited in Khaner, Linds, 2015, p. 134), which has also been utilised as the bases of CHEM. Planning artistic and design direction entails thorough research on issues identified in the Observe phase and choosing the best methods to elicit more knowledge on the challenge or task at hand. Without first observing, studying the context and defining the problem, the shift to planning is not possible. Establishing criteria and considering enabling constraints are part of the Planning phase, which steers the Action phase.
The Action phase is based on a selected approach aligned with the methodology, which then leads to reflection on the process and its outcomes. Reflection can contain a comparison of alternative solutions and lead to another loop or stage with more complexity

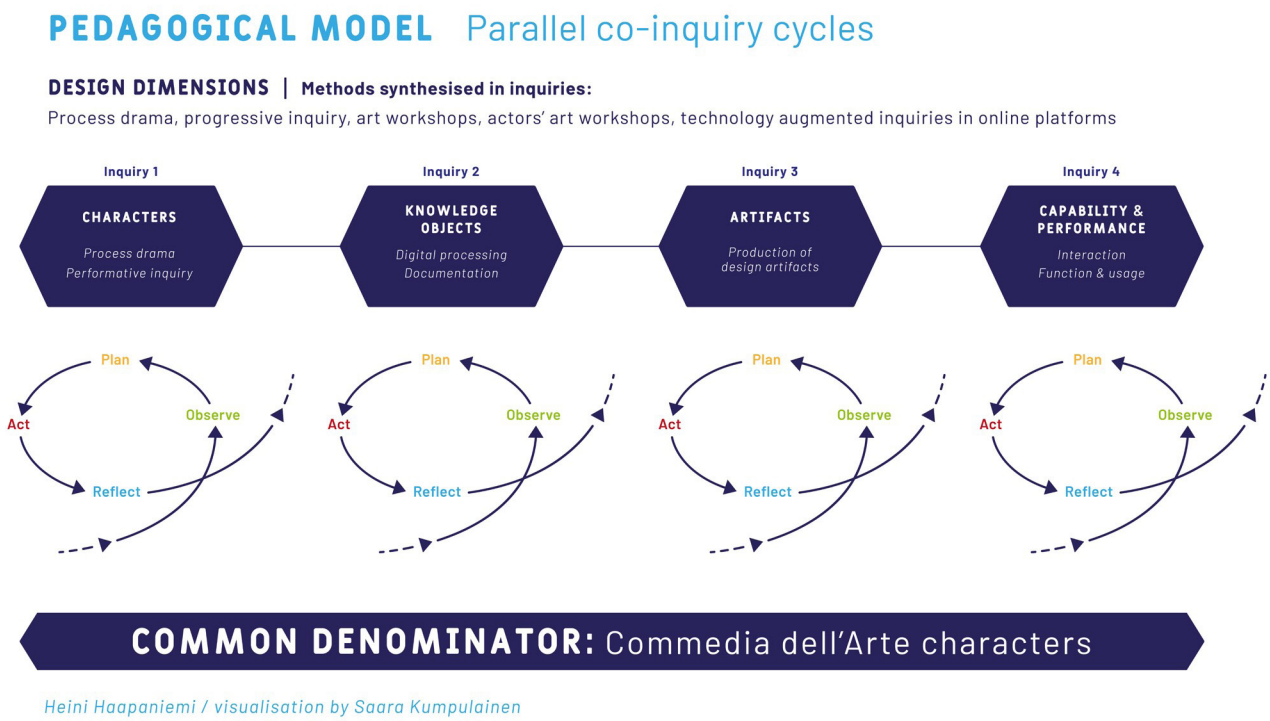

Figure 2. The Pedagogical model: Parallel co-inquiry cycles with four distinctive inquiry types and the common denominator Commedia dell'Arte characters as described in Haapaniemi and Leinonen (2023).

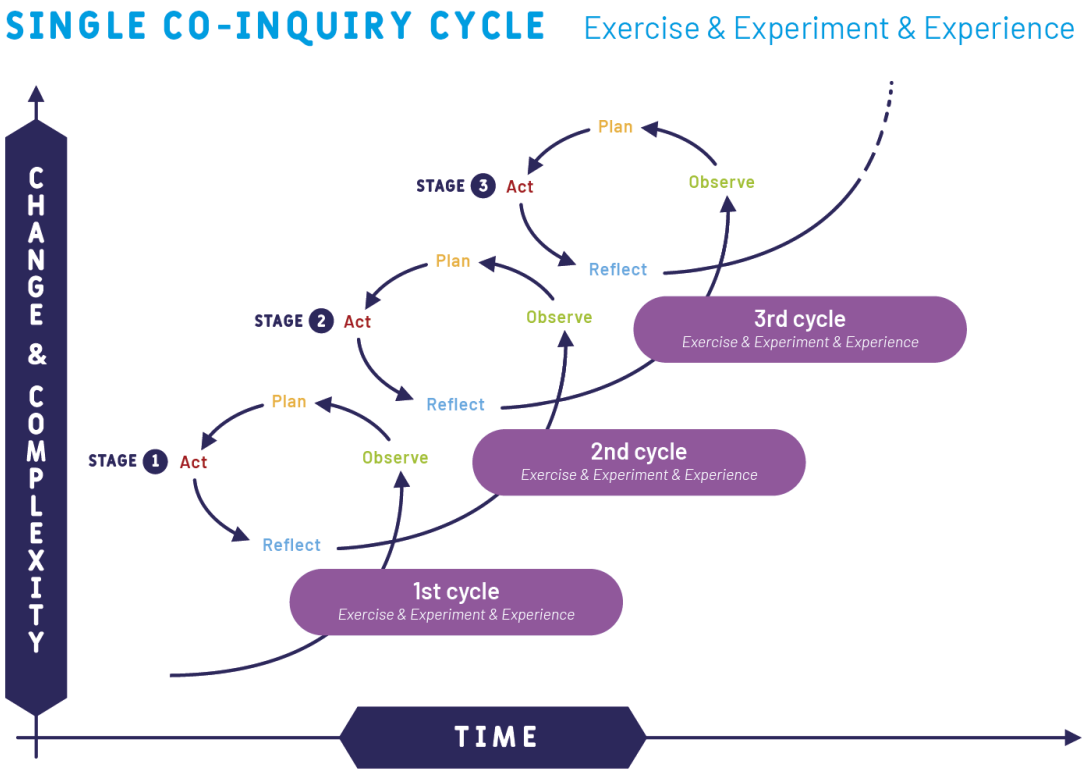

Figure 3. The iterative nature of a single co-design inquiry as visualised in Haapaniemi and Leinonen (2023).

based on the previous findings in the iteration cycles (Haapaniemi, Leinonen, 2023).

The model identifies three major components within the single 3E-inquiry cycles: Exercise, Experiment and Experience. The entire process acquires complexity as each single inquiry cycle enters the next loop of Observe–Plan–Act–Reflect (stage 1, 2, 3 and so on), and more time and resources are allocated to the process. For each stage, more time is invested in the knowledgebuilding activities based on the previous findings, prototypes, artefacts or other design outcomes (Haapaniemi, Leinonen, 2023).

Key features for impact in the model are collaborative co-design, multiplatform, multisensory, embodied art and design processes that acknowledge participants as active contributors in constructing knowledge together, and it uses technological platforms to enhance designing practices and iterative processes (Durall Gazulla, Bauters, Hietala, Leinonen, & Kapros, 2020; Friedman, 2003; Hakkarainen, Viilo, Hakkarainen, 2010; Hakkarainen, 2009; Hakkarainen et al., 2004). Focus is given to team processes and practices where interdisciplinarity, multimodality and embodiment are seen as a natural element of constructing knowledge, as the participants' mind and bodies react to relational experiences and work as a reference on how they might interpret them, first, in the design challenge and, second, receiving them in the future (Khaner & Linds, 2015, p.147). These generated realms of experiences are of utmost importance in promoting cultural sustainability: the ability of imagining someone else's experiences, interpreting their responses and feeling empathy – qualities and features at the core of transmitting cultural meaning and relevant cultural heritage narratives in the form of experiences (Laine, 2016; Pine, Gilmore, 2011). The significant stories become accessible through co-creation of digitally enriched installation art, digital narratives and mixed reality productions, as well as performances and visual artwork.

3. Replicability and transferability of CHEM

CHEM is replicable and transferrable to the versatile places of interest –P2L– and their multifaceted and diverse needs. CHEM provides a tool to intervene, reactivate and save the cultural heritage sites and their narratives at a reasonable cost, preserving them for future generations as cultural venues, attracting investment, and ensuring their reuse and preservation for the future, aligned with sustainability principles. CHEM activates the entire community through art-based methodologies to transform unique cultural heritage to high-quality design content, digital and tangible, to enrich the place, ensuring its appeal for tourists and investors.

Cultural heritage can be defined as the legacy of physical artefacts (cultural property), built and natural environment, and intangible attributes of a group or society inherited from the past. Old industrial sites, urban heritage sites and other P2L hold cultural significance for local communities and

tremendous potential for tourism as creativity hubs. Preserving the uniqueness of the P2L is very timely, otherwise they lose their tangible and intangible heritage aspects as the places deteriorate.

Built environment heritage sites include a variety of canals, mines, breweries, potteries, forges, railways, cotton mills, as well as industrial, urban and rural sites. These sites tell us as much about our heritage as celebrated archaeological sites, cathedrals and castles do. UNESCO World Heritage inscriptions number 1 199 across 168 countries (2023). The World Heritage Committee approved the extension of five sites and examined the state of conservation of 263 sites that were already inscribed in their 45th session, in September 2023, in Saudi Arabia. Historic England lists over 5 000 "at risk" heritage sites, representing a rise of 24 in 2023 compared to the previous year. According to the Finnish Heritage Agency, nationally significant built cultural heritage sites are located around the country, and the number of cultural environments exceeds 1 200, listed in the Finnish inventory of built cultural environments.

4. The four pillars of sustainability: the green shift and regenerative design

CHEM aims to foster cultural connection and social cohesion, aligning with the New European Bauhaus (NEB) principles and sustainability principles in four dimensions: cultural, social, economic and environmental, which are made visible and tangible at each step of the design procedures. The sustainability and responsibility efforts of universities, as well as cities and communities, are guided by the UN's Sustainable Development Program, Agenda 2030, consisting of 17 goals set collectively by the UN member states. The Agenda 2030 emphasises the interdependence of the goals and is the same for all countries, regardless of their developmental stage. Agenda 2030 recognises the importance of education and RDI activities in facilitating necessary changes. Currently, the four pillars of sustainability include dimensions of cultural, social, economic and environmental sustainability. Today, culture is included in many of the United Nation's Sustainable Development Goals (SDGs) from 2015: for example, safe and sustainable cities, reduced inequalities, gender equality, and peaceful and inclusive societies. Although the goals are grouped around the economic, social and environmental pillars of sustainability, culture contributes horizontally to each pillar. Further, economic, social and environmental pillars assist the development of cultural heritage and creativity (Hosagrahar, 2017).
Culture has both direct and indirect roles in sustainability, as proposed by researchers Soini and Birkeland (2014), after analysing scientific discourse on cultural sustainability. As summed up by UCLG (2018): "Cultural rights, heritage, diversity, and creativity are core components of human and sustainable development." Cultural perspectives have been recognised in sustainable development research with significant importance. Art,

design and culture are seen as significant dimensions in understanding major societal issues, such as sustainable development (Lewis, 2020; as highlighted in the British Council's research report, The Missing Pillar, British Council 2020; Hosagrahar, 2017; Lineberry, Wiek, 2016).

CHEM promotes social sustainability through participation in workshops, increasing inclusivity in cultural events and encouraging innovative approaches to heritage preservation. Sustainable practices are demonstrated by showcasing how investments in cultural heritage and CCIs promote sustainable methods, such as the adaptive reuse of historic buildings, integration of renewable energy and hosting of eco-conscious cultural events. Inclusive cultural engagement means ensuring that all events and workshops are accessible to diverse audiences. Social sustainability can be strengthened by championing cultural and social inclusivity, as well as celebrating and endorsing various minorities, marginalised groups, subcultures and indigenous heritages.

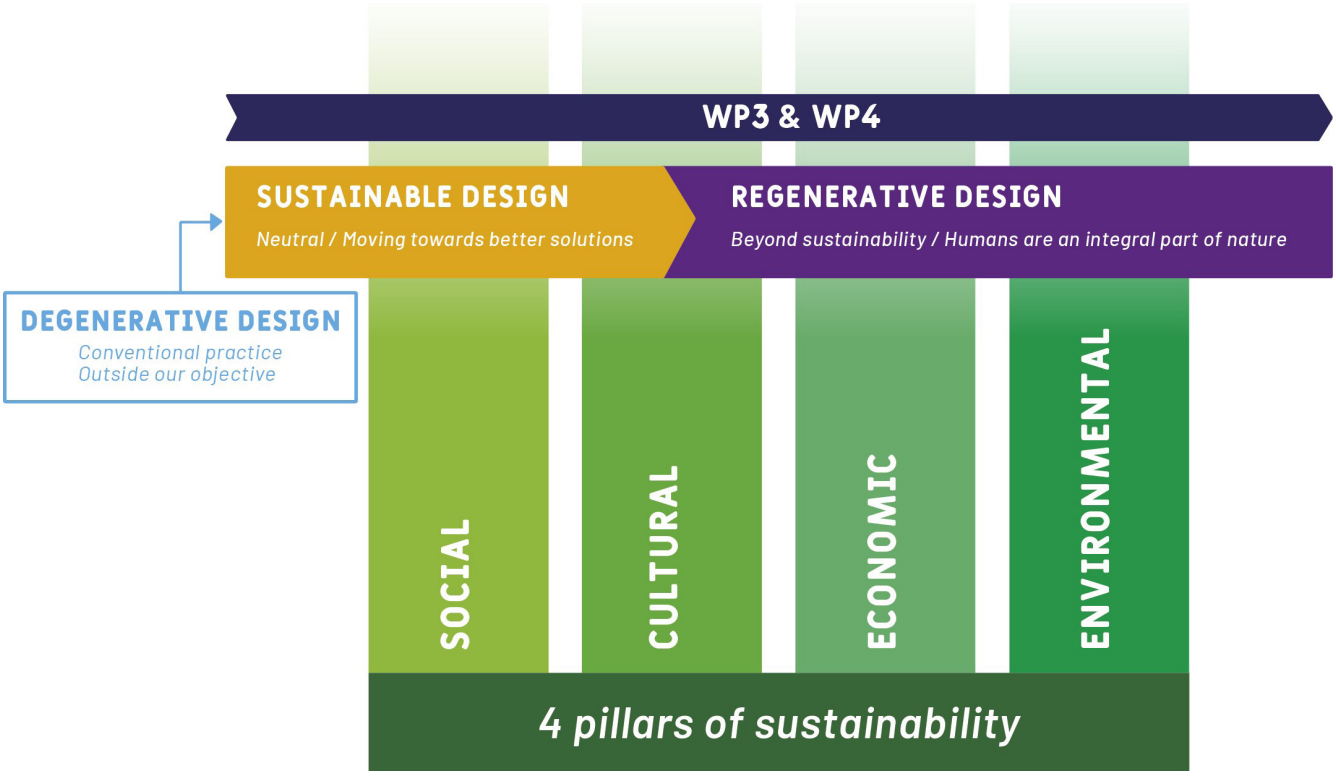

Figure 4. Regenerative design to address the 4 pillars of sustainability and reach beyond sustainable design by Haapaniemi, Kalmakurki, Savallampi and Vainio, visualisation by Kumpulainen.

In accordance with the Green Shift, emphasis in CHEM research design inquiries is given to ecological thinking and circular ideology in all four inquiries, particularly in applying them to the tangible, material elements of heritage-related design. Cultural modular design-research inquiry in CHEM realised with circular material highlights the importance of site-specific environmental factors. By moulding and prototyping with circular and recycled materials, the aim in CHEM is to reduce the carbon footprint by 70%. As a response to the climate crisis, the European Union is taking action and striving to become carbon neutral by 2050 (European Parliament, 2019; 2021).

Regenerative design encompasses the green shift and goes beyond the sustainable design principles (Cole, 2012). The principles of environmental sustainability are both a fundamental value and an integral part of CHEM processes, and the measures cut across the four dimensions of sustainable development horizontally. The goal is to move from sustainability towards regenerative design and development, where local actors, such as administrators, policy makers, CCI, entrepreneurs and citizens, are activated to implement the sustainability principles. Furthering reuse and recycling of materials from building processes and urban value chains, often referred to as "urban mining", reuse of architectural components and waste materials from other industries can all contribute extensively to local resource efficiency (Baiani, Altamura, 2022). These processes are integrated in CHEM in the Cultural modular design inquiry realised with circular material in urban spaces utilising demolition waste, replacing cement in construction with a Finnish circular-design-leading company, EcoUp (product Cubeco) and design universities' research units, BioSampo, Kymilabs and Creative Industries Research Unit, Xamk with design-research partners from France.

5. Transdisciplinarity, impact beyond academia and state-of-the-art CHEM

Transdisciplinary knowledge production includes non-academic stakeholders, together with various disciplines in academia, to address wicked problems and societal challenges to produce impact beyond academia (Caniglia et al., 2017). Transdisciplinary research produces knowledge that goes beyond the existing disciplines (Morton et al., 2015). It often draws from and contributes to hybrid fields that emerge around particular complex issues (Klein, 2017), such as sustainability in design and social engagement, as well as preserving cultural heritage in digital and tangible format with new interpretations and understanding of what heritage is. According to Seidl, it embodies a mission of science with society, rather than for society (Seidl et al., 2013); and it creates socially robust knowledge (Nowotny et al., 2003) by building on established methods to produce reliable knowledge. Transdisciplinary design research generates new networks and connections with societal impact. Therefore,

the transdisciplinary approach fits well with wicked problems that include elements of green transition and cross-innovation, also in a design context (Ferreira, Duxbury, 2017; Oliveira, 2016). Transdisciplinary research tackles transformations that involve versatile operators and horizontally cuts across the whole of society.

Service design helps find solutions with an optimal balance for all involved – organisations, entrepreneurs, customers and policy makers (Stickdorn, Schneider, 2012). Operational models, such as CHEM and the pedagogical model, are created in a systematic, solution-oriented and holistic manner, with special focus on design-related inquiry loops that are iterative, reflective and aligned with participatory design principles that foster co-development, co-design and user-centredness (Haapaniemi, Leinonen, 2023).

The integration of participatory art, design and co-creation methodologies in cross-innovation and urban development emphasises the significance of both the CCI and community involvement in designing appealing, aesthetical and regenerative urban spaces (Ventre, Cerreta, 2023; Ferreira, Duxbury, 2017; Oliveira, 2016). Cultural memory can be reactivated and reconstructed through digital storytelling that highlights the impact of immersive technologies (VR, AR, MR) in enhancing the understanding and engagement with historical and cultural heritage narratives (Fu, Mahony, Liu, 2023). Physical and digital spheres co-exist in immersive, three-dimensional installation art, highlighting the fusion of the two realms the public spaces to address the fragments of time; echoes of the past, the current time and transformations to the future, through new communication and interaction concepts for transformative experiences in 3D spaces (Tian, 2023). State-of-the-art technology in CHEM refers to incorporating innovative technologies, such as hologram-like digital characters, AR, VR and MR, and digital platforms, tools and processes to create digital design and multimodal installation art. The digital products, the process charts and the final models are deposited in the EU digital repository, the European Collaborative Cloud for Cultural Heritage (ECCCH), to give everyone access to the knowledge and data produced, aligned with the open science principles.

CHEM also investigates how digital technologies influence visitor engagement at heritage sites, emphasising the role of informal learning in enhancing visitor experience in the digital era and highlighting the shift from traditional methods of engagement to more interactive, digitally enhanced experiences, making heritage more accessible and engaging (Wang, 2022). To ensure state-of-the-art conservation, preservation and distribution through digitality, with ambitious maintenance of cultural richness and versatility in the digital age, CHEM includes a sub-framework of Cultural Heritage Information Systems (CHIS) to investigate user experience in relation to digital design processes and products, such as digitally enriched artefacts, objects and mappings.

6. Methodological framework of CHEM

To define the cultural heritage uniqueness of each place, data-gathering methodologies follow artbased, community engagement methods, aligned with ethnographic participatory-design principles, action research and creative, critical, communal and conceptual practice of inquiry (Blomberg, Burrel,
2009; Blomberg, Karasti, 2012; Robertson & Simonsen, 2012; Spinuzzi, 2005; Ventre, Cerreta, 2023; Thiollent, 2011). By engaging the community with CCI and art-based methodologies in collecting stories, devising narratives and gathering data to inform tangible and digital design, and installation art in public places, the transforming potential of art is acknowledged (Tian, 2023; Ventre, Cerreta, 2023; Wang, 2022). Participatory design and action research have been widely used in contexts where action, testing, observing, piloting and designing take place simultaneously in an iterative process (Blomberg, Burrel, 2009; Blomberg, Karasti, 2012; Somekh, 2005; Thiollent, 2011).

Participatory social research is an essential component strengthening the co-creation of knowledge. This involves diverse groups of citizens in the processes of shaping the memory and future of places (Laborgne et al., 2021; Lewin, Somekh, 2011). Participatory social research aims to link cultural heritage, the activities of artists, designers and activists, with the practices of cultural participants. These are mediated by art workshops and co-design inquiries and integrating the historical and social knowledge of the places being developed with the cultural expectations and practices of those involved. The criteria for rich data collection in CHEM consist of the following:

1. The quality of the artistic idea for the Cultural modular design realised with circular materials in urban spaces
2. The participatory dimension of the project – the inclusion of both residents and CCI representatives on an equal basis
3. Inclusiveness of the project
4. NEB principles integration: beautiful, sustainable, together
5. Usability for cultural heritage enrichment

The data collection phase is divided into two complementary phases. The first focuses on the critical analysis of the past of the places and processes involved in the project, to engage and integrate historical sources and wider stakeholders associated with the places and practices being developed. The first stage comprises of historical analysis, identity reconstruction and defining the genius loci for the selected cultural heritage areas. Both critical and participatory research techniques are used, including historical queries, expert interviews, scenario-workshop analysis, sentimental (meaning) mapping workshops with artists and stakeholders, to discover

and define the uniqueness of the cultural heritage of these forgotten cultural sites and the art and design practices attached to them. They can be used to learn about important moments, people and practices that define the memory of these cultural heritage areas. The process identifies not only important historical aspects and heritage moments, but also their current perception, impact and attributed meaning. The methods are complemented with art and drama workshop-based inquiries. Second, a methodology of social laboratory brings techniques and approaches of science and technology studies into the cultural realm, as researchers critically engage in the process of prototyping, production and implementation of the artistic interventions (Thiollent, 2011).

Participatory co-design, with an ethnographical approach, is used by conducting a hybrid, ongoing evaluation, seeking knowledge, skills and values flows between the involved actors, techniques, places and things, and to explore how the four pillars of sustainability (human, social, economic, and environmental) are defined and present during the artistic intervention process (Blomberg, Burrel, 2009; Blomberg, Karasti, 2012). The objectives of these phases are to ensure that the final culturalheritage-inspired design objects or products produced will entangle the cultural past with knowledge, skills, expectations and impressions of the various actors involved. The social-laboratory phase is concluded with a reflective meeting with the participants of the artistic interventions, to explore their perspective on the process. The final stage explores the impressions, perceptions and experiences of cultural-heritage-inspired artefacts among the audience (Pine, Gilmore, 2011).

Drama methodologies, led by professional drama pedagogues, seek to challenge the status quo. They imagine new possibilities of engagement, venturing across past-present-future boundaries of creative exploration and motivate fruitful dialogue (Dunn, 2016; Fels, 2015; Winston, Lin, 2015). Drama methodologies invite versatile social, cultural and political voices, unity, resistance, and creative presence inspired by the sites in which the data is collected (Ipid). Thus, the essence, narratives and aesthetics of each place are filtered through strong embodied presence. Engagement in these inquiries invites, challenges and questions the social and individual practices of participation. It seeks to voice new ways of engaging visitors and citizens alike and to understand who they are as individuals and as a community. Community Art focuses on artists' work with local inhabitants within that community, living in a specific place and building their identity around it. Community art strengthens the social fabric by activating the cultural heritage lineage and local stories derived from the community. The artist's task is not individual creative expression, but instead to serve as a facilitator, empowering and engaging the community, combining a participatory aspect with high aesthetic and artistic quality.

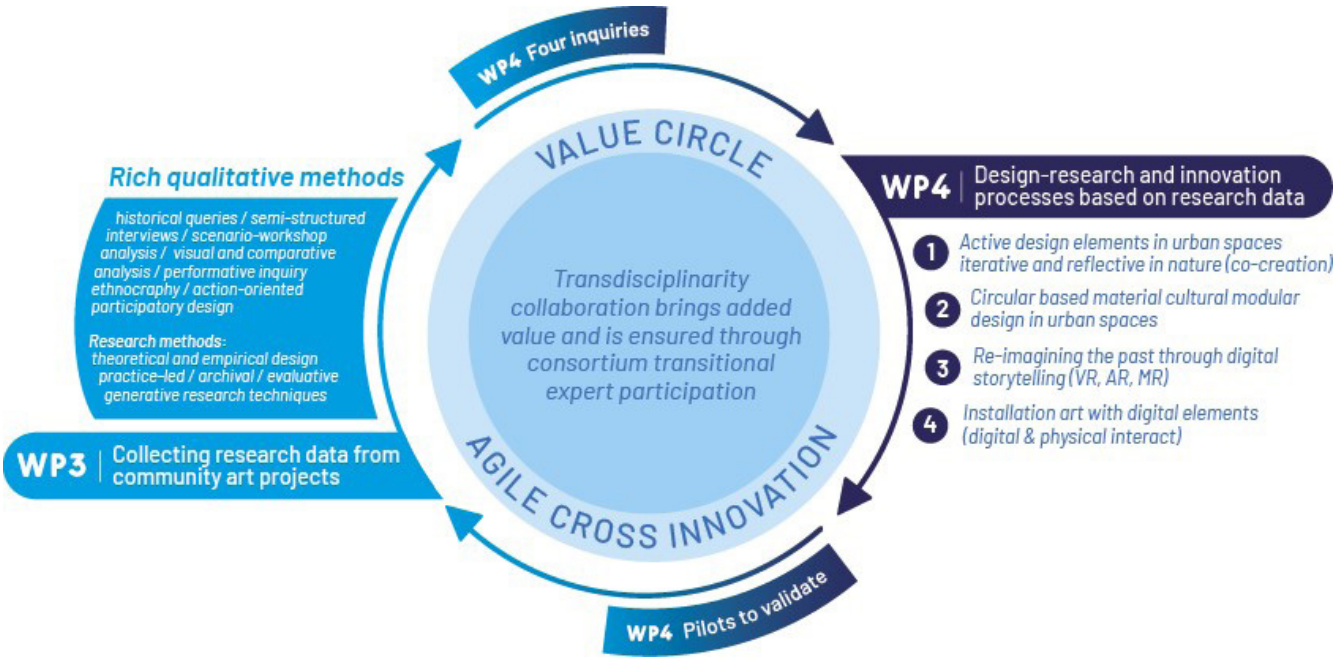

Figure 5. Value circle of the iterative process, where data collection and design-research inquiries intertwine by Haapaniemi, Kalmakurki and Vainio, visualisation by Kumpulainen.

The research-design inquiries are based on an interdisciplinary approach that encompasses the new advanced technologies, design, visual and performing arts. These are aimed to create a new ecosocial imagination for society, without distinction of race, gender and background, based on cultural heritage, a sense of belonging and site-specific dimensions. Iteration rounds for research-design inquiries, instead of a strict linear process, enable reflective lingering with the materials, forms, medium and the entire interdisciplinary co-design team, as CHEM pursues to have a wide spectrum and understanding of cultural heritage with indigenous nuances all transformed into products and artwork (Schön, 2017).

7. Ethics, gender balance, inclusion, diversity and representativeness

High ethical standards are consolidated by all parties participating in CHEM, in all phases of the activities, from collecting and devising the cultural heritage data through art-based methods, until the end products are exhibited. Informed consent from participants is requested prior to participation in the workshops. All participants' identities are anonymised, whether community art, drama pedagogy, ethnography, semi-structured interviews or observation. Preliminary data are stored in the cloud services, which require a two-factor authentication. When the cultural heritage data have been categorised, analysed, grouped and duly anonymised, it

will be stored in the ECCCH in accordance with the open science principles.

Gender balance, inclusion, diversity and representativeness are enhanced by creating a democratising, inclusive and polyphonic space for critical dialogue about the cultural heritage narratives of the past and their relevance today and in the future. Emphasis is given to inclusive stories evoked in compliance with equality and non-discrimination guidelines to provide representativeness, inclusion, diversity and ensure accessibility. On-site activities, exhibitions, community art and codesign workshops are organised at a low threshold, with free entrance to public places and cultural associate partners' premises. This promotes social and cultural inclusion, diversity and accessibility, as everyone is welcome to participate - different age groups, disabilities, minorities, cultural and language groups, genders including non-binary and transgender people, various local or global subcultures and marginalised people.

Societal resilience is promoted by strengthening the local cultural heritage narratives and providing a way for individuals and groups to express themselves and be heard, fulfilled and validated, not through commercialism but in deeply meaningful and valuable qualities that construct a local, sitespecific, individual and communal identity and sense of belonging. Especially with character-based interpretations of cultural heritage, the values and choices of people become central; the life situations are discussed and dealt with by addressing value sets denoted to different social groups, subcultures and minorities, women and non-binary included. Cultural heritage narratives that are derived from the lives of ordinary people, first nations, subcultures and minority groups, are equally valued and not preceded by the stories of majorities, kings and rulers.

8. Results, early findings, and conclusions

Expected outcomes of CHEM include the following:

1. Innovative solutions, validated in pilot trials, demonstrating how strategic investments in the spirit of the New European Bauhaus initiative in cultural heritage, which may include cultural landscapes, and the CCIs can be successfully realised.
2. Increase the understanding and visibility of the role that cultural-led innovation integrating the New European Bauhaus approach can play.
3. Wider involvement and social inclusion of citizens in the preservation and enhancement of cultural heritage through engagement with local ecosystems.

The overall goal of CHEM is to enable the transformation of cultural heritage into engaging digital and tangible artefacts, focusing on CCI and community involvement. In CHEM, art, design and culture are seen as drivers for sustainable development through

the four pillars of sustainability: cultural, social, economic and environmental.

Even though there is great interest in including CCI as a way towards thriving urban hubs, historical sites and sustainability, including social change, there is a lack of concrete methods and formats of cross-sectoral collaborations. CHEM offers a model and solution for interdisciplinary design through multiple modalities and inquiries that produce tangible and digital outcomes. Culture-led innovation ecosystems can be created and enhanced through interdisciplinary and transnational linkages, allowing organisations to tap into a larger base of ideas and technology and find complementary expertise and a pool of competences (de Vasconcelos Gomes et al., 2018).

The developed research design innovation processes interrelate and serve as examples of agile crossinnovation. In CHEM, there are two complementing layers of innovation processes - digital (online) and analogue (offline). In fact, these layers unify versatile generations of people as well as make the inquiries all-around-inclusive without a sharp border between online and offline to do the following:

4. enhance the sense of belonging and inter-generational unity

5. transmit cultural meaning across nations, genders, generations and online – offline realms

6. amplify and offer interpretations of NEB principles: Beautiful – Sustainable – Together

7. align with UN SDGs in four categories: cultural, social, economic, and environmental

8. address digitality, to be shared and stored in the repository European Collaborative Cloud for Cultural Heritage (ECCCH)

The economic impact of the CHEM model is significant, offering more opportunities for investments in preserving the cultural heritage P2L sites. By bringing art-based methodologies and digitisation to the preservation process, the CHEM model transforms these sites into vibrant centres of culture and learning. This contributes not only to the cultural vibrancy but also to the economic prosperity of the regions, creating business possibilities as well as jobs for CCIs and service sectors. Furthermore, the tourism sector benefits from the outcomes of CHEM, creating more value and prosperity.
The concept incubation and cross innovation are loaned to CHEM from the business world (de Vasconcelos Gomes et al., 2018; Oliveira et al., 2016). A process of ideation, prototyping, interdisciplinary co-design, demos, testing with end users and honing finally leads to end products displayed in digital and tangible exhibitions, festivals, events and performances. The outcomes rely on meaningful stories from the past and present, enabling envisioning the future through arts interventions and design interactions.

The cultural and societal sustainability impact is clear. The revitalised regional cultural heritage sites will become hubs for both stakeholders, local citizens and tourists. This will enhance local citizens' appreciation of their own places and culture, fostering a stronger sense of belonging to their living environment, and on a larger scale. It offers opportunities to learn, advance employment, exercise, socialise and be an active part of the community. CHEM provides a novel approach to employing various types of culture-led innovation methods, both together and separately in various design, social science and technological disciplines. It advocates creativity, dialogue, art, design, and cultural, social and economic sustainability with CCI (Loach, Rowley, Griffiths, 2017; Lopes, Farinha, Amado, 2017; Lineberry, Wiek, 2016).

Artists and designers can enhance cultural, social and economic sustainability through art and design, as they possess the power of imagination, creativity and new solutions, which are key factors in driving innovation (Lopes, Farinha, Amado, 2017). It is mutually important for designers, artists and creative industry representatives to provide a unique opportunity to explore, inspire, educate and empower participants in CHEM design-research inquiries, to harness the full potential of their imagination as a tool for creating the future change they desire through reinterpreting the past and present. Curiosity and the ability to imagine are transferrable skills that the business world, schools and academia alike should take seriously. Designers and artists are the catalysts and drivers of innovation, communication, social development and change. CCI are powerful vessels in delivering an evocative message, a story, a narrative and engaging people in collaborative, meaningful processes.

CHEM recognises that CCI can also play an important role in working with civil society, policy makers and administrators towards behaviour change in a given context, for instance the green shift to reduce energy consumption. To succeed, transdisciplinary frameworks in the public sector are needed – first, on the local, regional and national levels, and, finally, on the European and global levels. Transdisciplinary and transnational knowledge sharing is the key to success when implementing creative approaches to societal development for wider impact and gradual change (Jelinčić, Tišma, 2020; Laborgne et al., 2021). Art, design and CCI embody the dynamic spirit of the place, its commitment to excellence; and through adherence to regenerative design and sustainability principles in all four dimensions, they shape a better world for future generations. These notions of culture, art and design are deeply rooted in the Places to Learn - Cultural Heritage Enrichment Model, CHEM.

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HOW CAN GENERATIVE AI TRANSFORM SMARTPHONE COMMUNICATION?: EXPLORING NEW DESIGN LANDSCAPES FOR EVERYDAY EXPERIENCES

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ABSTRACT | The emergence of generative AI promises to revolutionize our daily lives, enabling the creation of fresh content, chat responses, images, synthetic data, and even deep fakes. This cutting-edge technology is expected to transform the smartphone experience by facilitating the development of innovative features. The purpose of this study is to explore the potential of generative AI in enhancing smartphone communication. Through a case study of an industryacademia collaborative design project in India, we aim to propose exploratory solutions to the challenges associated with traditional smartphone communication. The research team, comprising company representatives, students, and faculty, envisioned a more emotionally rich communication experience on smartphones with generative AI. Specifically, the team proposed communication methods that convey tone and emotion based on contextual understanding, moving beyond traditional monotone expressions. Additionally, they explored the creation of immersive stories that evoke emotions. The results of this study suggest that generative AI has the potential to improve existing communication practices on smartphones and create new, enriching user experiences. However, the study also emphasizes the importance of being aware of the risks associated with generative AI's influence on human emotions. While the development and implementation of new communication methods with generative AI are still in their infancy, progress is rapid, necessitating ongoing research, implementation, and careful consideration of ethical and philosophical issues.

KEYWORDS | GENERATIVE AI AND DESIGN; UX DESIGN; SMARTPHONE; COMM1UNICATION DESIGN



1. Introduction

1.1 New design landscape: Generative AI

Design studies have been grappling with a significant theme: the evolution of technology, particularly in relation to artificial intelligence (AI). The intersection between generative AI and design practices has emerged as a rapidly evolving and crucial area of research within the design field. Generative AI refers to artificial intelligence systems capable of producing creative output and has made significant impacts across various design domains, including architecture, graphic design, and product design. Its application has the potential to transform how designers approach creativity, problem-solving, and innovation.

Recent advancements in AI algorithms now enable the processing of data in its natural form, facilitating the analysis of unstructured data such as raw text and images (Dwivedi et al., 2023). Moreover, there has been a growing demand for AI algorithms capable of handling unstructured data due to industrial needs related to text mining and natural language processing.

Recent contributions in this field have explored various themes, including generative design methods (Singh & Gu, 2012), human-AI collaboration in design (Feldman, 2017; Zhou et al., 2022), personalization and customization (Jiang et al., 2022), the ethical implications of creative AI (Rezwana & Maher, 2023), and AI-driven creative tools (Jeon et al., 2021).

As the latest AI advancements allow for more intuitive natural language processing, the practice of design is undergoing significant transformation. Additionally, there is a burgeoning landscape of possibilities for user experience, and the evolution of generative AI is reshaping traditional design methods, the essence of user experience, and the role of the designer.

1.2 A New Design Landscape: Design for day-to-day experiences powered by generative AI

Generative AI utilizes machine learning algorithms to analyze extensive datasets and produce new content resembling the input data. For instance, by training on a large image dataset, a generative AI system can create novel images resembling those in the training set. An important aspect of generative AI is its non-deterministic nature, meaning that identical inputs will yield varying outputs on each occasion.

By exploiting these properties of generative AI, new design paradigms emerge, such as designing for multiple outputs, designing for incompleteness, and designing for mental models. These new opportunities for design created by generative AI facilitate the creation of innovative everyday experiences and present promising avenues for exploration and development in design research and practice. In particular, the potential for user experience innovation in existing user interfaces (e.g., smartphones, computers, and other digital devices), where there is significant room for generative AI to be reflected, holds great promise to be realized in the near future.

2. Methodology

This research conducts a case study to derive insights for designing innovative smartphone communication experiences augmented by generative AI. It is widely assumed that generative AI has the capacity to generate various types of content, including chat responses, designs, synthetic data, and deep fakes, thereby becoming increasingly integrated into daily life. The critical issue lies in ensuring that these AI systems are aligned with human intentions and values. Consequently, the primary challenge surrounding generative AI is how to develop user experiences that effectively complement its capabilities. In line with this assumption, a collaborative industry project was undertaken as the basis for the case study.

2.1 A case: “Design for day-to-day experiences powered by Generative AI”: a Project Based Learning (PBL) collaborating with Samsung India

The case study presented here offers a concrete illustration of a collaborative initiative between industry and academia carried out at the MIT Institute of Design (MIT ID) in Pune, India. The objective of this project was to investigate and propose innovative communication experiences for smartphones empowered by generative AI. The specific details and parameters of the project are outlined in Table 1.

Items	Settings
Goal	Exploring and proposing novel communication experiences of smartphones powered by generative AI.
Design Brief	• To Identify opportunities that arise with the help of generative AI to assist or enhance mobile experiences in the above scenarios. • To define experiences and use cases from the point of view of various walks of life
Participants	• 4 master students in design management program • 4 mentors from Samsung India • 2 faculties from MIT ID
Project details	• Duration: 6 months lasting industry-university collaborative project • Project approach: Project Based Learning (PBL) • Location: Pune, India
Project activities	• Research: secondary research and primary research • Ideation • Concept development
Outcomes	• Research results: Primary and secondary research results • Concepts of new day-to-day communication experiences of smartphones powered by generative AI

Table 1. Detailed project settings “Design for day-to-day experiences powered by Generative AI”

The primary challenge was framed based on a design brief provided by the industry partner, a prominent digital device company in Asia, Samsung India. The partner expressed a keen interest in exploring the convergence of generative AI and communication experiences, with a particular focus on potential radical changes in UX design. Generative AI, therefore, has the potential to revolutionize traditional smartphone communication methods as well as user interfaces and experiences.

In accordance with this background, a comprehensive design brief was developed to explore various experiences and use cases. These included opportunities arising from the integration of generative AI to enhance mobile experiences in everyday scenarios such as entertainment, identity and expression, lifestyle activities (e.g., shopping, traveling), well-being, shared experiences, staying connected (communication and social media), staying informed, and financial planning.

The project enlisted the participation of four master’s students from the design management program, chosen for their expertise in developing integrated product-service systems using design methodologies. These students were guided by two faculty members, the authors of this study, and were supported by four mentors from the collaborating company. Spanning a duration of six months, the project adopted a Project-Based Learning (PBL) approach, blending online and offline components in Pune, India.

2.2 Case Phases and Activities

The project activities were conducted in three phases: research, ideation, and concept development.

Phase 1: Research phase

This phase included three steps:

1. basic and secondary research: research to better understand generative AI, application challenges and opportunities for the technology, and contextual analysis of smartphones and communication.
2. user survey : to understand user behavior with respect to current smartphone functionality and identify user groups for the following individual interviews; a sample of 25 people was collected and surveyed for generations ranging from 18 to 55 years of age.
3. personal interviews: This anthropological approach provided deep insights into the target audience's daily smartphone communication experiences: 12 interviews were conducted with generations between the ages of 18 and 55.

Phase 2: Ideation phase

Key design development directions were defined and converged into three idea directions. Idea generation and refinement took place in an iterative process that included in-depth discussions with faculty and mentors. As a result, an idea direction was opened to further enrich the user's emotional expression in the areas related to Keyboard and Search in the generative AI.

Phase 3: Concept Development Phase

In this phase, specific solutions were designed and developed based on the narrowed-down themes:

1. User Personas Representative user personas were created, reflecting the findings of Phase 1 and 2.
2. communication experience design: Designed a new communication experience on smartphones that leverages generative AI. To materialize the experience, wireframes and user interfaces were designed to visualize the entire user experience.

Through these three phases, the project aimed to explore new communication experiences on smartphones utilizing generative AI. We proposed innovative communication experiences by moving back and forth between research, ideation, and concept creation, exploring directions in an exploratory manner.

3. Result

This case illustrates the potential for novel modes of communication facilitated by generative AI, a capability previously unavailable in smartphone communication. Generative AI holds promise for introducing more emotionally resonant communication methods that align better with human psychology, contextual situations, and interpersonal relationships, departing from the conventional reliance on mundane text and pictogram-based expressions.

3.1 Research result

During the research phase, the design team used a combination of secondary and primary research methods to explore the design possibilities and to chart the design trajectory. The secondary research included extensive investigation of generative AI and its impact on the smartphone communication experience. At the same time, the primary research phase included a user survey and personal interviews to delve into user behavior regarding current smartphone communication experiences and to gauge user attitudes toward current and future technologies, particularly generative AI. Ultimately, design direction emerged from the integration of these research efforts.

Secondary research provided an understanding of the potential impact of generative AI on the smartphone communication experience. The study particularly emphasized generative AI's capacity to revolutionize three traditional practices: file management, search, and keyboard use. In file management, the identified capabilities of generative AI include: 1. document generation, summarization, search, and change tracking, 2. fraud detection, 3. elimination of redundant processes and files, 4. analysis of document patterns to provide actionable insights. In the area of search, generative AI's capabilities encompass: 1. personalization, 2. intuitive search results, 3. image-based search initiation, 4. natural language processing (NLP). Regarding keyboard use, generative AI offers the following capabilities: 1. text rewriting and generation, 2. integrated search functionality within the keyboard, 3. suggestions for conversation style and tone analysis, 4. reduction of typing effort.

Building on this foundational knowledge, the primary study examined the communication challenges of current smartphones through surveys and personal interviews. Several specific issues emerged, highlighting the challenges faced by typical smartphone users, such as unidimensional communication, pictograms failing to adequately express

emotions, and frequent misunderstandings. Texting and messaging, as one-dimensional communication methods, often lack the depth and nuance of face-to-face interactions, resulting in misunderstandings and emotional disconnect. Current smartphone input methods prioritize efficiency and accuracy over the conveyance of tone and intent, neglecting important aspects of communication. Moreover, the primary survey revealed that users desire effortless communication, improved accuracy, and reduced anxiety.

Based on the extensive insights acquired during the research journey, the team refined their design objective: to devise smartphone input methods that enable users to convey their emotions, tone, and intentions with greater ease and precision in their communication interactions. Put succinctly, the central question becomes: "How can we leverage generative AI to facilitate the development of novel smartphone communication experiences that allow users to express emotions effortlessly?"

3.2 Ideation result

The initial ideation phase concentrated on two of the three topics: search and keyboarding, excluding file management. Through iterative sessions involving students, businesses, and faculty, the ideas converged into three broad directions using affinity diagrams.

First, enhancing tone and emotional expression to transform monotonous communication styles. Existing pictograms and stickers are often uniform and fail to convey messages accurately, sometimes leading to misunderstandings. Human emotions are more complex than what pictograms can express, necessitating the exploration of more nuanced expressions. Generative AI has the potential to support subtler and precise emotional expression for users, leveraging vast amounts of big data on communication patterns and individual behaviors on smartphones.

Second, exploring alternative input methods such as gestures and voice commands on smartphones. Existing methods like typing and voice input can be inconvenient, and users often experience frustration when gestures and voice commands fail, requiring repeated manual corrections. Generative AI can help develop new alternative input methods that address these challenges associated with current input techniques.

Third, generative AI can enhance existing search methods on smartphones. Users are often dissatisfied with search results from current search engines, especially when they need to find something for future use but struggle to relocate it later. Additionally, search engines frequently raise safety concerns by suggesting unsafe content. Generative AI has the potential to offer more desirable search methods for users by leveraging collective knowledge and big data on user searches, thereby addressing these challenges and improving search satisfaction and safety.

3.3 Conception result

Based on the design opportunities embodied through the research and ideation phases, the requirements for ideal smartphone communication were organized. In summary, the ideal communication should have the following characteristics: less manual, more accurate, and less anxiety-provoking. While meeting these requirements, the design team established two personas and developed two different proposed solutions.

Solution 1. A communication service that analyzes historical data and proposes heartfelt expression

The initial concept involves a communication service enhanced by generative AI, which examines past data and suggests appropriate expressions. Addressing prevalent issues identified in current communication services, the research findings indicate that existing platforms lack flexibility in adding a personal touch, struggle to find suitable emojis for conveying emotions, and often fail to deliver satisfactory messages. To address these challenges, a novel communication service was developed based on the following persona and scenario.

Persona and scenario:
Meet Rohan, a 17-year-old university student residing in Pune, India, who lives in a nuclear family and shares a close bond with his grandmother. He seeks to infuse every message sent from his smartphone with a personalized touch and is eager to explore inventive ways of communication to convey his affection for his loved ones. With his grandmother's birthday approaching and physical distance preventing an in-person celebration, Rohan is determined to send a heartfelt and customized birthday message that will bring joy to her.

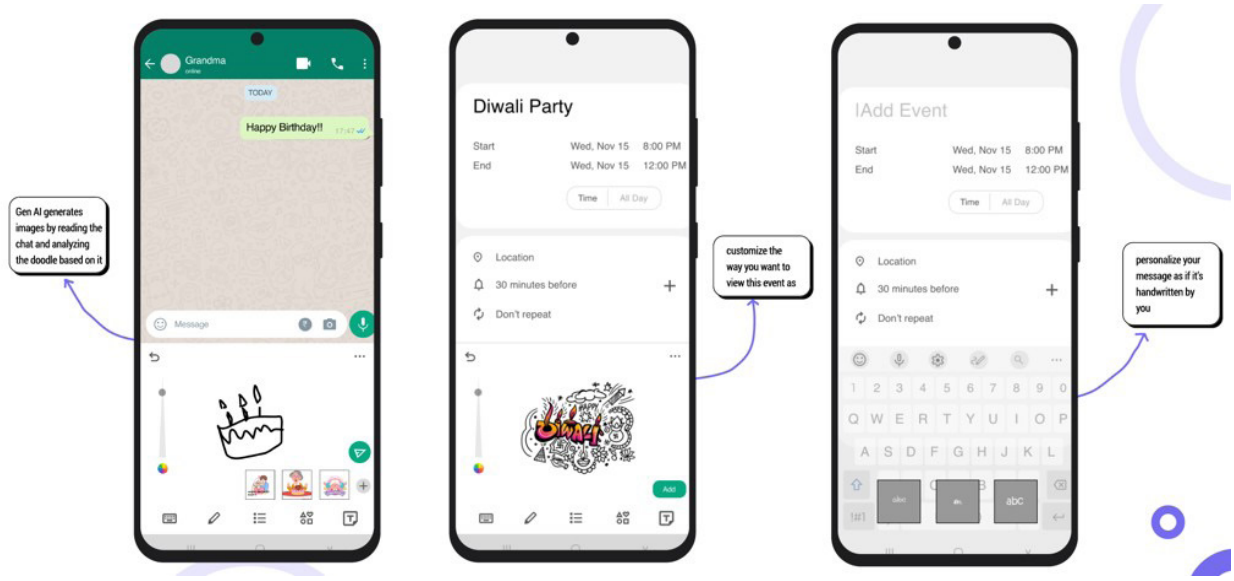

Figure 1. An intervention of generative AI for more heartfelt expression

New communication service:
Powered by generative AI, this communication service empowers Rohan to personalize his messages, craft heartfelt expressions, and convey the nuances of his emotions (Figure 1). The generative AI generates images by analyzing the conversation and interpreting the doodles accordingly. It then tailors the presentation of the event to Rohan's preferences and finally personalizes the message to appear as if handwritten by him.

Through this new communication service, users can convey their messages in alignment with their emotions, allowing for the expression of emotional nuances in a visual format. Moreover, the emotional transfer is highly individualized, enhancing the overall user experience.

Solution 2. Visualizing emotions based on deep learning

The second idea involves visualizing emotions by analyzing various data sources and expressing emotions through suitable mediums. Leveraging user historical data, including personal information and documented data such as photos, videos, files, and documents, as well as past conversations in certain applications, generative AI can assist users in effectively conveying their emotions. This technology is capable of discerning conversational contexts by recognizing tone, determining the nature of relationships, and identifying mutual interests.

Addressing prevalent issues identified in current communication services, the research findings indicate that existing platforms fail to adequately convey users' emotions and often leave them feeling disconnected from the recipients. Furthermore, users struggle to comprehend the emotions of the recipients during messaging interactions. To address these challenges, a novel communication service was developed based on the following persona and scenario.

Persona and scenario:
A 32-year-old software engineer based in Mumbai India, Kusha lives with her husband and a child, working long hours every day. She lives her parents away, so real-time talk with them seems impossible. She wants to prioritize her time with her family, however she struggles to emphasize with her family's feeling and emotions.

One day, just before a client meeting, Kusha receives a message from her mother that she is at the doctor's and has some news to give her. All her mother is able to tell her that her recovery is going well but she has to make some changes to recover faster. She feels overwhelmed and looks to get comfort and reassurance from Kusha.

A new communication service:
Assisted by generative AI, emotional communication is proposed as a feature. Users are prompted to select their emotional state from a range of options depicted on Plutchik's wheel of emotions (Plutchik, 1980),

which visualizes eight emotions through color theory (Figure 2). This feature allows users to customize their conversation accordingly. Generative AI facilitates creation, prediction, suggestion, text-to-speech (TTS), and automatic speech recognition (ASR), all of which are activated through various input modes (Figure 3). Following the user's emotional choice and the analysis of the situation, specific scenes with story-like backgrounds appear in the chat as images (Figure 4). Users have the flexibility to change their emotional state at any point during the conversation. The keyboard is redesigned to accommodate various input methods, including typing, voice messages, and drawing, based on the user's selected expression mode. For voice messages, users can edit the recording to adjust the tone of expression before sending it. Upon receipt, the recipient can listen to the message in the sender's voice profile.



Figure 2. Choose your feelings of today

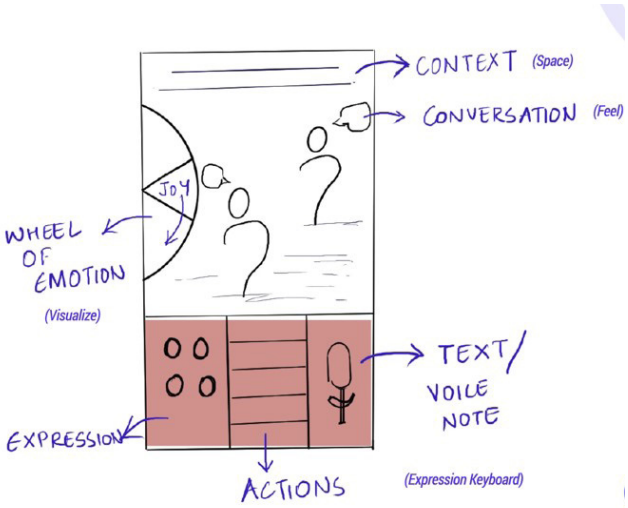

Figure 3. A sketch of multiple input mode to express emotions

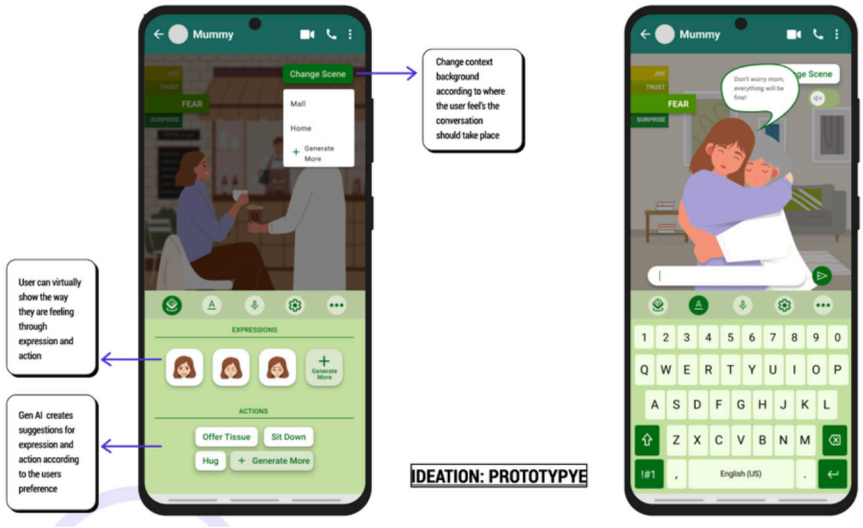

Figure 4. Fulfilling emotional expression with visual stories

Summative synthesis:
Implications of the two solutions

The two solutions suggest that generative AI has the potential to revolutionize the communication experience on smartphones. Addressing current problems of one-dimensional communication, use of irrelevant emojis, and misinterpretation, generative AI could bridge these gaps by helping users convey more authentic messages with a wider range of expressions. The study suggests a way of communicating that is best suited to the context and situation and allows for rich emotional expression, while leveraging historical and collective big data on individual smartphone use.

On the other hand, we need to be conscious of the fact that there are certain risks involved in technology intervening in the subtleties of emotional expression. The survey results indicate that, to date, smartphone communication has had certain inconveniences in terms of emotional expression, but people have been aware of these inconveniences. The more this becomes possible with the intervention of generative AI, which allows for expressions that better fit human emotions, the less likely users will be aware of the difference between their own emotions and the expressions on their smartphones. Furthermore, there is a danger that users will become confused about their own "true feelings" by perceiving that the expressions created by generative AI are their own feelings. Because of the dizzying technological progress of generative AI, ethical and philosophical considerations regarding human emotions and technological expressions of emotions are emerging as pressing issues.

4. Discussion

This study aims to explore the transformative potential of generative AI in everyday experiences, particularly in smartphone communication. Harnessing its non-deterministic nature, generative AI offers the prospect that identical inputs will produce diverse outputs each time. From these characteristics of generative AI emerge novel design approaches, including designing for multiple outputs, imperfections, and mental models.

The case study highlights the potential for creating new communication experiences on smartphones that enhance users' heartfelt and emotional expressions. By leveraging users' historical data, personalities, and social connections, smartphones have the potential to enrich communication experiences in a more personalized manner. Empowered by generative AI, smartphones can evolve into more empathetic and emotionally resonant communication tools.

This paper contributes to two important areas. First, it explores new design areas at the intersection of generative AI and smartphone communication experiences. As generative AI technologies continue to evolve rapidly, a new communication landscape is poised to emerge. Rather, there is a growing

need to immediately incorporate the daily evolving generative AI technologies into design and development, creating new communication experiences in a lean way with implementation. Second, we introduce a communication approach that prioritizes human-to-human connections, taking into account the user's personality, communication context, and relationships. As the traditional ways of communication are about to be qualitatively transformed by the technology of generative AI, this research raises questions about how to design communication in a way that is not an extension of the past.

One of the most compelling aspects of generative AI that is rapidly gaining importance is its ability to handle multi-modal inputs and outputs. This capability enables generative AI to process and integrate various types of data such as text, audio, images, and video, and generate responses that are equally diverse and contextually rich. The case study leverages this multi-modal potential to propose solutions that can significantly enhance smartphone interactions, making them more nuanced and engaging. For instance, by analyzing not just the textual content of a message but also the tone of voice, facial expressions, and contextual imagery, generative AI can craft responses that are more empathetic and aligned with the emotional state of the user. This leads to richer and more meaningful communication experiences.

Moreover, the multi-modal capabilities of generative AI allow smartphones to deliver personalized interactions that cater to the unique preferences and communication styles of individual users. As the AI system learns from the user's historical data, including their communication patterns and preferences, it becomes adept at predicting and adapting to their needs. This personalization is not just limited to content but extends to the mode of delivery as well. For example, if a user prefers visual information, the AI can prioritize infographics or video messages over text. Similarly, if a user tends to respond better to auditory cues, the AI can generate voice messages or audio summaries.

The immersive nature of these AI-driven interactions ensures that users remain more engaged and invested in their communication experiences. As smartphones evolve into more intelligent and intuitive devices, the integration of multi-modal generative AI stands to revolutionize how users interact with their devices and each other. This technology not only enhances the functional aspects of communication but also its emotional and social dimensions, making everyday interactions more profound and satisfying. Thus, the dynamic and adaptive nature of multi-modal generative AI holds immense potential to transform the landscape of smartphone communication, driving it towards a future where interactions are not only efficient but also deeply human-centric.

There is no doubt that it is also necessary to discuss here the risks and disadvantages that are likely to be latent in new ways of communication that take advantage of generative AI. Generative AI has been

discussed in this paper to play a supportive role in the expression of human emotions. However, this means, on the flip side, that the technology will intervene even in human emotions. In the first place, emotions are fundamental to human beings. The possibility of emotions being influenced by technology may not only necessarily have a positive impact, but may even involve the possibility of emotions being manipulated and controlled by technology. Humans do not always have a full understanding of their own emotions. In the realm of emotions, which includes such ambiguity, are the "emotions" guided by technology true emotions? This is a deep philosophical question.

It is important to recognize several limitations of this paper. First, the research methodology relies on a single case, a joint industry-academia project in India. Therefore, the insights derived require further validation through a variety of methodologies and across different national and cultural contexts. Second, the ideas generated in this study remain at the conceptual stage. Therefore, a major challenge is to verify new ways of smartphone communication using generative AI through implementation of services by partner companies. In particular, the challenge is to conduct empirical research, both qualitatively and quantitatively, on how the way people actually communicate has been transformed, and whether usability and emotional fulfillment have improved when compared to conventional methods.

Finally, we propose several avenues for future research. First, future studies could explore the specific types of everyday experiences enabled by generative AI on smartphones. It would be valuable to examine in greater depth the patterns of these experiences and how they evolve in various contexts, such as shopping, training, entertainment, and other daily activities. Second, it is crucial to investigate how generative AI can shape new experiences through interactions between smartphones and other devices. Research should focus on the transformation of user experiences facilitated by the integration of generative AI with diverse devices, equipment, and infrastructure, in tandem with technological advancements. Exploring how individuals of different ages and interests can engage with generative AI to enhance and experiment with their daily lives would also be highly meaningful. Various types of design research can contribute to these opportunities and improve overall well-being.

This emerging field poses a new academic challenge, drawing from the interdisciplinary nature of design disciplines—such as generative AI, communication design, UI/UX design, humancentered design, and service design—as well as from engineering and ergonomics in the realm of information technology. With the rise of generative AI, we anticipate that collective insights from these diverse disciplines will converge to further advance research in this domain.

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REGENERATIVE DESIGN IN TIBETAN REGIONS: PLACE-BASED LEARNING THROUGH STORYMAKING

Shuang Song, Linus Tan and Anita Kocsis.

ABSTRACT | This paper examines the practices of design anthropology through metaphors and methodologies informed by alternative lenses. It explores practices such as place-based learning and storymaking, which extend the remit of design within design anthropology and suggest alternative perspectives as demonstrated in the case studies. Harnessing the transformative potential of storymaking, the research underscores the pivotal role of narratives in reshaping humanity's perception of the Tibetan worldview and its relationship with the natural world. Key lessons gleaned from the research exemplify regenerative design principles through their integration of human and ecological systems, emphasizing the importance of incorporating Traditional Ecological Knowledge into design processes to achieve culturally relevant and regenerative outcomes. The paper advocates for place-based learning and storymaking to foster deep understanding and compassion. It also addresses the challenges and opportunities in balancing ecological conservation with community development, using community exhibitions and eco-learning programs as case studies. These insights can catalyze further dialogue among transdisciplinary practitioners regarding research methods deeply rooted in place-based contexts for narrative creation through storymaking, thereby fostering a paradigmatic shift toward a regenerative, collective learning climate.

KEYWORDS | Regenerative Design, Traditional Ecological Knowledge, Place-based Learning, Storymaking, Tibetan Worldview

1. Introduction: Regeneration, for whom and for what?

As a designer focused on ecological transitions, the Tibetan Indigenous communities in the Hengduan Mountain Region often evoke imagination for the region's rich biodiversity, diverse intangible cultural heritages, and strong sense of community and social bonds (Smyer, 2015). Moreover, the ecological mindset advocated by regenerative design principles, which emphasizes understanding the interconnectedness of all things and the co-evolution of humans and nature (Bellato et al., 2011; Mang & Reed, 2019; Pollock, 2012; Mang and Reed, 2011), has been an integral part of Tibetan everyday practices for millennia (Coggins, 2019; Yeh, 2014; Habito, 2007). They have coexisted with the land for generations, inherently understanding the appropriate positions and dynamic relationships between humans and nature. When external transdisciplinary teams formed by rural planners, scientists, designers, policymakers, and academics enter Tibetan communities to conduct co-design workshops, the local perspectives on development of their homeland have rarely been heard or effectively included in the planning process (Yeh, 2014; Guo, 2012). Therefore, when we talk about regenerative design in Tibetan regions, for whom are we designing?

This paper uses the regenerative design principles applied in the Zhonglu Township, Gyalrong Tibetan community, located under Mount Moerduo, as a case study to explore how design teams employ storymaking as a systemic catalyst to support community regenerative design. Regenerative design aims to design, build, and heal with the whole system in mind—a deeply integrated worldview that shifts from 'doing things to nature' to participation as partners with and as nature (Reed, 2007; Berry, 1992; Sterling, 2003). Gyalrong refers both to a unique branch of the Tibetan people, known as the Gyalrong Tibetans, and to a geographical area centered around Mount Moerduo, spanning a radius of thousands of miles (Li, 2014; Ju, 2020). In this community, mountains, water, and grasslands are not merely "protected areas" or "resources" nor just backdrops for human activity, but a shared space for all beings, including nature, spirits, and humans (Coggins, 2019).

However, since the 1950s, this region has undergone three industrial transformations due to the environmental crises. Following the extensive mica mining in the late 1970s, which caused severe geological changes and was subsequently banned, the community turned to traditional logging. Before 1998, the area heavily relied on logging as a primary industry, with "wood-cutting economy" constituting 80% of the county's fiscal revenue. Since 2000, the Gyalrong region, including Zhonglu Township, has been exploring regenerative tourism. The area's insufficiently modern production and living methods, coupled with inadequate infrastructure, mean that Zhonglu remains a traditional village with a semi-agricultural, semi-pastoral economy. Local youth, unwilling to endure the hardships of traditional farming life, seek work elsewhere, leading to a gradual decline in the transmission of traditional ecological knowledge (TEK) and intangible cultural heritage. In the context where neither scientists nor Indigenous people have perfect solutions to the systematic environmental challenges, how can designers weave the stories that make diverse sensory mechanisms and value orientations visible, including non-human perspectives?

To address this challenge, design anthropology encourages interdisciplinary cooperation within and outside design studios, generating concepts and prototypes, collaborating with stakeholders and various publics, and consciously focusing on promoting and driving change (Brown, 2011; Nelson and Stolterman 2012; Otto and Smith, 2013). Beyond expressing ecological knowledge and cultural heritages, regenerative design ultimately aims to articulate and practice ecological worldviews (Mang & Reed, 2019; Mehmood, 2020). In that sense, storymaking is a flexible tool that fosters cross-disciplinary collaboration and captures practices that cannot be fully encapsulated by regulations or Indigenous wisdom (Phillips and Bunda, 2018).

This paper aims to explore how the design team utilizes design anthropology methods in the Gyalrong Tibetan community of Zhonglu Township to investigate and achieve place-based knowledge. Using the Yunhe Center, a research-action lab that established an ecological learning center in Zhonglu, as a case study, it examines how place-based learning projects and community exhibition designs support the balance between ecological protection and community development, highlighting the importance of storymaking in regenerative design in Tibetan Indigenous communities.

2. Experiencing Place: The alternative ways of learning

2.1 A coming-to-know through experience

The Gyalrong Tibetan community lacks a written language, so their songs, dance culture, folk myths and oral stories, and embroidery traditions serve as crucial mediums for knowledge transmission (Li, 2014). Coming-to-know (Cajete, 2000), which is the way among Indigenous people acquire

knowledge, metaphorically entails an experience, a process, and a quest for knowledge and understanding. The Indigenous experience is evidenced not only through collective cultural expressions of art, story, ritual, and technology, but also through the more subtle and intimate expressions of individual acts of respect, care, words, and feelings that are continually extended to the land and its many beings (Cajete, 2000). Castellano (2000) described the characteristics of Indigenous knowledge as personal, oral, experiential, holistic, and conveyed in narrative or metaphorical language. To understand Indigenous knowledge, designers must begin with immersion in their everyday lives to gain insight into experiences and meanings that form the basis for reflection, imagination, and design (Nelson and Stolterman, 2012).

True knowing is based on directly experiencing a place (Cajete, 2000). This is why experiencing a place is key to exploring Indigenous knowledge, where knowledge is presented in "high contexts," in which multiple levels of information are shared through various levels of communication (Jessen et al., 2021). Just like the motifs in Gyalrong embroidery, each traditional pattern carries different meanings: blessings from the four directions, offerings for good fortune, warding off evil spirits, and the guardianship of local mountains (Dagyab, 1995). In traditional embroidered sashes, the motifs are arranged in a specific sequence to tell different stories (see Figure 1). These sashes are used in various rituals and celebrations, creating a nested relationship where smaller stories are embedded within larger scenarios. In this sense, experiencing a place refers to sense-making, which occurs over time through the relational interactions between people, their nature, and their social activities (Horlings et al., 2018).



Figure 1. Motifs of Traditional Embroidered Sashes

2.2 Place in Traditional Ecological Knowledge

Traditional Ecological Knowledge (TEK) refers to the knowledge, practice, and belief concerning the relationship of living beings to one another and to the physical environment, which is held by peoples in relatively non technological societies with a direct dependence upon local resources (Berkes, 1999). It is born of long intimacy and attentiveness to a homeland and can arise wherever people are materially and spiritually integrated with their landscape (Kimmerer 2000). This respectful attitude to enter into a heightened sense of awareness of the natural world allows the external teams intimate understanding of the processes of nature, and forms the foundation for respecting the compacts of mutual reciprocal responsibility shared with other inhabitants of one's environment. How something is related and the nature of causality in a given natural context are foci of deep reflection. The ways in which aspects of nature are transformed through time and space and the nature of proper orientation to "sacred place" demand the observation of subtle details that are the foundation of knowledge.

The regenerative process leads to the stories of place, a way to conceive of the role of the place in providing increased vitality, viability and ability to adapt to all those who are part of the place (Mang and Reed, 2020). This story can be treated variously as a framework, a mechanism and a process, rather than as a final product (Mang and Reed, 2012). The 'place-based learning' helps humans learn how to understand and co-evolve with their environments better, provided such storytelling explicitly addresses the relationship between humans and the ecology/non-human they are enmeshed in. Stories spoken from the heart hold a transformational power, they are a way for one heart to speak to another. They are a means for sharing knowledge, experience and emotion. As a mechanism, 'place-based learning' helps create the field of caring and commitment necessary for continuous potential building. It's calling on human actors to respond and remake meaning as its potential is realized or changes with regards to wider systemic changes through place-based learning.

2.3 Relational knowledge of the place

The fundamental belief of Indigenous worldview is that knowledge is relational, shared with all of creation (Hart, 2010). This encompasses not only interpersonal relationships or those with research subjects but also relationships with the cosmos, animals, plants, and the earth (Cajete, 2000; Kimmerer, 2002). Knowledge extends beyond the individual to encompass relational knowledge, implying that researchers are answerable to all their relations when conducting research. This way of learning and coming to know is deeply tied to environmental awareness and a reaffirmation of responsibility for the care of the Earth. It enables us to perceive

and pursue new potentials in ourselves, our families, communities, and our land (Haggard et al., 2002).

According to Otto Scharmer and Katrin Kaufer (2013), we cannot face today's disruptions by denying the past damage, but by envisioning forward, sensing, and actualizing the future as it emerges. At the core of such a profound transformation is the awakening of curiosity (open mind), compassion (open heart), and courage (open will) as powerful antidotes to regenerate from and with the place (Tuck 2009; Boutkan and Hadders, 2020). We need to come together with a radical commitment to co-create and live based on entirely new patterns, emerging from networks to communities into systems of influence (Wheatley, 2010). This involves moving forward with people in the pursuit of their dreams and aspirations rather than dwelling on their past (Leitão, 2020). That's where design anthropology comes into play; its observant participation nature emphasizes what is produced during fieldwork—such as social relations, practical knowledge, and new practices for the people involved—rather than what is produced after fieldwork (Glowczewski et al., 2013).

2.4 Design anthropology as wood-wide-web

An important feature of design anthropology is the way its practitioners work within multiple relationships and often complex roles involving different stakeholders, including designers, researchers from other disciplines, locals, government officials, and the public. Due to its engagement with multi-layered relationships, design anthropologists typically operate within multidisciplinary design teams, alternating between roles as researchers, facilitators, and co-creators in the design process. In doing so, stories play a crucial role that no amount of theorizing or recitation of statistics can reveal—they offer insights that generate empathy and build social bonds (Duncan, 1998). In a context where neither scientists nor Indigenous people have perfect solutions to systematic environmental challenges, how can designers weave stories that make diverse sensory mechanisms and value orientations visible, including non-human perspectives?

This paper proposes that design anthropology functions as a wood-wide-web in regenerative design—particularly in sensitive or precarious contexts such as Tibetan regions. It examines how designers, through participatory observation, facilitate communication and encourage storymaking to include the locals participating in regeneration processes for developing their homes. In the following discussion, the Yunhe Center's place-based learning projects and community exhibitions are used as empirical cases to explore the toolkit designers employ to learn from and with place, articulating and practicing TEK within the interdisciplinary teams.

3. Place-Based Learning: Thinking Like a Mountain

Learning the knowledge of place and the "dialects" of its plants, animals, and natural phenomena within the context of a "homeland" is a foundational element of Indigenous knowledge (Orr, 2004). In Tibetan belief, mountains are landmarks for their homeland and cultural identity, where people refer to each other as individuals from this or that mountain. Mountain gods serve as local guardians, and all things within and around the mountains are attributed to these deities. Each mountain has a name, character, and unique temper. In the Gyalrong Tibetan village, their Sacred Mountain is called Moerduo (Li, 2014). Together with surrounding mountains, they form mountain families with epic stories. In this sacred mountain system, from daily life to the spiritual world, all human wishes have the mountain gods to appeal to (Guo, 2012).

However, like Sacred Mountain Moerduo, global mountainous communities have experienced varying degrees of the degenerative process of take—make—waste (Kohn, 2013; Latour, 2004; Sullivan, 2010). With its rich biodiversity and precious minerals, Mountain Moerduo has been part of this degenerative story for the past 300 years, where resources are exploited for profit without reciprocity. How can we begin to regenerate these traumatized ecosystems and repair the sense of separation?

Since 2015, Yunhe Center began assisting in the creation of regenerative design in the Gyalrong Tibetan village, helping the communities celebrate and leverage the knowledge and wisdom of their traditional practices through eco-learning and regenerative tourism programs (UNESCO, 2020). In the case study of Yunhe Center, place-based learning under the sacred mountain is essentially about designing an experience that weaves human reconnection with nature.

In this sense, Thinking like a Mountain and Moving like a River encapsulate the essence of integrating TEK into design anthropology practices. Thinking like a mountain encourages a long-term, holistic perspective, recognizing the interconnectedness of ecosystems and the importance of deep time lenses. Moving like a river emphasizes adaptability, flow, and responsiveness to change, reflecting the dynamic nature of human and ecological systems. Together, these metaphors aim to inspire designers to address challenges in a creative way that is both resilient and in harmony with the natural world, fostering a more regenerative future.

3.1 Mountains as Teachers

Walking in the mountains can become a living classroom. The oral traditions of TEK offer a detailed prescription for "living in place," including elements of experience and metaphor (Kimmerer, 2002). Walking in the mountains can become a living classroom. The oral traditions of TEK offer a detailed

prescription for “living in place,” incorporating elements of experience and metaphor (Kimmerer, 2002). The Yunhe Center team has documented the oral traditions of the Gyalrong community through extensive participatory observation over the past nine years (see Figure 2). Below is an example of such oral traditions:

If one’s leg is painfully stung by nettles while walking, the antidote—sorrel—often grows nearby; crushing and applying it to the wound can provide relief. The Sichuan pepper trees commonly seen in the village are a major economic crop and are often planted along field edges to prevent cattle from entering and damaging the crops; their extensive root systems also help prevent wind erosion and stabilize the soil. The springs encircled by prayer flags are places where people pray to the mountain gods; Tibetans believe that the springs are the eyes of the mountain gods, and if they are polluted, human eyes will also fall ill.



Figure 2. Participatory observation about the oral traditions in the Gyalrong community

Through such deep listening and learning, a mountain transforms into a revered space. This sanctity is inherently subjective and even intimate, transcending objectivity (Guo, 2012). In Indigenous epistemology, something can only be fully understood when it is comprehended through all aspects of human experience—mind, body, emotions, and spirit (Cajete, 2003).

By facilitating the experience through rituals, observation, participation, meditation, storytelling, and everyday conversations—experiences that invite life back—it challenges the narrative of human separation from nature and reconsiders the reciprocal relationship between the people living on this land and the mountains (Seed, et al., 2007). In doing so, the Yunhe Center expands the notion of "teacher" beyond images of a person in a classroom. The "teachers" are mountains, other people, plants, animals, rivers, local villagers, community members, and our own imaginations, as nourished by relationships with them (Latour, 2004; Huan, 2016). This illustrates Bekoff's (2000) concept of holistic, heart-driven knowledge that is imbued with spirit and compassion, recognizing the full spectrum of interconnectedness between humans and nature.

3.2 Mountains as Pedagogy

Taking mountains as pedagogy involves recognizing that each territory near them has generated a unique link, relationship, and interaction. We need to prepare ourselves to engage productively with complex, multicultural, real-world communities and challenges (Kimmerer, 2002). When designing for the real world, any attempt to isolate design and treat it as a separate entity contradicts the inherent values of design as a foundational, life-supporting system (Papanek, 2012). In the Gyalrong community, Yunhe Center designed a learning program for high school students from urban areas aimed at promoting the eco-economic transition of the Gyalrong Tibetan village. Students engage in learning and researching Sichuan pepper from ecological, economic, cultural, and community perspectives, ultimately presenting reports and community presentations. The one-week learning module includes natural observation in the village, participation in traditional mountain deity worship ceremonies, interviews with Sichuan pepper farmers to understand their aspirations and environmental challenges, visits to inheritors of embroidery and folk songs, reading reports on the village's ecosystem diversity, and studying case studies from eco-designers. By engaging the head, hands, and heart, and weaving new stories from the old, it enables individuals and groups to grasp and share complex wholes and foster reciprocal relationships with the community as well as the mountain (UNESCO, 2020).

Among the mountains, there are lessons in culture, literature, poetry, botany, glaciology, science, history, spirituality, and the entire university curriculum (Frazier et al., 2019). When contemplating the pedagogy of mountains, we discover through historical research, social connections, and actions

that mountains can be seen as learning spaces, initiating co-creation from a deep-time and interdisciplinary perspective (Seed, et al., 2007). If the dialogue initiated around the project generates a storytelling process, where people experience the authentic place through actions and words, it can transcend the project and integrate into the community and beyond, creating what Atlee (2007) refers to as a new "story field." This mountain pedagogy reveals different values and meanings closely related to personal memories, local actors, and self-identity (Mang and Reed, 2012). In this sense, taking mountains as pedagogy that includes our embodied experience of places, has an acupuncture effect that ripples far beyond its direct impact.

3.3 Mountain Economy

Imagine a scenario where the mountains of the world form a network of learning spaces and focal points for ecosystem restoration and economic regeneration. What would economic theories, policies, and institutions look like if they aimed to promote human community in an ecologically responsible context rather than ever-increasing growth? John Cobb's book, co-authored with Herman Daly (1990), For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future, builds a bridge between economics and ecology, opening up possibilities for doing things differently.

For the past nine years, the Yunhe Center has been rooted in the Gyalrong community, developing a series of place-based learning programs focused on ecological economy, ecological restoration, and ecological design. These programs are grounded in participatory observation of place-based knowledge. By leveraging the interdisciplinary team led by designers, ecological, spiritual, and cultural knowledge is archived and transformed into learning programs for local and external students. Concurrently, market research and expansion are undertaken to attract external resources to the community through eco-tourism outreach. External experts and funding provide training in eco-tourism guidelines, homestay operation, and cultural heritage conservation, establishing mechanisms to empower the community. Ultimately, this ecological services-based economy model (see Figure 3) aims to engage local villagers and external visitors in gradually enhancing their ecological awareness, leading to ecological regeneration. These initiatives provide a mutual learning and practice space for the locals, government, and external stakeholders, and catalysts the mountain-centric, instead of user-centric, economy to support the regenerative circle. (UNESCO, 2020).

4. Storymaking: Moving as a River

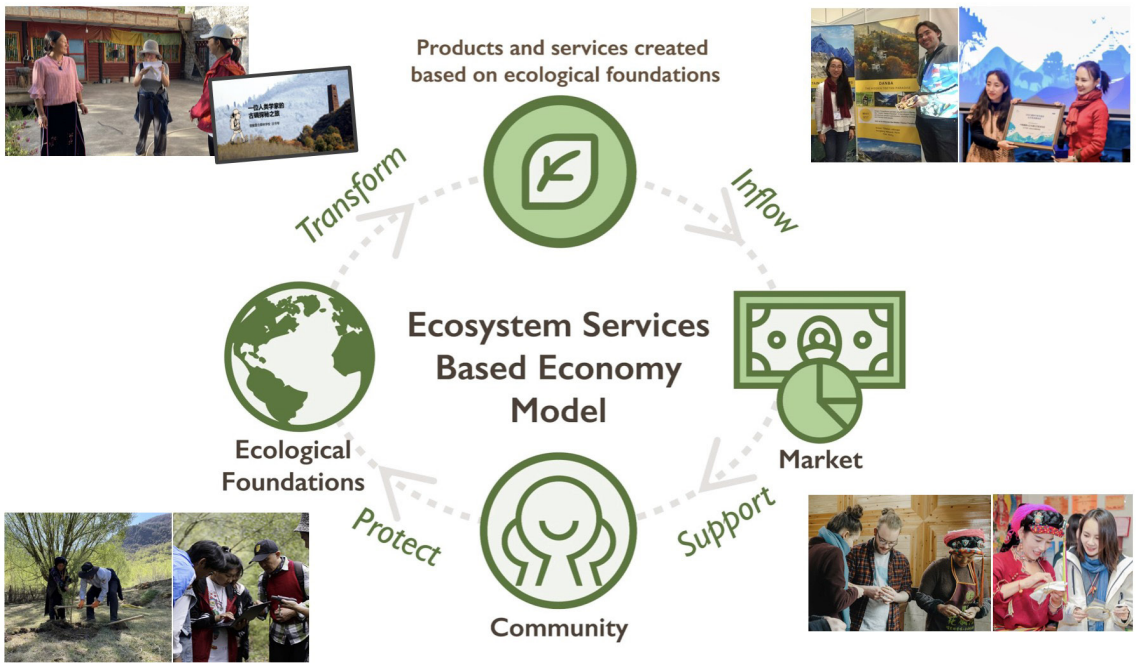

Figure 3. Ecological services-based economy model by Yunhe Center

Process philosopher Alfred North Whitehead (1985) posits that the entire world flows like a river, as both the world and its entities are processes of change. Just as a river flows, the world exists in a state of flux, forming a network of ever-changing events. Theodor Schwenk (1976) suggests that human thought mirrors the design principle seen in the universe's formation, which is similar to fluid dynamics, where elements of a fluid relinquish their forms, becoming ready to merge with, integrate, and encompass everything. For Indigenous peoples, stories breathe their own breaths, they are organic in nature, and dynamic in process (Chawla , 2011), embodying inter-cultural, intergenerational principles and spanning time and space (Phillips and Bunda, 2018).

Mountains change over geological time; humans change over human time, and within this context, stories provide a way for humans to frame their understanding of the world, giving it shape and order (Fisher, 1987). This section, through a case study of community exhibitions, discusses how human anthropology links stories through fluidity, illustrating how Tibetans perceive and understand the world: through oral stories, songs, paintings, and images, telling how water systems sustain an invisible world. Participatory visual methods help evoke memories, emotions, and implicit cultural knowledge (Mannay, 2016). As a design methodological framework, storymaking can empower individuals, communities, and networks, serving as an alternative that respects the complexity of people and places, social structures, geography, and socio-political contexts (Metta, 2015; Lucarelli and Giovanardi, 2014).

Moving as a River provides a metaphor for understanding the dynamic, interconnected, and adaptive nature of storymaking,

emphasizing the importance of fluidity, integration, and continuous flow in knowledge archiving, learning, and co-creation. From 2023 to early 2024, the Yunhe Center collaborated with the external design team of Shanhailiang to design and plan three exhibition spaces in Zhonglu Township, Gyalrong community. These three spaces respectively showcase the ecological nature, culture, and life, as well as the spiritual beliefs of the Tibetan people. The case study on community exhibition examines the life experiences, productive labor, and living traditions constructed around the sacred Muerdo Mountains, mediated by the Gyalrong people. This dialogue between the land, deities, and humans, like the flowing rivers in the village, interlinks, emerges, and cycles continuously.

4.1 Place-based Knowledge Archiving

As a river flows and adapts to its surroundings, storymaking in the three community exhibitions involves the fluid collection and archiving of place-based knowledge, encompassing ecological, spiritual, and everyday practice wisdom. The first exhibition space is located in an old Tibetan house named after its owner—Worebo. It showcases the lives of three generations of Gyalrong people over nearly 100 years, highlighting their spiritual beliefs, family blood ties, emotional bonds, customs, community relationships, natural ecology, agricultural labor, and the inheritance of folk wisdom and craftsmanship (see Figure 4). The exhibition curator invited inheritors of intangible cultural heritage to redraw auspicious patterns on the doors and walls, hired experts as curatorial advisors, purchased many antiques from folk collectors, recorded village festival sounds with musicians, and interviewed several village elders. These participatory visual methods not only serve as powerful tools to understand people's sense of place and multi-sensory experiences but also engage them in meaningful reflection, negotiation, and potential regeneration actions (Tassi & Valsecchi, 2016).

Simultaneously, regenerative design encompasses "adjusting one's modes of being, behavior,

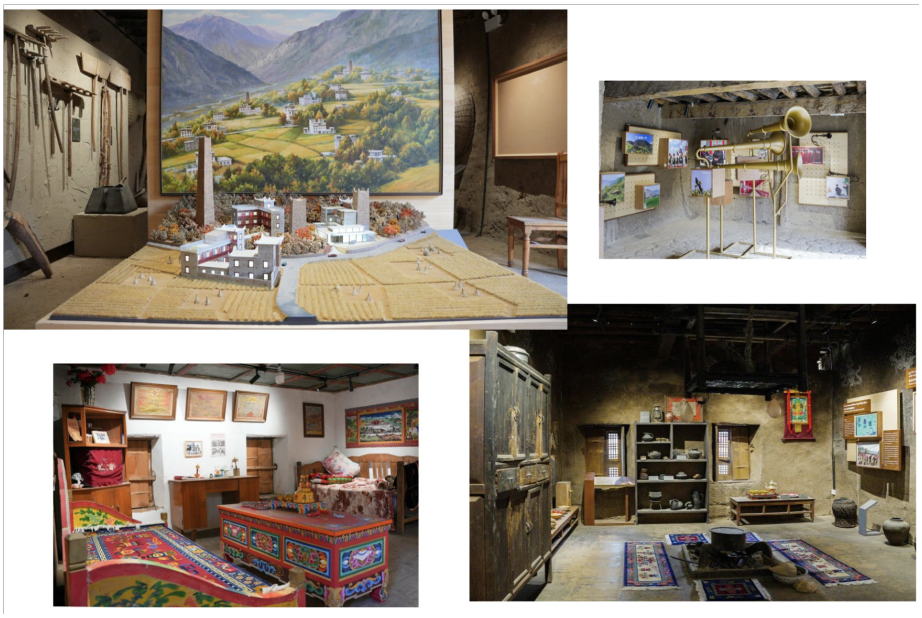

Figure 4. Exhibition space of the traditional Tibetan house

and communication, as well as the relationship to the broader life-evolution journey and coherence of the nested wholes—communities, ecosystems, the biosphere, and the cosmos—that we partake in" (Wahl, 2016). This principle is evident in the second exhibition space, which features the millennium murals in the Scripture Hall Tower of Salako Temple (see Figure 5). By using multimedia, the exhibition brings the divine statues from the imaginary world to the real space, with murals that move around the audience. The interpretation of Thangka stories, along with the display of five-colored prayer flags, religious instruments, and ritual symbols, showcases an aspect of Tibetan spiritual and cultural life. The need to re-create an intimacy with the Earth is essential to crafting the new story. As Berry (1988) states, by "creating some of our most powerful poetic references and metaphoric expressions" through the integration of cultural perspectives and scientific discoveries, this becomes a tool for addressing, and even solving, the challenges that threaten a sustainable existence (Berry, 1988, p. 16).

4.2 Alternative Learning Space



Figure 5. Millennium murals in the Scripture Hall Tower of Salako Temple

As rivers flow through different terrains, community exhibitions as alternative learning spaces encourage active engagement and artistic expression, allowing learners to immerse themselves in the local context and gain holistic understanding through multi-sensory experiences. (see Figure 6). In the Gyalrong Tibetan village exhibition design workshop, the curator led high

school students through three exhibition spaces: the Worebo exhibit of daily life, the spiritual world of the Sarako Monastery scripture hall, and the ecosystem of the White Tower Nature Observation Station. The curator introduced the entire process from project reception to exhibition completion, encouraging students to explore the place with multiple senses. The co-creation workshop examined how collaborative visual methods (maps, collages, videos, etc.) can be valuable tools for weaving stories. Ultimately, the students' collaborative works became part of the exhibition: short films about the Sacred Mountain, a map guide for village tours, a game design based on cultural heritage, and a renovation design proposal for the traditional watchtower. Multimedia, stories, and communicators intertwine to form the driving force of storymaking (Leavy, 2015).

Local learning exhibitions provide a safe space for learning and practicing design anthropology



Figure 6. Exhibition space of the White Tower Nature Observation

as a system catalyst. Stories are translated into scientific language, government language, village language, and the language of external learners to communicate different needs, promoting dialogue and implementing empathetic actions through participatory observation. This creatively harmonious approach represents a continuous reciprocity of giving and taking, reflecting what we can do for the place (Mang and Reed, 2012).

Designers uncover old stories of living in a place and begin creating new ones, as we are not just storytellers but creators of stories (Kimmerer, 2013). This requires designers to deeply reflect on their contributions to understanding the regeneration and transformation of fragmented narratives (Irwin, 2020).

4.3 Remember, Connect, and Move Forward

Stories flow continuously, connecting past, present, and future. Moving as a River underpins the way of remembering, connecting, and moving forward, where past knowledge and experiences are integrated into present actions and future aspirations. The three exhibitions invite people to imagine the future differently, weaving stories that enable individuals and groups to grasp and share complex wholes. Principles of solidarity, respect, relationship, and reciprocity, embodied in human-land relationships, religious rituals, and folk beliefs, stem from this shared perspective, forming a common foundation of consensus: place (Y.Luo and Leitao, 2024). Human memory is based on stories, not data, and stories are the foundation of how people learn and organize what they know (Schank et al., 2009).

The accumulated knowledge of the remaining Indigenous communities worldwide represents ancient thoughts, experiences, and actions, which, if respected and preserved as an important repository of ecological wisdom, can form the basis for repositioning cosmology (Brush and Stabinsky, 1996). As rivers eventually flow into the sea, this paper intends to introduce Indigenous internationalism as a framework, cultivating place-based cooperative alliances among global Indigenous communities, culturally and economically. Māori intellectual Linda Tuhiwai Smith (1999), basing her work on the ocean as a giver of life and time patterns, outlines an image representing their agenda. She depicts four concentric circles to symbolize decolonization, healing, transformation, and mobilization for self-determination. These are not just goals but processes that connect, inform, and clarify the tensions between local, regional, and global contexts (Smith, 1999). Just as water forms a network of rivers, streams and oceans, the process of remembering, connecting, and moving forward involves weaving individual and collective stories from local, to global.

Conclusion

This paper delves into the rich interplay between design anthropology and the Tibetan worldview, demonstrating the profound impact of place-based learning and storymaking. By immersing ourselves in the Gyalrong Tibetan community's traditions and practices, we have gained valuable insights into how TEK can inform and enhance contemporary design methodologies. The integration of human and ecological systems is not merely an academic exercise but a practical approach to fostering sustainable and regenerative design.

The key lessons derived from this research underscore the transformative potential of embracing TEK and the wisdom embedded in Indigenous practices. The Gyalrong Tibetan community's harmonious relationship with nature offers a compelling model for rethinking modern design paradigms. Through place-based learning, designers can cultivate a deeper connection with the environment, leading to more empathetic and ecologically attuned solutions.

Storymaking, as a method, further enriches this process by weaving narratives that bridge cultural understanding and empathy. It allows for the preservation and transmission of Indigenous knowledge, ensuring that these valuable insights are not lost but instead integrated into the fabric of contemporary design practice. By listening to and telling the stories of communities like the Gyalrong Tibetans, designers can create more inclusive and context-sensitive projects.

Ultimately, this paper advocates for a paradigm shift in design anthropology, urging practitioners to look beyond conventional frameworks and embrace the lessons from TEK and Indigenous worldviews. By doing so, we can foster a more holistic and regenerative approach to design, one that honors the intricate connections between humanity and the natural world. The Gyalrong Tibetan community case study serves as a powerful testament to the enduring relevance of traditional knowledge in addressing the pressing environmental and social challenges of our time.

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About the Authors:

Author 1 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE] [_P/RoD Author Bio and Acknowledgements]

Author 2 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE]

Acknowledgements: this section is optional. You can use this section to acknowledge support you have had for your research from your colleagues, student's participation, internal or external partners' contribution or funding bodies. [LEAVE BLANK UNTIL FINAL ACCEPTANCE]

SHIFTING GRAPHIC DESIGN PEDAGOGY: CO-CREATING WITH CANCER SURVIVORS FOR INCLUSIVE CLINICAL TRIALS

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ABSTRACT | This paper outlines how students, faculty, medical practitioners, and community advocates came together to redefine community engagement in clinical trials in Los Angeles County. Clinical trials, the main path to determining whether medical treatments and prevention strategies are safe for humans, are historically inequitable in the United States. To combat the representation disparity between those living in the United States and those participating in clinical trials, in April 2022, the United States Food and Drug Administration instructed clinical trial sponsors to recruit more equitable groups (Office of the Commissioner, 2022). Although, with a long history of unethical acts of testing, communities of color in the United States mistrust medical institutions (Rodriguez & Garcia, 2013). Increasing diversity in these trials is imperative for equity in health access but challenging due to the need for more trust between communities of color and health institutions. Cedars-Sinai Cancer Research Center for Health Equity partnered with Designmatters at ArtCenter College of Design to invite design students to reimagine recruitment for clinical trials. The authors utilize this paper to highlight the importance of the agility of faculty in guiding students and those closest to the challenge through co-design activities to design solutions that reflect the needs of those historically marginalized.

This paper exemplifies how partnership-based pedagogy is an innovative format to bring interdisciplinarity in the classroom. The authors share how this format shapes the present and future of pedagogical approaches in the field by outlining their learning. This paper highlights how the crux of this educational format empowers students to vocalize their curiosity and learn as creatives, shaping them into more collaborative, committed, and confident practitioners. While students are the primary learners, through this paper, the authors explore the discomfort and

comfort of educators being learners themselves. In addition to demonstrating a collaborative and transformative student experience, this paper proposes a framework that educators can assess and utilize to create enabling conditions for co-design between partners, communities, and students by reflecting on what it takes for designers to collaborate, unpack creative bias, and design for value. Educators are more than teachers when executing partnership-based curricula. Through this paper, the authors highlight the unique dynamic of the classroom, where they served as managers, facilitators, and connectors—expanding their roles and challenges. The authors explore the nature of research and partnership-based pedagogy as an agent of inclusive and representative work. In addition to highlighting the need for educational innovation and the enabling conditions required to co-design with those, not in the classroom, it also sheds light on the three community-centered campaigns tangibly developed as the outcome of this pedagogical approach.

KEYWORDS | GRAPHIC DESIGN PEDAGOGY, CLINICAL TRIAL RECRUITMENT, CREATIVE BIAS, CO-CREATION, RESEARCH-DRIVEN DESIGN

1. Introduction

Graphic designers can claim to be one without a formal degree (Wong et al., 2018; Debbie, 2011), which makes it a unique discipline to develop pedagogical approaches. With the rise in artificial intelligence and templatization, visual design has become an adaptable tool for all. Still, according to Benson (2020), most employers seek to employ trained design practitioners, expecting fresh practitioners to demonstrate extraordinary competencies to secure said jobs. (Benson, 2020; Adu, 2015). While graphic design students are expected to learn and grow for the benefit of their prospective employers, the discipline remains imprecise (Meron, 2022). Meron (2022) argued that graphic design lacks academic literature to learn from, which transfers the focus to the visual function of the discipline from a theoretical one. Graphic design also lacks social, political, cultural, and economic frameworks and methods (Walker, 2017), often playing a significant role in production. Addressing the articulated disciplinary needs, this paper approaches said challenges through the lens of educators, students, and co-design participants in an interdisciplinary environment. It attempts to codify a participative and co-design curriculum that results in evidence-based visual design practice for students while benefiting from the critical perspectives of community organizers and leaders.

This paper is the outcome of a class taught by Designmatters at ArtCenter College of Design within a transdisciplinary classroom developed by the college's social innovation design department in late 2022. Designmatters collaborates with mission-driven non-profit organizations, industry, and international development agencies, leading to an immersive and impactful research experience for students. The partner for this course, Cedars Sinai Cancer Research Center for Health Equity, is a leading cancer research center in a nonprofit hospital in Los Angeles. Both institutions have had the privilege of building a robust relationship of trust through continual partnership since 2018, which sets projects up for a collaborative and transparent environment for the students to develop authentic outcomes and products.

It may be difficult for individuals to create similar learning experiences without a similar institutional model of long-term partnerships. Hence, this paper focuses on the key strategies identified during and after the course to better devise enabling conditions and recognize disabling conditions of co-design and participatory practice in a classroom.

Drawing on literature review, post-course reflective roundtable discussions, and a proposed framework, this paper sheds light on the intersectionality of class and care, revealing the profound impact of social and environmental factors on design and access. It champions the value of co-design with individuals with lived experience, offering a unique reflection on the course methodology, challenges, and potential for future iterations. It attempts to reflect on the nature of learning in a unique classroom and is an exercise in creating a reflexive design practice. The reflective analysis is used as a systematic search for patterns, logic, and order, whereas the reflexive approach is the resulting framework. This paper proposes key pillars to a participatory-centric curriculum wherein the reflexive approach is utilized to engage in the reciprocal nature of perception and ethical action (Cunliffe, 2004; Buchert, 2021). The authors define reflexive pedagogy as the central theme of investigation to indicate that educators and students need to self-assess the circumstances as they are happening in the class to understand the nuances of applied design learning.

2. The Gap Between Medical Institutions and Communities

Context defines communication. Since it is crucial to learn from historical evidence to develop better and holistic outcomes, the faculty and partner recognized the need to understand the challenging context between medical institutions and communities when framing the project brief for the class. This paper delves into the strategies and tools used in the classroom to develop evidence-based practice, but in this section, the authors elaborate on the history of the subject matter to establish the significance of community engagement and co-design process for this project.

Historically, inequities in public health have been a result of race and class discrimination, where poverty led to health vulnerabilities. Simultaneously, the wealthy could retreat to country estates to distance themselves from infections (Institute of Medicine et al., 1988). The clear distinction between classes left those more vulnerable— individuals experiencing poverty and discrimination—to clean their surroundings, which they did not have the privilege to address. Additionally, to develop medication for the affluent, the US engaged in several illegal acts of testing individuals; for instance, a Guatemalan study in 1946 infected at least 5,128 individuals without prior consent (Rodriguez & Garcia, 2013). Another example of non-consensual experimentation led by the US government

is named the Tuskegee Syphilis experiment between 1932 and 1972, which left the participants without treatment (Rodriguez & Garcia, 2013).

Even today, US healthcare is tied to economic, social, and political factors—systematically designed to marginalize underrepresented communities. It was as late as 1974 when The Belmont Report (1979) established the ethical considerations and challenges in biomedical research. This report summarized the ethical principles into three [parts]: respect for persons, beneficence, and justice (Centers for Disease Control and Prevention). However, the ethical considerations led to regulating biomedical testing, not the marginalization or underrepresentation in research until 2022, when the FDA instructed research sponsors to recruit more equitably to combat health inequities (Office of the Commissioner, 2022). More recently, in 2020, 4,922 patients participated in clinical trials of 18 approved drugs, where 73% of the trial participants were White, 5% were Black/African American, 14% were Asian, and 6% were Latino/Hispanic (Owens-Walton et al., 2022), compared to the population share of 59.3% White, 12.6% Black, 5.9% Asian, and 18.9% Latino/Hispanic (U.S. Census Bureau, 2022).

In addition to institutional efforts to change research and testing for biomedical interventions, individuals like Dr. Nancy Krieger (Krieger, N. 2005) are trying to evolve traditional medical research to focus on community-based participatory research (CBPR). It is a process that aims to build partnership through trust, respect, and shared decision-making, which is also the pillars of the design process and strategies used in this course. In the Applied Design and Pedagogy: Pedagogical Innovation in the Classroom section, the authors outline the following subtopics that build on trust, relationship, and justice:

1. Designing for individuals and interdisciplinary learning
2. Creating an equitable and participatory learning environment
3. Addressing mistrust and bias through design
4. Team-building and brief-focused classwork

3. Understanding Design's Role in Disrupting Exclusionary Praxis

In 2017, George Aye highlighted that design students dedicate their time and skills to comprehend complex problems but often lack an understanding of power and its role in complex systems (Aye, 2017). The first generation of constructive design researchers focused on ergonomics, usability, and psychology (Koskinen, 2010), whereas colleges rarely operationalized design research that could disrupt inequitable systems. Hence, they rarely questioned power distribution

or were trained to engage in community-centered practice. The lack of co-creation eventually led to an art and design education agenda that did not prioritize research, with a few exceptions. While developing a robust research-driven design curriculum, the University of Art and Design Helsinki realized that few senior faculty had experience leading research.

In contrast, their curriculum focused more on strategic objectives than the School of Design had hoped (Keinonen & Koskinen, n.d.). The bigger challenge, however, is the shifting nature of design, which means that the pedagogy must contribute to the continually expanding methods students must grasp (Chmela-Jones, 2017). Design pedagogy perpetuates hierarchical structures by encouraging students to create in isolation and away from co-creation opportunities, such as design mechanics or addressing the politics of design (Singh Rathore & Schlaug, 2024). Bringing in community partners in the design process aims to hold the practitioners and students accountable for their outputs (Tarallo, 2013). It demonstrates the value of shared decision-making in design processes. This paper proposes that educators focus on a pedagogy that builds on participatory and co-creation with those closest to the challenge, equips students with critical thinking and tools to navigate power structures, design with community members, and create equitable systems.

4. Framework Methodology

This paper reflects on the need for teaching evidence and research-centric visual design practice by examining techniques used in the classroom and insights and lessons learned documented through a post-class interdisciplinary roundtable of designers, community members, and faculty. The undergraduate studio course, co-hosted by the Graphic Design and social innovation design departments, took place in the fall of 2022 and included students from the Graphic Design, Interaction Design, Product Design, Fine Art, and Illustration departments. The studio's project brief focused on increasing awareness of and enrollment in cancer-related clinical trials within diverse communities, specifically Korean and Latinx communities in Los Angeles. The class learning outcomes included: (1) the intentionality of the design process and its relationship to bias and delivery; (2) in-depth guidance for research aimed at understanding communities' perspectives; and (3) structuring deliverables based on feedback and co-design.

The course culminated in the three multi-media campaigns centering communities' experiences and perspectives. Since the class and curriculum were uniquely designed, the faculty recognized the need to reflect on the challenges and achievements of the course through an interdisciplinary roundtable, continuing documentation through the collaborative approach defined by a participation-centric curriculum.

The following two sections highlight the learnings of the class and roundtable discussion and propose a framework to create the enabling conditions of participatory environments and co-creation in a visual design studio classroom. The framework's analysis, documentation, and proposal are developed through primary research, i.e., qualitative data collection, during and after the course.

5. Applied Design and Pedagogy: Pedagogical Innovation in the Classroom

When it comes to class, hierarchy, and societal needs, care has been different for everyone. The Committee for the Study of the Future of Public Health (1988) argued that the public responsibility for the health of the population needs to become more fiscally possible because, before the nineteenth century, diseases were used as tools to segregate the rich and poor (Institute of Medicine, 1988). However, with the plague, it became more evident that the wealthy could not escape contact to avoid illness. In this section, the authors explore how pedagogical innovation can bring sensitivity and awareness to the classroom. In order to understand and address inequities in public health outreach, the authors implemented qualitative strategies like focus groups and community dialogues that students could lead and learn by doing. Articulated in the following teaching and management strategies, the authors outline the impact on student and community engagement below.

5.1 Designing for individuals and interdisciplinary learning

Design students have research opportunities in their classrooms, but fewer that include research participants and introduction to participatory practicum. A core component of this class was to co-design concepts through participatory methods and community engagement. It focused on introducing students to human-centered design, its critique, and tools to engage with research participants. The class equipped students with tools and tactics to engage community members through interviewing, listening, creating user journey maps, and taking community members along with them through the creative process. During the course and the roundtable discussion, the class acknowledged how the politics of people, design, and research intersect through lived experience. Centering the class on lived experience and those closest to the challenge helped the students learn through primary research and sources. The class soon realized that individuals do not know about clinical trials unless they are diagnosed with cancer, and even then, it is difficult to find a suitable trial for themselves. Even individuals with a family history of cancer are often unaware of cancer clinical trials and the process to participate in them.

Using participatory research, the students engaged with those experiencing and in remission from cancer to understand the lived experience and those conducting health research to learn about the qualitative

and quantitative data available to identify behaviors and trends in the field. Since research stakeholders shared the value of introducing clinical trials earlier in the diagnostic process, the students were able to design tools and products that focused on proactive engagement and learning processes—challenging the misconception that clinical trials are only for cancer patients with a terminal diagnosis. The classroom aimed to shift the traditional focus from designing from organizations to designing for individuals in order to underscore the significance of applied design. The curriculum served students from different disciplines, such as Fine Art, Interaction Design, Product Design, and Graphic Design, to learn from each other and research participants, resulting in a unique blend of art, usability, and a learning experience. During the roundtable, the students stated that interacting with health professionals and community members distinguished this class from other classes. It provided them an environment to learn from real-world experiences and depart from traditional prompt-based classes.

5.2 Creating an equitable and participatory learning environment

Through a participation-centric curriculum, the faculty created an environment that emphasized equity, co-creation and commitment to the lived experience of the community members. Mindful of the barriers that students sometimes face in accessing research opportunities outside of the classroom and class time, including access to transportation, time and funds, the faculty arranged for field trips to health clinics with provided transportation during regular class time, and invited partners and community members into the classroom for discussion and engagement. The cancer research center handled recruiting healthcare workers and community members to engage in this experience through its relationship with health clinics and other support organizations. The cancer research center organized compensation for community members for whom participation was a burden, and the class offered options to join sessions virtually for those that could not travel to the college. Students also received stipends to cover any out of pocket expenses related to the class, including supplies and prototyping materials. This all helped set an equitable foundation for the class. The classroom environment also guided the students to reflect on the historical marginalization, devise ways of partnership, and build a robust process supported by evidence of community engagement. Through co-creation and participation, the students developed outcomes that centered the authentic needs of impacted individuals, creating a sense of belonging for prospective participants of cancer clinical trials. The objective of grounding in the community and those closest to the challenge helped the classroom learn from, and design with individuals who have felt excluded—who do not see themselves reflected in verbal or visual outreach components of medical institutions. The intentional tools used in the classroom emphasized the critical role

of interaction in making effective products, bridged the gap between design students and their subject, and the criticality of field interaction and understanding the community perspectives. As a result, students experienced the value of making decisions through consensus, community feedback, and effective communication between the designer and stakeholders.

5.3 Addressing mistrust and bias through design

Reflecting on the historical marginalization and impact of healthcare practices helped the students discuss the instances of eugenics, discrimination, and mistrust. The lack of institutional accountability was a central theme in the classroom. It helped students design campaigns to gain trust and build an intentional and authentic relationship. During the roundtable discussion, the students underscored the value of addressing personal bias and positionality as a designer. They recognized the challenging nature of the class due to its different format and learning experience. More importantly, they noted that a critical challenge for design students is to learn to design for systems they are not beneficiaries of, which is often different from the perspective they come across in other classes. Designing for different languages helped the students reimagine communication in and outside the medical institution. As a result, the students focused on community and interpersonal relationships.

"With the [omnipresent] mistrust of medical institutions, we relied on the community as a guiding factor for our project. We were fascinated by how strongly the concept of community works. So we took advantage of [the mistrust] through our application and concept. It was fascinating how we had to get deep into this and how much of this health problem does not involve health aspects. We are talking about communities around Los Angeles; we are talking about income and transportation. This course made us consider the many aspects of just one problem."

FACULTY MEMBER, ROUNDTABLE DISCUSSION

5.4 Team-building and brief-focused classwork

The unique dynamic of the classroom was not limited to research and partnership. Divided into three teams, the students navigated different skills, interests, and personalities to arrive at successful outcomes. The students worked together to complement their skills. During the roundtable, the students emphasized the value of learning from each other as being more significant than the challenges they faced. However, teamwork is more challenging within a competitive design institution that fosters individuality more than cooperation. In a competitive and individualistic environment, it can be challenging to break through the focus on

personal portfolio pieces and work towards a common goal defined by a partnership-based project brief. More importantly, any discomfort in collaboration and focus on said individuality can make it difficult to evaluate the work done in the classroom and achieve success—in terms of experience, learning, and outcomes. When done authentically, this participative and interdisciplinary environment can emphasize stepping out of one's comfort zone to create meaningful work and impact for the students.

The social innovation department specifically seeks and frames projects with partners in which the student-designed outcomes may be moved beyond the walls of the classroom and into further development toward real-world pilot implementation; with this specific partner, all of the previous projects had some level of implementation for student projects. As a result, educators were not just engaging in discourse and supporting creative endeavors; they also acted as project and research managers tasked to lead the project through educational components. In most instances, one is either managing a project or teaching, but in this instance, both roles influence each other. As a result, while the beneficiaries of this process are students and partners, the faculty are responsible for managing expectations, creating through learning, and designing an intentional yet fast-paced environment.

6. Building Co-Design and Participation-Centric Curriculum

This section describes the key framework for enabling conditions of success to create a participative curriculum and environment that educators can use to create a similar opportunity for their classrooms. This framework is intended to demonstrate the value of lived experience and reflexive collaboration, driven by the belief that values outweigh the effort and difficulty of the process. In order to develop a visual design class focused on applied methodology, educators and partners can reflect on the following key learnings as ideological pillars of the curriculum and engagement:

- **Foster a transparent classroom environment:** Design as a discipline is shaped by privileged perspectives, and the classroom can see this impact on materials the students may develop. It is imperative that the classroom is centered on sharedpower and decision-making to ensure it develops tools that foster shared decision-making. Educators can develop this environment by modeling the behavior themselves and sharing references that encompass the results they expect from the students. During the course, the educators showcased case studies that demonstrated critical analysis and strategic solutions. They also featured works from students grappling with similar challenges to encourage a dialogue and foster peer-

learning discussions throughout the term. Alongside faculty's own research and projects, each lecture ended with a space for reflections and observations, where the faculty and students could share successes and failures. With these intentional yet small steps, faculty nurtured a classroom environment that enabled students to collectively celebrate successes and confront failures head-on.

· **Value students, teachers, and participants' perspectives alike:** Reflexivity and reflections do not come easy in a fast-paced environment, but they are a crucial step in valuing the perspectives of all stakeholders. In this course, the educators built reflection space for all tools and tactics shared; they demonstrated the needs before assigning tasks and created space for students to reflect on their emotions as well as their work. As a result, the students were able to bring their full selves to the class, be more in tune with themselves as creatives, and get an opportunity to vocalize their needs. When the classroom valued listening and reflection, it seamlessly translated to research participant sessions and interviews. The intentionality of these actions led to more collaboration that created conditions for shared power.

· **Commitment to partnership:** Since there are several moving pieces, educators, partners, community members, and students form a dynamic web; everyone must maintain open communication and collaborative spirit. True partnership meant transcending the traditional roles and working together seamlessly. This united effort empowered participatory practices and ultimately delivered inclusive outcomes to benefit the end-user and all stakeholders. In this class, beyond learning, students contributed by translating knowledge into impactful design deliverables. Educators, in addition to guiding, offered art direction and expertise while managing projects. Lastly, the partners were deeply engaged in bringing those closest to the challenge to the classroom, facilitating research partnerships, and amplifying meaningful experiences.

Students continually express the need for tools and methods that contribute to sustainable and inclusive practice (Lupton et al., 2021). The Program Learning Outcomes of the social innovation design department drive towards ensuring students understand how to collaborate through transdisciplinary and team-based work; how to center communities in their work through advocacy and social change; how to apply ethical design research practices; and how to seek out resources to understand historical, cultural and community contexts of any design brief. The overall goal of the Program Learning Outcomes is to create a community of equity-minded designers in the classroom and post-graduation.

As a result of this endeavor, the faculty recognized that empowering students to vocalize their needs and insights leads to a space that values the external collaboration of non-designers. By reflecting on the enabling conditions of the successful class, the authors identified the classroom to be more confident, committed, and collaborative to design for the greater good. Creating space for reflection and exchange also held educators responsible for bringing their full selves to the classroom and addressing challenges as a group rather than making decisions themselves.

7. Project Outcomes

A key part of pedagogical innovation is ensuring the learning objectives of the classroom are not sacrificed. Where students can learn and practice community-centered tools, a visual design curriculum needs visual artifacts and centers each student's growth. Hence, the co-design process and the proposed framework are not the only outcomes of this class. Here are the three projects shared with the clients, with one in production, that student teams proposed. These three projects are briefly described below to illustrate how the final design outcomes connect and reflect the stakeholders' experiences. The cancer research center hired a student as a Fellow to continue developing the concepts for a pilot implementation planned for later in 2024.

7.1 Cure for the Community

Students: Xiyu Chen, Jesslyn Lee, Megan Pantisks

This student team worked with older adults in Latinx and Korean communities to create a campaign that offered 1) easy-to-understand, basic information about clinical trials and 2) positive personal stories from individuals who have previously participated in clinical trials to create a personal connection. The message is welcoming, inviting people to Be Part of the Cure: Participating in a clinical trial can help save not just your life, but the lives of others in your community. The overall campaign tone is friendly to respond to the community members' expressed desire for connection, but professional to build trust for the information being shared. The campaign uses an illustrative style, integrating handwritten text and hand-drawn characters and iconography that can be customized for different languages. The decision to develop an illustrative language is a reflection of field engagement and study that helped the students better understand the aesthetics that would resonate with the audience. Campaign materials were designed for specific local sites mentioned by community members, such as bus stops, churches, community centers and retirement communities.

7.2 DIVERCT

Students: Taiga Haruyama,
Cindy Chu, Lillian Yian Lin

This project empowers healthcare workers, including oncologists, nurses, patient navigators and primary care physicians to be confident and culturally sensitive sources of information about clinical trials for their patients. The main outcome is a website that features up to date clinical trial information and community guides to help healthcare workers understand the cultural needs of their patients. The website is supplemented with a print campaign that includes two sets of posters for healthcare settings. Posters for healthcare workers announce “Healthcare Providers are Information Providers” with a QR code to the website. Healthcare workers will also be given pins that state “Ask me about clinical trials” and “Clinical trials provide hope.” For patients, posters describe the benefits of clinical trials. The student team also designed a portable information booth for healthcare workers to take with them to community events, responding to a stated need for something eye-catching that can spark conversations. DIVERCT responds to the lack of conversation about cancer clinical trials, to encourage dialogue through simple artifacts like the pins, posters, and the information booth.

7.3 Our Trial

Students: Noah Cousineau,
Vanessa Huang, Haoran Xu

This student team designed a social media program to offer education and support for cancer patients, from those in remission to those who are newly diagnosed, based on the individual experiences described by cancer patients in the classroom. After a user enrolls in “Our Trial” at the recommendation of their healthcare provider, they can select which communities (similar cancers, similar ethnic or cultural backgrounds, interests, locations, etc.) they want to join. Users can connect via chat or through healthcare clinic-hosted in person support groups. Those further along in their cancer treatments can offer advice to those newly diagnosed, and those who have participated in clinical trials can share their experiences with others who might be eligible. “Our Trial” uses pop art tones and fluid groovy shapes of the 60s/70s, a playful iconography that resonates with many cultures and with the adult age groups most likely to be diagnosed with cancer.

8. Conclusion

Design educators face the dual task of defining the present and shaping the future of their discipline simultaneously. At this pivotal time, while visual templates and tools are readily available for anyone to use, design educators have an opportunity to define how research, community-centered, and evidence-based practices can bring more value to formally educated graphic designers. Research, community-centered, and evidence-based visual design pedagogy means an intentional and critical creative process, which can help graphic design students firmly situate themselves as valued professionals.

As illustrated in this paper, co-designing with those closest to the issues helps faculty and students better understand the nature of power, the impact of design work, and the reality of (multi-lingual) implementation. The proposed framework highlights the need for an honest, agile, and collaborative classroom that respects and co-designs with individuals most impacted by the design choices made and have lived experience of the problems the project brief is addressing. There are various purposes that design can serve, and this paper proposes how design pedagogy can evolve to better align with the intended goals of the project brief, its environment, and the historical context of the identified problem.

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RESEARCH ON BRAND EXPERIENCE DESIGN STRATEGY FOR MR VIRTUAL COMMUNITY BASED ON AHP-QFD MODEL

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ABSTRACT | In recent years, the academic community has paid more and more attention to virtual communities, but the research on brand experience design for MR virtual communities is still relatively insufficient. This paper applies an integrated AHP-QFD research methodology based on the user requirements perspective to propose a set of specific design strategies. Firstly, user requirements are collected through the interview method and observation method, and the card classification method is used to classify the attributes of user requirements, initially obtaining 4 categories and 17 user requirements. Secondly, AHP is used to construct a hierarchical model of user requirements, and the user requirements are weighted. Finally, QFD is used to transform the user requirements into 12 specific design elements, and the design elements are ranked according to the degree of weighting. Based on the design elements, a set of design strategies for the MR virtual community brand experience was sorted out: the principles of interactivity and consistency, sociality and diversity, aesthetics and intuitiveness, user-centered and personalization. Through the comprehensive use of the AHP-QFD model, this paper can explore user requirements more objectively and scientifically, effectively guide the design of the MR virtual community brand experience in the future, and provide new ideas for the research and development of similar brand experience designs.

KEYWORDS | VIRTUAL COMMUNITIES, BRAND EXPERIENCE, DESIGN STRATEGY, AHP-QFD

1. Introduction

With the rapid development of Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) technologies, people have higher expectations for immersive digital experiences that go beyond the boundaries of traditional screens (Flavián et al., 2019; He et al., 2018). Traditional social media and online communities can no longer fully meet modern society's needs for new types of social experiences, and the emergence of MR virtual communities provides a new platform to support richer and deeper exchanges and experiences, which is expected to become a key bridge to connect virtual and real and promote further integration of human society (Al-Quran, 2022). MR virtual communities refer to the combination of Mixed Reality (MR) technology to form a unique online community and interactive social space based on digital networks (Ridings & Gefen, 2004). In MR virtual communities, users can exchange information and ideas, as well as immerse themselves in a hybrid scenario that combines reality and virtual reality through devices such as head-mounted displays, providing users with richer and more intuitive ways of communicating and enhancing the sense of interactivity and participation in the user experience (Allcoat et al., 2021; Bec et al., 2021; Lomicka, 2020; Rokhsaritalemi et al., 2020). It not only represents a possibility for the future of socialising but also brings unprecedented convenience and fun to people's daily lives (Hoyer et al., 2020; Jamil et al., 2022). Brand experience refers to the comprehensive feelings and perceptions of users during their interactions with a brand (Van der Westhuizen, 2018), and brand experience in MR virtual communities is not only about shaping its brand image but also a key factor in driving business growth, maintaining customer relationships, and enhancing users' loyalty to the brand (Kaur et al., 2020; Kim & Chao, 2019; Mostafa & Kasamani, 2021).

There has been an increasing academic interest in virtual communities in recent years, but current research on virtual communities focuses on technological innovation, management, definitional classification, user behavior, and applications, with fewer

design studies (Agag & ElMasry, 2016; Baldus et al., 2015; Kapoor et al., 2018; Panigrahi et al., 2018). Moreover, the concept of MR virtual community is relatively new, and the research on MR virtual community brand experience design is still relatively insufficient. Furthermore, the existing research in this area is not well user-centred, so it is necessary to form design strategies through mining and research on user requirements to guide the future brand experience design of the MR virtual community (Bu et al., 2021).

This paper adopts a combination of qualitative and quantitative methods, primarily utilising the combined AHP-QFD (Analytic Hierarchy Process-Quality Function Deployment) research methodology, to conduct the brand experience of the MR virtual community. Finally, the paper outlines a set of design strategies for the MR virtual community's brand experience, providing new ideas for developing similar brand experience designs.

2. Research Methodology

In modern design research, user needs-driven approaches to design innovation include the Kano model (Kano), Analytic Hierarchy Process (AHP), Quality Function Deployment (QFD), Theory of Inventive Problem Solving (TRIZ), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and so on (Jin, 2023). In recent years, a number of scholars have constructed integrated models from these methods and applied them to the development of design projects.

AHP (Analytic Hierarchy Process) is a qualitative and quantitative research method proposed by Professor T.L. Saaty, a mathematician at the University of Pittsburgh, USA, in the 1970s. The method is primarily used to ascertain the weighting coefficients of the user's needs, which helps the researcher to prioritise and make optimal decisions (Canco et al., 2021; Munier & Hontoria, 2021).

QFD (Quality Function Deployment) was initially proposed by Japanese scholars Prof. Yoji Akao and Prof. Shigeru Mizuno in the late 1960s and further developed and refined in the 1970s (Ginting et al., 2020). QFD is a quantitative research methodology for analyzing user requirements that focuses on transforming user requirements into design elements to increase user satisfaction (Jaiswal, 2012; Li & Zhang, 2021).

However, the AHP method can determine the weight of each user requirement, but it cannot directly quantify user requirements into specific design elements (Bagassi et al., 2020). QFD can transform user requirements into design elements, but it cannot capture important user requirement indicators (Ginting & Ishak, 2020). Therefore, this study develops a set of design strategies for MR virtual community brand experience through the integrated AHP-QFD research framework (Figure 1) to guide future MR virtual community brand experience design.

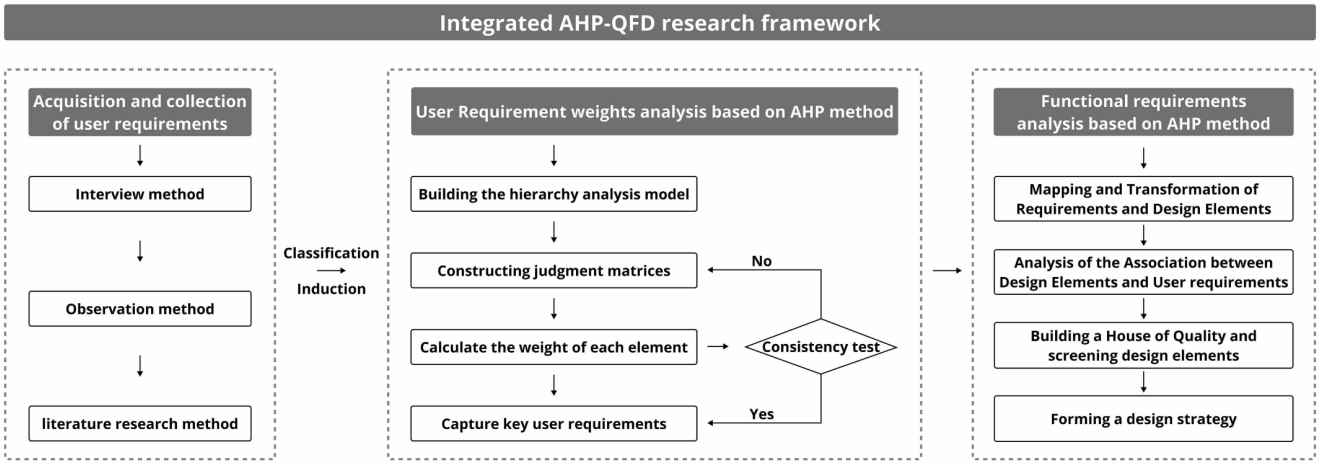

Figure 1. Integrated AHP-QFD research framework. Source: Author's own work

3. Research on the MR virtual community's brand experience design strategy using the AHP-QFD model

3.1 User requirements extraction

This paper will focus on users' brand experience requirements in the MR Virtual community, necessitating an investigation into the target user base to better meet their needs and enhance their experience. Define the characteristics of the target group: all ages, interest in relevant technologies and experiences, high acceptance of emerging things, high demand for socialising, etc. At this stage, a research method combining semi-structured interviews and on-site observation was used to conduct a user survey on 37 people (aged 10-70, 16 females, 21 males), both online and offline, who met the target characteristics in terms of their habits of using the MR virtual community, purpose of use, problems encountered when using it, use scenarios, attitudes towards using it, needs, experience, and so on. Table 1 displays the demographic information of the respondents.

The collected valid information was used to hierarchically unfold the user requirements through a card classification method, grouping the requirement words with high similarity and overlap into one category and excluding low requirement words (Conrad & Tucker, 2019). Preliminarily, 4 categories (17 items) of user requirements are obtained for function, interaction, emotion, and sensory. Finally, a more scientific and comprehensive user requirement hierarchy development table for the MR virtual community brand experience was constructed, as shown in Table 2.

Table 1. Demographic information of respondents (based on semi-structured interviews with 37 individuals).

	Option	Number of people	Proportion
Gender	Male	21	56.76 %
	Female	16	43.24 %
Age	10-24	15	40.54%
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	25-39	13	35.14%
	40-54	7	18.92%
	55-70	2	5.41%
Degree of education	Junior High School or Below	3	8.11%
	Senior high school	5	13.51%
	Undergraduate	19	51.35%
	Postgraduate or Higher	10	27.03%
Economic income level	5,000 and below	11	29.73%
	5,000 -10,000	5	13.51%
	10,001-15,000	8	21.62%
	More than 15,000	13	35.14%

Table 2. MR virtual community brand experience user requirements hierarchy.

Requirements and criteria	Requirements secondary criteria	Specific description of requirements
Functional requirements B1	Comprehensive content C1	Rich and varied content categories.
	High sociability C2	Desire to create interactive communities within the community.
	Community guidelines C3	Good community guidance and management system.
	Personalization C4	Want personalised content recommendations and services.
Interaction requirements B2	Immersive interactive experience C5	Immersive, high-resolution, high-fidelity visual graphics effects.
	Clear information architecture C6	Want to be able to locate and retrieve information quickly.
	High usability C7	Platform and equipment are easy to operate.
	Smooth and sensitive C8	Ensure a smooth, low-latency interactive experience.
Emotional requirements B3	Value identification C9	Desire for values resonance.
	Vivid narrative style C10	The story is tight and provides good narrative pacing and style.
	Wear comfort C11	Having a good wearing experience and providing a rest reminder service.
	Positive incentive C12	Desire to be seen, recognised, and receive positive feedback.
	Privacy and security C13	Guaranteed privacy and security.
Sensory requirements B4	Multimodal C14	Gain multi-dimensional perception, including sight, touch, hearing, and more.
	High visual appeal C15	Provide a recognisable and aesthetically pleasing visual style.
	Anti-fatigue and anti-dizziness C16	Ensure comfortable visuals and prevent dizziness and fatigue during use.
	Environmentally adaptive C17	The interface's visual effects match the changes in the external environment.

3.2 Calculation and analysis of user requirement weights based on AHP method

In 3.1, the user requirements in the MR virtual community brand experience were categorised but not ranked in terms of importance. In order to further clarify the focus of the subsequent design, the AHP hierarchical analysis method was applied at this stage to clarify the weight of each user requirement and improve the accuracy of the user requirement analysis.

The AHP hierarchical analysis method constructs the hierarchical analysis model, as shown in Figure 2. The hierarchical analysis model divides into the target level, criterion level, and subcriterion level based on the user requirements and design objectives of the MR virtual community brand experience. The target level, is the MR virtual community brand experience design strategy; the criterion level, is the functional requirements (B1), interaction requirements (B2), emotional requirements (B3), and sensory requirements (B4); and the sub-criteria level, is the user requirements corresponding to the attributes of the requirements, with a total of 17 items, which are comprehensive content (C1), high sociability (C2), community guidelines (C3), personalization (C4), immersive interactive experience (C5), clear information architecture (C6), high usability (C7), smooth and sensitive (C8), value identification (C9), vivid narrative style (C10), wear comfort (C11), positive incentive (C12), privacy and security(C13), multimodal (C14), high visual appeal (C15), anti-fatigue and anti-dizziness (C16), and environmentally adaptive (C17).

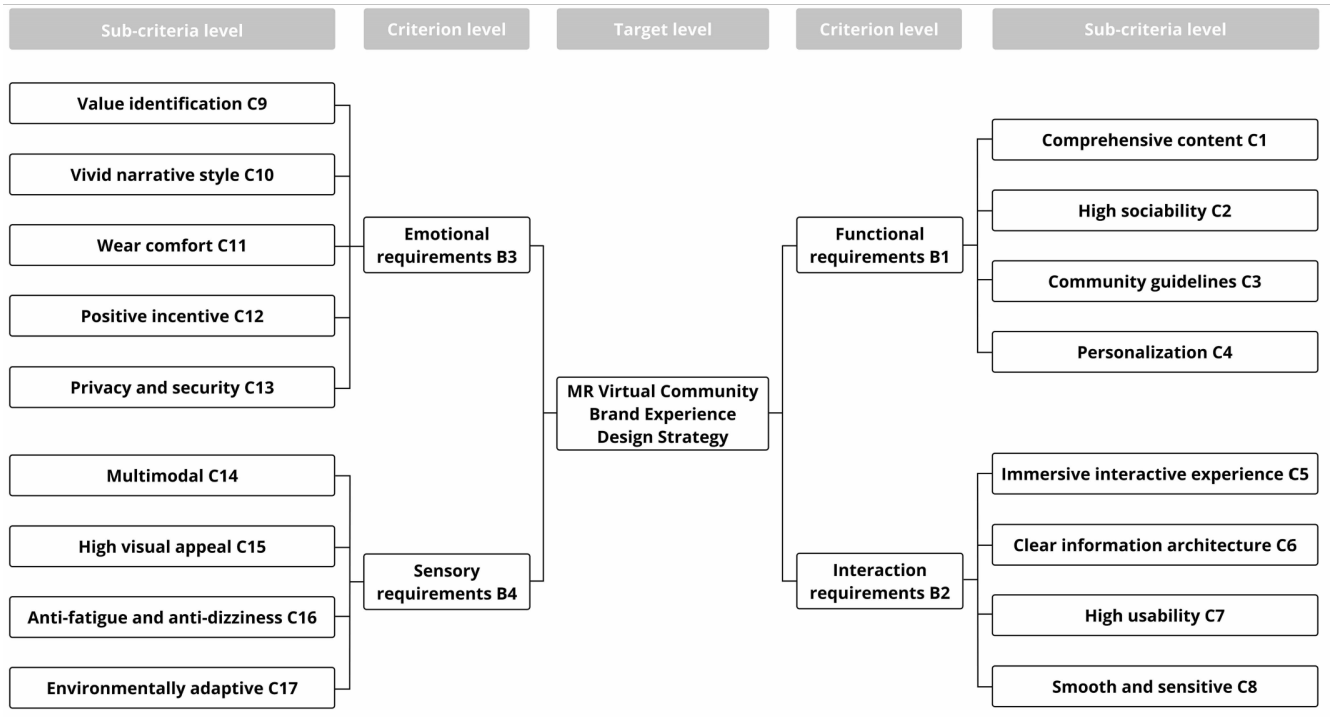


Figure 2. MR virtual community brand experience hierarchy model. Source: Author's own work

In order to ensure the scientificity and objectivity of the results of user demand weighting, a total of 17 researchers, experts, and target users were invited in this study to establish a questionnaire of neighbouring evaluation indexes through the scale method of 1 to 9 levels, to compare the importance of the demands of each level and score them two by two, to take the average of the evaluated results and to compare them to construct the judgement matrix, and then to calculate the weight value of the demands by using Matlab and to score the matrix. Then use Matlab to calculate the weight value of the requirements and conduct a consistency test on the matrix scoring to further identify the more important user requirements. The specific calculation process is as follows, and the results are shown in Table 3 and Table 4.

1. Constructing a judgement matrix:

$$R=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{bmatrix}$$

Among them, aij·aji=1, j≠1, 2, ..., n.

2. Weight calculation: Apply the geometric mean method to find the average value of Vi based on the judgement matrix.

$$V_i=\sqrt[n]{\prod_{i}^{n} S_{ij}}$$

The calculation results are normalised to obtain the average value of each weight W1 and the weight vector W.

$$W_1=\frac{\sqrt[n]{\prod_{i}^{n} S_{ij}}}{\sum_{i=1}^{n}\sqrt[n]{\prod_{i}^{n} S_{ij}}}$$

$$W=\left(w_1 w_{2,\cdots} w_n\right)^T$$

3. Calculate the maximum characteristic root (λmax):

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} \frac{S_{wi}}{W_i}$$

Where Swi is the ith component of the vector Sw, n is the order.

4. Consistency of results test (ICI):

$$I_{CI} = \frac{\lambda_{max} - n}{n - 1}$$

$$I_{CR} = \frac{I_{CI}}{I_{RI}}$$

Where n is the value corresponding to the evaluation scale of judgement moments; IRI is the consistency index; and ICR is the consistency ratio.

Finally, it is necessary to test the consistency of the calculation results; when ICR≦0.1, the consistency test passes, and vice versa, it fails.

Table 3. Indicator weights at the criterion level.

Demand Attributes	B1	B2	B3	B4	Weighting	I_{CR}
B1	1	1/2	1/3	1	0.1411	0.004
B2	2	1	1/2	2	0.2631	
B3	3	2	1	3	0.4547	
B4	1	1/2	1/3	1	0.1411	

Table 4. Indicator weights at the sub-criteria level.

Secondary Indicators	Judgement matrix					Weights	Relative weights	I_{CR}	Ranking
C1	1	1	3	4	x	0.3845	0.0543	0.008	7
C2	1	1	3	4	x	0.3845	0.0543		7
C3	1/3	1/3	1	2	x	0.1433	0.0202		14
C4	1/4	1/4	1/2	1	x	0.0878	0.0124		16
C5	1	3	2	4	x	0.4658	0.1226	0.012	2
C6	1/3	1	1/2	2	x	0.1611	0.0424		11
C7	1/2	2	1	3	x	0.2771	0.0729		6
C8	1/4	1/2	1/3	1	x	0.0960	0.0253		13
C9	1	1/2	3	2	4	0.2618	0.1190	0.015	3
C10	2	1	4	3	5	0.4162	0.1892		1
C11	1/3	1/4	1	1/2	2	0.0986	0.0448		9
C12	1/2	1/3	2	1	3	0.1611	0.0733		5
C13	1/4	1/5	1/2	1/3	1	0.0624	0.0284		12
C14	1	1/2	4	5	x	0.3118	0.0440	0.017	10
C15	2	1	6	7	x	0.5302	0.0748		4
C16	1/4	1/6	1	2	x	0.0962	0.0136		15
C17	1/5	1/7	1/2	1	x	0.0618	0.0087		17

Finally, to ensure the scientificity of the results, a consistency test was performed on the calculation results. The ICR of the criterion level is 0.004≦0.1, and the ICR of the sub-criteria level is 0.008, 0.012, 0.015, and 0.017, respectively, which are all less than 0.1, and the consistency test is passed. From the results of the relative weight calculation ranking table in Table 4, it can be seen that the emotional requirements have the highest weight value (0.4547), followed by the interaction requirements (0.2631) in the needs category, which indicates that the emotional requirements are the most important in the brand experience of the MR virtual community, followed by the interaction requirements. The top 10 ranking of secondary user requirements includes vivid narrative style (C10), immersive interactive experience (C5), value identification (C9), high visual appeal (C15), positive incentive (C12), high usability (C7), high sociability (C2), comprehensive content (C1), wear comfort (C11), and multimodal (C14). Thus, paying more attention to these needs will significantly boost user satisfaction with the MR virtual community branding experience.

3.3 Design element analysis based on the QFD method

In order to further determine the conversion of user requirements into specific design elements, this paper applies QFD after AHP hierarchical analysis to convert user requirements into design elements through quantitative analysis. Design elements are an important part of building a house of quality (HOQ). As a result, it is necessary to map user requirements to design elements and decompose design elements before using QFD. Considering the high similarity of MR, AR, and VR virtual communities and the generality of design features, there are many commonalities among them. Therefore, it is highly informative to integrate the design features of VR and AR virtual communities into the development of MR virtual communities.

Firstly, the relevant design elements of the MR virtual community brand experience are preliminary obtained through the literature research method (Table 5); secondly, five virtual communities with a high usage rate or popularity on the market are selected through the case study method, including the MR virtual community, AR virtual community, and VR virtual community, and analysed in terms of the product name, type, and design elements, respectively (Table 6). Finally, the Delphi method was used based on the literature research method and the case study method to make sure that the design elements were objective, scientific, and complete. We invited two professors from the UX design research direction, two interaction designers, and one brand strategy designer to propose modifications to the inferred design elements. Finally, through collation and summarization, we identified 12 design features (Table 7).

Table 5. Analysis of literature related to brand experience in MR virtual communities.

Literatures	Design elements
(Dan et al., 2021)	Interaction: seamlessly blends virtual and reality; high-fidelity storytelling interface; intuitive gesture interaction.
(Park et al., 2022)	Function: structuring diverse content; designing multiplayer synchronization and collaboration platforms. Interaction: high-fidelity storytelling interface. Emotion: diversity of cultures and contexts. Sensory: multisensory synchronization.
(Herckis et al., 2020)	Function: designing multiplayer synchronization and collaboration platforms; user preferences. Emotion: emotional design; logging achievement paths; clear privacy settings and controls; first-person perspective narration.
(Gomes et al., 2020)	Interaction: clear information architecture; seamlessly blends virtual and reality; intuitive gesture interaction. Sensory: visual balance and unity.
(Sorathia et al., 2017)	Function: structuring diverse content. Interaction: intuitive gesture interaction with voice control, consistency. Emotion: Logging Achievement Paths.
(Serghides et al., 2024)	Function: designing multiplayer synchronization and collaboration platforms based on user preferences. Interaction: high-fidelity storytelling interface; intuitive navigation elements; intuitive gesture interaction. Emotion: first-person perspective narration.
(Jeon et al., 2024)	Interaction: high-fidelity storytelling interface; Intuitive gesture interaction with voice control; intuitive navigation elements. Sensory: multisensory synchronization.
(Barbara et al., 2021)	Interaction: seamlessly blends virtual and reality; high-fidelity storytelling interface. Emotion: first-person perspective narration; diversity of cultures and contexts.

Table 6. The MR virtual community case study.

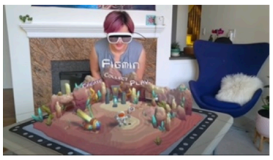
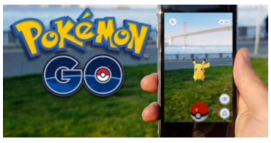
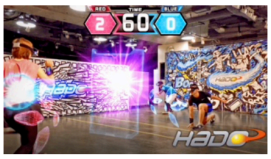
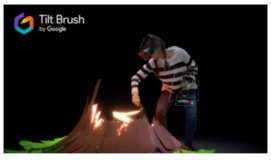
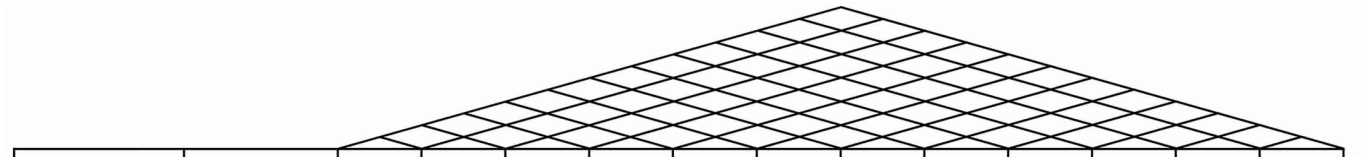
Product name	Product picture	Product type	Design elements
Figmin XR	 (Image from Google)	MR Virtual Community	Function: decorate rooms, games, educational experiences, and so on. Interaction: seamlessly blends virtual and reality; intuitive gesture interaction with voice control; consistency; simple, intuitive elements and layout. Emotion: logging achievement paths and leaderboards; first-person perspective narration. Sensory: multisensory synchronization; balanced and unified visual brand design.
Pokémon Go	 (Image from Google)	AR Virtual Community	Function: treasure hunt. Interaction: high-fidelity storytelling interface; simple, intuitive elements and layout. Emotion: emotional design; first-person perspective narration; logging achievement paths; clear your privacy settings and controls. Sensory: multisensory synchronization; balanced and unified, yet dynamically soft visual brand design.
HADO	 (Image from Google)	AR Virtual Community	Function: sports competitions, fitness. Interaction: high-fidelity storytelling interface that seamlessly blends virtual and reality; intuitive elements; intuitive gesture interaction with voice control. Emotion: emotional design; first-person perspective narration; clear privacy settings and controls. Sensory: multisensory synchronization; balanced and unified visual brand design.
Tilt Brush	 (Image from Google)	VR Virtual Community	Function: painting, sculpture. Interaction: high-fidelity storytelling interface; intuitive elements and layout; intuitive gesture interaction with voice control. Emotion: first-person perspective narration; diversity of cultures and contexts; logging achievement paths; privacy settings. Sensory: multisensory synchronization; balanced and unified, yet dynamically soft visual brand design.
Beat Saber	 (Image from Google)	VR Virtual Community	Function: music games, sports experiences. Interaction: high-fidelity storytelling interface; intuitive elements and layout; intuitive gesture interaction with voice control; consistency. Emotion: first-person perspective narration; logging achievement paths and leaderboards; clear privacy settings and controls. Sensory: multisensory synchronization; unified visual brand design; simple elements and layout.

Table 7. MR virtual community brand experience user requirements-design elements conversion.

Criterion level B	User requirements C	Summary of design elements D
Functional requirements B1	Comprehensive content C1	Structuring Diverse Content D1 Designing multiplayer synchronization and collaboration platforms D2 Community credit and reward mechanisms D3 User Preferences D4 High-fidelity storytelling interface that seamlessly blends virtual and reality D5 Simple, intuitive elements and layout D6 Intuitive gesture interaction with voice control, consistency D7 Emotional design, first-person perspective narration, diversity of cultures and contexts D8 Logging Achievement Paths and Leaderboards D9 Clear privacy settings and controls D10 multisensory synchronization D11 Balanced and unified, yet dynamically soft visual brand design D12
	High sociability C2	
	Community guidelines C3	
	Personalization C4	
Interaction requirements B2	Immersive interactive experience C5	
	Clear information architecture C6	
	High usability C7	
	Smooth and sensitive C8	
Emotional requirements B3	Value identification C9	
	Vivid narrative style C10	
	Wear comfort C11	
	positive incentive C12	
	Privacy and security C13	
Sensory requirements B4	Multimodal C14	
	High visual appeal C15	
	Anti-fatigue and anti-dizziness C16	
	Environmentally adaptive C17	

The House of Quality (HOQ) is the core element of the QFD methodology, including the target user requirements and the relationship matrix of related design requirements. As shown in Figure 3, with user requirements and their weights as the left wall and design elements as the roof, three experience design experts of MR Virtual Communities were invited to score the relevance of user requirements and design elements of the MR Virtual Communities brand experience. The weight of strong relevance is 1.5, indicated by "●"; the weight of average relevance is 1.2, indicated by "◎"; and the weight of weak relevance is 1, indicated by "△". The House of Quality (HOQ) is constructed by taking the sum of the products of all the user requirements and the corresponding weights as the final weight degree of the element. This study divides the design elements into three levels based on their weight degree, as illustrated in Table 8. The four design elements of Level 1 and the five design elements of Level 2 should take precedence in the MR virtual community brand experience design strategy ranking table, while the three design elements of Level 3 should receive secondary consideration.



User requirements	Weight	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
C1	0.0543	●	△						△				
C2	0.0543	◎	●						◎				
C3	0.0202			◎									
C4	0.0124				●						△		
C5	0.1226	△	◎			●		●	●			●	◎
C6	0.0424						△	◎					
C7	0.0729						●	●				△	
C8	0.0253					●	◎	△					
C9	0.1190	△	◎						◎	◎			
C10	0.1892	△				●			●			◎	
C11	0.0448				◎								
C12	0.0733									●			
C13	0.0284		◎	△							●		
C14	0.0440					◎						●	
C15	0.0748					◎	●					△	●
C16	0.0136						◎	△				◎	●
C17	0.0087					△							
Weighting of design requirements		0.5774	0.4598	0.0526	0.0724	0.3731	0.3141	0.3830	0.7300	0.2528	0.055	0.6410	0.2797
Arrange in order		3	4	12	10	6	7	5	1	9	11	2	8

Figure 3. House of Quality (HOQ). Source: Author's own work

Table 8. Sequencing of design elements.

Hierarchy	Design elements	Ranking
Level 1	Emotional design, first-person perspective narration, diversity of cultures and contexts D8	1
	multisensory synchronization D11	2
	Structuring Diverse Content D1	3
	Designing multiplayer synchronization and collaboration platforms D2	4
Level 2	Intuitive gesture interaction with voice control, consistency D7	5
	High-fidelity storytelling interface that seamlessly blends virtual and reality D5	6
	Simple, intuitive elements and layout D6	7
	Balanced and unified, yet dynamically soft visual brand design D12	8
	Logging Achievement Paths and Leaderboards D9	9
Level 3	User Preferences D4	10
	Clear privacy settings and controls D10	11
	Community credit and reward mechanisms D3	12

4. Derivation of brand experience design strategies for MR virtual communities

The above results led to the further sorting and summarization of the design elements into four design principles: interactivity and consistency, sociality and diversity, aesthetics and intuitiveness, user-centered and personalization. Together, these four principles form the basis of the MR virtual community brand experience design, which not only relates to user satisfaction in the process of use but also determines the user's loyalty to the community and willingness to promote it to others.

4.1 Principle of interactivity and consistency

Interactivity is the key to ensuring that users can communicate and operate effectively with the MR virtual community. Consistency allows users to experience a unified operating logic in all parts of the community, reducing learning costs and increasing user efficiency. This principle includes three design elements: emotional design, first-person perspective narration, diversity of cultures and contexts (D8), multisensory synchronization (D11), intuitive gesture interaction with voice control, and consistency (D7). In particular, emotional design and first-person perspective narration make the experience more immersive for users, while respecting and reflecting different cultural backgrounds through diverse virtual environments and character design. High-quality visual and auditory effects and haptic feedback technology create a synchronized multi-sensory immersive experience for users. Intuitive gesture interactions and voice control make sure that the experience is consistent, letting users interact with the virtual environment naturally.

4.2 Principle of sociality and diversity

The sociality of MR virtual communities refers to encouraging communication and interaction among community users, thereby deepening the ties among community members and enhancing the overall cohesion and social activity of the community. On the other hand, diversity is embodied in community content, activities, and user groups, which can attract a wider range of users to participate and satisfy the needs and interests of different users, thus enhancing the vitality and attractiveness of the community. This principle includes three design elements: designing multiplayer synchronization and collaboration platforms (D2), community credit and reward mechanisms (D3), structuring diverse content (D1). Specifically, real-time synchronization and the provision of collaboration platforms, such as virtual meeting rooms, to support effective cooperation among community members; the establishment of a credit scoring system and transparent rules for rewards and penalties to maintain community order by rewarding active members and punishing non-compliance; and the creation of an ecosystem of diversified and high-quality content through personalization to cater to the needs of different users.

4.3 Principle of aesthetics and intuitiveness

Aesthetics enhances the user's sensory experience through attractive visual design, making the MR virtual community appear more professional and engaging. Intuitiveness enhances the user experience by ensuring that the user interface is easy to understand and operate, and that users can quickly find the function or information they are looking for. This principle consists of three design elements: balanced and unified, yet dynamically soft visual brand design (D12), simple, intuitive elements and layout (D6), high-fidelity storytelling interface that seamlessly blends virtual and reality (D5). Specifically, the brand identity is strengthened by uniform colours, visual elements, and typography, while the dynamic effects are soft to ensure visual comfort and reduce vertigo and fatigue; a simple interface design is adopted to enable new users to quickly get started and effectively operate community functions; and high-quality visual presentation, as well as engaging storytelling and character interactions, are combined to create a virtual experience that seamlessly blends with the real world. The combination of high-quality visual presentation, compelling storytelling, and character interaction creates a virtual experience that seamlessly integrates with the real world.

4.4 Principle of user-centered and personalization

User-centered emphasises that design should be centred on the needs and experiences of users, ensuring that community services and features meet their expectations. Personalization enables users to tailor the community experience to their preferences, which helps to enhance their positive feelings

about the community and promotes long-term engagement and support. This principle includes three design elements: user preferences (D4), clear privacy settings and controls (D10), logging achievement paths and leaderboards (D9). Specifically, personalization is provided to enable users to tailor the interface and interaction experience to their individual preferences; privacy settings panels are designed to be easy to understand and operate to ensure that users are able to control the use of and access to their personal information; and an achievement system and leaderboards are established to motivate cooperation, competition, and participation among users within the community.

5. Conclusions

To improve users' brand experience in MR virtual communities, this paper explores and constructs an integrated AHP-QFD theoretical design strategy development process, guided by user requirements. Firstly, interviews and on-site observations are conducted with the users of the MR virtual community, and attributes of user requirements are classified by the card classification method, initially obtaining 4 categories and 17 user requirements. Secondly, the AHP model is applied to rank the weights of the user's requirements to further obtain the important user requirements. Finally, the QFD model transforms the important user requirements into specific design elements, outputs their weights, and ranks them. This paper finally summarizes the design elements into four design principles, forming a relatively complete set of design strategies for the MR virtual community brand experience. From a theoretical perspective, the integrated AHP-QFD method's design strategy development process not only meets user-centered needs but also compensates for the limitations of single-method research to a certain extent, providing a framework for addressing design issues. From a practical perspective, it provides ideas for user demand-driven MR virtual community brand experience design; it systematically builds a design framework for MR virtual community brand experience, which provides a relatively complete set of strategy guidance for the development of MR virtual community brand experience.

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DESIGN AND BIOMATERIALS: INTEGRATING NEW MODELS FOR SUSTAINABLE DESIGN

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ABSTRACT | Over the past few decades, human society has experienced rapid development, accompanied by a significant increase in consumption in daily life. This change has led to a large influx of chemical substances into everyday garbage, causing severe environmental pollution. This pollution disrupts the balance of natural ecosystems and threatens human health. In response to this challenge and concern for human well-being, designers have started to meet market demands by launching a series of design solutions centred around sustainability. In the context of sustainable development and based on material innovation, this research explores the advantages of biomaterials in green fashion design, such as renewability, degradability, and environmental friendliness. Based on these advantages, a piece of clothing was designed, inspired by the Bagua diagram created by ancient Chinese philosophers. The interaction of yin and yang in the Bagua diagram symbolizes the harmonious coexistence and mutual dependence between humans and nature, a concept reflected in the arrangement of loofah. Moreover, the natural characteristics of the loofah make it an ideal habitat for fungal growth, further embodying the concept of symbiosis.

The sustainability model of this design is mainly reflected in three aspects: 1) Material renewability: The materials used in the design are regenerative, meaning they are degradable and can be decomposed by microorganisms under natural conditions, thus avoiding long-term environmental pollution. 2) Design innovation: It provides designers with new ideas for sustainable design, reducing reliance on traditional clothing materials (such as polyester, nylon and so on.) and consequently lowering landfill waste and environmental pollution. 3) Symbiotic concept: The design emphasizes the close connection between humans and nature, advocating for a harmonious coexistence.

Through this design approach, the research aims to establish a new model of sustainable design that adapts to modern development, achieving a balance between economic, social, and environmental dimensions. This model meets people's needs for fashion and comfort, mitigates environmental stress, and promotes the development of a circular economy. Therefore, this research provides new ideas and methods for sustainable design from the dimension of material innovation and is expected to bring breakthroughs to the innovation of sustainable development models.

KEYWORDS | DEGRADABLE MATERIALS, GREEN DESIGN, SUSTAINABLE DEVELOPMENT MODEL, SUSTAINABLE DESIGN, MATERIAL INNOVATION

1. Introduction

With the rapid growth of the global economy and population, people's living consumption levels continue to rise, leading to increasingly serious environmental problems. Many chemical substances enter daily life garbage, causing environmental pollution problems to become more prominent. This pollution destroys the balance of natural ecosystems and seriously threatens human health. It also has a profound impact on the Earth's ecosystem. In 2015, 193 countries of the United Nations jointly signed "Transforming Our World: The 2030 Agenda for Sustainable Development," formally proposing 17 Sustainable Development Goals (SDGs) and 169 specific targets, aiming to promote global sustainable cooperation and development. Against this backdrop, sustainable development has gradually become a global consensus, and people have begun to focus on reducing the environmental impact while ensuring the quality of life. The design field has also started to focus on achieving harmony among the environment, society, and the economy while meeting people's needs. Concepts such as green and sustainable design have gradually gained attention, and designers have begun to explore how to integrate sustainable development concepts into design.

In recent years, "sustainable development" topics have maintained a hot research status, focusing mainly on sustainable development strategies and economic, agricultural, and industrial sustainability. Rajkishore Nayak and others mentioned the environmental impact of manufacturing various textile fibres, covering challenges related to sustainable development. Sofia Soledad Duarte Poblete and others have researched and analyzed emerging materials related to sustainable design, encouraging their responsible development, dissemination, and adoption. Sandy Black discussed in her book how the fashion industry should respond to environmental and social responsibilities, from the fashion industry's impact on the environment to the practice of eco-friendly materials in sustainable fashion and prospects for future eco-friendly fashion.

The concept of sustainable design is rooted in the strategy of sustainable development. It reflects a deep understanding of the theoretical system under the concept of sustainable development, thus awakening and examining the defects and non-sustainability of traditional design. In this context, the so-called "re-design" concept belongs to sustainable design. It is a design method that comprehensively considers human development needs, environmental protection, and social responsibility. In the book "Designing for Sustainability: A Practical Exploration," Tracy Bamra elaborates on eco-friendly design through four dimensions: green design, ecological design, sustainable development, and sustainable design. She advocates that designers should integrate social responsibility elements when making design choices, thus transforming from a design method that solves single problems to a comprehensive design strategy that assumes social responsibilities. The book proposes to integrate the concept of sustainable development through design. Biological materials, as a powerful choice embodying the concept of sustainable development in sustainable design, are being adopted by more and more designers (Jones & Williams, 2020).

Research on biological materials at home and abroad has achieved certain results, mainly focusing on preparing biological materials, performance optimization, and their applications in medical, construction, packaging, and other fields (Zhang et al., 2019; Li & Li, 2021). These studies have laid the foundation for applying biological materials in fashion design. However, in the field of fashion design, the application of biological materials is still in the exploratory stage (Wang & Zhang, 2022). Some researchers have tried applying biological materials to fashion design, but there are still areas for improvement. First, the application scope of biological materials is limited, mainly accessories such as buttons and zippers (Smith & Brown, 2021). Second, there needs to be more innovation and fully tap the potential of combining them with culture, design, and art.

Based on the concept of sustainable development, this paper explores the innovation of fashion design materials, which helps enrich the theoretical system of green design and sustainable design. It pays attention to environmental pollution and human health and, through design practice, provides new ideas and methods for sustainable design, promoting sustainable development in fashion design.

2. _P/RoD Sustainability

With the growth of the global population, the demand for resources by humanity continues to increase, leading to increasingly serious problems such as resource depletion, environmental pollution, and ecological damage. In the face of this severe situation, sustainable development emerged at the right moment, becoming the focus of attention for governments, businesses, and academia worldwide. Governments, businesses, and academia have begun to realize the urgency

of adopting sustainable practices to ensure long-term social and ecological well-being.

The traditional industrial production model has led to many environmental problems, such as resource depletion, air pollution, and water pollution, which seriously threaten the Earth's ecosystem (Sachs, 2015). Sustainable development is key to the long-term survival and development of human society. It maintains the stability of the Earth's ecosystem and the sustainable development of human society by reducing the environmental burden, improving resource efficiency, and protecting biodiversity (WCED, 1987).

In terms of the environment, the long-term security and stability of human society are inseparable from the health of the Earth's ecosystem. The advocacy of clean production and environmental protection technology in sustainable development can effectively reduce the emission of pollutants and decrease the negative environmental impact (UNEP, 2012). For example, the use of low-carbon and zero-emission technologies to reduce air pollution from industrial activities can improve air quality and reduce the formation of acid rain and photochemical smog, which plays an important role in protecting human health and the integrity of ecosystems in urban and natural environments (IPCC, 2014). At the same time, paying attention to ecological protection and maintaining biodiversity also plays an important role in the stability of ecosystems (Díaz et al., 2019).

In terms of the economy, sustainable development advocates for a circular economy, emphasizing the coordinated development of the economy, society, and the environment. A good environmental condition can reduce production costs and decrease economic losses caused by environmental damage (Geissdoerfer et al., 2017). These measures can promote long-term stable economic development by ensuring sustainable forestry management for the continuous supply of timber and promoting renewable energy to reduce price fluctuations (FAO, 2020).

In terms of society, the traditional development model has ignored the equitable distribution of resources and social participation, expanding the wealth gap and increasing social conflicts (Sen, 1999). However, sustainable development promotes inclusive growth, positively impacting human well-being (Raworth, 2017).

3. _P/RoD Sustainable Design

3.1 _P/RoD Rise and Development

Sustainable design has evolved from its initial presence in a few areas to gradually infiltrating various industries and fields. It has become an integral part of modern industrial and consumer product design. Sustainable design emphasizes reducing environmental impact during product design, manufacturing, and consumption, improving resource efficiency, and enhancing the sustainability of the product life cycle. It focuses on the environmental

impact generated by the product itself and considers the environmental and social responsibilities throughout the entire production and usage chain.
The global design field's deep reflection on the relationship between human development and environmental challenges has given rise to the concept of "sustainable design." This concept represents a continuous process of exploration and innovation. Its development can be roughly divided into four main stages: the green design stage, the eco-design stage, the product-service system design stage, and the design for social equity and harmony stage (Fuad-Luke, 2009).

Green Design Stage: Originating in the 1980s and 1990s, this stage emphasized using materials and energy with low environmental impact. It included concepts such as reducing the consumption of materials and energy, recycling materials, and designing for reusability, such as "harmless design," "demountable design," and "durable design" (Cramer et al., 2004; Chapman, 2005).

Eco-Design Stage: This stage went beyond just focusing on the result and instead considered environmental issues at all stages, aspects, and links of product design. It involved reducing energy and material consumption during product production, avoiding pollution emissions, and reducing the generation and treatment of waste materials (McDonough & Braungart, 2002; Zurbrügg, 2003).

Product-Service System Design Stage: This stage moved beyond focusing solely on "materialized products" and entered the field of "system design," which intervened at the level of "products and services," aiming to create new business models (Manzini & Vezzoli, 2008; Mont, 2002). Design for Social Equity and Harmony Stage: This is the latest frontier of sustainable design research, focusing on social equity and harmony and people's consumption and values. This stage involves the sustainable development of local cultures, respect for cultural diversity, attention to vulnerable groups, and promoting sustainable consumption patterns (Gibbs, 2009; Thackara, 2005).

3.2 _P/RoD Application of Sustainable Design in the Fashion Industry

In the consumer goods sector, the fashion industry, one of the largest industries globally, stands out for its significant consumption of resources and environmental impact. Traditional fashion production models come at the cost of high energy consumption and pollution, with extensive use of non-renewable resources and synthetic chemicals, leading to severe environmental problems (Joy et al., 2012). Sustainable fashion has emerged as a new design concept and business model to address these challenges, gradually gaining attention. Sustainable fashion not only focuses on the environmental and social impact of products throughout their design, production, sales, and consumption cycles but also requires innovation in technologies and materials to reduce negative environmental impacts (Fletcher, 2008).

Sustainable fashion is more than just environmentally friendly products; it is a comprehensive design and management strategy to achieve a triple balance of economy, society, and environment (McKinsey & Company, 2020). Its core characteristics include using eco-friendly and renewable materials, reducing carbon footprints and pollution emissions, optimizing supply chain management to minimize resource waste, and promoting fair trade and social responsibility. These characteristics are reflected in the products and the ethical and moral values embedded in the design process and brand culture (Niinimäki, 2020).

The application of sustainable design in the fashion industry is mainly manifested in the following aspects:

Material Innovation: Seeking environmentally friendly, renewable, and biodegradable alternative materials to reduce dependence on traditional fossil energy sources. Such materials can be decomposed by microorganisms into harmless substances under natural conditions and re-enter the ecological cycle. Moreover, reducing the use of harmful chemicals to minimize pollution of soil, water, and air (Harrison et al., 2005). At the same time, avoiding the long-term presence of traditional fossil energy-derived materials in the environment after disposal helps alleviate the issue of "white pollution," effectively reducing the fashion industry's environmental burden, especially regarding greenhouse gas emissions and resource consumption (Perry, 2014).

Lifecycle Management: Within the framework of sustainable design, focusing on the entire lifecycle of clothing from design, production, and use to disposal to minimize environmental impact. Clean production technologies are employed during production to reduce energy consumption and pollution emissions, enhancing efficiency. Additionally, waste is treated and resourcefully utilized to achieve the goals of a circular economy (Fletcher & Tham, 2019).

Design Innovation: Actively exploring eco-friendly materials, low-carbon processes, and technologies to green and environmentalize clothing. Providing designers with new sustainable design ideas reduces reliance on traditional clothing materials (such as polyester, nylon, etc.), thereby reducing landfill waste and environmental pollution. The design emphasizes the close connection between humans and nature, advocates for harmonious coexistence between humans and nature, and encourages green consumption (Bick et al., 2018).

As consumer awareness of environmental protection and sustainability continues to grow, the position of sustainable fashion in the market is gradually rising. An increasing number of brands and designers are turning to sustainable fashion, winning consumer trust and support through green innovation and social responsibility. In the long run, sustainable fashion helps enhance brand image and market competitiveness and brings long-term stable economic benefits and social influence to businesses (Amed et al., 2022).

3.3 Potential of Biomaterials in Sustainable Design

Biomaterials, known for their renewability, biodegradability, and environmental friendliness, are gradually becoming a key choice in sustainable design. The extensive application of these materials reflects the effective substitution for traditional resources and profound consideration for environmental protection. Research and application of biomaterials in the design field are gradually gaining attention, with scholars and designers actively exploring their potential in fashion.

Renewability is a significant advantage of biomaterials, typically derived from plants or other natural resources. They can absorb carbon dioxide during growth, reducing greenhouse gas emissions (Avermaete et al., 2019). For example, plant-based raw materials like bamboo fibre, hemp fibre, and soybean fibre not only have low energy consumption during growth but can also naturally decompose, reducing the environmental burden of waste (Koo et al., 2019). Compared to traditional synthetic materials, the biodegradability of these materials allows them to decompose rapidly into harmless substances after disposal, making them more in line with the concept of a circular economy in design and promoting the reuse of resources and reduction of waste (Gao et al., 2021).

The unique properties of biomaterials have attracted many scholars to study their application in fashion, providing designers with rich creative inspiration. Lee et al. (2018) research shows that biomaterials like bioplastics and bioc fibres can be used in traditional textiles and improve their performance and comfort through improved production processes. At the same time, Rissanen and McQuillan (2016) explored how to achieve more environmentally friendly clothing production methods through biomaterials, including the use of agricultural by-products (such as rice husks and corn cobs) as raw materials to reduce dependence on fossil fuels. Miller (2020) mentioned that designers are trying to use food waste (such as coffee grounds and apple peels) as new textile materials, reducing production costs and effectively utilising waste resources. These explorations show the great potential of biomaterials in achieving sustainable design goals (Liu et al., 2021). Sustainable design is an important way to address global resource scarcity and environmental pollution challenges and a key strategy for promoting human social welfare and long-term economic stability. Implementing sustainable practices, including promoting clean production technologies and using environmentally sustainable materials, provides an effective and long-term path to sustainable development for current and future generations.

4. _P/RoD Application Practice of Biomaterials in Fashion Design

In line with the principles of sustainable development, a new model of integrating design with biomaterials is sought within the context of sustainable design. Based on this, through repeated experiments and comparisons of the performance of different materials under different ratios, more sustainable clothing materials are identified.

4.1 _P/RoD Design Concept and Principles

In this highly developed industrial society, the environment has been damaged during industrialization. We hope to guide people to re-examine the relationship between humans and nature and think about how they should coexist with other living beings. Fungi in nature are decomposers, like bacteria and microorganisms. Fungi decompose organisms into various inorganic substances, making the land more fertile and thus recycling and regenerating, creating new life. This symbiotic relationship between species is contrary to the interspecies relationships we take for granted in evolutionary theory (predator-prey relationships) – they are not trying to destroy each other; as anthropologist Luo Qinghuan said in "The Last Day of Matsutake," the message it conveys is ultimately about "symbiosis," about how "I" can continue to evolve with "non-I" instead of losing ground in confrontation. It is about how "I" and "non-I" can continue to co-evolve instead of consuming each other in confrontation – this is the rule of the fungal world, which can, should, and is also our rule.

Therefore, a raincoat was designed, which, when used in rainy weather, the moist environment and the heat generated by the human body can jointly create an environment suitable for the growth of mycelium. On the other hand, mycelium can provide waterproof and warm protection to protect people from external harm, achieving mutual benefit.

In appearance, loofah pulp is used as an ornament, arranged and combined to form the symbol created by ancient Chinese philosophers – the Bagua diagram. The Bagua diagram, as an important symbol of traditional Chinese culture, originated from ancient Chinese philosophers' profound insight into the universe's law of operation. Based on the theory of Yin and Yang and the five elements, it summarizes various phenomena in the world into eight basic trigrams. Each trigram represents a basic element of nature and corresponds to different aspects of human life. The interaction of Yin and Yang in the Bagua diagram expresses a dynamic balance of opposites and movement, emphasizing the complementary nature of humans and opposite forces in nature. This philosophical concept deeply explains that humans and nature are not isolated existences but integral parts of each other. Introducing loofah pulp into the design and arranging it into the shape of the Bagua diagram symbolizes the interdependent relationship between humans

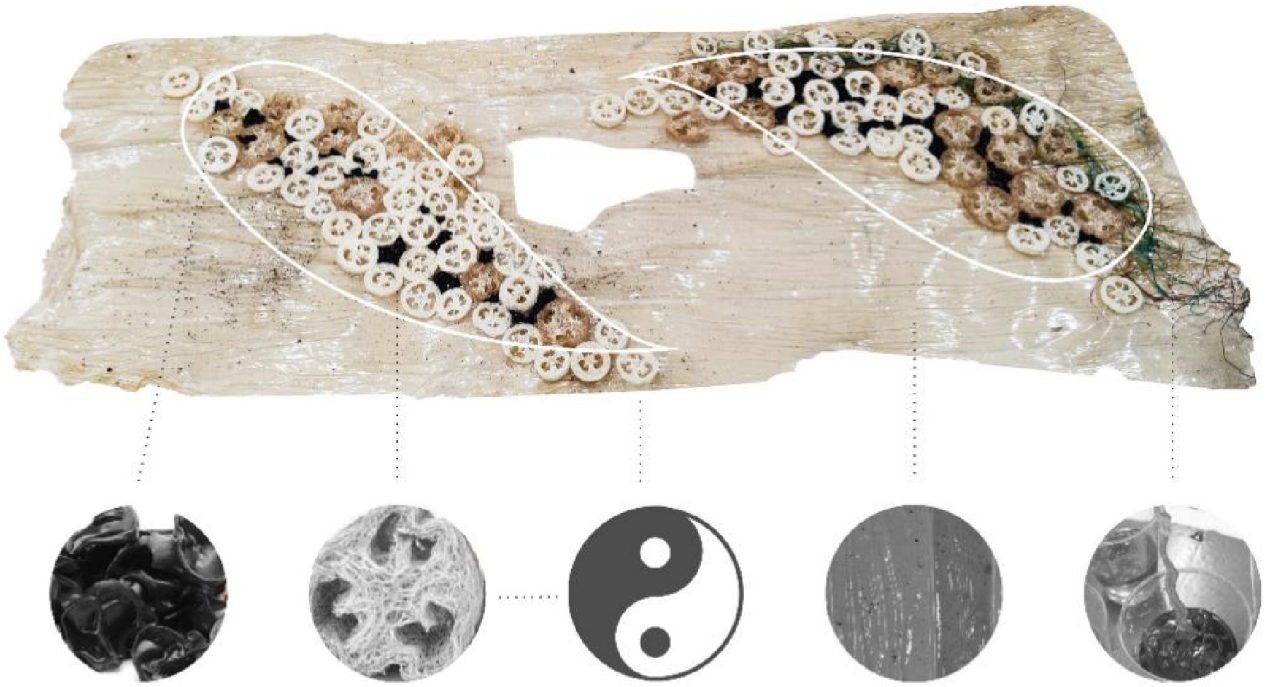


Figure A.Design Showcase

and nature. Moreover, the arrangement of loofah pulp forms a visual echo, emphasizing the concept of the intertwining of human survival and natural forces. In addition, loofah pulp as a culture medium for fungi further reflects the symbiotic coexistence of different organisms, highlighting the concept of harmonious coexistence.

4.2 _P/RoD Experimental Process

4.2.1 Materials and Methods

Materials: Water, sodium alginate, glycerin, gelatin, agar, calcium chloride solution, wood ear, fungal culture pack.

Method One:

1. Add 200 ml of water to a measuring cup, measure and add 3 grams of sodium alginate, mix with a blender, then add 3 ml of glycerin and continue to mix;

2. Place the coloured fabric in a wooden embroidery hoop, and add 100 ml of water and 3 grams of calcium chloride to a spray bottle;

3. Spray the fabric 2-3 times, then pour the sodium alginate mixture into a 3 mm wooden embroidery ring;

4. Add the fungal culture pack to the mixed sodium alginate and store it in a cool place.

Method Two:

1. Prepare the embroidery hoop with textiles;

2. Pour 240 ml of water into a pot and turn on the electric stove with a small flame;

3. Measure 48 grams of gelatin powder and slowly add it, then add colour;

4. Add 10 ml of glycerin and stir, then scoop out the foam;

5. Turn on the heater and wait 3 minutes to cool, then pour the material into the ring and add the fungal culture pack to the mixed gelatin solution, storing it in a cool place.

Method Three:

1. Add 300 ml of water and 8 grams of agar to a pot simultaneously;

2. Turn on the small flame and start stirring;

3. Add 6 ml of glycerin and stir for 5-8 minutes;

4. When it starts to "gel," pour the mixture into the ring (only 0.2-3 mm). Add 10 ml of glycerin with the remaining agar, stir, and pour into the next ring;

5. Add the fungal culture pack.

Method Four(Shoes):

1. Melt 45 grams of pine resin in a pot;

2. Add 20 ml of 95% alcohol, stir and melt, then add 5 grams of wax and continue to stir;

3. Add waste materials (fungal culture pack, etc.) and pour quickly into the mould.

Method Five:

1. Add 9 grams of sodium alginate to 600 ml of water and stir with a mixer;

2. Pour the stirred solution into a cup with prepared dye, and then suck the solution into an injector with multiple colours;

3. Squeeze the solution into calcium chloride and dry to get line-shaped ornaments.

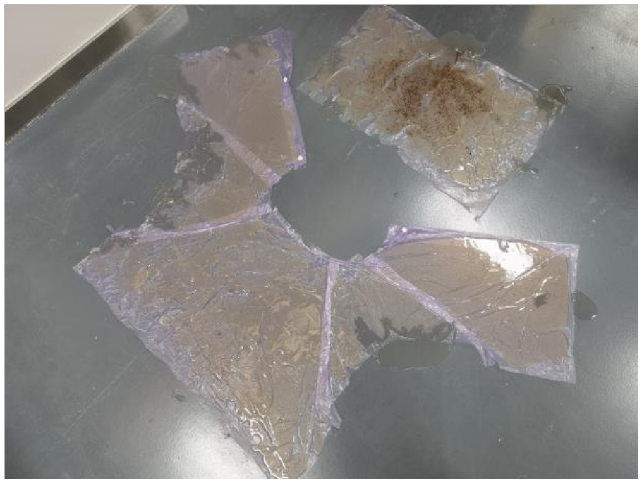
4.2.2 Experimental Methods and Result Analysis

(1) Experimental Methods

The experiment adopts a research design combining a controlled variable method and a comparative experiment. Specifically, the controlled variable method refers to effectively controlling other factors that may affect the experimental results, except for the research variable, to ensure the accuracy and reliability of the experimental results. On the other hand,



_P/RoD Figure B



_P/RoD Figure C



_P/RoD Figure D



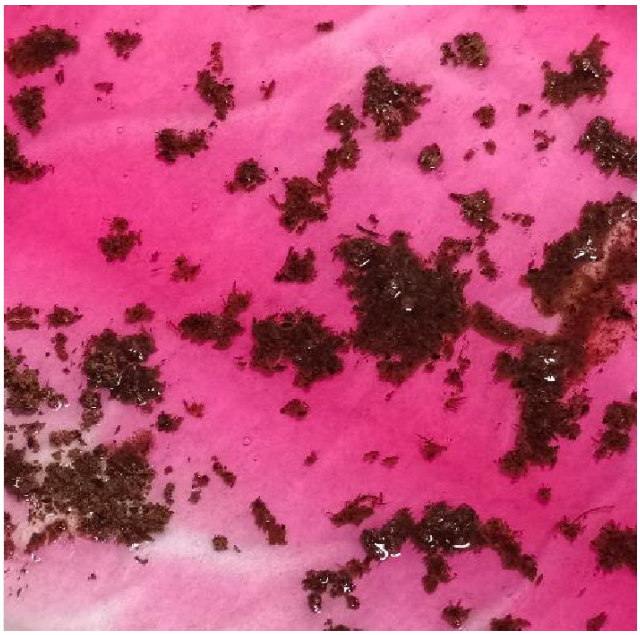
_P/RoD Figure E

the comparative experiment is based on the controlled variable method, and it explores the specific impact of the research variable on the experimental results by comparing the changes in results under different experimental conditions.

(2) Experimental Results



P/RoD Figure F



P/RoD Figure G



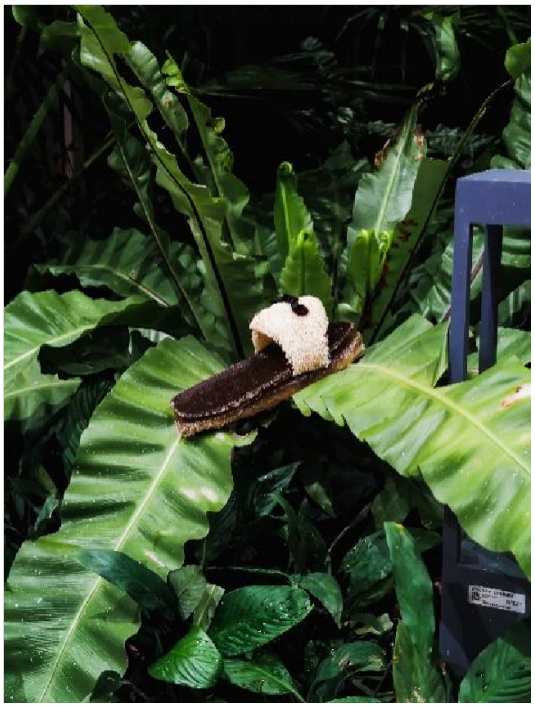
P/RoD Figure H



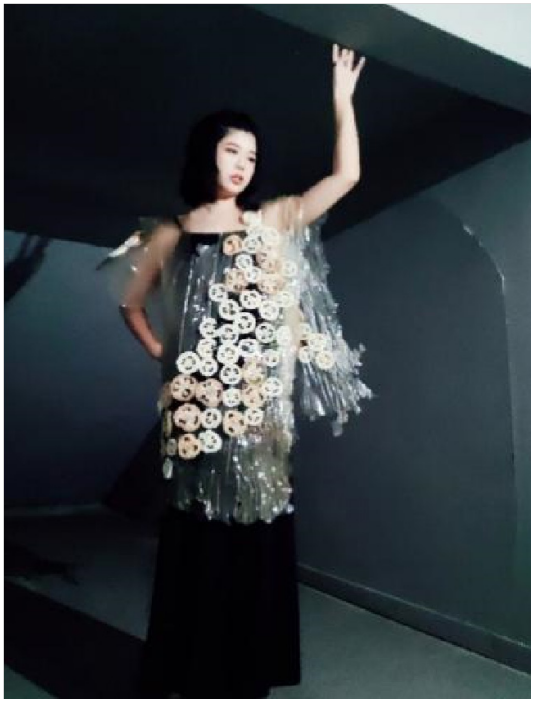
P/RoD Figure I

The solution made in Method One had a thicker thickness in the embroidery hoop (Figure B), making it difficult to dry. Therefore, the original recipe was increased six times (1200 ml of water, 18 grams of sodium alginate, 18 ml of glycerin), poured into the cut mould (Figure C), and the solution dried rapidly, forming a very thin film. However, it was difficult to de-mould, with multiple parts breaking directly during the demolding process, and due to the rapid drying, it was difficult to shape (Figure D, Figure E).









_P/RoD Figure J.Finished product display

Method Two used the solution made with 48g of gelatin, 10ml of glycerin, and 100ml of water as the control group (Figure F). In the experimental groups 1, 2, and 3, fungal culture packs (Figure G), wood ear mushrooms (Figure H), and fungal culture packs and wood ear mushrooms (Figure I) were added, respectively. In this scheme, the solution served as a growth bed for fungi, but the material was too soft to dry easily and was prone to mould growth.

Therefore, in the final experiment, a ratio of 240g of gelatin, 50 ml of glycerin, and 1200 ml of water was used for production, and it was found that this produced excellent toughness, maintaining structural integrity under external forces and being less prone to breaking. At the same time, the material had strong adhesion, with loofah pulp firmly attached to it. Additionally, it was simple to shape, and melting and reshaping could be easily achieved.



Figure K. AI-generated blueprints of future designs

In summary, the experiment provided a sustainable clothing material with easy drying, good adhesion, and strong toughness. In the design, the combination of loofah pulp and the Bagua diagram was attached to the sustainable material-made clothing, showing the harmonious coexistence between humans and nature. This provided new ideas and new materials for sustainable design for designers.

(3) Future Outlook

The author's practice of biomaterials in sustainable design initially focused on the basic attributes of clothing and wearability and integrated traditional cultural concepts into the design. In the future, it is necessary to continue in-depth research on the characteristics of biomaterials, combined with modern design contexts, to create more design-oriented, wearable clothing.

5 _P/RoD Summary

Since the inception of the First Industrial Revolution, humanity's pursuit of enhanced production
efficiency and quality of life has led to extensive utilization of fossil fuels and chemical substances in manufacturing processes. While this has significantly propelled societal productivity and played a crucial role in various sectors, the negative environmental and ecological impacts cannot be overlooked. Issues such as over-exploitation of resources, emission of harmful substances, and disruption of ecological balance underscore the profound environmental effects of material selection and use. Against this backdrop, striking a balance between economic development and environmental protection has emerged as an urgent and critical challenge.

This article provides a comprehensive overview of the current applications of sustainable materials in fashion design, analyzing the challenges they face and proposing strategies for future growth. It integrates traditional cultural symbols like the Bagua diagram and loofah pulp into practical applications, enriching aesthetic expression and deepening cultural heritage narrative. Using these symbols in fashion design bridges the gap between ancient wisdom and modern expression, facilitating discussions on sustainability and ecological harmony. Employing elements from traditional Chinese philosophy evokes a sense of cultural pride among consumers and guides reflection on environmental protection. Integrating eco-friendly materials like biomaterials into fashion design has become a new design paradigm in pursuing sustainable development. This approach promotes the widespread application of sustainable design principles and contributes to global green development with wisdom and strength. Building on this, the article further explores how strategic innovation can drive the fashion industry towards greater sustainability and environmental friendliness, achieving a win-win situation for the economy, society, and environment.

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Author 1 focuses on sustainable fashion and digital heritage preservation, with notable achievements in national design competitions and publications in top international design conferences.

CULTURAL REGENERATION OF DOMESTIC WASTES FROM PARTICIPATORY DESIGN PERSPECTIVE

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ABSTRACT | Background: Environmental and social issues arising from waste management are critical topics addressed by the United Nations Sustainable Development Goal 12, which focuses on responsible consumption and production. Modern cities are increasingly dominated by consumerism, making the promotion of sustainable lifestyles and consumer awareness essential. Goal: As fundamental units of self-government and administration, communities play a crucial role in addressing social conflicts and promoting sustainable practices at the grassroots level. This study aims to develop innovative tools and strategies for sustainable cultural innovation through participatory design methods within urban communities. Methodology: A participatory curatorial project called "Throw away Museum", which includes workshops and exhibitions in the community, was initiated to recruit the public to participate and pay attention to the life cycle of the production, use and disposal of domestic wastes. The project employs archival practices as an artistic strategy and conducts ethnographic research with local communities. This approach aids in developing assessment dimensions and application guidelines for using archives as a communication tool in participatory design. Conclusion: The findings suggest that archives can effectively function as communication tools, providing public access to community curation and allowing individuals to express themselves creatively through exhibitions. This design practice addresses public issues in diverse forms, Qianwen ZHU, Lei Zhang facilitating collaborative solutions with the public, fostering civic and ecological awareness, enhancing public participation, strengthening interpersonal connections, and promoting a broader environmental symbiosis. Ultimately, this approach enables public participation to form a sustainable narrative force.

KEYWORDS | DOMESTIC WASTE, CULTURAL REGENERATION, PARTICIPATORY DESIGN, COMMUNICATION DESIGN, DESIGN TOOL

1. Introduction

The process of globalisation in China, marked by China's accession to the WTO, has led to consumerism taking over the daily lives of most Chinese people (Bao, 2008). This surge in consumerism significantly influences public consumption behaviors, with one of the most critical implications being the social and environmental issues stemming from excessive waste generation. According to the United Nations Statistics Division's Glossary of Environment Statistics, waste is defined as:

"materials that are not prime products (that is, products produced for the market) for which the generator has no further use in terms of his/her own purposes of production,transformation or consumption,and of which he/she wants to dispose.Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products,and other human activities, Residuals recycled or reused at the place of generation are excluded."

(UNITEDNATIONSSTATISTICSDIVISION, 1997)

Waste represents one of today's most pressing meta-problems, highlighting the critical need for society to transition towards a circular economic model that promotes sustainable production and consumption, rather than following the simplistic extract-produce-discard pathway. While improving waste management techniques is necessary, it is crucial to address the fundamental issues by redesigning the relationship between humans and resources and rethinking our production and consumption patterns (M. Simon et al., 2020). Domestic waste is perceived by the public as daily refuse produced within residential settings. In modern urban environments, it is common to observe a significant volume of disposables and even items that appear nearly new in rubbish bins. This phenomenon underscores the prevailing consumer attitudes toward waste, highlighting a disposable culture among users.Decades ago, numerous artists began utilizing trash as a creative medium, with trash art emerging as the most prominent example of this practice. This genre, often referred to as Junk Art, involves the transformation of discarded materials from consumer society into art pieces. By

removing these objects from their mundane contexts and imbuing them with new aesthetic and functional values, artists not only challenge traditional perceptions of art but also critique consumerist culture.

Cultural regeneration has emerged as a global strategy to foster urban renewal and drive economic and social transformation (García, 2005). This approach to cultural regeneration has also been implemented in projects aimed at enhancing community resilience through regeneration. Cultures of Resilience (CoR) represents a cultural experiment underway in London, predicated on the belief that art and design can meld community creativity with reflective originality to foster a more resilient society. Additionally, Cultural strategies fulfill four crucial roles in promoting sustainable development: they serve as catalysts and educators for raising awareness about climate change and fostering the development of 'ecological citizenship' (Duxbury et al., 2017).

Today's society is experiencing a shift toward sustainability, with the field of design becoming increasingly interwoven with other disciplines. Participatory design has risen as an open, collaborative approach that leverages the collective wisdom of the public to propel sustainable development forward. Communities, serving as the bedrock of grassroots governance and focal points for social conflicts, have become critical venues for public involvement in sustainability goals and initiatives. In recent years, a variety of social organizations in Shanghai have incorporated sustainable lifestyles, ecological consciousness, intergenerational exchanges, and active aging into their community activities. These efforts resonate with the sustainable 'lifestyles' and 'awareness' goals set forth by the United Nations (UnitedNations, n.d.), see as Table 1. Achieving these sub-goals involves a long-term strategy of integrating sustainable practices into daily life through design, thereby fostering a culture that supports the broader sustainability objectives.

Table 1: Expressions of Sustainable Lifestyles and Awareness in Sustainability Goals.

SDG 4: Quality Education	4.7: By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for **sustainable development and sustainable lifestyles**, human rights, gender equality, promotion of a culture of peace and non–violence, global citizenship, and appreciation of cultural diversity and of culture's contribution to sustainable development.
SDG 12: Responsible Consumption and Production	12.8: By 2030, ensure that people everywhere have the relevant information and **awareness for sustainable development and lifestyles in harmony with nature.**"

The research question of this study is to explore the application of participatory methods in the cultural regeneration of household waste, with the aim of raising public awareness of sustainable art and fostering civic ecological responsibility. To address this, the paper initiates a community-based collaborative curatorial project, which utilizes everyday objects as a starting point and employs participatory curation to engage the public in discussions on social issues, thereby integrating household waste into a new cultural context.

In the first phase, we reviewed relevant literature and case studies on participatory design, summarizing the levels of participation within this field. In the second phase, we conducted field research in a typical community in Shanghai to collect qualitative data, using thematic analysis to identify the applicable dimensions of participatory design methodology for this community. In the third phase, we implemented Practice-led research through workshops, developing tools for various types of participants and completing the collaborative curation. This phase aimed to stimulate discussion and reflection on waste. In the final phase, we proposed action guidelines and practical strategies for the collaborative curation project.

2. Theoretical background

The origins of Participatory Design can be traced back to the Nordic political democratization movement in Scandinavia during the 1970s. This method serves as a guide for design practice, where designers or researchers typically co-create with participants by organizing workshops. Conceptually, Participatory Design can be seen as the abstract essence of these workshops, which serve as its practical manifestation (SHEN et al., 2018). Participants have varying levels of language proficiency, knowledge backgrounds, and personal emotional experiences. The visual advantages of design tools help overcome communication barriers, facilitating the conveyance of complex information, uncovering implicit cognition and emotions, improving communication quality, and enhancing the collaborative experience (Zhong & Liu, 2018).

Liz has made significant contributions to the field of participatory design tool innovation (Figure 1). She divides the use of these tools into two phases: individual thinking and collective thinking. Tools for individual thinking assist users in understanding their own perceptions and experiences, while tools for collective thinking help users explore emotions and express future ideas, feelings, and aspirations. Liz also categorized participatory design tools based on behavioral patterns, proposing a model of 'Tell-Make-Enacting.' These three types of tools are not limited by a fixed sequence and can be used in any order or combined in various ways(E. B.-N. Sanders et al., 2010).

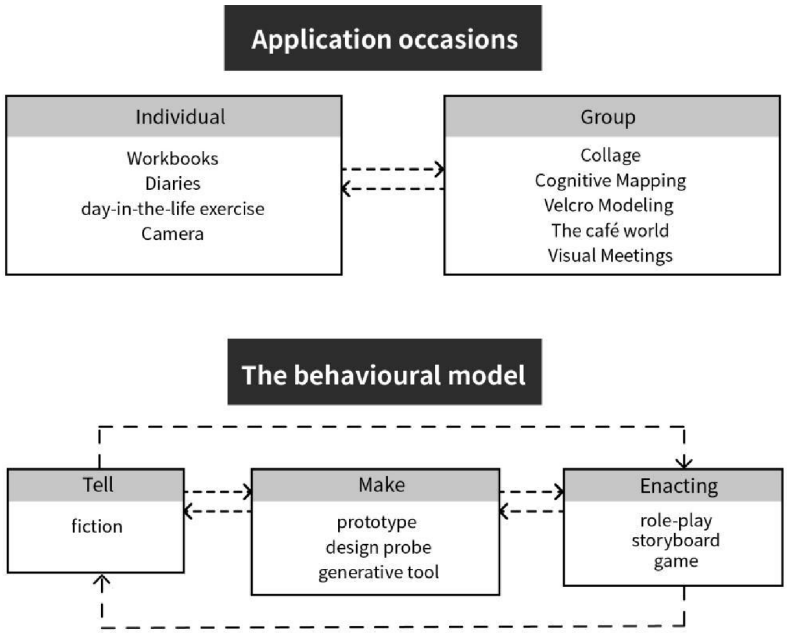


Figure 1.Different types of tools in participatory design.

The tools used in participatory design are not unique to its methodologies; they originate from various disciplines, including product design, service design, architectural design, sociology, and theatre. This diversity highlights the openness and adaptability of design tools within the participatory design framework. In Chinese communities, a wide range of these tools is currently employed in urban planning and spatial revitalization. According to Ryo Yamazaki, the early stages of community design often focus on constructing physical infrastructure to address immediate practical concerns. However, he contends that without incorporating cultural creativity, communities may struggle to maintain growth once these issues are resolved, as there would be a lack of compelling reasons for people to come together. (Ryo, 2011). Despite these insights, participatory tools in China often fall short in cultivating a genuine community culture. They are frequently used merely as symbols of participation, lacking substantial research or practical application.

Nina Simon's influential work, "The Participatory Museum," has significantly impacted the museum industry. She develops a participation theory for museums, emphasizing engagement as a foundational principle. Simon posits that a participatory museum transcends the conventional museum format by enabling visitors to create, share, and interact with others around a thematic framework. This model integrates participation techniques and philosophies extensively (Simon, 2010). On the practical front, participatory curating manifests through digital platforms like social media, as well as through offline modalities such as focus groups, educational workshops, and calls for contributions and topic-specific research.

These activities facilitate the dissemination of information and involve the public in aspects of museum management.

Participation pathways in museums are categorized into three types: grassroots, top-down, and an intermediate facilitation approach. Grassroots initiatives involve community members initiating and organizing museum-related projects, often sparking changes at higher organizational levels. Top-down approaches are characterized by museums leading and implementing strategies to engage the community in alignment with their missions. Meanwhile, the facilitation approach positions museums as stewards, supporting but not dominating the participatory activities (Black, 2012).

Drawing on WolfBrown's 'Public Involvement Spectrum', which delineates levels of public participation in artistic activities(Brown et al., 2011). we have classified the actual levels of participation in participatory exhibition design into the following four categories (Figure 2):

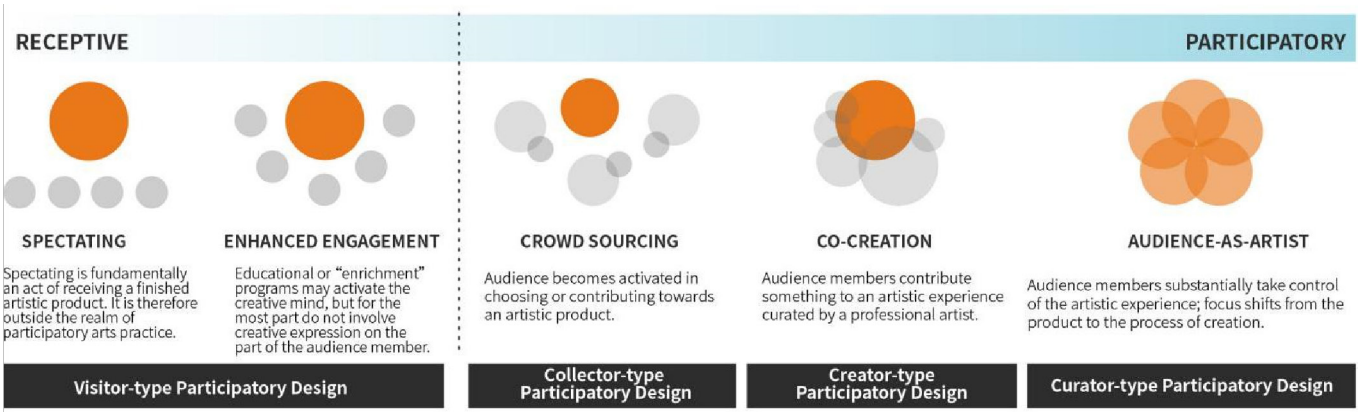
1. Visitor-type Participatory Design: Upon the completion of community curation, individuals engage as visitors. They interact with the exhibition by viewing and sharing, and leave interactive footprints, such as voting or messaging, on the installations at the curation site.

2. Collector-type Participatory Design: During the curatorial process, participants contribute objects and collections and share the stories behind these items. This engagement supports professionals by providing substantive content and material resources that enrich the exhibition's primary themes.

3. Creator-type Participatory Design: Participants in this role actively develop exhibits that align with the exhibition's thematic direction. They employ creative tools, supplied by professionals, to effectively realize their creative visions.

4. Curator-type Participatory Design: In this approach, participants conceptualize the curatorial theme, select and organize exhibits. Professionals assist by facilitating and co-creating, enhancing the collaborative aspect of the exhibition process.

Figure 2.Level of co-curatorial involvement.



we propose the following three hypotheses based on literature review and case studies:

1. The application of participatory design methodologies in creating community culture in Shanghai necessitates the development of design tools tailored to the specific characteristics of each community.

2. Participatory design tools can promote cultural regeneration based on domestic waste in local communities and raise ecological awareness among citizens.

3. Action guidelines and strategies derived from co-curatorial projects can offer viable pathways for addressing similar scenarios and themes.

3. Methodology

3.1 General context of the study

The typical understanding of waste or trash encompasses items that are overlooked, forgotten, or intentionally discarded. The lifecycle of waste starts with the production of goods, positioning consumers not only as direct producers of waste but also as agents of waste reduction, sorting, and transformation (Zhang, 2021). This participatory curatorial project utilizes everyday 'waste/garbage' as exhibition materials to spotlight routine behaviors of 'Buy', 'Use', and 'Throw away', encouraging participants to shift from discarding to collecting waste.The project's framework guides participants through a structured process of engagement:

1. Observation: Observe the domestic wastes in a different view.

2. Collection: Select objects and create archive for the exhibition.

3. Action: Engage participants in sharing personal stories with others.

4. Communication:Invite participants to collaborate on curating exhibitions.

This pathway brings public attention to often-overlooked aspects of daily life, highlighting their broader societal and environmental implications. The exhibition serves as a platform to engage visitors in dialogue, promoting a culture of recycling and enhancing ecological awareness among citizens.

3.2 Participatory observation



Figure 3. Leshan Community

The term “Lao Po Xiao” is uniquely Chinese, often used to describe aging, deteriorated, and compact residential neighborhoods in major cities like Shanghai. This descriptor merges the characteristics of being “old(Lao),” “shabby(Po),” and “small(Xiao).” Typically constructed in the mid-20th century or earlier, these structures are in poor condition. Despite this, their central locations in urban cores confer significant residential and investment appeal. To enhance the quality of life and well-being of residents, and to foster the concept of a “15minute community living circle” aimed at improving public services and grassroots governance, every community in Shanghai features a facility known as a “living box.” This new living space combines elements of art, exhibitions, and leisure to create a vibrant community hub. However, in practice, these spaces have not become the focal points of cultural activity they were intended to be. The lack of resident participation can be attributed to several factors, including perceptions that community cultural events are merely administrative exercises, the repetitive and outdated themes of activities, and a general absence of community belonging among residents.

We gathered first-hand information through various methods including joining community online chat groups, conducting participatory observations in the field, and documenting the entire process by using field notes. These notes comprised textual descriptions, photographs, and memos. Subsequently, the data was organized via thematic analysis.

3.3 Practiced-led Research

Archives are records curated and preserved for their cultural, historical, and evidential value, maintained either permanently or long-term. They may include a diverse array of materials such as manuscripts, letters, photographs, maps, books, illustrations, and

digitized texts. Increasingly, contemporary scholars from non-historical disciplines, including artists and designers, are adopting various critical and aesthetic approaches to archives. These approaches often focus on constructing meanings, influencing situations, and fostering new processes for knowledge creation. They offer alternative interpretations and contextualizations of meaning that diverge from official narratives, suggesting that archival art is less about the past but more about the future(Carbone, 2020).

We visualize and present a collective archive of discarded items from everyday life as a narrative form, encouraging participants to contribute objects along with their backstories, express personal perspectives or inspirations, and inspire others to engage with society in novel ways. The communication tool categorizes participants into four types: tourist, collector, creator, and curator. The design of the tool specifically targets the latter three types, recognizing that different participant types may experience varying factors influencing their cost of participation. Consequently, the tool was designed to accommodate all participant types and allows for adjustments based on practical application.

The table below shows the workshops held during the practice-led research process , see as table 2.

Table 2: Workshop Schedule

Number and Date	Duration	Number of participants	Participants	Test Goals
May 2023	None	5 persons	Collector–type Participants; Adults	Completing the co–creation of rubbish archives through the collection of participants' rubbish
Workshop 1 Jan 2024	2 hours	4 persons	Creator–type Participants; 3–6 year–old child	Participants are invited to share stories of choosing rubbish through the archive toolkit
Workshop 2 Jan 2024	3 hours	8 persons	Creator–type Participants; Adults	Participants utilize the archive toolkit to collect stories from fellow participants and invite their friends and family to join.
Workshop 3 Feb 2024	18hours	14 persons	Curator–type Participants; 9–12 year–old child	Participants employ the archive toolkit to gather stories associated with litter, inviting friends and family to join the initiative. They are encouraged to explore the community, utilizing the archival skills they have learned to compile a community archive. This process culminates in the creation of a curatorial model design.

3.4 Informal Discussions

Ongoing observation facilitates brief, unstructured conversations with various participants. These interactions can occur during discussion periods in workshops or while viewing an exhibition of co-created works alongside the participants.

3.5 Questionnaire Survey

In Workshop 3, the participants included 14 children, with their parents also participating in various stages. A questionnaire was distributed to the parents to gather multidimensional data for the study.

4. Results

4.1 Key Dimensions of Applying Participatory Methods in Neighborhood

Based on field observations of the following four scenarios, we employed thematic analysis to identify and interpret the textual data (Table 3). The detailed analysis process involved three levels of coding, resulting in the identification of sub-themes and overarching themes from the field notes, ultimately leading to a structured analysis (Table 4).

Table 3: Field Research for Leshan Community

Scene Serial No.	Title	Time
Scenario 1	Discussion with the resident design team on implementing participatory projects in the community.	8 January 2024
Scenario 2	Conducted the initial in-person survey of residents' needs in collaboration with a team of resident designers responsible for community cultural activities.	13 January 2024
Scenario 3	Observe the venue of the resident team's first cultural event in the community.	16 January 2024
Scenario 4	Directly observe the interactions within an online chat group of community residents.	20 January 2024

Table 4: Coding example

Scene Serial No.	Title
01	The meeting took place in community activity centres, a small two-story building. The ground floor typically serves as a convenience service area, offering services such as dispensing medicine spoons, haircuts, blood pressure measurement, and shoe repair. Each booth is manned by a person (1-1 Convenience Service). The first floor functions as a library, and the meeting rooms are provided to the community as activity spaces (1-2 Public Space). When I first met the operational staff, I noticed they were quite young. Two of the main individuals in charge had backgrounds in design education (1-3 Design Specialists). Z, one of the principals, remarked, "This is an age-friendly community, and we want to showcase the vitality and value of the elderly (1-4 Value of the Elderly). One college teacher I collaborated with in another community spent nearly a year collecting mementos from seniors, and these seniors continued to contact her to donate items (1-5 Everyday Items). The trash-themed project you're working on is also a great fit for our community, as we maintain a part dedicated to sustainable themes (1-6 Promoting a New Lifestyle)."

I responded, "Yes, I hope you can reach out to more residents to participate."

Z added, "We can organize the core members of the community council to help you gather participants (1–7 Community Backbone Leaders), but I hope the project itself can attract more people (1–8 Project Autopoiesis). The elderly here often sunbathe on the green, so you can come by sometime to interview or speak with them directly. If you're going to initiate a project, conduct thorough research beforehand. The residents here might not be as receptive as those near your university (1–9 Slow Acceptance)."

I smiled and said, "I also have limited interaction with the elderly near my school. One reason is the language barrier; I feel that if I don't understand Shanghainese, I can't fully grasp the essence of our conversations. Another reason is the challenge of engaging with the elderly."

Z continued, "We hope your project can facilitate intergenerational communication because the elderly often feel excluded from society. If you can make them feel valuable (1–10 Discovering Individual Values), their participation will increase. Some active members have very full daily schedules, and the place where we meet is also where they practice dancing. I recommend visiting this place frequently before starting your activities. It will be beneficial for your project, and you should be prepared for the possibility that the project may not go as initially planned; adjustments will need to be made based on actual conditions (1–11 Project Compromise)."

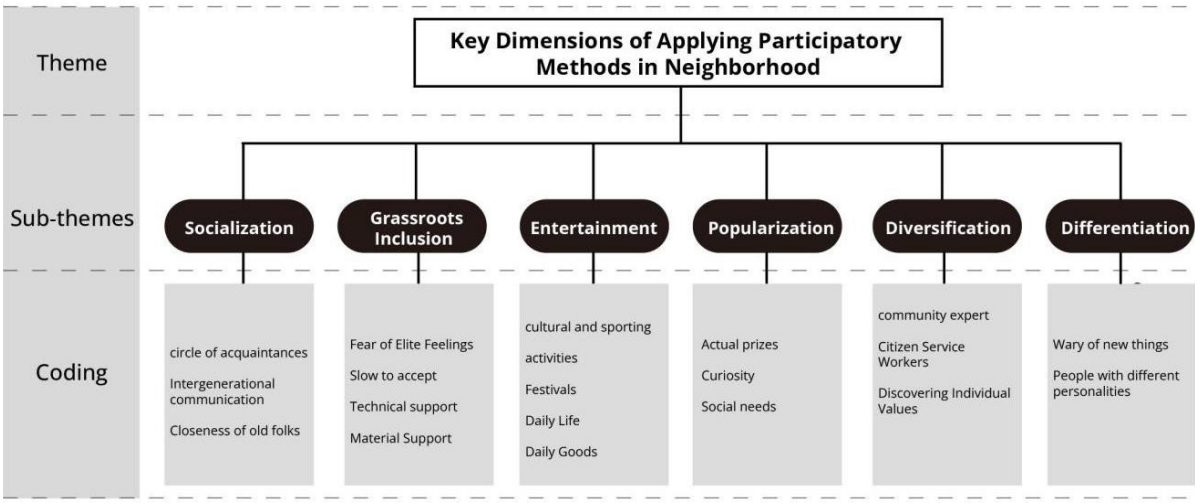
I asked, "So, are there many children here?"

Z replied, "Yes, a lot. You'll see kids coming out of school after 4 o'clock, and their parents walking them on the green. You must have seen it when you walked over here; there's a kindergarten at the intersection (1–12 Children)."

Z, who has been in charge of community operations for over two years, mentioned that the "ministers" are the grassroots leaders of this community, specifically hired as the operations team. I also attended the following day's meeting with the minister and the secretary of the neighborhood committee of Lishan 1–7 village, and learned that they hoped to encourage young people to focus on the community (1–13 Young People's Energy) and to leverage the community's own resources to secure policy support (1–14 Striving for Resources).

The coding and categorization process identified six sub-themes. These sub-themes represent the applicability demensions of participatory design methods in the community. Additionally, they provide diverse and inclusive references for the development and application of design tools (Figure 4).

Figure 4. Thematic analysis



1. Socialization: Assesses whether the tool fosters dialogue and mutual understanding within the neighborhood, thereby fostering emotional connections.

2. Grassroots Inclusion: Ensures that the participation threshold is accessible to all community members, including disadvantaged individuals, non-literate residents, preschool children, and others.

3. Entertainment: Evaluates whether the tool can generate interest or provide a relaxing experience, encouraging participants to engage beyond their everyday routines.

4. Popularization: Engages people emotionally, intellectually, or experientially through the lens of daily life, thereby sparking imagination and discussion.

5. Diversification: Stimulates the unique characteristics and self-worth of each individual within the community.

6. Differentiation: Uses appropriate mediums to avoid generating resistance within the community.

4.2 Archive-centred participatory Design Tools

Due to the low level of engagement as collectors type participants—primarily resulting from limited participation time—workshops were not feasible for them. Instead, all other participant types engaged in archival co-creation exhibitions focused on domestic waste through workshop formats. The design of the participatory tools was guided by three primary objectives (Figure 5):

1. To make the tools accessible to as many community members as possible;

2. To enhance participants' civic ecological awareness and stimulate their imagination during the process;

3. To assist participants in visually displaying the results of the exhibition.

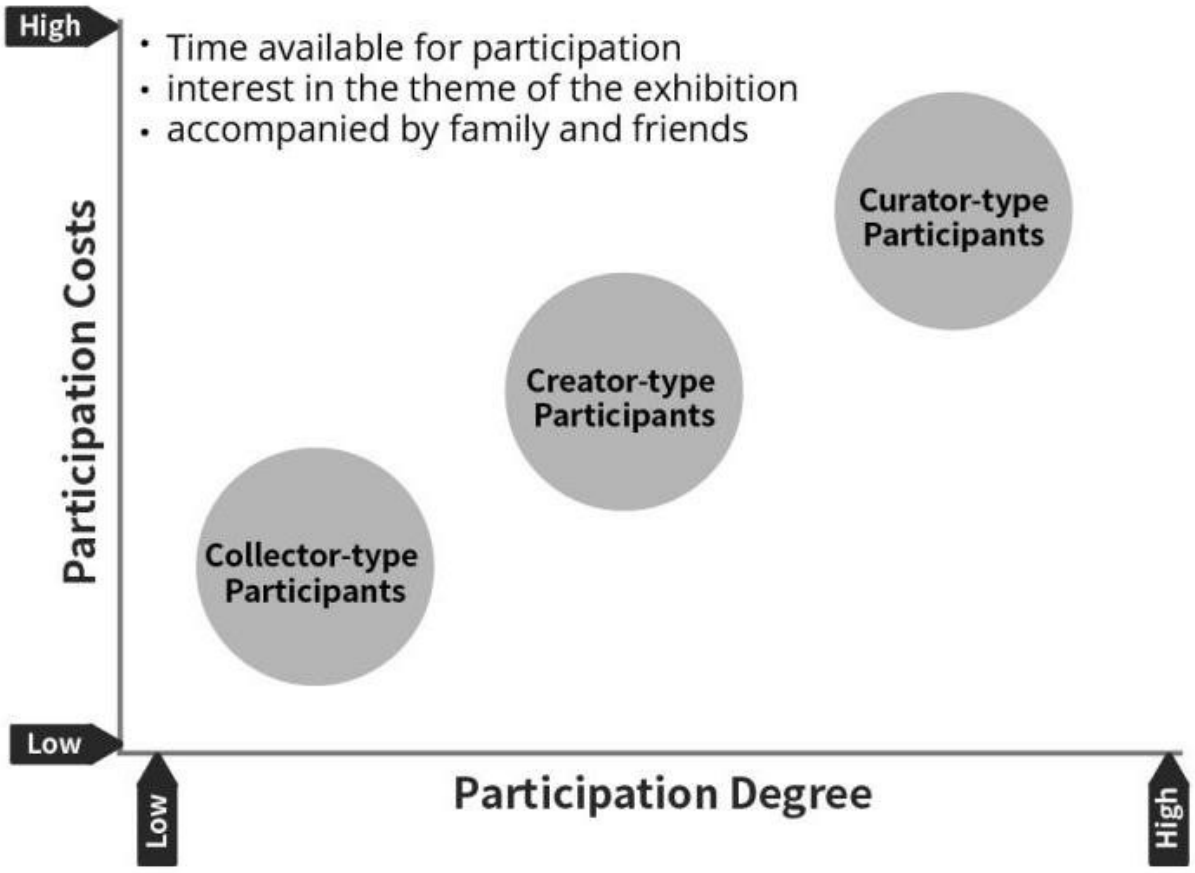


Figure 5.Levels of Participation Among Different Participants



Figure 6.Rubbish provided by participants.



Participants are invited to contribute a bag of unsorted rubbish as a means of engagement, assisting professionals in generating the main content and providing material support (Figure 6). This contribution marks the completion of the engagement process for collector-type participants. The method involves objects from different individuals, employing the visual style of archival photography as a reference. The focus is on detailed descriptions of the objects, which are then artistically combined in collages to establish a thematic connection through a visual narrative.

Figure 7. Exhibition of Works in Galleries in Vienna

The co-created works were exhibited in the gallery, where participants contributed everyday materials, and professionals facilitated creative expression by reconstructing these object combinations into individual visual images (Figure 7). We observed the exhibition alongside the participants, engaging in informal discussions throughout. Feedback revealed that participants were initially surprised by the photograph which not only highlighted a sense of conflict but also prompted participants to reflect on environmental concerns and the nature of waste. The discussions indicated a growing awareness and concern among participants about the implications of trash (Table 5).

Table 5: Informal Discussions with actors

Participants	Informal Discussions
Participants 1	I never pay attention to the garbage I throw away. This garbage reminds me of things that are easily forgotten. It feels like garbage is like the footprints of my life. I think the topic of garbage is quite interesting
Participants 2	These photos make me unable to recognize the garbage. I feel that the garbage is quite dirty. It seems like there is a sense of order now, a very special feeling."
Participants 3	The labels in the photo are the price tags I collect every time I buy second-hand clothes.I almost always wear second-hand clothes, mainly because they were cheap, but I really felt that shops were very attentive to selling second-hand clothes.

Workshop 1 Participatory Methods for Creator-Tpye Participants

This workshop targets creative participants—those who can contribute their own ideas to the curation theme, possess creative skills, and are proficient in using the tools provided by professionals. The 'archival drift box,' a designated design tool, aids in the curation process. This tool kit includes a tool box (Figure 8), instructions for the toolkit (Figure 9), and several archive forms, primarily used for observing, documenting everyday waste. (Figure 10).



Figure 8. Tool box

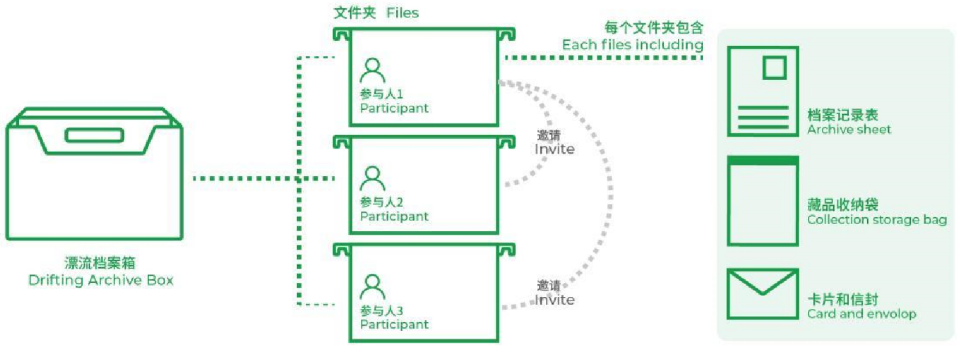


Figure 9. Instructions for the toolkit



Figure 10. Archive forms.

We invited six participants to collect a piece of waste daily using the toolkit for one week. Upon completion, they were to place the filled forms and collected waste into a box and pass it along to friends, relatives, or strangers. This design tool effectively transforms individual contributions into a collective endeavor, shifting the focus from 'me' to 'we.' The initial user of the box acts as a liaison, gathering all materials to return to the author, who then collaborates with participants to organize a community exhibition.

During the workshop, participants were instructed to bring three pieces of waste to the site and select an anonymous piece from another participant. They were then asked to speculate on the backstory of the waste and infer the personality of its owner. The goal was to encourage participants to adopt



Figure 11. Workshop test.



Figure 12. recycled toolkit

new perspectives and consider the waste from an unfamiliar viewpoint (Figure 11). Using waste as props in this setting added a tangible, experiential element to the creative atmosphere, prompting participants to step outside their personal viewpoints and engage in documenting the archive.

After three weeks, the four archive kits were recycled (Figure 12), and the retrieved archives were showcased under the theme "Community Window Story." The exhibition was set in the window of a local community coffee shop (Figure 13). This choice of location underscores the integration of the exhibition into the everyday community landscape, rather than confining it to a specific cultural venue. the exhibition serves as a touch point designed to spark attention, dialogue, and reflection among community members.



Figure 13. Exhibition in Coffee Shop

Workshop 2
Participatory Methods for Creator-Tpye Participants

After completing the adult workshop, we returned to the Leshan community to recruit parentchild pairs with children aged 3-6 to participate in a new workshop (Figure 14). We invited children in the community to bring sustainable items from their daily lives to contribute to the workshop (Figure 15). The items were then displayed in a public space (Figures 16). The design tool was tested with four different groups of children, assessing its accessibility and relevance within the children's community.

Workshop 3
Participatory Methods for Curator-Tpye Participants

The curatorial workshop involved the entire process of curating living waste. Fourteen children from grades four to seven participated in the workshop. The content is divided into three stages: Stage one is observation, Stage two is action, and Stage three is communication. Each stage progresses to a deeper level of participation and scope, accompanied by the co-creation of corresponding curatorial content. During the curatorial process, five roles were established to provide guiding instructions for participants at each stage, with incentives introduced to enhance participant motivation.

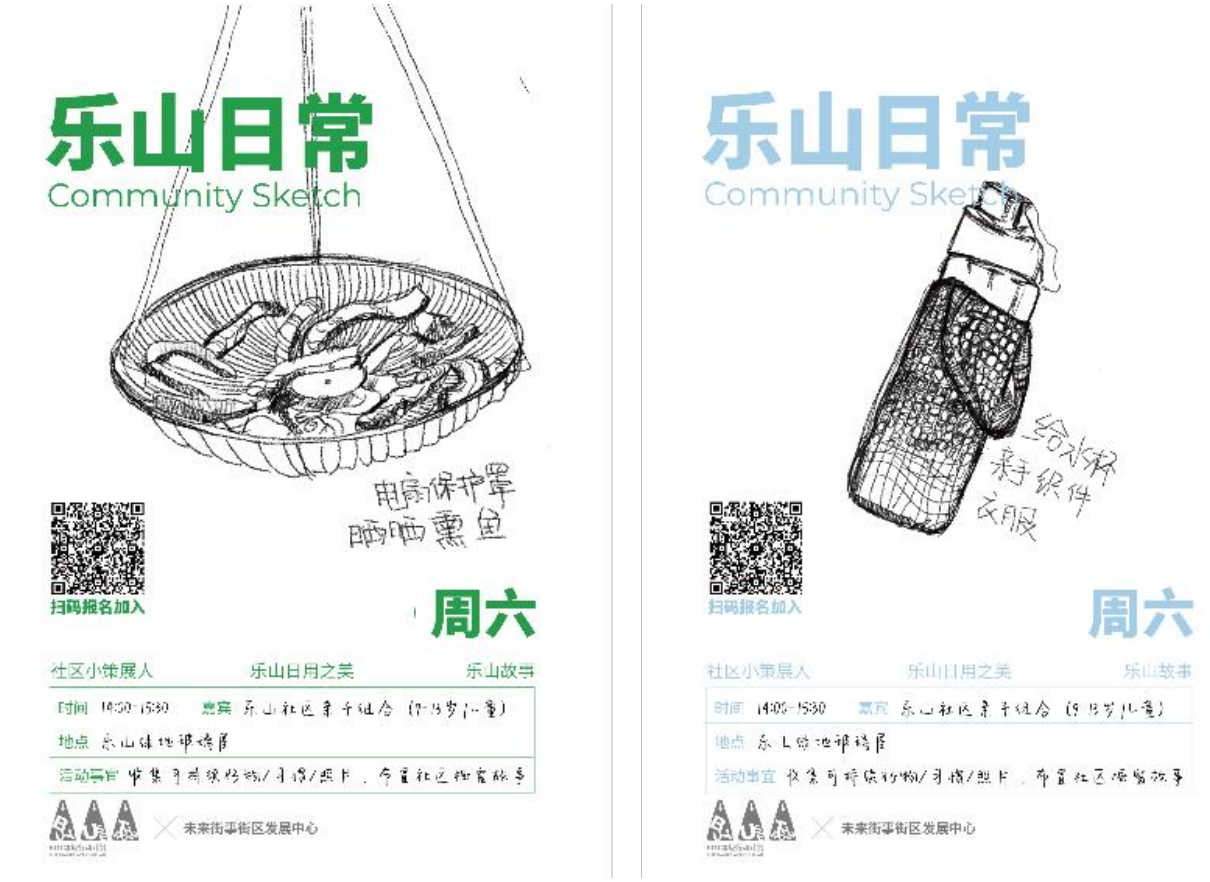


Figure 14. Workshop poster

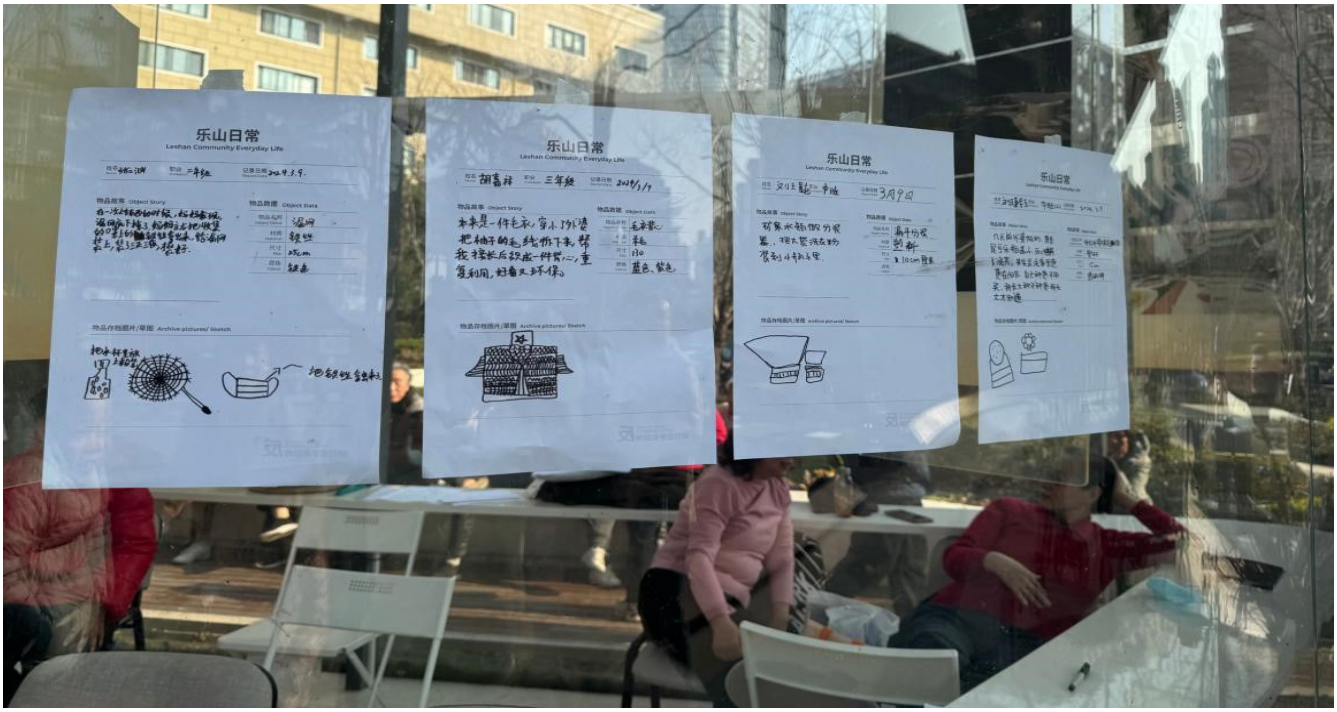


Figure 15. Archives completed by participants

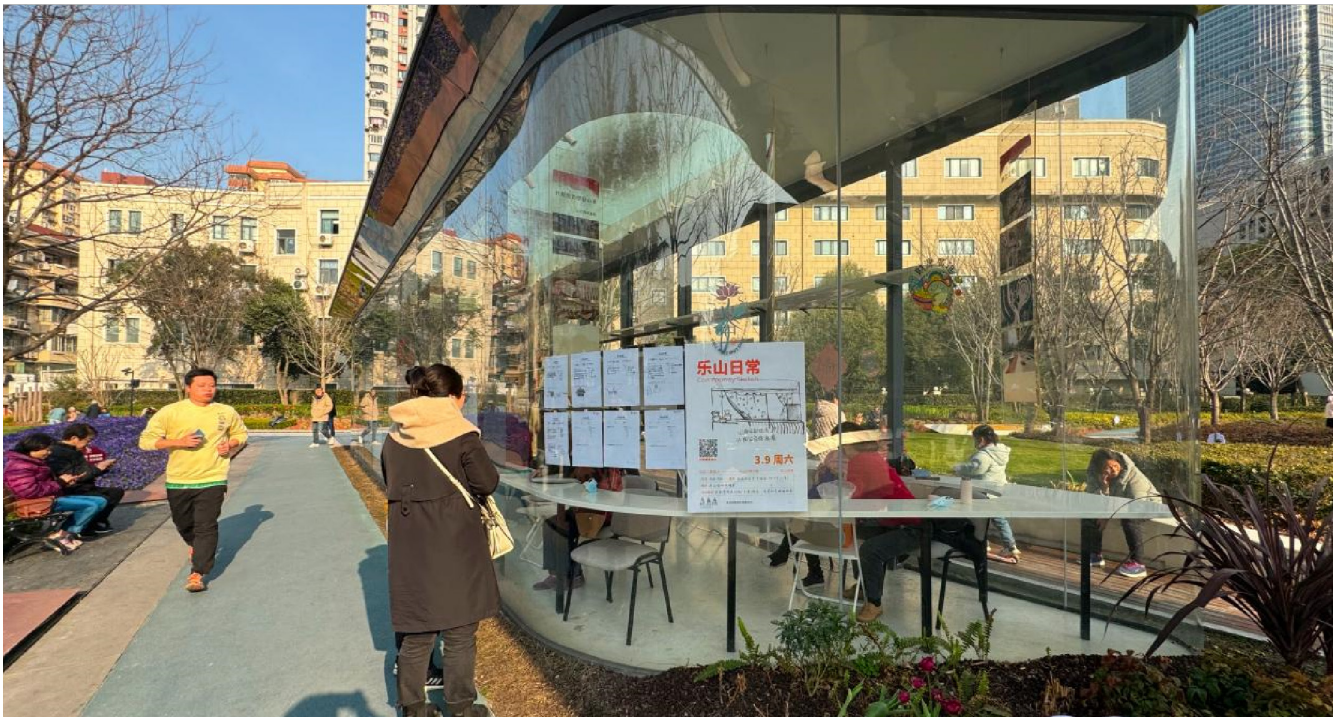


Figure 16. Exhibition in community

The main goal of Stage one was to emphasize behavioral change among participants by initiating the act of 'observation'. In this stage, the roles of collector, observer, and archivist were established to increase engagement with the external environment and clarify the perspective participants were expected to adopt for observation (Figure 17).

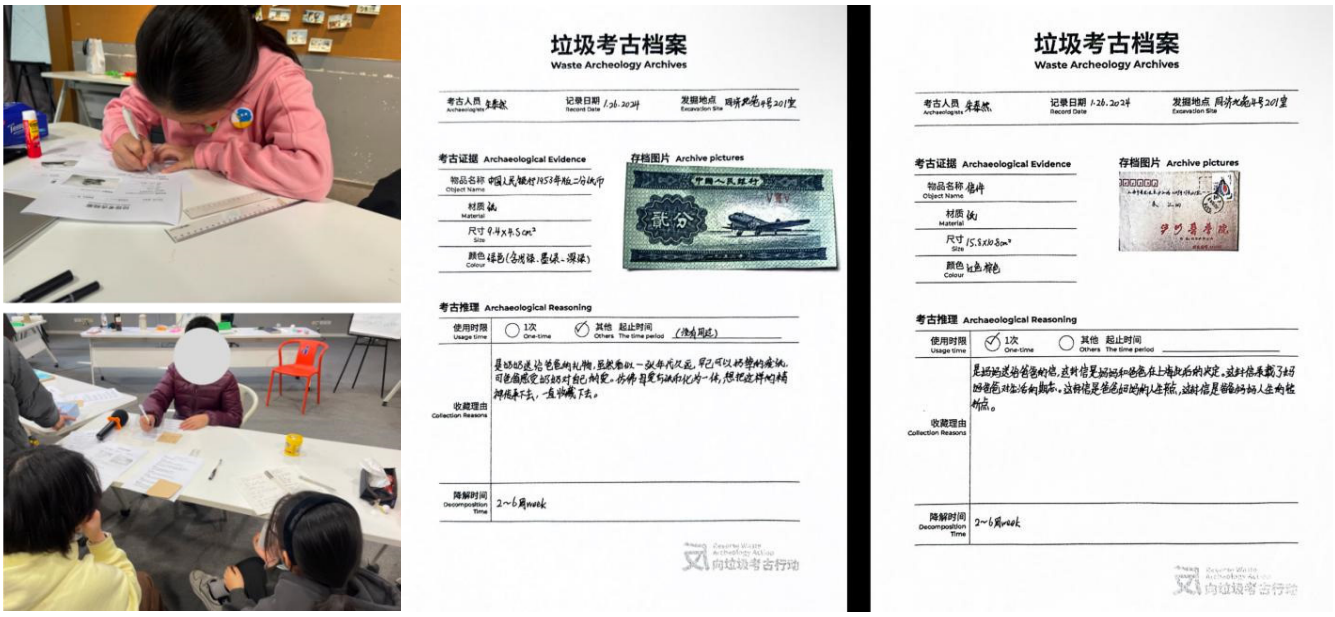


Figure 17. Participants were interviewing each other in pairs about the stories behind the rubbish

The goal of Stage two is to shift the participants' perspective from focusing on the 'object' to the 'community.' The behavior emphasized in this stage is action, specifically through activities such as a community walk (Figure 18) and subsequent creative expression. After the walk, participants were asked to draw the route from memory and create hand-drawn reflections on archival photographs, utilizing existing photographs as references (Figure 19). This phase highlights action, including both fieldwork during the community walk and creative expression afterward.

The aim of stage three was to create a small exhibition of the archives from the last stages, which required participants to set up the exhibition according to the appropriate conditions (Figure 20). Participants need to consider how to present the exhibit so that it engages in a dialogue with the viewer. Participants chose to hide some of the objects under cardboard boxes, as well as placing rubbish generated during the curation process on the ground, using materials to mark it.



Figure 18. Community walking

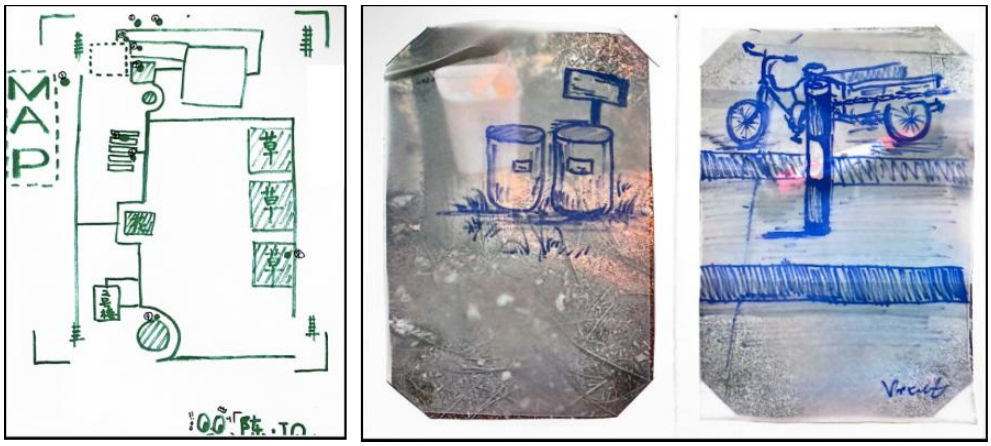


Figure 19. Hand-drawn reflection



Figure 20. Exhibition Venue

After the curation, We conducted a return visit to the participants for the questionnaire survey and collated the results according to the three levels of affective design (instinctive, behavioural and reflective). The results showed that the behavioural phase of the participatory curation helped participants deepen their thinking about the theme of household waste and basically achieved the effect of fostering eco-citizenship (Table 6).

Table 6: Summary of the questionnaire based on the behavioural hierarchy

The behavioural level	Summary
Instinctual level	Community walks are enjoyable and provide a fun experience.
	Engaging in conversation while filling out profiles helps enhance family bonding.
Behavioural level	Discovering materials in everyday life and being able to make creations similar to those made by professional designers.
	Our work doesn't have to be paintings or photographs, we can even exhibit our ideas!
Reflection level	Sustainability can be integrated into everyday life.
	Objects can be repurposed and used sustainably.
	Developed a new understanding of the concept of sustainability.
	Gained a deeper understanding of the community's spatial environment.
	Experienced the mindset of a designer

5.Conclusion

During the three workshops mentioned in the article, we observed changes in participants' perceptions of garbage through informal discussions or questionnaires, and we created a dialogue with the public through participation in community curation activities. Participatory design can benefit from the use of archives as a communication tool. The use of community curation as a long-term residency project will gradually develop a new culture of sustainable living in urban communities. For this purpose, we propose action guidelines and strategies for community curation.

5.1 An Action Guide to Community Participatory Curating

Based on the workshop practice, a participatory curatorial action guide was developed, focusing on community scenarios. This guide offers practical guidance for applying participatory design methods in community building. The action guidelines are intended to assist the public and community workers in independently conducting curatorial activities (Table 7).

Table 7: Guidelines for public and community

Stage	Goals	Participant behaviour	Roles	Task
Stage 1	Arouse attention to the exhibition theme and exhibition objects	observation	Collectors Actor Archivist	Through the completion of the dossier, participants' understandings and reflections on the graphic and textual aspects related to the theme are collected
Stage 2	Practicing a deeper understanding of the curatorial theme through walking within the region	Action	Activist	Participants use their cameras to record scenes and objects of interest during the walk, and use text or hand–drawing to create a secondary version of the photo.
Stage 3	Display of works completed in the first two phases	Communication	Curators	Displaying obejects or works in public spaces and using visual techniques to draw public attention to them

5.2 Participatory Curatorial Strategies in Community Contexts

Activate participant creativity through different roles

In practice, we used identity props, such as an archival toolkit, to frame participants' involvement as an act of modern urban rubbish archaeology, designating them as archaeologists in the archival process. We assigned different roles at each stage of the curatorial practice (Figure 20). These identity props enabled participants to break free from habitual thinking, allowing them to view everyday behaviors and objects from new perspectives, thereby stimulating greater creativity and ideas (Figure 21).



Figure 21. Identity props



Figure 22. Community photos

A parent and child documented their experience of this practice during a walk in their neighborhood (Figure 22). The images on the left were taken by the child, while those in the center and on the right were captured by the parent. These photographs, accompanied by notes from the walk, reflect how both the child and parent began to develop new perspectives and reflections on everyday objects during the activity.

Table 8: Informal Discussions with participants

Photos	Informal Discussions
Cat House	Another kitty litter put up by a kind person, but no Ben cat went in to live there. It feels like feral cats prefer a little more originality.
Chair	An unblemished rattan chair that had been abandoned at the rubbish dump. Judging from the batter on the armrests, it had been used for a long time and was well maintained. Could it be that the old man who used to sit on this chair passed away and the younger generation disposed of the chair as rubbish?
Tree	Shanghai's winter is getting colder and colder, and plants that are not frost–resistant are wrapped up tightly. I just don't know if the plants will be uncomfortable.

Children as a link in Community cultural activities

A community is a complex ecosystem composed of places, people, cultures, values, and organizations. The applicability of participatory design in different contexts must be adapted to the specific circumstances of each location. Fei describes the social structures of Chinese and Western societies using the metaphors of bundles of firewood and ripples, respectively. In Western societies, social groups are like bundles of firewood, with clear boundaries between them. In contrast, Chinese social structures resemble ripples, where each person is the center of a circle of influence, with each outward layer encompassing different levels of interpersonal relationships, including those within the community, family, workplace, and broader society (FEI, 1985).

In this study, we used the parent-child combination to participate in curatorial activities in the form of experiments in old neighbourhoods and received good feedback. After the children became friends or partners with each other, families began to participate in community-related cultural activities because of the “children” as a link, and parents entered into dialogue, chatting and socializing more quickly and naturally because

of the friendship between the “children”. The parents also enter into dialogue, chatting and socialising with each other more quickly and naturally because of the friendship between their children(Figure 22). In community design, finding interpersonal bonds can be a powerful way to advance the design process and enhance the impact of the project.



Figure 23. Parent-child pairs are invited to conduct walking observations in the community.

The Third Place as an exhibition space

Third spaces are physical locations where people can experience warmth, conviviality, spiritual support, and a sense of belonging. These include cafes, pubs, libraries, and hairdressers, where individuals from diverse backgrounds can gather in a relaxed and casual atmosphere(Oldenburg, 1989). This concept emphasizes that relationships need to be nurtured and that communities are often built on simple elements like a few tables, friendly shopkeepers, and a shared desire to meet and connect. Curatorial venues are chosen with this idea aiming to visually present the daily life and culture of community members within these third spaces.
These settings are ideal for the creation and

dissemination of community culture. Third spaces can be found in neighborhood centers, parks, squares, and even at the end of streets. Some “temporary spaces,” which are rent-free, unregulated, and often overlooked, can also serve as exhibition spaces, adding a unique visual tension and authenticity.

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DESIGN-DRIVEN INNOVATION (DDI) AS A CATALYST FOR TRANSFORMATION: A CASE STUDY OF THE AIR-MEMBRANE VERSION OF HUO-YAN LABORATORY

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ABSTRACT | This paper explores how the Huo-Yan Laboratory developed by Tongji University's College of Design and Innovation and BGI Genomics Co., Ltd. embodies transdisciplinary design-driven innovation. Robert Verganti, a representative scholar of design-driven innovation (DDI), proposes a third type of innovation that embeds new meanings into products and services, beyond merely focusing on technological or market advances. Through expert interviews and card-sorting methods, this paper analyzes and summarizes the composition of the interpreter network in this DDI project. It explores how the visions of key interpreters can be transformed into collectively achievable meanings during the product innovation process, thereby generating significant social impact. The study visualizes and supplements Verganti's classic model by specifically detailing critical interactive relationships. The results indicate that the project successfully created a radical design solution to urgent social needs. This highlights the importance of transdisciplinary collaboration in generating social value and driving social change. Additionally, it provides a practical example of design-driven transdisciplinary collaboration for Tongji University's "Innovative Design and Intelligent Manufacturing Disciplinary Group", contributing Chinese solutions and insights to the theory of DDI.

KEYWORDS | DESIGN-DRIVEN INNOVATION, NETWORK OF INTERPRETERS, AIR-MEMBRANE VERSION OF HUO-YAN LABORATORY, TRANSDISCIPLINARY

1. Introduction

The creative concept of the "Huo-Yan Laboratory" originated from the vision of BGI Genomics Chairman Wang Jian. In the early stages of the COVID-19 pandemic, BGI Genomics rapidly developed the Huo-Yan Laboratory for COVID-19 nucleic acid testing. The name "Huo-Yan" is derived from Sun Wukong's "Fiery Eyes" in "Journey to the West," one of China's four great classical novels. Just as Sun Wukong could identify demons and monsters with his "Fiery Eyes," BGI Genomics accurately detects various viruses through the Huo-Yan Laboratory.

The COVID-19 pandemic, which began at the end of 2019, quickly spread, becoming a particularly significant infectious disease worldwide. BGI Genomics Co., Ltd. recognized the need to rapidly build a large number of testing laboratories. In mid-February 2020, Mr. Su from Tongji University began conceptualizing an inflatable membrane structure for a protective isolation system. He led his team to apply for a patent and develop a prototype. Subsequently, BGI CEO Mr. Yin and Mr. Su from Tongji University, based on the needs and challenges of COVID-19 testing, collaboratively conceptualized and developed the Air-membrane Version of Huo-Yan Laboratory (Fig.1). This project played a crucial role in global pandemic control, providing timely support to several countries and receiving widespread recognition from the public and governments.

Reports related to the Air-membrane Version of Huo-Yan Laboratory have accumulated over 2.2 million mentions, including more than 60 reports by CCTV and over 80 by the People's Daily. The CCTV documentary "Scientific War on COVID-19" featured the Huo-Yan Laboratory as the only showcased testing facility. Over 20 international officials visited and highly praised the contributions of the Huo-Yan Laboratory, with more than 10 officials sending letters of appreciation. The President of Serbia awarded the Huo-Yan team the "Order of the Serbian Flag, 1st Class," making it the only enterprise to receive this honor. Various levels of government and related departments sent a total of 23 letters of appreciation to the BGI Huo-Yan team, expressing high recognition of their contributions during the pandemic.



Figure1. The Air-membrane Version of Huo-Yan Laboratory was selected for the Best Scientific Image of the month in the top international journal Nature in June 2020 (image sourced from the internet).

This project demonstrates that design is not only the aesthetic driver of innovation but also a comprehensive innovation management practice. It encompasses a new set of processes, mindsets, capabilities, and organizational setups. By analyzing the success of this project from the theoretical perspective of DDI, this paper aims to provide theoretical guidance for the "Innovation Design and Intelligent Manufacturing Discipline Group" initiated by Tongji University in 2021. This group, led by the design discipline, is oriented towards major national development strategies (Fig. 2).



Figure 2. The First Tongji Innovation Design and Intelligent Manufacturing Summit (photo from the Internet).

2. Theoretical background

2.1 Theoretical Foundation

Verganti is the most cited and authoritative scholar in the field of innovation of meaning, and much of the theoretical work on this topic is based on his research findings (De Goey, Hilletofth, & Eriksson, 2019). We have studied two of Verganti's seminal works: "Design-Driven Innovation" (DDI) published in 2006 (Verganti, 2006) and "Innovation of Meaning" (IOM) published in 2018 (Verganti, 2018). The reason for selecting DDI as the primary theoretical basis is that DDI mainly focuses on enterprises, discussing the relationship between companies and the intrinsic meaning of their products, which highly aligns with our research case. Although the Air-membrane Version of Huo-Yan Laboratory demonstrates radical innovation in the intrinsic meaning of the product, the process of meaning creation more closely follows the DDI design discourse. The IOM process, with its highly detailed methodological tools, tends to be somewhat restrictive. Therefore, we analyze the case of the Huo-Yan Laboratory from the DDI perspective.

2.1 Current State of Research

Verganti introduced the concept of DDI in 2003 (Verganti, 2003). Unlike previous frameworks, this concept focuses explicitly on innovation in the meaning of products, providing new strategies for companies to develop more valuable products. In DDI, product meaning refers to the value a product creates for consumers, including utilitarian, emotional, psychological, and socio-cultural values (Verganti, 2006).

Currently, some scholars consider DDI a strategic direction, particularly in the upstream stages of the innovation process (Dell'Era, Magistretti, Cautela, Verganti, & Zurlo, 2020; Sarpong & Maclean, 2012). Some researchers focus on how to construct meaning, such as Professor Knudsen from Oldenburg University, who proposed in 2019 that the construction of meaning in DDI begins with a paradox and is realized through a series of frameworks (Knudsen & Haase, 2019). Other scholars, like sociology professor Krippendorff and management professor Micki Eisenman, have explored understanding meaning, introducing concepts like second-order meaning and secondorder understanding (Eisenman, 2012). Professor Wang Hanyou from Nanjing University of Aeronautics and Astronautics' School of Economics and Management suggests that there are two paths to achieving product meaning innovation: user-driven innovation and DDI. The former, through in-depth contact and analysis of user needs, is effective for incremental meaning innovation, while the latter is a radical meaning innovation based on subtle changes in socio-cultural institutions, proposing entirely new product meanings that go beyond existing user experiences and perceptions (Wang, 2019). Professor Chen Jin from Tsinghua University's School of Economics and Management, a Yangtze River Scholar, points out that

the process of intrinsic product meaning innovation in DDI is relatively obscure, with very few detailed records and a lack of case reviews on the meaning construction process. Specific issues include: the theory may be limited to specific business or market needs without considering broader socio-cultural contexts; the tools and methods on which DDI relies may not fully capture and handle complex socio-cultural dynamics; and the emphasis on economic benefits in DDI might overlook socio-cultural values, leading to an overemphasis on short-term economic returns rather than long-term social impact or sustainability.

Moreover, the relationship between technology and meaning innovation is a key research focus. For instance, Trabucchi and Verganti from Politecnico di Milano, combining meaning innovation theory, emphasize the interaction between technology and meaning, stating that technological innovation not only drives the creation of new meanings but that new meanings can also redefine and enhance the value of existing technologies (Trabucchi, Pellizzoni, Buganza, & Verganti, 2017). In 2017, Goto Satoru from Universidad de Hurtado explored the specific role of technological insights in the integration process of products and services, filling a research gap (Goto, 2017).

2.3 Research Conclusions

Through the study of DDI, we found that its process is relatively obscure, with few detailed records, especially concerning the construction of intrinsic product meanings and how new meaning frameworks are built. Although many researchers in the fields of business and technological innovation have proposed related theories, there is still a lack of articles or cases that highlight the importance of designers and design thinking, necessitating further research. Therefore, we conducted an in-depth study of the Air-membrane Version of Huo-Yan Laboratory with these issues in mind. Through this case study, we hope to supplement the process of constructing new product meanings in the design context of China while emphasizing the crucial role of design thinking in this process. This not only enriches the theoretical foundation of DDI but also provides valuable references for future research.

3. Methods

3.1 Expert interviews

The expert interview method allows for the rapid and objective collection of expert experience and subjective judgments, providing in-depth exploration of the research subject (Yue, Xiahou, & Li, 2020). To understand how radical innovation emerged in the Air-membrane Version of Huo-Yan Laboratory, our study aimed to identify: (1) the roles and team collaboration methods of different participants; (2) the project iteration process and reasons for its success; and (3) the social impact of the project. The research team developed a semi-structured interview guide and invited core members of the project to participate in expert interviews

(Table 1). The interviewees included project leaders and collaborators from various functional departments involved in the Huo-Yan Laboratory. To gather information from multiple perspectives, the interviewees also included other participants in the business ecosystem, such as technical consultants, to investigate the entire network and system. Aggregating opinions from project participants from multiple perspectives enhances the accuracy of the research results and enriches the research data. Additionally, the sample size (N = 8) in this study aligns with qualitative research recommendations (Dworkin, 2012).

The interview guide included five themes, with the most important for this study being "team division of labor," "design innovation process," and "project impact". After a pilot interview, the research team refined the wording of questions based on interviewee feedback to avoid leading questions, further improving the guide. Interviewees were allowed to expand on additional content flexibly, ensuring data accuracy.

The interviews were conducted from July 18 to 22, 2024, via online Tencent meetings or face-to-face meetings, lasting between 40 and 90 minutes. At least two research team members were present at each interview. Before starting the interviews, research team members briefly introduced themselves, explained the research context and the purpose of the interview, and confirmed that the interview was conducted with informed consent. They also obtained permission to record and photograph the interviews (Fig. 3), while ensuring the anonymity of the stored data. The interviewees, as key information providers, were core members who participated in the entire iteration process of the Air-membrane Version of Huo-Yan Laboratory and made significant contributions to the project.

Table 1. Basic Information of Interviewees.

Participant	Name	Self-described role	Date of interview	Interview time	Interview form	Interview topic
1	Mr. Su	Project Leader	2024.07.18	60min	In-person meeting	-Project Management and Team Division -Technological and Design Innovation -Language and Meaning in Product Design -Business Models and Organizational Collaboration -Value Proposition -Project Impact and Future Outlook
2	Mr. Chen	Technical Supervisor	2024.07.22	80min	Online Meeting	-Willingness to Cooperate and Role Assumption -Business Resource Integration and Departmental Supply Chain Improvement -Goal Vision and Business Strategy -Reasons for Exceeding Company Expectations and Industry Impact -Future Iteration Plans and Development Strategies

3	Mr. Kun	Designer	2024.07.18	70min	Online Meeting	-Team Division of Labor and Individual Roles -Challenges Encountered in the Design Process and Execution Status -Construction of Product Meaning and Roles of the Three Parties -Supplier Sources and Responsibilities -Product Vision and Concept Origins -Social Impact and Future Development
4	Ms. Li	Business and Promotion	2024.07.20	30min	Online Meeting	-Origin of Cooperation and Co-creation Methods -Involved Departments and Resource Integration -Alignment of Project Meaning with Company Vision -Project Competitive Advantage and Investment Value -Impact of the Project on the Company
5	Ms. Yu	Document Writing	2024.07.18	30min	In-person meeting	-Roles Assumed and Team Communication Methods -Project Progress from an Observer's Perspective -Project Conception, Process Management, and Future Planning -Social Impact and Initial Predictions
6	Mr. Wang	Product Manufact-uring	2024.07.18	40min	In-person meeting	-Professional Background and Responsible Sections -Division of Labor and Cooperation Model among Three Parties -Interdisciplinary Integration Results in the Implementation Process -Basis of Previous Research and Project Presentation -Personal Growth and Impact during the Project
7	Ms. Zhou	On-site Managem-ent and Logistics	2024.07.22	40min	In-person Meeting	-Role Allocation and Participation Process -Communication Methods and Departments Involved at the Experiment Site -Iteration Process and Social Impact at Different Stages -Unexpected Surprises During the Supervision Process -Future Iteration Directions for Derivatives
8	Mr. Liu	Technical Advisor	2024.07.22	50min	In-person meeting	-Professional Background and Technical Challenges -Collaboration Methods and Challenges Encountered -Impact of Vision, Mission, and Meaning on Project Advancement -Social Impact and Predictions



Figure 3. Interview settings.

3.2 Card-sorting

Card sorting is commonly used to create an effective information structure that matches the mental models of the target group, enabling them to easily find, interpret, and cluster information (Wentzel, Muller, Beerlage-De Jong, & Van Gemert-Pijnen, 2016). There are two forms of card sorting: open and closed (Katsanos, Zafeiriou, & Liapis, 2022). This study employs the closed card sorting method to cluster information from the interview texts. Closed card sorting involves participants being given numerous cards and different predefined categories, with the task of placing the cards into these established categories (Adamides, Christou, Katsanos, Xenos, & Hadzilacos, 2015). In this study, the categories were derived from key classifications extracted from the literature review.

The steps for processing interview data in this study are as follows (Fig. 4):

1. Initial Reading and Keyword Collection

   Research team members print and carefully read the paper versions of the interview texts, circling keywords to collect entries and establish preliminary insights.

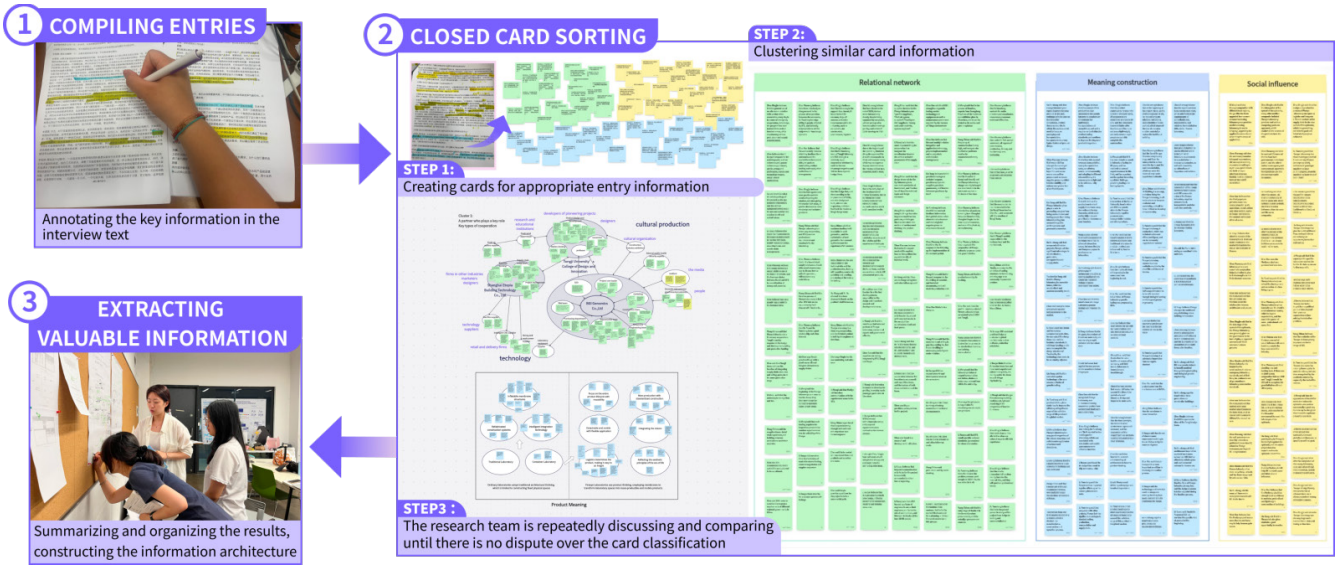
2. Card Creation and Clustering

   Useful information is extracted from the collected entries to create cards on Boardmix. Using conclusions from the literature review in the previous section, team members assess the validity of the card information and drag the cards into the pre-established categories of “Meaning Construction,” “Network Relationships,” and “Social Impact,” thereby clustering similar card information. This step is carried out sequentially by team members to ensure full understanding and judgment of the card information. After classification, the team conducts a semi-structured discussion around the research question itself to ensure that each researcher’s viewpoints are understood and considered (Barriball & While, 1994). Cards are continuously discussed, dragged, counted, integrated, and sorted until there is no dispute over the classification, finalizing the clustering results (Back & Collins, 2021).

3. Induction and Logical Structuring

   The card sorting results are summarized and organized, and relationships are mapped against the theory. Then, the cards are dragged to create logical diagrams, thus constructing the information architecture.

Figure 4. Data processing and analysis procedure.



4. Discussion

The author conducted an information architecture analysis of the cards categorized under the interpreters' theme, systematically identifying and organizing the key organizations and individuals involved in the Air-membrane Version of Huo-Yan Laboratory project. Subsequently, the author matched these subjects with the types of interpreters proposed by Verganti, ultimately constructing the network of interpreters for the Huo-Yan Laboratory (Fig. 5).

4.1 Network of Interpreters

Faced with the urgent social need for large-scale rapid testing brought by COVID-19, BGI Genomics Co., Ltd. quickly assembled the Huo-Yan Laboratory project team. This team served as a bridge for discourse between various internal departments such as laboratory testing and smart manufacturing, and external interpreters, actively building a transdisciplinary collaboration network to swiftly respond to societal challenges.

Mr. Su is the most critical interpreter and mediator in the network. A building materials industry exhibition became the opportunity for him to meet and maintain contact with Mr. Yin, the CEO of BGI Genomics. This cultural organization sowed the seeds for innovative collaboration between these two professionals from disparate fields, particularly from a materials perspective. Mr. Su's academic research and practice focus on architecture design and urban planning. Since 2008, he has been exploring modular building design for emergency aid logistics and transportation, as well as the application of membrane materials in architectural spaces, resulting in several related patents. In the collaboration with BGI Genomics, he not only led the Tongji University's College of Design and Innovation design team to take on the roles of developers of pioneering projects and designers, but also connected BGI Genomics Co., Ltd. to new interpreters through his network in the educational and academic circles.

Another critical interpreter in the Huo-Yan Laboratory project was Shanghai Etopia Building Technology Co., Ltd. Working in close collaboration with the design team, this company assumed the role of firms from other industries within the network, having long explored the application potential of PVC membrane structures. Their participation brought important technology resources such as membrane retailers, enabling cross-domain innovative applications at the material technology level for the iteration of Air-membrane Version of Huo-Yan Laboratory products from single-layer to double-layer membranes.

Additionally, when the Huo-Yan Laboratory encountered technical challenges in achieving the required negative pressure standards, Mr. Su, through his connections at Tongji University's College of Architecture and Urban Planning, established a link with Mr. Liu's intelligent environment building research team. As research and educational institutions deeply engaged in spatial environment research, they provided expert technical guidance on new air systems as well as recommended reliable retail and delivery firms, ensuring the product met the stringent standards of P2 level laboratories.

During COVID-19, local governments and public health departments, as main customers, became key recipients and evaluators of the meaning of the Air-membrane Version of Huo-Yan Laboratory. More importantly, they emerged as crucial bridges for Chinese design to expand both domestically and internationally. Through transdisciplinary collaboration with the key interpreter design team, BGI Genomics Co.,

Ltd. achieved results on media platforms such as design award institutions and academic publications.

4.2 Critical Interactions Among Interpreters

Based on the study of the Huo-Yan Laboratory project, the relationship lines connecting various units are clearly defined. Considering the distinction between key interpreters and regular interpreters, the relationships between different entities should vary. To explore the interactions that played a critical role in the radical innovation of the Air-membrane Version of Huo-Yan Laboratory, we further integrated relevant card information and, upon analysis, derived three insights:

1. Cross-Organizational Leadership Team (See the line labeled 'a' in Figure 5)

   Based on mutual trust and consensus on collaborative innovation, the cooperation between BGI Genomics Co., Ltd. and Tongji University's College of Design and Innovation transcended the boundaries of traditional client-supplier relationships. High-frequency online communication meetings averaging six times daily facilitated a closely collaborating leadership team. This stimulated the potential of the design team as the key interpreter, enabling it to connect breakthrough resources across industries and academic research fields such as air membrane supplier and new air system technology. Meanwhile, in the process of constructing the product vision and meaning, the design team maintained a convincing value-leading role, ensuring that through several iterations, the modular vision of the Air-membrane Version of Huo-Yan Laboratory - being mobile, easy to transport and assemble, while also aesthetically pleasing with an excellent user experience - was thoroughly implemented.

2. Design-Led Transdisciplinary Value Integration (See the line labeled 'b' in Figure 5)

   As core interpreters, the design team and design executors formed a complete value integration chain from market needs to engineering technology by arranging dedicated personnel to be stationed in Shenzhen, which served as a logistics transfer hub for raw materials and finished products or maintaining close communication with BGI Genomics' engineering team. This ensured that the value demands of multiple stakeholders including domestic and international customers, BGI Genomics, suppliers, and laboratory personnel were promptly heard and expressed. Transdisciplinary collaboration drove product iteration. For example, the P2 grade hard indicators for virus detection laboratories needed to consider the impact of the air membrane space's enclosure on the psychological state of laboratory personnel, as well as

the adaptability to spatial conditions in different application sites. Radical innovation of the air membrane mobile detection laboratory was achieved through the discourse between experience and technology considerations.

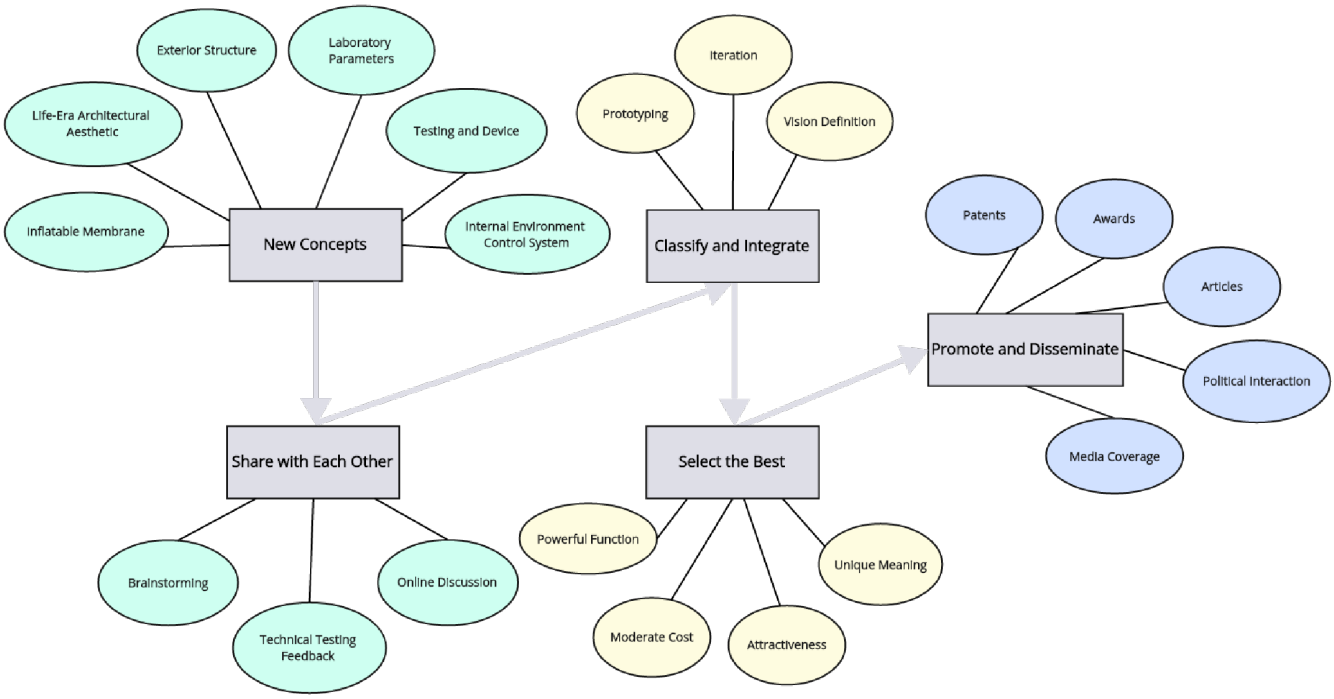
3. Prototype-Driven Product Meaning Realization (See the line labeled 'c' in Figure 5)

When a company obtains radical innovation in product meaning through design-driven research, it needs to transition to a more conventional solution-oriented product development phase. The prototype testing methodology, a critical component of design thinking, plays a pivotal role in this product development process. It serves to ensure that the new intrinsic meaning of the product can be effectively realized and implemented. In the emergency caused by the rapid spread of COVID-19, although clients at the time could hardly afford the costs of prototyping, which had been the usual practice for BGI Genomics in delivering solutions in the past, considering the varied needs of different stakeholders and the technical challenges of product innovation, BGI Genomics decided to financially support the design team's prototyping efforts. The company maintained an open attitude towards trial and error. As a tangible communication tool, prototypes promoted active participation from various entities from the company to suppliers, collectively iterating the solution hundreds of times in just over ten days, efficiently promoting the complete cycle of the DDI process.

4.3 Design Dialogues

BGI Genomics Co., Ltd., in collaboration with Mr. Su and other interpreters, conducts design dialogues for open discussions and radical innovation. The project team brings together ideas from experts and practitioners across various fields through brainstorming, prototyping, and technical testing. These ideas are then filtered to develop feasible and practical design concepts, ensuring the sustained promotion and implementation of DDI within the project (Fig. 6).

Figure 6. Design dialogues of the Huo-Yan Laboratory.



1. Proposal of New Ideas

Mr. Su, with his extensive experience in spatial design, is the key figure in proposing new ideas. He has independent research achievements in inflatable structure isolation rooms and unique insights into the relationship between buildings and urban life forms. During brainstorming sessions, Mr. Su proposed that to quickly respond to public health emergencies and align with the development trend of life-era architecture, the use of inflatable structures should continue for the construction of the Huo-Yan Laboratory. As a novel design, it lacks market precedents for reference. To evaluate feasibility, Genomics Co., Ltd. utilized its extensive expert resources in the laboratory field, inviting domestic experts and over thirty engineers to propose design standards and optimization suggestions. To meet national certification requirements, Mr. Su's team integrated traditional laboratory parameters into the inflatable laboratory design, innovatively using double-layer inflatable structures to create a negative pressure space. Genomics Co., Ltd. simplified the testing process into three steps: sample preparation, nucleic acid extraction, and nucleic acid detection, corresponding to the layout of each inflatable module. Suppliers of intelligent control systems and other equipment also provided feedback on equipment layout and other issues.

Due to time constraints, the Huo-

Yan Laboratory adopted a rapid iterative process of designing and implementing simultaneously, establishing a “concept design-structural design-productionconstruction-on-site inspection-feedback-design optimization” cycle, integrating resources and ideas from partners in different industries. In the early versions, new needs or ideas constantly emerged during practice, prompting Mr. Su’s team to make design modifications. Once the product took shape, Genomics Co., Ltd.’s overseas marketing teams would gather local requirements to better adapt to specific conditions. Due to the high time and economic costs of transporting materials and components during the pandemic lockdown, Mr. Su’s team prioritized logistics and delivery processes in the product design. They aimed to compress the volume of the inflatable laboratory to save transportation costs and used prefabricated inflatable modules to reduce installation difficulty, allowing for remote guidance of engineering personnel during lockdowns. In summary, Mr. Su’s team integrated their product design experience with building design, continuously updating design concepts in response to the requirements and standards of other interpreters.

2. Sharing of New Design Concepts

Due to the need for rapid iteration, interpreters and the project team of the company share new design ideas through instant e feedback or group discussions, involving everyone in solving design and technical issues. Project personnel generally use WeChat video calls for frequent communication, as previously mentioned. Meanwhile, Genomics Co., Ltd continually introduces new expert teams to modify or supplement product design concepts.

3. Integration of New Concepts

Core project members maintain an open attitude towards design discussions, integrating new ideas proposed by interpreters and constructing the vision for the Huo-Yan Laboratory, which has undergone radical innovation in its conceptual dimensions. Genomics Co., Ltd. transitioned from providing standardized, integrated genetic testing laboratories to offering systematic solutions for the design, production, transportation, installation, use, and recycling of inflatable laboratories. Through categorizing and integrating various viewpoints, the project team gradually clarified the new vision. Mr. Su’s understanding of architecture is “to use the minimum skin to effectively create the largest space volume isolated from nature”; BGI Genomics Co., Ltd.’s corporate vision is “benefiting humanity

with genetic technology." At the intersection of these visions, the vision of the Air-membrane Version of Huo-Yan Laboratory emerged: "creating flexible and efficient spaces for the interaction between humans and technology with a product-oriented mindset," allowing more people globally to enjoy the benefits brought by technology.

4. Selection of Design Concepts

Genomics Co., Ltd. has multiple R&D teams working on new nucleic acid testing laboratories, resulting in various products, such as laboratories combining metal frames and inflatable structures. However, these products could not match the functionality of traditional laboratories and lacked unique innovative meaning in product language. In contrast, the Air-membrane Version of Huo-Yan Laboratory not only has powerful functions and moderate costs but also possesses attractiveness and innovation in product language and intrinsic meaning, making it a design project that Genomics Co., Ltd. has chosen to invest heavily in. In terms of product language and meaning, the project team adheres to two main points for the design of the Huo-Yan Laboratory: first, standardizing the productization of buildings, offering innovative Chinese laboratories as products for external customers, providing differentiated excellent products and services; second, combining emergency and regular use, allowing the Huo-Yan Laboratory to go beyond short-term emergency nucleic acid testing needs and maintain its unique product features and advantages, meeting deeper needs such as public health testing and precision medicine. Through this design concept, the Huo-Yan Laboratory can continue to function as a multi-functional space product.

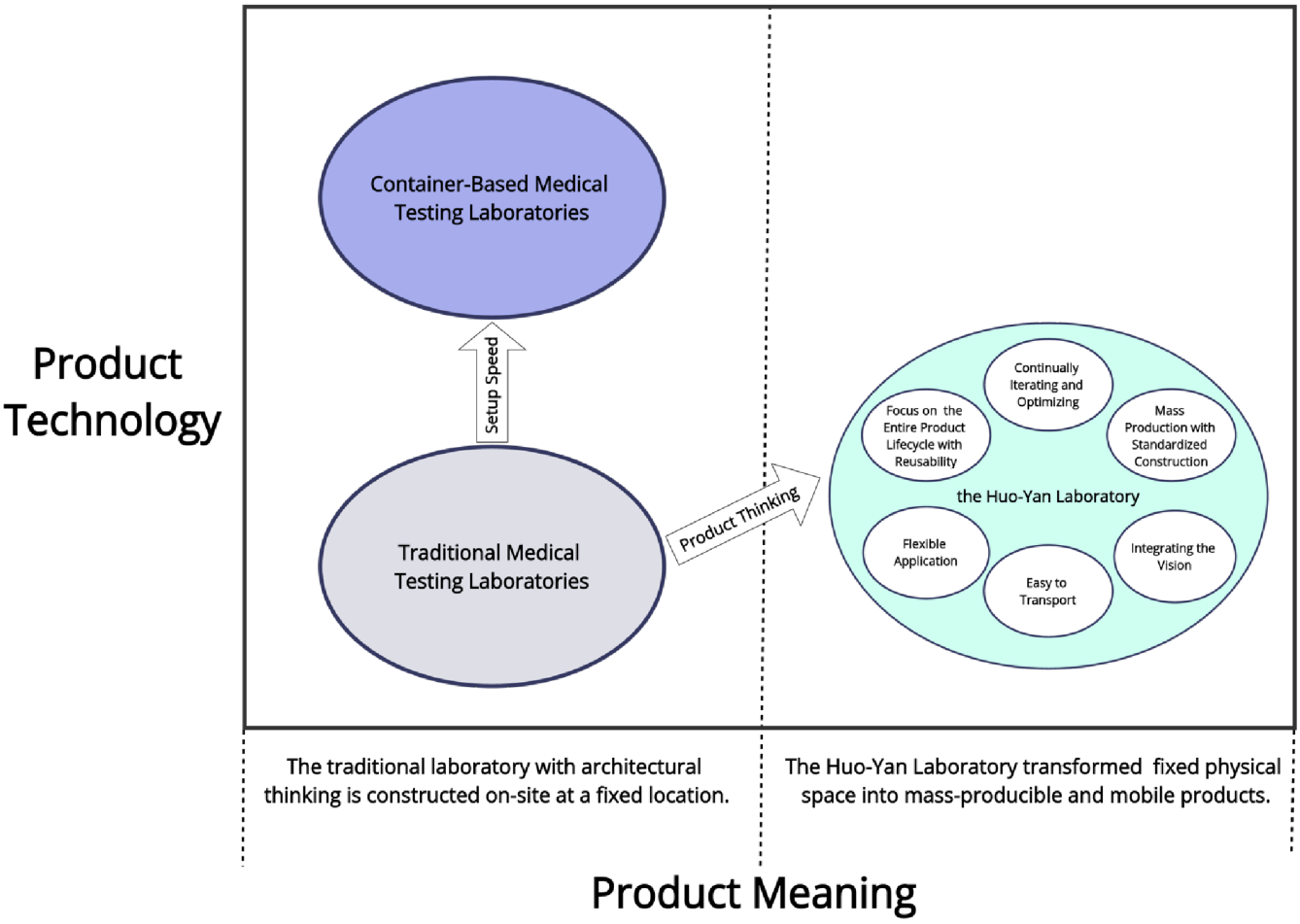
5. Promotion and Dissemination of Product Meaning

Mr. Su's team and BGI Genomics Co., Ltd. actively carried out a series of promotional activities to spread the concept of inflatable building productization. These activities include applying for technical patents, submitting for international awards, publishing academic articles, engaging in interactions with political leaders, and cooperating with media reports. Through these efforts, the team successfully established the Air-membrane Version of Huo-Yan Laboratory as a benchmark, enhancing societal recognition and acceptance of the entire solution. Although some competitive products emerged later in the market, the Huo-Yan Laboratory's status as an initial product was already established in both academia and the market.

4.4 From Architectural Thinking to Product Thinking

Inflatable technology, known for its quick setup and removal, is commonly used in rapidly deployed temporary buildings, but few companies explore the intrinsic meaning behind inflatable buildings. The Air-membrane Version of Huo-Yan Laboratory represents a new architectural concept and way of thinking. Its radical meaning lies in the shift from architectural thinking to product thinking (Fig. 7). In the design dialogues, the company and interpreters acquired new ideas and visions, pushing the transformation of biological testing laboratories from engineering projects to industrial products. They believed that the inflatable structure of the Huo-Yan Laboratory considered the mobile attributes of the product, expanding the laboratory's reach in the global market through modular production, standardized installation, and improved logistics efficiency. As a systematic product and service solution that made significant contributions to the global fight against the pandemic, the Air-membrane Version of Huo-Yan Laboratory has shown the potential to become a design classic.

Figure 7. Comparison of the traditional laboratory, container-based laboratory, and Huo-Yan Laboratory.



The Air-membrane Version of Huo-Yan Laboratory was designed as a comprehensive

solution, integrating multidisciplinary knowledge and technology to achieve refined lifecycle management of the product. The design and production processes considered cost control. The 5.0 version of it combined containers and inflatable modules, the iterative upgrading approach also reflected product thinking. In logistics, Mr. Su proposed the concept that logistics determine the building product, setting the size and weight of the Huo-Yan Laboratory based on civilian aviation luggage compartments to meet the procurement needs of overseas countries like Saudi Arabia and Kazakhstan. In terms of usage, the design team considered the cost-effectiveness issue rarely addressed in traditional buildings, allowing the Huo-Yan Laboratory to be disinfected and stored for reuse.

The successful development of the inflatable laboratory also demonstrated the advantages of building productization. As a new architectural paradigm lacking existing concepts and standards, the R&D team overcame technical challenges to maintain the unique details of the product. The initial XY chromosome shape and later time tunnel-like light strips in the product's appearance design catered to the flexible installation characteristics of inflatable materials, unifying futuristic aesthetics with flexible building techniques. For internal environmental control, the team adopted intelligent integration technologies, including light-interactive access control, environmental sensors, and cabin pressure intelligent control systems.

5. Conclusion

The Air-membrane Version of Huo-Yan Laboratory serves as a crucial carrier of China's technological interpretation of the "Community of Shared Future for Mankind." Through an engineered paradigm, it has been built in various countries around the world, efficiently aiding in global pandemic prevention and control, and becoming a "Chinese symbol" in the global fight against COVID-19. This project's success once again validates the value of radical innovation in product intrinsic meaning.

This project also provides a successful case study for DDI. It demonstrates how design can act as a catalyst for transformation, achieving a fusion of technology and humanities through close collaboration among transdisciplinary teams, offering new insights and directions for future innovation. The successful experience of this project not only provides valuable practical references for the role of the design discipline in addressing major societal challenges but also significantly contributes to the theoretical research and practical application of DDI.

Furthermore, the Air-membrane Version of Huo-Yan Laboratory project showcases new organizational forms and cooperation models. The close collaboration between BGI Genomics Co., Ltd. and Tongji University transcended the traditional client-contractor model, resulting in highly frequent exchanges

and cooperation, ensuring rapid response and efficient execution during crises. This close cooperation model provides new directions for future research on organizational definitions and types in innovation theory, facilitating further exploration of more flexible and efficient organizational structures and cooperation mechanisms.

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PEMO, POSITIVE EMOTION: A GAMIFIED AI JOURNALING WEBSITE CENTERED ON FACILITATING USERS IN DEVELOPING MORE POSITIVE NARRATIVE IDENTITIES

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ABSTRACT | Contemporary young individuals commonly tend to immerse themselves in pessimistic narrative identities, often slipping into pessimistic mindsets unconsciously. Narrative Identity Therapy and Expressive Writing Therapy in psychology offer potential transformations for pessimistic individuals. However, expressive writing has limitations in emotional regulation, conversational therapy with oneself often leads users to merely document negative occurrences without effectively addressing their pessimistic emotions. Hence, we propose the design of a gamified AI interaction website named PEMO, signifying Positive Emotion. PEMO facilitates a shift in users' pessimistic narratives through post-journaling dialogues with ChatGPT-4.0. Users may opt for traditional pen-and-paper journaling, with handwriting recognition pens transferring text to computers. The trained GPT4.0 model embodies three personas: Family, Close Friend, and Wisdom Figure. These personas emulate counseling techniques, utilizing continuous questioning to guide users toward actively disengaging from pessimistic narrative identities. Leveraging natural language processing, user sentiment analysis generates flowers corresponding to diary emotions. These flowers converge to form a socially oriented Diary Garden, where users can visit each other's gardens, observing emotional states to enhance user engagement. PEMO is dedicated to using gamification and AIGC interventions to guide users toward better self-reflection and overcoming "pessimistic narrative identities" through engaging interactive formats.

KEYWORDS | PESSIMISTIC NARRATIVE IDENTITIES, EXPRESSIVE WRITING, AI INTERACTIVE WEBSITE, GAMIFIED SOCIAL SCENARIOS, EMOTION RECOGNITION, CUSTOMIZED GPT 4.0, MULTIMODAL EMOTION RECOGNITION

1. Introduction

1.1 Background

In the current era, contemporary young people generally face psychological health problems and pessimistic emotions to varying degrees. Although mental health is an individual issue, it has broader societal implications. Psychological disorders can undermine social trust and reduce behaviors that promote societal prosperity, such as workforce participation and entrepreneurship. Mental health also influences people's visions of the country's future and human progress, making it a significant concern. Our investigation reveals that adults under 30 are generally more pessimistic than older groups, with the younger Generation Z being the most pessimistic age group in China. Although some young individuals appear to withdraw from intense competition, their pessimistic outlook on the future cannot be ignored. How to help young people alleviate anxiety and pessimism in this era is a significant topic that requires careful consideration by designers.

Given this background, the field of psychology has proposed various healing methods, such as "Narrative Identity Therapy" and "Expressive Writing Therapy." Both therapies are psychological treatments used to improve mental health, each with unique theoretical foundations and practical applications. Moreover, many researchers combine the two therapies to achieve better therapeutic effects. Therapists can encourage clients to express their emotions through writing and then help them reconstruct and reinterpret these writings through Narrative Identity Therapy.

In addition to traditional psychological healing theories such as "Narrative Identity Therapy" and "Expressive Writing Therapy," AI's application in psychology has become increasingly widespread with technological advancements. Examples include AI emotional analysis, virtual psychological therapists, and AI mental health prediction models,

all playing significant roles in psychological therapy, mental health assessment, and prevention. Integrating AI into the field of psychology has become a significant trend. According to a Psychology Today report, AI's application in mental health is proliferating, with the global AI medical market expected to reach $19 billion by 2025. Multiple studies indicate that the application of AI technology in mental health assessment and treatment improves efficiency and significantly enhances patients' psychological well-being. AI has become crucial in promoting innovation and development in mental health services.

1.2 Research Questions

Explore the scalability and limitations of Expressive Writing and Narrative Identity as therapeutic methods for emotional regulation.

Investigate how AI technology and gamified design can mitigate the limitations of Expressive Writing and more effectively guide users away from pessimistic narrative identities.

1.3 Research Goals

Design and validate the effectiveness of a gamified AI interactive diary website, "PEMO."

2. Literature Review

2.1 Narrative Identity Therapy

Narrative identity therapy is a form of psychotherapy where individuals construct and shape their identities through narrating and understanding their life stories. How a person recalls their past experiences and views the details of their life constitutes their "narrative identity." This therapeutic approach helps individuals reassess and reconstruct their life stories, allowing them to view their lives more positively and optimistically. Narrative identity therapy also facilitates a deeper understanding and integration of one's identity, helping individuals establish a more positive self-concept. By narrating and reconstructing their understanding of traumatic events, individuals can mitigate the impact of negative emotions and promote psychological healing. Numerous studies have shown that narrative identity therapy has significant positive effects in reducing PTSD symptoms, alleviating anxiety and depression in chronic illness patients, and helping adolescents achieve higher self-esteem.

The formation of our narrative identity naturally develops and deepens as we age, and the narrative styles of our caregivers significantly influence it during childhood. The presence of good listeners and whether these listeners respond to and affirm our narratives also impact the formation of our narrative identity. Through extensive interviews and dialogues, McAdams ultimately categorized two distinct narrative styles: redemptive narratives and contaminative narratives. Research indicates that individuals with a "contaminative" narrative style do not believe they can change their current circumstances or accept past events, leaving them adrift in life with regret. Conversely, a redemptive narrative style can significantly mitigate the

impact of adverse events on individuals and is positively correlated with subjective well-being. That is, the more an individual interprets events as under their control, the better they can process the impact of adverse events, turning crises into opportunities and achieving positive transformations.

This design research explores how to assist individuals with a contaminative narrative style (i.e., a pessimistic narrative identity) in gradually transitioning to a redemptive narrative style (i.e., an optimistic narrative identity) to help alleviate anxiety and improve happiness levels.

2.2 Expressive Writing Therapy

Expressive writing therapy is a method that promotes emotional release and mental health through writing. Research has found that writing helps individuals process and express emotions, reducing stress and improving psychological well-being. Through writing, individuals can freely express and explore their inner emotions and experiences, helping them better understand these feelings.

Smyth (1998) found that a four-day expressive writing intervention improved participants' scores in emotional management by 30%. This study also found that the writing group showed significantly lower emotional reactivity and stress levels than the control group. A survey by Pennebaker et al. demonstrated that individuals participating in expressive writing showed significant enhancement in immune function indicators (such as T-cell activity) and a 40% reduction in the number of illness occurrences. A meta-analysis by Pennebaker and Chung (2011) summarized over 30 studies on expressive writing, revealing an average effect size of 0.47, indicating that expressive writing has a moderate effect in reducing post-traumatic depression and anxiety symptoms.

Currently, this therapeutic method is widely used in psychological clinical counseling and treatment, demonstrating significant effects in dealing with psychological trauma, managing emotions, improving mental health, and enhancing physical health. Despite the substantial research supporting its effectiveness, expressive writing also has certain limitations:

Expressive writing requires individuals to sincerely recall and document negative emotions and events, which can initially lead to increased emotional distress. Pennebaker et al. found that some participants reported emotional deterioration during the initial phase of expressive writing. If the participants do not have robust psychological resilience or proper guidance, this short-term discomfort might cause more significant distress in the initial stages. Moreover, the effectiveness of expressive writing varies significantly among individuals; not everyone can alleviate anxiety through writing. Although expressive writing therapy offers a convenient method for individuals to confront and manage stressful events, the sense of "unresolved issues" it can bring has been a concern for many participants.

2.3 Combined Application of Expressive Writing and Narrative Identity Therapy

To address the limitations of expressive writing, some researchers have proposed combining expressive writing with narrative identity therapy. Studies indicate that a combined approach of expressive writing and narrative identity therapy significantly improves issues like psychological trauma, depression, and anxiety. The narrative identity shift significantly reduces short-term emotional discomfort. For example, a study found that a treatment group using a combination of expressive writing and narrative identity therapy had higher mental health scores than groups using either method alone (Lepore & Greenberg, 2002). Case studies show significant improvements in dealing with complex emotions and reconstructing self-identity through the combined application of these therapies. For example, a study on domestic violence survivors found that their self-esteem and life satisfaction significantly improved after using the combined therapies (Smyth & Helm, 2003).

Combining the two therapeutic methods allows individuals to record daily emotions and events through expressive writing and, subsequently, through narrative identity therapy, reassess and redefine their life stories, enhancing self-identity and psychological resilience.

2.4 Applications of AI in Mental Health

Existing AI Counseling Tools and Their Effects:

AI technology in mental health applications has become a significant trend. Existing AI counseling tools such as Woebot, Wysa, and Ginger have shown remarkable effects in providing immediate support and improving mental health. These tools not only increase the accessibility of mental health services but also significantly enhance users' psychological well-being through various technical means.

For example, Woebot, a chatbot based on cognitive-behavioral therapy (CBT), can converse with users, providing emotional support and CBT techniques. Research shows that users of Woebot significantly reduced depressive and anxiety symptoms after two weeks. Woebot guides users to identify and adjust negative thinking patterns, helping them develop healthier emotional coping mechanisms.

Ginger combines AI and human therapists to provide instant mental health support. The AI component is used for initial assessment and emotion monitoring, while human therapists offer personalized treatment plans. Research indicates that this combination effectively improves users' mental health status. Ginger's AI technology can analyze users' text inputs and behavioral data to provide real-time emotion management suggestions and crisis interventions.

AI technology in mental health applications not only provides new therapeutic methods but also significantly enhances the efficiency and accessibility of mental health services. The successful application of AI counseling tools like Woebot, Wysa, and Ginger marks a profound technological transformation in the mental health field. The widespread use and significant effects of these tools further demonstrate the enormous potential of AI in improving the quality and effectiveness of mental health services.

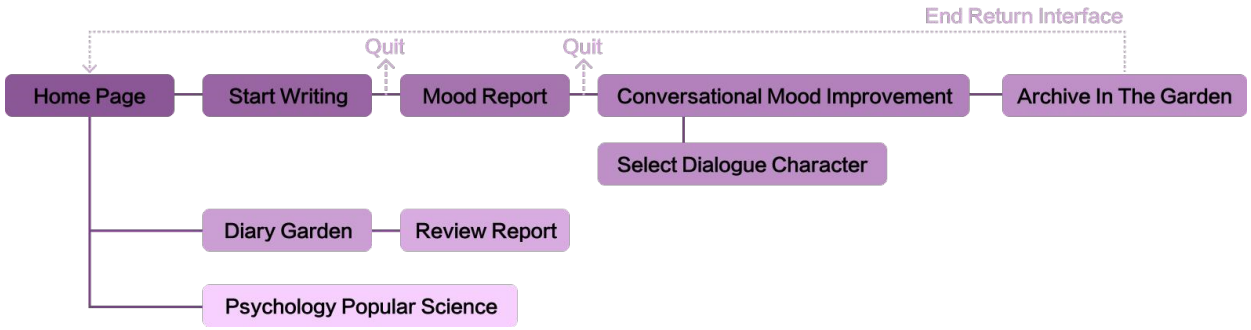
The Role of Gamification in Mental Health Interventions:

Expressive writing requires long-term persistence to see apparent effects. Appropriately introducing a gamified design can increase user engagement and stickiness. Reward systems and progress tracking can provide users with immediate feedback and a sense of achievement, helping to enhance continuous participation and helping users achieve psychological healing and change their narrative identities. Additionally, gamified design can reduce the burden of therapy, making mental health interventions more interactive and engaging, reducing the monotony and tedium of traditional therapy. Lowering the threshold for psychological healing makes it more universal and easier. Moreover, gamified design can improve users' self-efficacy, helping them build better selfmanagement capabilities and enhance their control over their mental health.

3. Design Methods (Design of the PEMO Platform)

This design research will use expressive writing and narrative identity therapy as the foundational design principles to create a gamified AI interactive diary website called “PEMO,” meaning “positive emotion.” PEMO aims to change users’ pessimistic narratives through AI chat interactions after diary writing. With handwriting recognition pens transmitting text to a computer, users can write on paper. The trained GPT-4.0 model has three identities: “Family,” “Best Friend,” and “Wise Sage.” These roles mimic psychological counseling methods, using continuous questioning to actively guide users to escape pessimistic narratives. We use natural language recognition technology to identify user emotions, generating flowers corresponding to the diary’s emotions. These flowers gather to form a social “diary garden” where users can visit each other’s gardens, viewing emotional states to increase user engagement. PEMO aims to guide users better through gamification and AIGC, leading them to self-reflection and escape from “pessimistic narrative identities.”

Figure 1. PEMO platform user usage overall framework



The specific main functions of the PEMO platform are introduced as follows:

3.1 User Diary Writing Module

The healing aspect of expressive writing is closely linked to users’ diaries, but this is not limited to traditional diary forms. It includes various recording methods, such as essays, thoughts, and notes. PEMO provides users with a free, open writing environment, encouraging them to record their moods, thoughts, and experiences at any time, whether detailed diary entries or brief fragments.

Users have two main choices for diary writing on the PEMO platform:

Online Writing Interface: Users can type directly on the PEMO platform’s writing interface, designed to be simple and easy to use, with multiple font and format options. The platform also features an autosave function to ensure content is not lost unexpectedly.
Handwriting Recognition Upload: PEMO offers a handwriting recognition upload function for

users who prefer handwritten records. Users can write their diaries on paper, use a handwriting recognition pen to convert the text to digital format and upload the content to the cloud. This retains the healing experience of physical writing while making handwritten content easy to store and manage electronically.

To enhance the writing experience, PEMO also offers additional options within the handwriting recognition upload function:
Notebook Synchronization: Users can choose specific bright notebooks that synchronize writing content to the platform in real-time via Bluetooth or Wi-Fi.
OCR Optimization: Advanced optical character recognition (OCR) technology ensures high accuracy in converting handwritten text, preserving the original style and format.

Handwritten Diary Templates: The platform provides printable templates for emotional records, goal setting, and daily reflection, allowing users to choose suitable templates for writing.

Figure 2. PEMO writing input interface. The left picture is the display mode and the right image is the hidden mode.

3.2 Emotional Recognition Using Natural Language Processing

PEMO uses advanced natural language processing (NLP) technology to recognize and analyze emotions in diary content. Core functions include:

Emotion Analysis and Feedback: Deep learning models trained to recognize various emotional states accurately in diary entries. The platform offers empathetic phrases and personalized emotion management suggestions immediately after diary completion.



Emotion Visualization: Emotional states are tagged and weighted, generating an artistic visualization of emotions. For instance, a diary might reflect 70% happiness and 30% anxiety, with a comprehensive emotional evaluation presented artistically.

Emotion-Corresponding Flower Generation: Flowers representing emotional states are generated and arranged in the user's "diary garden," visually reflecting emotional changes.



Figure 3. PEMO Feedback interface. Picture A: Generate flowers and words of comfort corresponding to the user's mood; picture B: flower and diary emotion visualization chart; picture C: Pessimistic emotion display and dialogue AI selection; picture D: Pessimistic emotion display and dialogue AI selectionThe left picture is the display mode and the right image is the hidden mode.

3.3 AI Role Interaction (Family, Best Friend, Wise Sage)

After diary completion and emotional feedback, PEMO offers interaction with three AI roles: “Family,” “Best Friend,” and “Wise Sage,” each with unique dialogue styles and guiding methods to help users move away from pessimistic narratives.

Family Role: Warm and supportive dialogue, offering emotional security and encouragement.

Best Friend Role: Intimate and empathetic interaction, sharing experiences, and providing suggestions.

Wise Sage Role: Thoughtful and insightful guidance, prompting deep reflection and self-discovery.

Personalized psychological support is based on emotional state, with AI roles dynamically adjusting interaction strategies.

3.4 Generation of Emotional Flowers and Formation of “Diary Garden”

Each time a user completes a journal entry and performs an emotional analysis on the PEMO platform, the system generates corresponding floral patterns based on the user’s emotional state. These emotional flowers are not only symbols of emotions but also visual representations of emotional changes. Different emotional states generate different types and colors of flowers:

Positive Emotions: Happiness, satisfaction, and excitement generate brightly colored, full-bloomed flowers.

Negative Emotions: Emotions such as sadness, anxiety, and anger generate darker-colored, wilted flowers.

Neutral Emotions: Emotions such as calmness, contemplation, and boredom generate neutralcolored and shaped flowers, such as elegant orchids or common daisies.

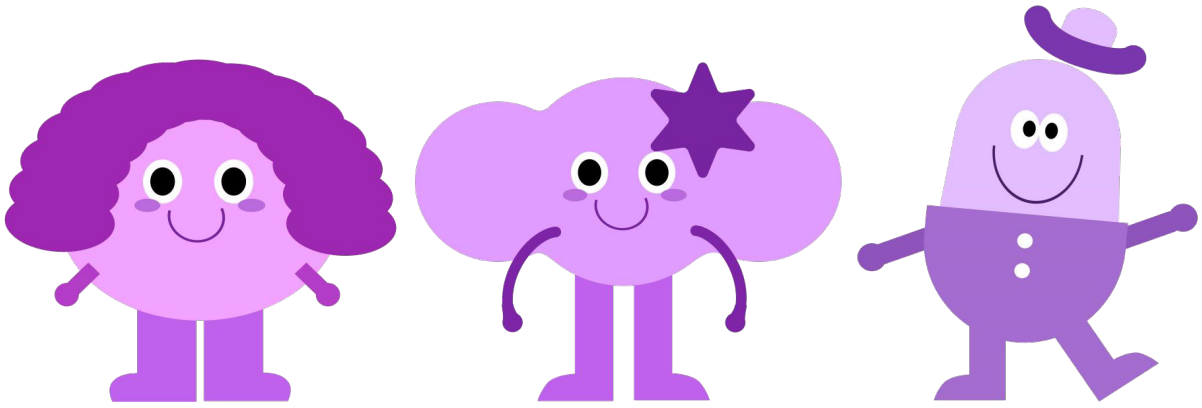


Figure 4. Three AI dialogue roles, from left to right: family role, Best Friend Role, and wise sage role.

These flowers are automatically arranged in the user's "Diary Garden," creating a unique emotional landscape. Users can intuitively review their emotional changes over different periods by viewing the flowers in the garden.

Garden Management and Personalization
Users can personalize and manage their Diary Garden, including:

Garden Layout: Users can freely adjust the layout of flowers in the garden, choosing different arrangements such as chronological order, emotion type, or random placement.
Garden Themes: The platform offers various garden themes and background settings, allowing users to choose themes that match their preferences, making the garden more personalized and aesthetically pleasing.

Flower Descriptions: Users can add brief descriptions to each flower, recording their feelings and events at that time. This allows users to understand the stories behind each flower better when revisiting the garden. Clicking on a flower reveals the journal entry written at that time, along with the platform-generated emotional review report, emotional visualizations, dialogues with AI characters, and the flower's state change process.

Social Interaction and Visiting Features

The Diary Garden module is a space for personal emotional display and a platform for user interaction and communication.

Users can make their gardens public and invite friends or other users to visit. Visiting features include:

Visits and Comments: Users can visit others' Diary Gardens, browse their emotional flowers, and leave encouraging and supportive comments. This allows users to share emotional experiences and build emotional connections.

Likes and Shares: Users can like their favorite gardens and flowers and share them on social media through the platform's sharing feature, attracting more attention and participation.

Emotional Communication: While visiting others' gardens, users can engage in emotional exchanges and interactions with the garden owners, sharing their emotional stories and insights enhancing mutual understanding and support.

The Diary Garden is a platform for users to showcase their emotional changes and a tool for selfreflection and emotional healing. Through the flowers in the garden, users can visually observe their emotional fluctuations and development, identifying patterns and triggers. The flowers representing positive emotions continually inspire users, reminding them of their past joyful moments and helping them maintain a positive mindset.



Figure 5. Flower opening status changes (left) and garden homepage (right).

4. Research Methods

4.1 Main Technical Implementation:

Using a handwriting recognition pen to transfer written text into the computer.

Application of natural language processing (NLP) and emotion recognition technologies.

Training the GPT-4.0 large model to simulate psychological counseling and customize three AI interactive characters.

User Research and Data Collection:

Participants: How Platform Testers Were Selected

The PEMO platform considered the following factors when selecting participants:

Diversity and Representativeness:

Demographic Characteristics: To ensure a representative sample, participants were selected from various age groups, genders, professions, and educational backgrounds. The primary target group was women aged 18-35 with a high standard of living and basic educational background.

Psychological Health Status: Participants with different psychological health statuses were chosen, including emotionally stable individuals (subdivided into generally stable and highly stable), emotionally volatile individuals (subdivided into mild, moderate, and severe), and those requiring psychological counseling.

Technological Proficiency: Participants with varying levels of technological proficiency were included, ranging from users familiar with online platforms to those less acquainted with technology, ensuring the platform's design was universally applicable.

Volunteer Recruitment Methods:

Recruitment information was disseminated through social media, mental health forums, and platform user communities to attract volunteers. Appropriate incentives were provided to encourage active participation in the research.

4.2 Data Collection Methods:

(Preliminary) User Interviews and Writing Emotion Habits Data Collection:

Diary Texts: Users' diary entries on the platform, including handwriting recognition uploads and direct input texts, were collected. Writing habits and emotional content were analyzed to study different users' emotional expressions.

Emotion Tags: Each diary entry was analyzed for emotions using NLP technology and emotion recognition algorithms, generating emotion tags and intensity scores. The emotional fluctuations in most diaries were observed, and extensive text data were used to train AI models for faster and more accurate recognition of users' writing habits.

Content Themes: Diary content was analyzed thematically to identify common emotional issues and psychological concerns, such as work stress, interpersonal relationships, and personal growth. Various themes and common concerns were collected to facilitate better emotional counseling.

Visual Preferences: Testers from different backgrounds were interviewed, and reference images were shown to select visual styles for the platform and flowers that were generally preferred and accepted by most participants.

(User Testing) Platform Usage Recording:

Usage Frequency: Users' login frequency, the number of times, and duration of using different functional modules were recorded.

Interaction Records: The number of interactions with AI characters, dialogue content, and user feedback were documented.

5. Research Results

5.1 User Emotional Changes

Pre- and Post-Diary Emotional State Comparison:

A pre-post experimental design assessed PEMO's impact on users' emotional states using standardized emotional assessment tools (SAS and SDS). Data analysis showed significant improvements in emotional states after intervention.

Anxiety Levels: SAS scores decreased from 28.5 to 22.1 ($t(95) = 4.56$, $p < 0.01$).

Depression Levels: SDS scores decreased from 31.2 to 24.3 ($t(95) = 5.23$, $p < 0.01$).

These results indicate that PEMO significantly reduces anxiety and depression through expressive writing and AI interaction.

Impact of Different AI Roles on User Emotions: Users were grouped based on chosen AI roles, with emotional state changes assessed before and after interaction.

Family Role: Anxiety was reduced by 6.3 points, and depression by 5.2 points.

Best Friend Role: Anxiety was reduced by 5.7 points, and depression by 4.8 points.

Wise Sage Role: Anxiety was reduced by 4.5 points, and depression by 4.0 points.

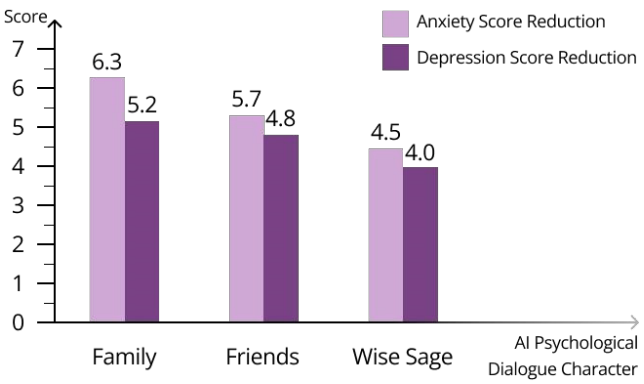


Figure 6. A bar chart showing the reduction in anxiety and depression scores of different AI roles in alleviating user emotions.

The "Family" role most effectively provided emotional support, while the "Wise Sage" offered unique advantages in reflective guidance.

5.2 User Experience Feedback

User Satisfaction Survey:

A detailed satisfaction survey assessed user experience, with 121 users providing feedback. The overall satisfaction was high, with scores as follows:

Overall Satisfaction: 4.25/5

Function Satisfaction: 4.1/5

Interface Design Satisfaction: 4.37/5

Interaction Experience Satisfaction: 4.4/5

Users appreciated the gamified design and AI interaction but suggested improvements in system response speed.

Evaluation of Gamification and AI Interaction Experience:

Quantitative Evaluation: Users provided quantitative feedback on their satisfaction with the gamification design and AI interaction experience. The satisfaction score for the gamification design was 4.1 out of 5, and for the AI interaction experience, it was 4.3 out of 5.

Qualitative Feedback: Through user interviews and open-ended questionnaires, detailed opinions and suggestions for improvement about the platform's functionality were collected. Feedback included comments such as redundant homepage design, high

user entry barrier due to the necessity of a computer, overly digital visual style lacking warmth, long waiting times for the AI character, instances where the AI failed to understand the user, and the AI not recognizing when the user's mood had already improved, and they wanted to end the interaction.

Experimental Results:

1. Gamification Design: Most users found that gamification elements significantly increased the platform's attractiveness and engagement. The diary garden feature, where each diary entry generates a flower, was widely recognized as an innovative and enjoyable design.

2. AI Interaction Experience: Users expressed satisfaction with their interaction experience with the AI character, considering the emotional support and guidance provided by the AI to be effective. However, some users reported that the personalized feedback from the AI character could have been more sufficiently accurate and in-depth. While the emotion recognition in the diary section was relatively precise, it struggled to adequately match the user's psychological state when the diary entries lacked sufficient detail, necessitating better recognition through subsequent dialogue processes. Nonetheless, the emotion recognition during the dialogue could have been more accurate and required continuous calibration.

3. Analysis and Discussion: The gamification design and AI interaction experience are considered the core highlights of the PEMO platform, significantly enhancing user experience and emotional support effectiveness. However, to further improve user satisfaction, the platform needs to optimize the AI character's ability to provide personalized feedback, ensuring more accurate responses to users' emotional needs.

6. Discussion

6.1 Research Findings

Effectiveness of PEMO in Guiding Users Away from Pessimistic Narratives:

PEMO significantly improves emotional states, reducing anxiety and depression. AI roles' guided questioning and emotional support help users reframe problems, effectively changing pessimistic narratives. User feedback indicated an 85% positive impact on emotional expression and narrative transformation.

Low Rejection Rate of AI Among Young Users:

Initially, researchers and designers expressed concerns that user resistance to AI psychological counselors would affect the overall usage of the platform. However, surveys and experiments revealed that 85% of young users aged 20-25 do not exhibit a high level of aversion to AI psychological counseling. Most participants indicated, "The

experience with AI counseling is not worse than that with most human counselors," "Talking to AI actually reduces psychological pressure," and "Talking to AI makes it easier to reveal one's troubles because the process feels like talking to oneself." The possible reasons for this are as follows:

4. Young people generally have a higher acceptance of new technologies and innovations.

5. Due to social environment and mental state, many young people face significant social pressure. Since mental health remains a relatively stigmatized topic, they may prefer anonymous and non-human assistance.

6. With advancements in AI technology, personalized voice interactions and more human-like empathy have reduced the perceived coldness of the technology.

However, 67% of participants also expressed concerns about how AI protects their privacy, which could affect their overall user experience.

Impact of Gamification and AI Interaction on Mental Health:

Among the 121 participants, 45 had prior experience with psychological counseling. Of these, 56% felt that although AI counseling could provide light companionship and guidance in the short term, repeated usage revealed that AI could not match the communication depth of human therapists.

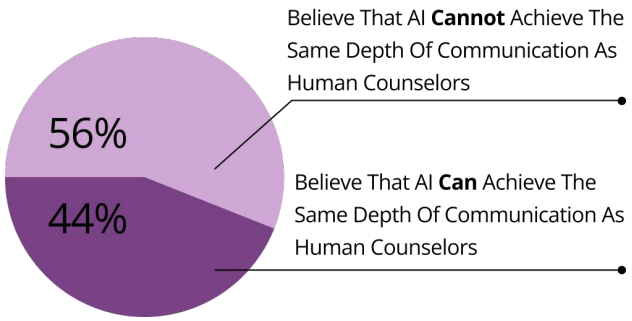


Figure 7. Regarding the question "Do you think AI can achieve the same level of communication depth as human counselors? ", pie chart.

This phenomenon arises because each person's voice contains unique timbre, loudness, and frequency information. While acoustic analysis technologies can reflect specific emotional cues, they are limited by the single voice modality and cannot fully comprehend a person's emotional state. A comprehensive understanding and analysis of emotions necessitate combining visual, auditory, and tactile cues, similar to the "multimodal intuitive response" observed in offline counseling services. Human therapists instinctively and subjectively utilize these cues to grasp the context quickly. However, participants felt that AI's capabilities still need to measure up to those of real psychological counselors.

Experiments and interviews show that in specific structured scenarios, AI can better understand human emotions when given appropriate instructions. However, the challenge lies in human emotions' inherently unstructured, or highly complex structured, nature. Emotions are volatile;

one might be happy and suddenly unhappy, making it difficult for AI to predict these changes accurately.

It is unreasonable to expect AI to achieve such a level of understanding. Nonetheless, on the Pemo platform, AI still provides significant value, especially in situations where individuals feel lonely or distressed for various reasons but have not reached severe levels of anxiety or depression. AI can alleviate these feelings through conversation, with experiments showing AI's efficacy in this regard to be notably evident.

In addition to AI's anxiety-relieving effects, which significantly boost user engagement, gamification features such as the "Diary Garden" have also markedly increased user participation and platform stickiness. Surveys indicate that 92% of users found gamification elements enhanced their willingness to use the platform. The personalized interaction of AI roles and emotion recognition technology offers tailored psychological support. The differential impact of various roles on emotional improvement further substantiates the effectiveness of personalized interventions.

6.2 Research Limitations

Sample Size and Research Duration:

The sample size of 200 users is relatively small, limiting generalizability. Future research should expand the sample size for more excellent reliability. The four-week intervention period is short, and future studies should consider more extended observation periods to verify long-term effects.

Potential Issues with Platform Technology and User Habits:

User feedback indicated the need for improvements in system response speed and interface design. Some users, especially those unfamiliar with digital diaries and AI interaction, found adaptation challenging. Differences in user habits affect platform adoption and widespread use.

6.3 Future Research Directions

Multimodal emotion recognition: Introducing Multiple Emotion Detection Methods Beyond Text Recognition

In psychological counseling, emotion detection based solely on text recognition may not fully capture the user's emotional state. In the future, the platform can introduce the development of multimodal emotion recognition, aiming to enhance the accuracy and depth of emotion detection by introducing multiple methods rather than relying solely on text analysis. These methods include facial expression analysis, voice intonation recognition, physiological signal monitoring, and behavioral pattern analysis.

Further Optimization of PEMO Platform Features and User Experience:

Future research should optimize platform technology and enhance system response

speed and stability. Analyzing user behavior data for more personalized experiences is essential. Developing training and support materials can help users adapt better, especially those unfamiliar with technology.

Potential Applications of AI in Other Mental Health Interventions:

Exploring AI applications in other mental health areas, such as anxiety disorders, depression, and PTSD, is crucial. Researching AI technology's cross-cultural applicability and effectiveness and developing culturally sensitive platforms can meet global user needs. Ensuring data security and privacy protection is vital as AI applications expand.

7. Conclusion

7.1 Research Conclusions

Potential Positive Effects of PEMO in Helping Young People Escape Pessimistic Narratives:

Emotional Improvement: PEMO helps users identify and manage negative emotions, promoting emotional improvement.

Narrative Restructuring: AI roles' guided questioning and support help users reframe problems, changing pessimistic narratives.

Increased Engagement: Gamified design and social elements enhance user engagement and platform stickiness.

Gamification and AI Interaction as an Effective Approach for Mental Health Interventions:

Innovative Intervention: Combining gamification and AI creates a novel mental health intervention method.

Personalized Experience: AI roles' personalized interaction and emotion recognition provide tailored support, improving intervention effectiveness.

Data-Driven Improvement: User data collection and analysis help continuously optimize platform functions and services.

7.2 Practical Implications

Providing an Innovative Mental Health Intervention Method with Practical Application Value:

Practical Application: PEMO's design and functions practically demonstrate mental health interventions, combining psychological theories with modern technology.

User Friendliness: Gamified and social elements make interventions more accessible and userfriendly, reducing psychological barriers and increasing willingness to accept psychological interventions.

Providing Reference and Inspiration for Future Development of Related Technologies and Platforms:

Technology Integration: PEMO showcases

the potential of integrating AI and gamified design, providing practical experience for future developments.

Functional Innovation: Features like handwriting recognition, emotion recognition, and AI role interaction offer insights for future mental health intervention technologies.

Data-Driven Design: User data collection and analysis provide an effective model for optimizing future mental health technologies.

8. Summary

This paper aims to design and validate a diary gamification AI interactive website called "PEMO," exploring its effectiveness in helping young people overcome pessimistic narrative identities. The research combines the theoretical foundations of narrative identity therapy and expressive writing therapy, leveraging AI and gamification technologies to provide users with an engaging and interactive platform for self-reflection and emotional regulation.

The "PEMO" platform employs digital innovation and advanced AI technology to effectively address young people's short-term feelings of loneliness, anxiety, and sadness. Using gamification design, the platform enhances user engagement and motivation, making self-reflection and emotional regulation more enjoyable and interactive. However, due to the current single-modal emotion recognition approach, while the platform excels in short-term emotional alleviation, its effectiveness in providing long-term empathy and emotional comfort requires further improvement and testing.

The study suggests gradually incorporating more modalities of emotion recognition technology to enhance the platform's long-term efficacy. Multimodal emotion recognition can integrate various data sources, such as facial expressions, voice tones, and physiological signals, to offer more comprehensive and precise emotional analysis, thereby improving user experience and platform effectiveness.

An increasing number of young people are beginning to accept and embrace the application of AI in the field of psychological healing. This positive social phenomenon provides a broad prospect for the emergence of innovative mental health intervention methods. As the user base continues to grow, the platform's data and feedback will drive rapid technological development and refinement, offering more efficient emotional support and psychological guidance to many young people.

In conclusion, this paper explores the short-term emotional regulation effects of the "PEMO" platform and proposes feasible solutions for improving long-term empathy through multimodal emotion recognition technology. In the future, with continuous technological advancements and positive societal response, AI psychological healing platforms will bring more innovation and possibilities to young people's mental health.

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About the Authors:

Author 1 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE] [_P/RoD Author Bio and Acknowledgements]

Author 2 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE]

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PULI PROJECT SEMILLAS DEL FUTURO: IMPLEMENTING DESIGN-LED EDUCATION TO TRANSFORM COMMUNITIES.

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ABSTRACT | The project “Semillas del futuro” emerges as a transformative initiative rooted in design-led education for social innovation. This paper presents the second stage of the collaborative academic project between Japan and Mexico under the Post Urban Living Innovation (PULI) Program. This project aims to empower children in Monterrey’s Campana Altamira community by integrating technology, design thinking, and sustainable practices into their education. Through an iterative design process, university students, professors, and researchers from both institutions analyze local issues and co-create solutions with community members, mainly with young people. The project adopts a multidimensional approach, drawing on theoretical frameworks emphasizing the pivotal role of education in tackling complex societal challenges. It leverages design thinking methodologies, ethnographic research, and collaborative problem-solving to develop a sustainable educational model. Divided into three iterative stages - research and conceptualization, prototyping, and implementation and testing - the project fosters continuous improvement and community empowerment. During the initial stage in 2023, workshops in Mexico and Japan identified waste management and education accessibility as focal points for intervention. The subsequent phase, currently in progress, focuses on prototyping tangible solutions. Collaborating with a Design professor and students, the emphasis is on designing equipment to process recycled plastics, promoting active student engagement in the design process and instilling a sense of ownership and responsibility. Rather than opting for ready-made solutions, the emphasis is on empowering university students to actively engage in the design process. By immersing themselves in the iterative journey of creating this equipment, students not only gain valuable hands-on experience but also internalize the importance of design in addressing environmental challenges within their own community inside the campus in Monterrey, Mexico. As part of this phase, students from both universities convene for workshops

to promote the prototyping project. Additionally, the “Semilla Lab” is proposed as a mobile design space within the Monterrey campus, fostering interdisciplinary collaboration and hands-on learning. Inspired by the Japanese educational system, Semilla Lab aims to equip students with practical skills and sustainable practices, preparing them to address real-world challenges and drive positive change in society.

In summary, this program promotes hands-on learning, creativity, and critical thinking among participants. Through activities such as upcycling, recycling, and micro-manufacturing, participants are encouraged to develop practical skills and innovative solutions to local problems. The program also emphasizes inclusivity, bottom-up innovation, and cultural sensitivity, ensuring that solutions are tailored to the community’s needs and aspirations. The implementation process involves close collaboration between university stakeholders and community members, with a focus on sustainability, accessibility, and infrastructure development. By engaging residents in the design and production of tangible solutions, the project fosters a sense of ownership and pride, empowering them to address environmental, educational and venture challenges in their own community.

KEYWORDS | DESIGN LED EDUCATION, SOCIAL INNOVATION, SUSTAINABLE PRACTICE

1. Introduction

The project is focused on co-design with Mexican communities emphasizing the importance of involving local stakeholders, particularly young people, in the process of identifying and solving community issues. This participatory approach not only ensures that the solutions are contextually relevant but also fosters a sense of ownership and empowerment among community members. In regions facing significant socio-economic challenges, design education can play a crucial role in equipping children with the skills and mindset needed to address local problems and improve their quality of life.

The project "Semillas del futuro" emerged as a transformative initiative rooted in design-led education for social innovation during an international collaborative project between universities in Mexico and Japan. During a series of workshops in both countries focused on the topic of "education for the future", professors, students, community members, and researchers proposed to concentrate on education for children and teenagers and decided to focus on the community surrounding the Monterrey campus, Campana Altamira, as a key location for the implementation of this initiative.

This paper presents two stages of this collaborative project called Post Urban Living Innovation PULI Program (Chiba University, 2015) which aims to address post-urban living challenges through innovative design solutions by fostering international collaborations. However, for this research, the main focus is on the second and last phase where the first approach with the Mexican community of La Campana was made. By integrating technology, design methodologies, and sustainable practices into education, the "Semillas del futuro" project specifically targets empowering children in Monterrey's community. However, the collaboration is ongoing for this project; the next iteration will take place in September in Japan, and we are expecting to continue our collaboration for at least five years.

2. The Community

Campana Altamira, is a community nestled in the mountains of Monterrey, Nuevo León, Mexico, that faces a unique set of challenges and opportunities that make it a compelling focus for design intervention. The urbanization development has resulted in

an informal settlement perched 700 meters above sea level, resulting in significant risks of flooding and landslides, especially during the rainy season (Gobierno del Estado de Nuevo Leon, 2016). Due to inadequate planning and urbanization, homes in these mountainous regions experience urban segregation in terms of accessibility and service provision. Many areas are inaccessible to motorized vehicles, and residents in the higher parts of the district must walk an average of 35 minutes to reach the nearest bus stop (Gobierno de Municipal de Monterrey, Nuevo León, 2021, p.14).

In addition to the problems related to its location, this community faces most of the urban problems of an informal settlement including the provision of basic services, poor environmental conditions like inadequate garbage disposal, insecurity, and lack of health and educational facilities (Menshawy, A, 2011). Despite these challenges, the community of Campana Altamira is deeply rooted in a strong sense of identity, social cohesion, and cultural diversity. The residents, originally migrants from various parts of Nuevo León and other regions of Mexico, have cultivated a shared identity centered on hard work, sacrifice, and a collective effort to build their homes and communal spaces. This rich cultural tapestry is reflected in the diverse traditions and celebrations, including the revered December festivities, posadas, and the veneration of religious figures, whose images are commonly found in homes and public spaces.
However, insecurity remains a pressing concern for the inhabitants of Campana Altamira. Approximately 34% of residents report feeling unsafe in their neighborhood, with heightened perceptions of insecurity at night. Problems such as alcoholism, drug addiction, and youth altercations are prevalent, contributing to the overall sense of insecurity. In addition, basic services such as electricity, drainage, and waste management are very problematic for the community. The difficulty for most service providers to access the upper parts of the mountain results in a shortage of basic services and deficient facilities. In the case of waste, public and private garbage collection services cannot access the upper part of the community, resulting in an accumulation of garbage that endangers the community, causing significant short- and longterm health and environmental issues. In terms of education, 10% of children and young people aged 5 to 18 have dropped out of school in the last three years, accounting for 131 cases of school desertion.

Additionally, 795 individuals aged 15 and older lack any form of schooling, and 564 are illiterate, representing 2.88% of the total population. Despite these daunting challenges, Campana Altamira presents a significant opportunity for innovative design solutions aimed at improving the quality of life for its residents.

By focusing on co-design with the community, particularly for educational purposes, design interventions can address these multifaceted issues. Design education is particularly vital for children in impoverished communities, as

it equips them with practical skills, fosters creativity, and encourages critical thinking, ultimately empowering them to drive positive change within their community.

3. The process

In the pursuit of fostering socially conscious, innovative, and proactive individuals, we propose an educational model focused on the design process for social innovation (Figure 1) (Martínez Baca, A. et al. 2024), aimed at creating a self-sustaining program capable of long-term continuation. The model follows a structured, iterative design process divided into three stages: 1) Research and Conceptualization, 2) Prototyping, and 3) Testing. This approach guides participants through an organic journey of problem-solving and innovation. The model operates within a continuous learning loop, beginning with university students, professors, and researchers from Tec de Monterrey and Chiba University, who collaboratively develop solutions for local social issues. Community members are gradually introduced during the Testing stage of the first loop and progressively integrated into the earlier stages of the design process in subsequent iterations. The goal is for community members to autonomously replicate the process, enabling them to propose and develop solutions to their own local challenges.

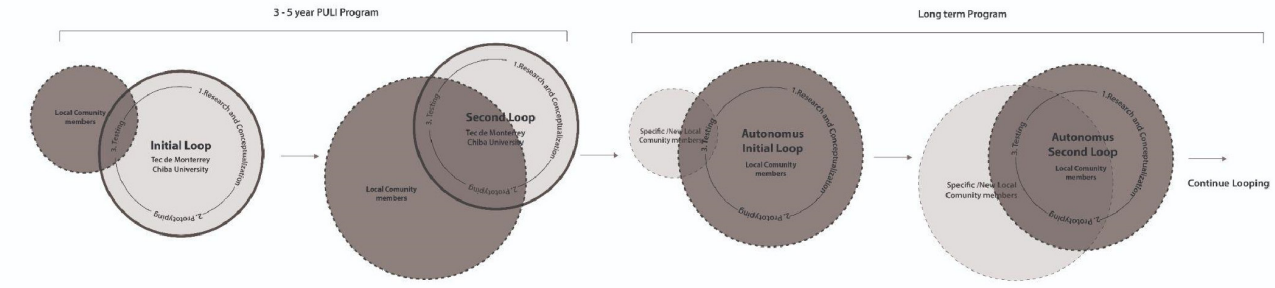

Figure 1. Proposal of Iterative educational model for social innovation based on the design process

3.1 Stage 1 /Initial Loop - Analyze, identify opportunities and propose

The initial stage in 2023 consists of two workshops with international students, the first one in Mexico and the second one in Japan. During the first workshop in Monterrey, Mexico the objective was to analyze the opportunities to design an intervention for the education of the future. The team investigated the educational issues around their campus and decided to focus on childhood and basic education inside the community of Campana Altamira, which is expected to have a long-term positive impact on improving living conditions at different levels. Since this workshop involved international students, being able to immerse themselves in the Mexican context helped them to look at the issue from more than one angle and to understand the

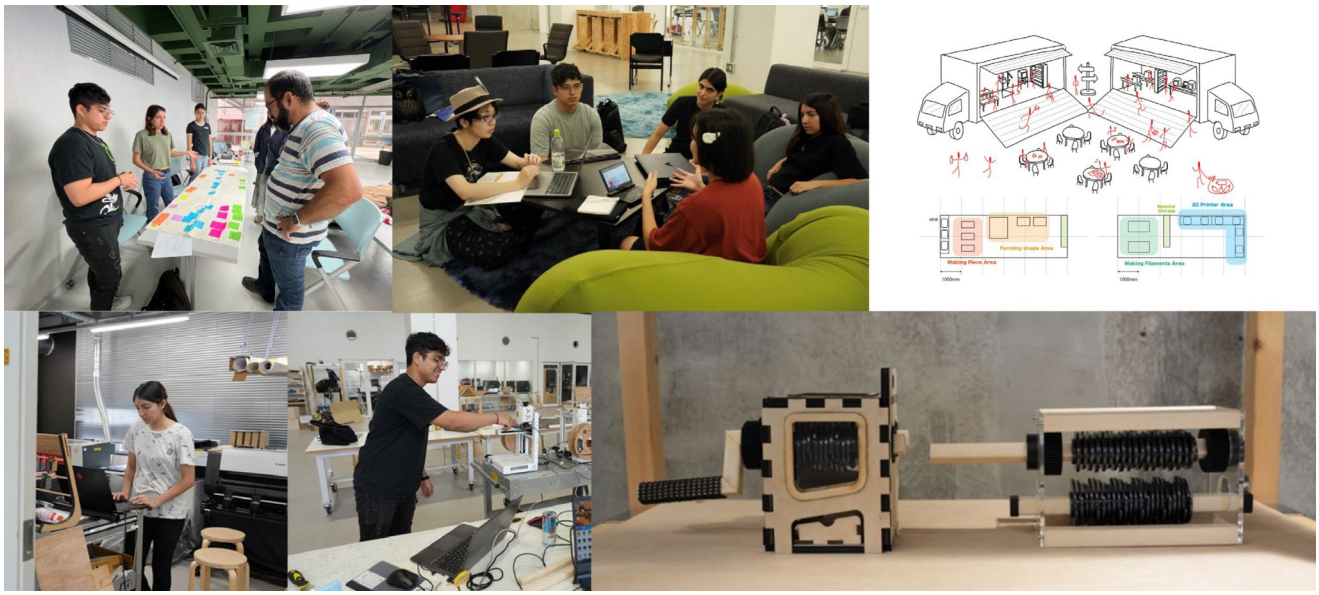

Figure 2. Workshop sessions and results during the first stage of the PULI project in Mexico and Japan.

problem from more than one perspective. As a result of this multicultural exchange, the “Semillas del Futuro” project emerged, where students, teachers, and researchers identified and proposed to focus on waste management and accessibility of education as key areas of intervention.

Afterwards, the Mexican participants had the opportunity to travel to Japan to continue with the second iteration of the workshop where the Mexican students were able to immerse themselves in the Japanese context and observe and analyze different educational and entertainment interventions that address the same issue. This process was very beneficial to the project by following iterative methodology of education based on the design process (Figure 2) likewise the students proposed a physical and movable space, where different products and design solutions could be generated using the waste materials of the same community focusing on plastics. The students also prototyped machines that would facilitate plastic recycling, emphasizing that these machines could be produced on campus or in the community. This hands-on involvement promotes a deeper understanding of environmental challenges and instills a sense of responsibility and ownership.

As a result of this Collaborative workshops involving students, professors and researchers from both institutions proposed the “Semilla Lab,” a name for a mobile hybrid space that aims to foster interdisciplinary collaboration and hands-on learning, inspired by the Japanese educational system. This design lab or creative space is designed to equip students with practical skills and sustainable practices, preparing them to address real-world challenges and drive positive societal change.

3.2 Stage 2 / Second Loop - Co-design with the community

Following the international workshops, as part of the University initiative (Iniciativa Campana Altamira, 2024), the Design Professor of Mexican University initiated contact with community members, authorities of the Campana Altamira social program, coordinators, and students. This initial approach resulted in the participation of twelve first-year secondary students in a foundational training loop (Figure 3). The objective was to immerse these students quickly into the discipline of design, teaching them ideation, drawing, model making, and mold production for accessory creation. The six-session activity provided a comprehensive learning experience, where students grasped the design process from ideation to production of their proposals.

Given that the participating students are teenagers aged 10-15 and have never been exposed to the Design Thinking method, we have adapted the process into a simpler, more relatable approach that aligns with their daily experiences. The approach needs to be adapted to the rural context, where teenagers might not have the same exposure to technology or design methodologies. This includes addressing unique challenges and leveraging local resources and knowledge (Gazali, et al, 2018). Additionally, this workshop is designed to be highly interactive



Figure 3. first plastics session and workshop with students from Campana Altamira community.

and hands-on activities such as creating physical prototypes and engaging in creative expression to ensure better engagement and understanding (Fisher, et al, 2013). This process allows students to observe and solve everyday unresolved issues creatively.

Building on the success of the initial engagement, the “Semillas del futuro” program conducted a second iteration of the PULI Workshop, involving 15 junior high school students from the Campana Altamira community, three students from a Mexican University, and a Researcher and professors from Japanese University in a hybrid modality. This phase aimed to equip students with design tools and knowledge to identify and address local problems. Under the guidance of University students and professors from Japanese and Mexican Universities, students developed preliminary proposals for implementation, focusing on sustainability and entrepreneurial skills.

This 5-day workshop was designed to run 2 different approaches. During the first half of each session, the focus was on co-design (Figure 4), where students from the Mexican university, Japanese researchers, professors, and young members of the community focused on running the design process to identify problems in the Altamira community to propose innovative and conceptual solutions to improve these conditions. The second part of the session focused on the technical part where the students were taught plastic treatment processes (Figure 5). During this part, through educational videos and examples of global initiatives, students learned about reusing and designing products from plastic waste. This hands-on activity, involving collection,



Figure 4. Hybrid Co-design session to identify community problems and propose possible solutions.



Figure 5. Practical session on plastic recycling and injection molding techniques.

cleaning, color sorting, shredding, and plastic injection molding, provided a tangible understanding of recycling processes and the creation of value from waste materials.

During the co-creation hybrid session, the students were divided in 3 teams following these steps of design process:

- Identifying Problems

Students began by mapping the generation of plastic waste in their daily activities, identifying individual and community issues, and creating a list of needs. Rather than using the traditional emphasis method in design thinking, which focuses on identifying problems, we implemented an adapted solution mapping method. Solution mapping involves tools that help uncover and understand solutions from the grassroots level. These tools are designed to explore the community's capacity to innovate and solve daily challenges (Taepoer, et al., 2023). We chose this method to gain deeper insights into the students' daily lives and to demonstrate that design is not solely about creating sophisticated, aesthetically pleasing products, but fundamentally about problem-solving. To adapt solution mapping, we asked participants to identify solutions to plastic bottle waste within their living environment. Examples included a vase made by one participant's mother and mini-games played with friends using used plastic bottles. This approach ensures that solutions are

generated from the bottom-up. Additionally, we introduced the concept of the user-designer, a fundamental principle in design, to help students understand that they can actively participate in the design process.

- Ideation process

Students learned to ideate new solutions to tackle the problems they considered relevant. Building on the solutions they identified in the previous step, they began the ideation process by voting on the most pressing problems or promising solutions. Once a theme was chosen, students brainstormed and drew as many ideas as possible.

During this phase, we emphasized the importance of not being afraid to draw and ideate. Encouraging them to freely express their ideas through sketches helps them become more comfortable with the design process.

- Defining and design

Teams utilized design tools to refine and select the most effective solutions, iterating through various sketches. They evaluated and voted on their peers' sketches and ideas, providing feedback and suggestions. Following this, they revisited and revised their problem definitions and solutions based on the feedback received.

Interestingly, some teams began by defining the problem before refining their solutions, while others approached it in the reverse order. This variation in process highlighted different approaches to problem-solving and solution development. Ultimately, the teams made decisions regarding their final design and the specific solutions they would prototype in the subsequent phase.

- Cardboard Prototyping

In this phase, students constructed and validated their volumetric designs with support from university students and AI tools. This stage marks the introduction of technological advancements, specifically AI, to the students, emphasizing the importance of leveraging technology correctly in the design process.

The use of AI tools helps students refine their prototypes, while cardboard prototyping provides a tangible, hands-on approach. By working with cardboard, students are encouraged to engage in the prototyping process without feeling overwhelmed, as they are using familiar and easily accessible materials. This practical experience helps demystify prototyping and fosters a more comfortable and creative design experience.

As a result of this co-design process, significant contributions could be identified. Each team decided to focus on different problems in their environment. Two of them focused on the problem of garbage management in the community, and another team on the problem of public lighting and electricity. Due to the co-design process, teams came up with very interesting ideas and proposals that included the recycling of plastics with a feasible approach for

the community members to develop and implement them with the help of the educational institutions.

The two teams concentrating on waste management each adopted distinct and innovative strategies. The first team suggested creating a neighborhood organization and garbage collection system that would be managed and led by the community members themselves. They also designed a product to support this system, ensuring it accounted for the geographic features of the Campana Altamira community (Figure 6). The second team, also focusing on waste management, identified stray dogs as key stakeholders. They proposed installing feeders to improve the dogs' lives and prevent them from scavenging through garbage for food (Figure 7).

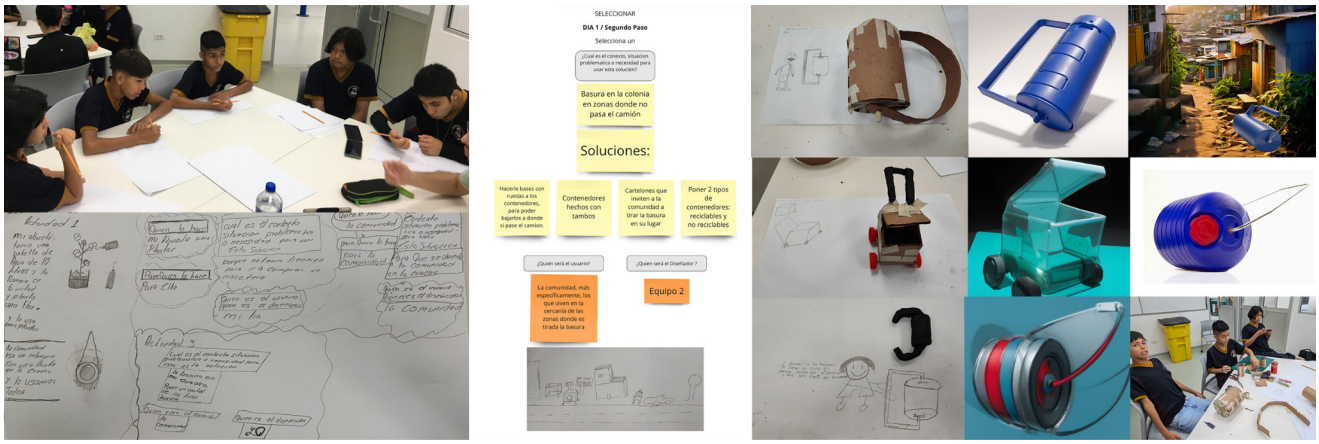

Figure 6. Co-design Process during Hybrid Puli Workshop. A waste management system designed for the community allows residents to roll their garbage down from the mountaintop until it reaches a place for the public trash collection vehicle.



Figure 7. Co-design Process during Hybrid Puli Workshop. A dog feeder for the stray dogs, which are considered community stakeholders. Without a stable food source, these dogs tear through residents' trash, worsening the waste management conditions in Campana Altamira.

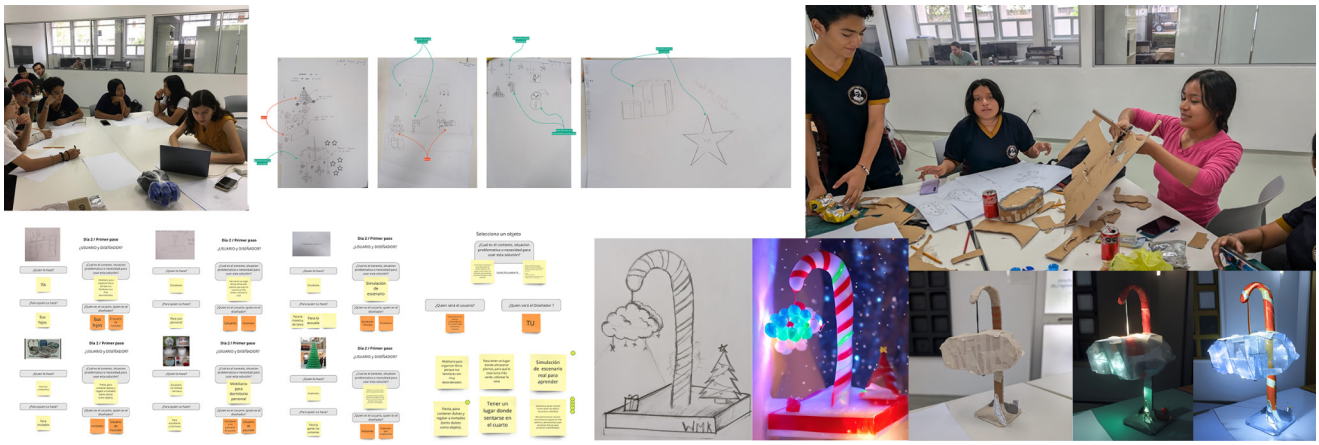

Figure 8. Co-design Process during Hybrid Puli Workshop. Design of a public space installation to promote natural vigilance to reduce crime.

Similarly, the team addressing the issue of insufficient public lighting proposed installing lights in a public park, incorporating cultural elements like Christmas celebrations.
Their plan aimed to create a decorative feature that would enhance community engagement, encouraging people to spend time outdoors and interact with the public space. Additionally, the increased lighting would improve natural surveillance, helping to prevent crime in the area (Figure 8).
The initiative achieved significant outcomes:

-Problem-Solving and Design Methodology: Students successfully identified and proposed to solve complex community issues that include social, economic, organizational, cultural, and healthimpacting aspects using design methodologies, emphasizing recycling and creating new products from plastic waste.
-Co-design approach: Because the co-design process involved the community inhabitants as stakeholders, each proposal effectively addressed various aspects of the social issues facing the community. This level of comprehensive engagement would have been challenging to achieve without the active participation of the Altamira residents in the design process.
-Increased Participation: From twelve to fifteen students, with a 60% return rate, indicating sustained interest.
-Engagement and Learning: The program instilled an appreciation for design as a discipline and sparked interest in future educational and entrepreneurial activities.
-Community Collaboration: Strengthened ties with community members, authorities, parents, and educational institutions, fostering a collaborative environment for continuous engagement.

Additionally, one of the primary goals of this workshop was to highlight the importance of sustainability (Martínez Baca, A. et al. 2024). However, traditional classroom teaching methods proved insufficient for instilling these values, as students often struggle to grasp sustainability when it is neither a primary value nor a familiar concept in their daily lives.

In the final products presented by the

students, one team notably focused on improving their community's waste management system to enhance waste collection. This achievement is a significant milestone for the workshop, demonstrating that the students are beginning to think about sustainability on a systemic level. This progress provides optimism that future stages of the workshop can further integrate and emphasize sustainability values.

This case study illustrates the profound impact of integrating design education into community initiatives. By engaging secondary students in Campana Altamira, the program not only addressed local issues but also empowered the participants with valuable skills and knowledge. The iterative design process, combined with real-world problem-solving and entrepreneurial training, provided a robust framework for fostering innovation and sustainable development within the community.

4. Conclusions

The "Semillas del Futuro" project demonstrates the transformative potential of integrating design education with community involvement to address local socio-economic challenges. Through international collaboration and a focus on co-design, this initiative empowered young people in the Campana Altamira community, equipping them with practical skills and a creative mindset necessary for social innovation.The project's success underscores the importance of involving community members, particularly youth, in the design process. By doing so, solutions were not only contextually relevant but also fostered a sense of ownership and empowerment among participants. The initiative's iterative approach, combining technology, design methodologies, and sustainable practices, provided a comprehensive educational experience that extended beyond traditional learning environments.Key outcomes of the project included increased participation, effective problem-solving, and strengthened community collaboration. The involvement of local stakeholders ensured that diverse aspects of social issues were addressed, while the hands-on activities and co-design sessions deepened the students' understanding of environmental challenges and instilled a sense of responsibility and ownership.By focusing on practical applications of design thinking and entrepreneurial skills, the project has paved the way for sustainable development and innovation within the Campana Altamira community. This case study highlights the significant impact of design education on empowering young people to drive positive change, emphasizing the role of universities and educational institutions in fostering such initiatives.Despite the difficulties, Campana Altamira is also a landscape rich with opportunities for innovative design interventions aimed at improving the quality of life for its residents.

Through case studies, theoretical insights, and practical examples, we aim to demonstrate the transformative power of design in creating sustainable, resilient, and thriving communities. By highlighting the opportunities for positive change, we hope to inspire

designers, policymakers, and community members to collaborate in reimagining and revitalizing Campana Altamira. The resilience and creativity of Campana Altamira's residents provide a strong foundation for collaborative design efforts that can transform the community. By focusing on inclusive, bottom-up approaches that engage residents in the codesign process, we can develop solutions that are tailored to the unique needs and aspirations of the community.

Overall, "Semillas del Futuro" is a current project on development for the future of education aiming to address complex social problems through collaborative and design-led approaches, to demonstrate that meaningful community engagement and empowerment can lead to lasting improvements in quality of life.

5. Limitation and future work

Despite the promising outcomes of the "Semillas del Futuro" project, several limitations need to be addressed. Firstly, the project's scope was limited by its initial engagement duration and the number of participants. Expanding the program's reach to include more students and community members could provide a broader impact and more diverse perspectives.

Resource constraints, such as limited materials for prototyping, access to technology, and sustained funding, can affect the ability to fully implement and scale the proposed solutions within the community. Ensuring the sustainability and scalability of the initiatives without constant institutional support is crucial. Furthermore, while the focus on plastic recycling and waste management is commendable, other pressing issues like access to basic services, security, and comprehensive education need to be integrated into future iterations of the project.

The program currently relies on a master-apprentice model, which needs to be re-evaluated (Souleles, 2017). Our goal is to reduce this dynamic and encourage students to be more proactive in their learning. However, it is understandable that during the initial iteration, students perceived the situation as a typical classroom setting, largely due to the age and social class gap between them and the university students.

Looking ahead, we aim for a more integrated co-design experience where university students contribute without dominating the decision-making process. We plan to address this issue further, focusing on creating a more seamless and collaborative environment. Enhancing communication strategies will be a key aspect of this discussion, ensuring that students feel more engaged and empowered in the design process.

The next iteration of the "Semillas del Futuro" project is scheduled to take place in Japan in September 2024. This phase aims to continue developing the solutions proposed during the initial codesign process with the community of Campana Altamira. By relocating the project to Japan, the team will leverage

the advanced technological resources and innovative educational practices available in Japanese institutions. This iteration will focus on refining and testing the educational model developed during the initial workshops. Participants will have the opportunity to engage in hands-on sessions to further explore the practicality and sustainability of their proposed solutions. The collaboration between Mexican and Japanese universities will also benefit from enhanced cultural exchange and knowledge transfer, fostering a more robust and comprehensive approach to addressing the complex issues faced by the Campana Altamira community.

Future work should aim to build a more robust, self-sustaining model that empowers local stakeholders to continue the initiatives independently. This could involve developing bottom-up design programs and training modules to equip community members with the skills needed to manage and sustain the projects. Additionally, incorporating digital tools and platforms could enhance communication and collaboration among participants, making the project more resilient to external disruptions. Expanding the research to include longitudinal studies would provide valuable insights into the long-term impact of the project on the community. Finally, exploring partnerships with local businesses and government agencies could offer additional resources and support, ensuring the project's ongoing success and integration into broader community development strategies.

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DESIGN FUTURES FOR TRADITIONAL CRAFT: A COLLABORATIVE AND INTERNATIONAL APPROACH.

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ABSTRACT | The potential of traditional craftsmanship to become part of contemporary design, not merely as a source of inspiration, but as a driver to address the issues of sustainability and ethical integrity of the production system in a innovative way, is leading to a growing interest in its production and consumption models at different geographies. Indeed, it is only by making the value components of traditional craft supply chains that it will be possible to ensure the repositioning of these great socio-technical-cultural heritages on alternative forms of value system, feeding new flows of experience. These new value systems, guided by design, make it possible to explore new directions for the protection, revitalisation and repositioning of traditional craftsmanship.

The paper will present the results of FRONTIER, an international collaborative project, among Universities in Italy, Colombia and Brasil, that encourages the recovery and promotion of ancient textile-related crafts of their territories, through different drivers: creative processes supported by encounters with designers and artists, technological integration, the renewal of processes, ranging from digital fabrication to the virtual production of models also thanks to the introduction/ replacement of biomaterials. The international research group, adopting responsible advanced design approach, created responsible innovation pathways, able to involve the academic communities, craft enterprises and their related territories, in the research for a link between innovation, design and traditional craft. The results are a combination of new emerging cutting-edge technologies, platforms and development of methodologies, curricula, entrepreneurial skills and vocational training courses, creation of sustainable relationships and networks with sectors and different stakeholders to promote innovation, employment and sustainable growth.

KEYWORDS | TRADITIONAL CRAFTSMANSHIP; DIGITAL TECHNOLOGIES; SUSTAINABILITY; CO-DESIGN; RESPONSIBLE INNOVATION

1. Introduction: Exploring new complexities: traditional craft and design cultures

The potential of traditional craftsmanship to become part of the contemporary design discourse is leading to a growing interest in its production and consumption models, at different geographies and socio-economical systems. In a more complex perspective, traditional craft is strictly linked to the relationship between design cultures and innovation: it can be considered as a driver to address issues of sustainability and ethical integrity of the production system; as a catalyst capable of contributing to the specific cultural identity of a territory; an object and subject in the dynamics of material and immaterial heritage's preservation and enhancement. According to this perspective, the close and historical affinity between design and craft can be assumed, in its most extreme borders, as an activator of changes. In particular, design – as mediator of knowledge and needs - can play a strategic role in triggering innovation processes in wide territories across the globe.

The paper is framed in a research field that deals with the relationship between design and territories. This topic is widely investigated by design cultures, through different perspectives. Beatrice Villari (2012; 2018) introduces the territory as a place of continuous exchange between people, artefacts, natural elements, and knowledge, that is handed down, sedimented and reworked. It is a set of tangible and intangible elements capable of transformation and design. According to this interpretation, the territory is no longer defined through individual identities or in geographic terms, but as a reservoir of know-how and, thus, as a cultural space (Bortolotto, 2010) made up of social, economic, natural, political factors. So, the territory can be considered as a transformative field in which collaborative design methods lead to co-creation and co-production of prototypes that face contemporary challenges. The research presented in this paper perfectly fit into the binomial design-territory, reading it through the enhancement of local craftmanship in context characterized by high-cultural traditions, but, at the same time, strong conflictual and emergency conditions (Cardozo Vasquez et al., 2019).

The paper develops the discussion according to the following structure.

In the first paragraph, it presents an innovative vision of the relationship between design and craftmanship. It is only by making the immaterial components of traditional craft supply chains usable and reactivatable through the co-creation with new subjects (designers, artists, digital experts) that it will be possible to ensure the repositioning of these great socio-technicalcultural heritages on alternative forms of value system, feeding new flows of experience in the wake of a global transition marked by complex problems which can only be solved through collaborative and experimental approaches.

Starting from these premises, a specific design driven approach is presented, as a methodology used to frame the applied experience. It links the concept of Responsible Innovation to that of Advanced Design. The primary objective is to propose a design model attentive to both the material (available resources) and immaterial (relationships, know-how) aspects of a territory, as well as to the values that define its social and cultural identity, and the stakeholders involved.

The third paragraph introduces the applied experience, the funded project called *"FRONTIER: Design Innovation and Traditional Craft"* developed between 2022 and 2023 as an international collaboration between the University of Bologna in Italy, UNAL of Palmira in Colombia, and UNISINOS of Porto Alegre in Brazil. The aim, methodology, phases, tools and results of the project are explained in the following paragraphs, focusing on the national and transnational developments, as expected in the program.

Finally, the conclusion summarizes the main cultural, social, and educational impacts, trying to frame them through a holistic vision that takes into consideration both local and global contexts and led the experience to be a replicable model.

2. New Links Between Traditional Craftsmanship and Innovation by Responsible Design

Traditional craftsmanship is regarded as a living tradition according to the Convention for the Safeguarding of the Intangible Cultural Heritage (UNESCO, 2022), encompassing a broad range of practices and approaches (Gianfrate, 2024). This expansive definition includes both historical techniques and contemporary innovations, as well as the organization of work and creativity, to preserve the essence of traditional craftsmanship and its cultural values. The ecosystem of traditional craftsmanship integrates explicit and profound knowledge of materials and tools, alongside tacit knowledge derived from human expertise, mastering production processes, creativity, and work organization, all deeply connected to specific territories and locales.

This connection is emphasized by Fløysand and Jackbsen (2010), who highlight how the spatiotemporal context influences social relations and the production of both formal

and informal knowledge. The growing interest in traditional craftsmanship is driven, according to Frayling (2017), by the current economic climate and, according to Sennett (2009), by the human dignity inherent in skilled craftsmanship. Consequently, craftsmanship becomes a significant model for design, production, and consumption, contributing to specific values such as cultural identity, sustainability, and the preservation of tangible and intangible knowledge.

This new value system, guided by design, make it possible to explore new directions for the protection, revitalisation and repositioning of traditional craftsmanship through different drivers. Traditional craftsmanship integrates into contemporary design sectors not only as a source of inspiration but also as a catalyst for addressing sustainability and ethical integrity in production systems. The collaboration with planners, designers, technologists, and artists must be a primary vector of innovation, making the value components of traditional craft supply chains usable and reactivatable.

Hybrid skills (manual + digital) activate responsible change processes by pursuing a holistic approach to innovation, with technologies serving the socio-economic component, supporting new relational languages, structures, and ethical issues. Innovation is driven by the ability to adapt to new circumstances, co-create solutions with end users, and design new organizational and cross-sectoral workflows.

This collaborative approach enhances traditional craft techniques by combining them with emerging technologies to develop new products, services, and professions. Platforms and methodologies are created to foster entrepreneurial skills and vocational training, promoting innovation, employment, and sustainable growth. Through new tools and innovative approaches, the heritage of craftsmanship becomes more accessible, usable, and interactive, creating opportunities for exchange, profit, and interaction in various contexts, including virtual ones. This cultural heritage is reinterpreted through a new ontological definition that highlights its systemic nature, facilitating analysis, comparison, and interpretation of these phenomena, and involving a plurality of voices to capture new trends and future practices.

The connection between innovation, design, and traditional craftsmanship can manifest through various trajectories:

- **Valorization and Promotion:** Elevating and promoting traditional craft techniques by integrating them with emerging cutting-edge technologies.
- **Fusion of Know-How and Technology:** Merging traditional expertise with new and digital technologies to develop superior and novel products, services, and professions.
- **Platform and Methodology Development:** Creating platforms and developing methodologies, curricula, entrepreneurial skills, and vocational training courses to generate employment

and revitalize businesses where tradition meets innovation.

- **Sustainable Relationships and Networks:** Establishing sustainable relationships and networks with cultural and creative sectors, institutions, universities, research institutes, regional and national authorities, businesses, and other stakeholders to foster innovation, employment, and sustainable growth.

The potential of emerging and digital technologies, alongside strategies for knowledge valorization, focuses on innovation and repositioning within the value chain. This involves experimentation, optimization, accessibility, and creating new experiences flowing through innovative tools and approaches, making heritage more accessible, usable, and interactive.

Information, stories, techniques, aesthetic canons, places, equipment, sounds, and related materials can be transformed into data nodes within new product or service chains and value components. This process interweaves the physical and virtual worlds, enhancing the interaction and utilization of cultural heritage.

3. RAD Methodological Approach

To address the complexity of traditional crafts, encompassing both tangible products and the intangible knowledge required to create and sustain production traditions, and to propose new responsible economic-cultural models for innovation, the research group investigated three dimensions:

1. Identity: Social factors, traditions unique to each region, and creative-productiveinnovative skills derived from historically layered technical and artistic knowledge (Calabrese, 1999).

2. Community: Relationships among various ecosystem actors, and the community's active involvement in recreating the heritage itself (Celaschi, Formia, Iñiguez Flores et al., 2019).

3. Sustainability: Geographical configuration, resources, and raw materials, along with social inclusion and responsibility.

This cross-cultural analysis, focusing on specific productive sectors, revealed that traditional craft is deeply rooted in a complex substrate of skills, traditions, and relationships unique to each environment, which have developed over time. Simultaneously, it highlighted a common need across different territories for process renewal, knowledge recovery, and strengthening territorial networks.

The adopted model to address these challenges is Responsible Advanced Design (RAD) (Formia, Gianfrate & Succini, 2023), which has been tested in complex transnational contexts and within heterogeneous working groups. One example of RAD application is the international project *"Winter School Design for Responsible Innovation"* [1] that involved, through a collaborative process, the University of Bologna, the TEC of Monterrey and UC de Santiago of Chile with the aim of investigating

[1] https://adu.unibo.it/winterschool/

the relationship between design, gender equity, inclusion and ethics in a transversal and interdisciplinary perspective. Other experiments have been conducted in third mission activities, particularly in knowledge innovation processes developed with companies in the productive sector of the Emilia-Romagna region (Italy).

This approach stems from the principles and theoretical foundations of Advanced Design (AD) (Celaschi, 2016; Celi, 2015; Iniguez Flores et al., 2019), a methodology that the Advanced Design Unit (ADU) of the Department of Architecture at the University of Bologna has been exploring scientifically and through local and international action research projects since 2013. ADU investigates how AD can transform economic-cultural models within traditional, organizational, educational, and socio-technical contexts, promoting an integrated and collaborative approach among all key actors and communities in the product/service value chains (Succini et al., 2021).

The four key dimensions of Advanced Design (Celaschi, 2016) – designing for the future anterior, collecting semi-finished products with a shelf innovation perspective, imagining projects without clients, and researching outside domains for extreme design solutions – define this systemic approach, its objectives, and application tools.

This approach leads to:

- Activating iterative multi-stakeholder creative design processes for continuous innovation.
- Embracing visions, needs, and perspectives across scales through co-design processes.
- Anticipating the future by experimenting with technological, methodological, or process solutions to broaden the long-term visions of products and services.
- Considering the temporal factor by continuously engaging with the accumulated material and immaterial heritage and contemporary and future influences on it.

Since 2020, the principles of Responsible Innovation (Stilgoe et al. 2013) have been integrated into this approach, aiming to initiate research and project forms that promote ethical-social innovation balance, consider social and environmental impacts from the early project stages, and propose sustainable, open-access, inclusive, and non-hegemonic development strategies.

The interconnection between Advanced Design and Responsible Innovation led to the formulation of the Responsible Advanced Design (RAD) approach and its testing in various local and international contexts. From 2020 to the present, these experiments have allowed for the validation and refinement of certain practices, altering the interaction among the various constitutive factors.

Responsible Advanced Design can be synthesized into four macro-actions: Responsible Thinking, Responsible Community, Responsible Production, and Responsible Design (Succini, 2023). Each

macro-action, depending on the context in which it is applied, can be more or less dominant or present. Based on the project goal and the composition of actors, each macroaction offers a series of RI-oriented actions and tools adaptable to the situation.

4. Cross Countries Experimentation: the Frontier Project

Within the *FRONTIER* Project, the Responsible Advanced Design approach served as a starting point for initiating dialogue among the partner universities, sharing visions, and conducting a research, training, and action process among young designers and researchers, and the traditional knowledge characteristic of the three territories: Italy, Colombia, and Brazil.

"FRONTIER: Design Innovation and Traditional Craft" commenced in late 2022 as an international collaborative initiative involving the University of Bologna, UNAL of Palmira in Colombia, and UNISINOS of Porto Alegre in Brazil. This project aims to revitalize and promote traditional textile crafts by integrating customized digital technologies in the areas of Biocreativity, Data Visualization, and Artificial Intelligence (Llorach, 2021; Sangüesa & Guersenzvaig, 2019). By doing so, it seeks to enhance cultural heritage, foster creativity, and emphasize the unique artisanal identity of the respective regions.

Participants from the three universities explored the intersection of innovation, design, and traditional craftsmanship to develop projects that enhance and promote traditional artisanal techniques through the integration of cutting-edge and emerging digital technologies. By merging traditional know-how with new and/or digital technologies, the aim was to preserve and modernize products, services, and professions. This was achieved by fostering sustainable relationships and networks with cultural and creative sectors, institutions, universities, research centers, regional and national authorities, businesses, and other stakeholders, all with a focus on innovation, employment, and sustainable growth.

Information, stories, techniques, aesthetic canons, places, equipment, sounds, and materials were interpreted as data and incorporated into nodes of new value chains for products or services, intertwining the physical and virtual worlds (Gianfrate et al., 2024). Through an analysis of traditional craft supply chains, the project responses were characterized by a strong connection to local territorial capital, understood as a systemic ensemble of material and immaterial elements, factors, and resources, including communities, entrepreneurs, landscapes, as well as capacities for innovation, traditions, infrastructure, and both explicit and tacit skills.

Participants in the International Workshop envisioned how traditional factors contributing to value creation could be

extracted, repositioned, or recombined in different, including virtual, contexts. They explored how diverse usage modalities could generate opportunities for exchange, profit, and interaction, offering alternatives to mere production, thus making this heritage more accessible, usable, and interactive.

The collaboration between designers and artisan communities resulted in a fusion of cultural identity and preservation of material and immaterial knowledge heritage with the creation of products and services. This was achieved through the highly customized use of digital technologies to activate new hybrid and "phygital" (physical + digital) artisanal skills, promoting a responsible transformation process for society.

The application of RAD Methodological Approach to *FRONTIER*, has been started with the macroaction of Responsible Design: through the support of an open-source cataloging tools, each country mapped various factors characterizing the textile production process, including materials, production/processing techniques, patterns, and reference communities. This led to the activation of Responsible Thinking, resulting in the development of Design Experience, which included cross-disciplinary competence modules on potential frontier technological innovations relevant to traditional crafts.

The interaction among these macro-actions initiated experimental design workshops within each university and subsequently among the different research groups, tools included in Responsible Production, leading to the development of prototypes integrating elements of material culture, immaterial culture, new technologies, and responsible innovation strategies. Finally, Responsible Community was built through various tools: peer-to-peer reviews, knowledge sharing, and co-design in complex contexts, as will be analyzed further.

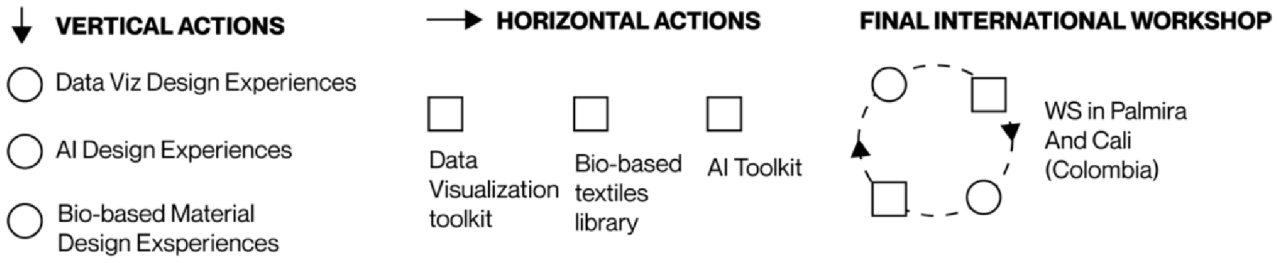

Figure 1. Application of the methodology in the FRONTIER project.

4.1 The Blended Experience

The preparatory phase involved designing an interaction process between research and teaching that would promote teaching/learning methods among transnational groups and with actors outside the academic world. The first phase of the project has been developed through the blended Design Experiences, hybrid laboratory teaching activities (conducted in person at the three campuses, interconnected online) from late February 2023 to April 2023 to familiarize students with cutting-edge technological innovations related to design on three key themes: Bio-creativity (knowledge and application of local circular materials), Dataviz (use of open tools and open data as an analysis methodology, transmittable and replicable across different disciplines), and Artificial Intelligence (using AI to unlock new value from existing data and relationships, enabling new product-service systems). The Design Experiences were led with an interdisciplinary approach (computer science, design, textile materials, and fashion) and provided students with the individual skills to address project topics, allowing them to conduct experimental initiatives using new open-source hardware and software tools. Additionally, during the Design Experiences, digital collaborative tools and blended teaching delivery methods were tested to facilitate collaboration among local and international groups.

In Italy, the project involved 5 professors and 20 students from bachelor's and master's Degree Courses of Design and Advanced Design of the University of Bologna, divided into 4 groups. Projects will be conducted with the participation of traditional craft realities of Italian context linked to textile traditions and materials (Turrini & Sbordone, 2020). Students created their own connections, participating to on-site visits, attending on-line meetings with experts, and collecting data and ideas according to their background and inspired by the traditions of their places of origin.

In Colombia, the *"FRONTIER: Design Innovation and Traditional Craft"* was developed by 21 undergraduate students and 10 professors from Industrial Design, belonging to the Facultad de Ingeniería y Administración, Universidad Nacional de Colombia, Sede Palmira. Seven teams were created, with a focus on the textile production of the Departamento del Cauca in Colombia, considering two references:

- The work developed by CODESPA with the "Enredarte con Identidad" Indigenous Women's Association (2024).
- The CORSEDA company (2023).

The Indigenous Women's Association "Enredarte con Identidad" is a collective of nearly 200 artisans who expertly handcraft bags and other items using locally sourced wool and fique. They employ traditional techniques including hand-dyeing, crochet,

and vertical loom weaving to create products, primarily handmade bags adorned with designs inspired by indigenous cosmology. To gather information, the students conducted three meetings and conversations with experts and indigenous artisans from the CODESPA Foundation, to identify specific characteristics of the community, and the social goals of the project, but also to delve into the production process, including raw material extraction, treatment, design, product creation, and knowledge transfer. The last meeting brought indigenous artisans to the university for a handson demonstration of weaving techniques. The artisans shared their expertise, showcased their products, and interacted with the students, providing invaluable insights into the intricate craftsmanship behind these unique pieces.

A visit was conducted to CORSEDA, an organization situated in the Department of Cauca, Colombia. This enterprise is comprised of approximately 200 families dedicated to the production of silk cocoons and handcrafted silk items. Their operations encompass the entire silk production process, from silkworm breeding to the sale of finished fabrics in both domestic and international markets. By incorporating the expertise of silk masters, they create unique pieces that distinguish themselves in terms of yarn type, color palette, texture, and overall appearance.

Participants documented the distinctive sounds, scents, colors, and flavors characteristic of the local environment.

At the end of this first phase, students divided into groups from their home universities submitted 11 projects in May ‘23, that took up the challenge to identify and map the factors influencing the traditional textile design production processes, in order to share the most innovative resources and transform them into new data and prototypes through the collective action of multidisciplinary and international teams. Through new tools and innovative approaches able to make these heritages more accessible, usable and interactive, information, stories, techniques, aesthetic canons, places, equipment, sounds and related materials have been interpreted, in the form of data, into nodes of new product or service chains and value components that interweave the physical and virtual worlds. The participants’ projects were assessed by a committee from the 3 universities involved. Students from the winning projects were able to participate in international mobility.

4.2 The International Workshop in Palmira

The *FRONTIER* experience in Palmira-Colombia involved a collaborative effort with students and professors from the three universities. Approximately 35 individuals, including students, professors, and researchers, participated in this initiative. To facilitate the dynamic process, three groups were formed, each consisting of seven students from both Italy and Colombia. Professors and researchers from the three universities

worked together to develop the workshop and create a unified methodology and approach based on field diaries to document the region's characteristics, participatory activities with local stakeholders, and systemic maps to analyze the problem and develop relevant concepts.



Figure 2. Co-Anylisis activities.

In this context, the participants reflected on the interdependence of the factors characterizing a traditional production process, metaphorically viewed as an algorithm, and its potential representations in the form of data, discovering new relationships between the material and immaterial dimensions. The Palmira's experience allowed for the practical application of acquired skills in a region offering a wealth of innovation opportunities related to the subject of investigation: visits to museums, street tours, exploration of significant graphic production sites, and experiences of local flavors and sounds, topography and biodiversity in urban and rural areas were reported in field diaries to document sensory experiences (hearing, touch, sight, taste, and smell) at each location. Students participated in a series of design activities, including creating relationship maps to identify key factors and research questions, developing preliminary alternatives, and formulating a final proposal on three topics:

- Fighting the impact of artificial urbanization in the Boulevard del Río Cali area by mixing artificial and natural elements in this territory
- Accessible and inclusive interactions through sensory narratives between visitors and the Alameda Gallery?
- Use of natural materials in lantern printing to ensure the transmission of this tradition to future generations in Valle del Cauca

Several key factors contributed to the workshop's success, including effective communication, time management, and a positive, empathetic atmosphere. Communication throughout the workshop was smooth, utilizing multiple languages (Spanish, English, Italian, and Portuguese), as well as gestures and body language. This linguistic and nonverbal diversity greatly facilitated understanding and interaction among participants.
To complete the project, In October 2023, a delegation of students and faculty from Colombia participated in an exchange in Italy, attending the *FRONTIER* Finissage Workshop.

5. Frontier Results

The combination of these activities enabled the identification of new learning and training formats on an international scale, providing concrete experiences of the necessity to circulate science and knowledge beyond borders, in an interactive process of content integration, comparison of the involved realities, and identification of shared values.

The challenge posed by the action-research initiative from *FRONTIER* was to deconstruct the critical and defining socio-technical factors of traditional craftsmanship, assumed also as cultural heritage, in order to more easily identify its relationship with the innovative potential of emerging technologies. Craftsmanship represents a complex ecosystem, built upon a deep knowledge of workable materials and a mastery of its processes. However, artisan enterprises are structurally fragile due to several factors, including their size, operational capacity, ability to innovate, investment capabilities, and difficulty in mobilizing and leveraging external skills and knowledge.

One of the strengths of this approach lies in the potential to shape and anticipate future scenarios, positioning the valuable components of traditional craftsmanship within a rapidly evolving value chain.
This has certainly driven the design of intervention strategies aimed at integrating new technologies, a necessary step as this ecosystem continues to undergo profound transformation.

Additionally, the FRONTIER initiative facilitated the implementation of an open knowledge program (webinars, design experiences, intensive workshops, blended lessons, etc.), linked to the advancements achieved during the eighth International Forum of the Latin Network[2].

[2]https://www.forumdesignprocess.org/dgdw22/

The development of transdisciplinary educational programs based on the learning-by-doing approach through unconventional forms of teaching/learning in collaboration with actors outside the academic sphere was another significant achievement. This included the creation of physical and digital outputs of product-services capable of investigating the relationship between material culture and the humans who produce and/or consume it, within a multi-level innovation system, approaching the understanding of production processes through the application of open and online tools:

- A digital library of local biomaterials for textiles (FRONTIER Materials Library). This tool for the three countries promotes local resource processes on global actions.
- A portfolio of workflow tools for students to process and analyze data gathered during the research phase (AI and Dataviz toolkit), consisting of interactive cloud sheets to prototype algorithmic processes on their data through pre-set code, and tutorials for using commercially available online generative AI tools for processing texts, quantitative data, or images.

Enhancing collaboration between the academic and non-academic worlds resulted in the development of transversal skills in communication, sharing, and digitalization among students, as well as among the faculty and young researchers involved. Knowledge dissemination was further promoted through the organization of seminars open to public and private entities, a series of interviews conducted by UNAL television, and the exhibit of winning projects during the side event Bootcamp Design for Human and Planet Care organized in Bologna on October 12. This event was part of the Tenth Anniversary Celebrations of the Design Course at the University of Bologna, in collaboration with EIT KIC Culture & Creativity, which organized the C&C Days during the same period. The event featured the participation of international guests for a panel discussion.

6. Responsible and Advanced: Design for the Future

FRONTIER initiated a preliminary design effort among the various participating institutions to establish a common language, facilitating a collaborative approach to the complexities of responsibility, ethics, and gender, as well as the values inherent in traditional production processes. This approach particularly emphasizes human, cultural, and environmental components, and the rituals that render these processes unique.

The project's impact highlights how contemporary and future cultural flows, anticipated through scenarios developed using Advanced Design methods, influence how people live, act, and behave according to intersectional variables, which assume unexpected dimensions in transnational contexts. The collaborative process activated in both experiences was tied to design research and education pathways, exploring the capacity of design cultures to anticipate

shocks and support engagement and co-creation with diverse communities. This was achieved through interdisciplinary innovation, integrating social sciences, humanities, and cutting-edge technologies to address situated concerns from a global perspective and considering the value of anticipation for developing more sustainable, inclusive, and generative futures (Bosco et al., 2021; Zembylas et al., 2023).

Responsible innovation and education form a dynamic and interconnected duo, fostering transformative skills in students and supporting the adaptability of educational programs in facing the increasingly intricate challenges of sustainability and inclusion characteristic of contemporary times (Boehnert et al., 2022). This promotes an inter-, trans-, and multidisciplinary vision, where design constantly mediates between different forms of knowledge (Celaschi, 2008).

FRONTIER experimented with both online and on-site forms, emphasizing the collaborative and multi-stakeholder aspect underpinning responsible, inclusive, and sustainable innovation. This requires hybrid and flexible learning spaces to be integrated into the training of young designers. Creating a learning community comprising researchers, teachers, and students capitalizes on the collective intelligence of individuals from diverse backgrounds and cultures, adopting and testing various tools, and blending skills and competencies.

The Advanced Design approach supported these principles from a perspective of educational universality, stimulating its ability to embrace a global movement aimed at responsible, inclusive, and sustainable innovation. However, it also adapts to territorial specificities, enriching the process with new values and visions. This requires a design attitude capable of addressing the specific transformations of the contexts of application and establishing a permanent learning community.

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A STUDY ON MODULAR CONCEPT DESIGN FOR STREET VENDOR MARKETS IN THE CONTEXT OF CONSUMPTION DOWNGRADING

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ABSTRACT | In the aftermath of the COVID-19, with the economy slowly recovering in a "W" shape due to complex factors and emergencies. "downgrading consumption" has become the most direct choice for people to cope with the challenges. Vendor bazaars provide an alternative public space satisfying a diverse and borderless consumer experience. However, vendor bazaars are seldom supported by policies; on the contrary, they tend to be vigorously evicted by the relevant authorities mainly due to their non-prescriptive nature, which affects the city's appearance and violates the city's street order. There is still a lack of research that can resolve the conflicts between consumers, vendors, and management in the context of consumer downgrading. There is a lack of a design intervention strategy to explore the model of rapid commercial erection actively.Taking Chengdu Shuyuan Street as a case study, this study uses qualitative methods such as participatory tracking method, street notes with quantitative research methods such as questionnaire surveys to obtain the current problematic status of the hawker bazaar, combined with the actor-network theory to systematize the analysis of actors in the hawker bazaar, and, finally, design a modular stall space that can be quickly constructed for assembling and disassembling, in order to meet the needs in the context of consumer downgrading and promote urban inclusiveness for vendors. This research creates a modular hawker bazaar design solution that can be replicated and scaled up to promote the application and practical research of hawking in other cities.

KEYWORDS | MARKET VENDORS, MODULARIZATION, ACTOR-NETWORK THEORY, CONCEPTUAL DESIGN

1. Introduction

"Under the severe impact of the epidemic on the global economy, per capita consumption in various countries has declined, and the trend of consumption downgrading is obvious" (Shi et al., 2023, p. 1). In China, after the state deregulated the ground stall economy to cope with the problem of employment pressure in the post-epidemic period, the governance of vendors has become a hotspot of urban development research. "In order to promote economic recovery and alleviate employment pressure, the State Council and local governments have issued and adjusted a series of policies, proposing to support multi-channel flexible employment and rationally set up a model for the management of vendors without fixed business premises" (Liu & Wang, 2023, p. 27). In this context, consumption downgrading is gradually becoming a trend, and vendors have become a direct choice for most people to cope with the challenges.

"Street vendors play an important role in urban economies, especially during economic downturns" (Bromley, 2000, p. 1). "Consumption downgrading has led to the revival of markets as affordable shopping destinations" (Berner et al., 2012, p. 382). "Consumption downgrading has changed consumer preferences for more affordable and accessible shopping options." (Prahalad & Hart, 2002, p. 54) In addition, its existence has positive implications for alleviating urban unemployment and poverty, promoting urban cultural diversity, and lowering the cost of living in cities (Cross, 2000; Huang et al., 2018; Chen & Carré,2020).

However, vendor bazaars are seldom supported and recognized by policies. Instead, they are often vigorously evicted by the relevant authorities, mainly due to their non-prescriptive nature, which affects the city's appearance and violates the city's street order. "Vendors often face challenges in terms of space, regulations, and competition" (Cross & Morales, 2007, p. 12). "In the case of vendor bazaars, the central issue is how to reconcile city managers with the conflicting demands of vendors and consumers" (Huang et al., 2012, p. 78).

There have been studies on the design and governance of vendors to carry out reform practices, to a certain extent, easing the intense spatial conflicts and social contradictions. However, in general, it is still based on the spatial game of passive acceptance, tolerance, and compromise, and it still lurks in the context of social crises and governance deficiencies. Research on clarifying the conflicts between consumers, vendors, and city managers in the context of fee degradation and proposing design strategies to explore the model of rapid commercial construction actively is still somewhat insufficient. Based on this, this paper adopts actor-network theory to analyze the difficulties and deficiencies of current governance and combines empirical cases to explore governance and design solutions for urban vendors, providing new ideas for improving governance efficiency and design planning.

Actor-network theory emphasizes the characteristics of heterogeneous actors and their agency, providing an innovative perspective for the study of vendor bazaars. In Actor-Network Theory, "an actor is defined as any individual or thing, both human and non-human, capable of triggering change. Its core characteristics are heterogeneity and agency, i.e., all actors, human and non-human, can impact other actors in the network. In this way, the interaction process between actors becomes the key to the network, and these interactions are achieved through translational mechanisms that promote the maximization of the interests of all parties" (Latour, 2005, p. 71). These characteristics provide a better theoretical basis and analytical tool for studying vendor bazaars.

The article examines the following questions (RQ1): How does actor-network theory explain the complex interactions of vendor bazaars? Moreover, (RQ2) How can modular design strategies solve the spatial problems currently faced by vendor bazaars?

The article adopts a combination of qualitative and quantitative research design to answer these questions and to explore their inherent contradictions, using the vendors on Shuyuan Street in Chengdu City as a case study. The design study consists of two phases. In the first stage of data receipt, 36 actors related to the hawker bazaar participated in the questionnaire survey. Participatory tracking and observation of Chengdu Shuyuan Street vendors were carried out to explore the potential commonalities behind them in depth based on a single case study. In the second stage of the design study, the actor-network theory was applied to sort out the contradictions among the consumers, city managers, and vendors. The modular design methodology was adopted, with the units being customized to provide the vendors with various choices and reorganization planning for the vendor bazaar.

The findings reveal the relationship of mutual constraints between the parties; the article's research proposes corresponding design strategies: 1. optimize stall design, 2. enhance consumer experience, and 3. promote

tripartite collaboration, which outputs design practice through a modular design approach. This study contributes to the hawker bazaar by (a) proposing a new approach that combines modular design with actor-network theory to provide a new perspective for urban research and design theory and (b) creating modular hawker bazaar design strategies that can be replicated and scaled-up to promote the application and practice of hawking in other cities.

This paper is divided into five parts; firstly, the article briefly introduces the theoretical background of actor-network theory. Secondly, the article reveals the study's findings from the data obtained from the qualitative research methodology, as well as the constraints and current situation of all stakeholders behind the vendor bazaar. Next, the article highlights the relevant design strategies and how the modular design approach can resolve their conflicts and promote the development of hawker bazaars in the context of consumption downgrading. Finally, the article details the shortcomings and contributions of the study.

2. Literature Review

This section mainly discusses the literature review related to actor-network theory and modularization, specifically adopting actor-network theory as the primary research theoretical basis to systematically analyze the internal analysis of the hawker bazaar, to explore the relationship and influence between its different actors, and at the same time selecting the modularization design methodology to reorganize the planning of the hawker bazaar, and the following is the review of the existing theories.

2.1 Actor-Network Theory

In the context of consumer downgrading, the study of the modular conceptual design of vendor bazaars is of great significance. In order to gain a deeper understanding of this area of research, this study will use Actor Network Theory (ANT) as a theoretical underpinning to explore the various types of actors and their interactions in hawker bazaars.ANT provides a unique perspective that can reveal how social and environmental factors work together to shape the operation and development of a bazaar by including both human and non-human actors in the same network.

In Reassembling the Social: An Introduction to Actor-Network Theory, Latour states that "society is not only made up of individual human beings, but also includes a variety of non-human factors such as technological, material, and natural phenomena". Phenomena. These non-human factors play an essential role in the social process. They should not be ignored" (Latour, 2005, p109). He emphasizes that "social structures are constructed through the process of interaction and translation between human and non-human actors". In this process, actors negotiate, adjust and redefine each other's roles and positions to form a solid network structure. John Law further develops

the theoretical framework of ANT in Actor-Network Theory and After. “Actor-network theory is not just about the relationships between objects and humans, but also about the dynamics and changes in those relationships”. “Each node in the network (i.e., each actor) is active, and the form and function of the network are constantly changing “ (Law, 1999, P20).

Given the relationship between vendor bazaars, consumers, and city managers and the influence of non-human actors such as the regulatory, institutional environment and the built environment on vendor bazaars. This paper utilizes actor-network theory, which can provide insight into the complex network structure of hawker bazaars and theoretical support for design. By focusing on the interactions of heterogeneous actors, the design of hawker bazaars can be better adapted to dynamic changes and enhance the vitality and sustainability of the bazaar. Therefore, actor-network theory provides a better perspective for analyzing and studying hawker bazaar research. The adaptability of actor-network theory to the study of hawker bazaars is reflected in four aspects:

First, actor-network theory aims to explore how heterogeneous networks of human and non-human entities are constructed and maintained. This breaks with the traditional sociological view of society as an inherent, static, orderly entity. Instead, society is viewed as a dynamic and ongoing process of connections between multiple elements (Latour, 2005, p. 7).

This view has important implications for designing vendor bazaars, which are a complex network of multiple heterogeneous human and nonhuman elements.

Secondly, as human actors, vendors, consumers, and city administrators play critical roles in vendor bazaars. Their interactions and transactions not only determine the economic activities of the bazaar but also influence the social culture of the bazaar. However, non-human actors (e.g., the design of stalls, digital payment systems, communication platforms, etc.) are equally important. Latour points out that “the agency of non-human actors cannot be ignored, and they can make a difference or have an impact that alters the behaviour of human actors” (Latour, 2005, p. 34).

Thirdly, the design of vendor bazaars needs to emphasize the interaction process between actors. These interactions include direct transactions between vendors and customers, the balance between vendors, coordination between vendors and management, and interaction between vendors and other influences. “By tracking these interactive processes, their dynamics can be better understood and provide valuable references for design” (Latour, 2005, p. 71).

Therefore, this study analyzes the vendor bazaar using actor-network theory. This theoretical framework not only helps to reveal the complex relationships in the operation of the bazaar but also can provide innovative ideas for design practice.

2.2 Modular Design

Modular design is a practical approach to solving contemporary urbanization problems. For example, in their book Refabricating Architecture, Kieran and Timberlake explore the potential of modular architecture, arguing that this approach can significantly shorten the building construction cycle, reduce costs, and improve the quality of buildings (Kieran & Timberlake, 2003, pp. 45- 49). By having prefabricated modules that do most of the construction work in a factory and are then assembled on-site, modular construction can reduce the impact on the on-site environment and provide greater building flexibility. It can provide flexible operating space for vendors to adjust the layout of their stalls according to market demand and individual needs. In addition, the modular design can facilitate cooperation and resource sharing among stallholders, enhancing the overall effectiveness and attractiveness of the bazaar. For example, Schneekloth and Shibley noted in their study that "modular design helps to create more inclusive and dynamic public spaces that enable a variety of stakeholders to work better together" (Schneekloth & Shibley, 2000, pp. 85-88). "Modular market structures offer solutions to spatial constraints in urban areas." (Davis, 2006, p. 29) "Modular stalls can be assembled and disassembled quickly, providing flexibility for street vendors." (Mehrotra, 2011, p.12) "Modular design provides a cost-effective solution for market infrastructure in urban environments." (Kieran & Timberlake, 2003, p. 29) "Modular design can enhance the inclusiveness and accessibility of markets in urban environments" (Deleuze & Guattari, 1987, p. 45). "In urban planning, modular approaches can address the challenges posed by the informal economy" (Roy, 2005, p. 147). "Modular design allows for flexibility and adaptability of urban spaces to the dynamic nature of markets" (Chen & Luo, 2018, p. 45).

The adaptive relationship between modular design and actor-network theory provides a new perspective to understanding complex systems and social phenomena. "Modular design emphasizes the flexibility of systems and fits with the concept of heterogeneous networks in ANT. Each module in a modular system can be seen as an independent actor that connects and interacts with each other through network relationships." (Langlois & Garzarelli, 2008) "The scalability of the modular design allows the system to add or subtract modules as needed, similar to the scalability of networks in ANT. By continually introducing new modules or actors, the system and network can continue to expand and evolve." (Yoo, Henfridsson, & Lyytinen, 2010) "Maintainability in modular design is closely related to network stability in ANT. Modular design makes it easier to identify and fix system problems and maintain the network's stability and continuity." (Pollock & Williams, 2008) By combining these two approaches, we can better analyze and design flexible, scalable and stable systems that reveal the network's interactions and relationships between human and non-

human actors. This not only helps to improve the effectiveness of design practice but also provides new perspectives on the study of vendor bazaars.

Therefore, the article uses modularization as the design method to design modular standard hawker space, to resolve the existing conflicts, to enhance the flexibility and adaptability of hawker bazaar, and to form a fast-constructing business model, to be more adaptable to the needs of the current business society.

3. Methodology

3.1 Research Methodology

This section is intended to enhance the understanding of the particular research area and to propose appropriate strategies for subsequent research. This study first uses a combination of qualitative and quantitative research methods, using Chengdu Shuyuan Street as a case study, with a survey period from April to July 2022. Qualitative methods such as the participatory tracking method, street notes, and semi-structured interviews were used to obtain the current status of the problem of current vendors. In-depth case studies of current vendors were conducted to obtain a more direct, complete, and comprehensive understanding of behavioural interactions and to obtain vendors' characteristics regarding their size, type, and space through on-site observation and recording during peak business hours.

Qualitative research provided detailed descriptions and complex background information for this study. Quantitative research was adopted by distributing 40 questionnaires to residents and consumers through questionnaire surveys, and 36 valid questionnaires were collected. Quantitative research provides objective and quantifiable data and patterns. The mixed research method allows for a more comprehensive understanding of the research phenomenon and enhances the depth and breadth of the study. This complementarity makes the findings more persuasive, provides richer insights for subsequent research, and enhances the validity and reliability of the study.

Second, the actor-network theory is applied to sort out the patterns of space use of the vendors in Shuyuan Street, the consumer behaviour and interaction between the vendors and the city administration, and the facilitating role of the digital payment system and the communication platform, to analyze the complex relationship among consumers, vendors and city administrators more comprehensively, to reveal how the human activities, the design practices and the social dynamics work together to form a complex interactive network, and to clarify the interests and obstacles of the actors in the process of constructing the network. The interests and obstacles of each actor in the network construction process are clarified. Finally, combining the modular design methodology proposes a conceptual design solution for the Chengdu Shuyuan Street Vendor Bazaar.

3.2 Research Analysis

The site is located in the Shuyuan Street area of Chengdu; the site has a large number of vendors, but there is currently no planning for vendors, and there is a more severe conflict between vendors and city managers within the entire site, making it difficult to strike a balance. The current site has the following characteristics:

- The site is located in the old city of Chengdu, with many residents and high traffic flow in the neighbourhood;
- The existing site already has a certain number of vendors congregating and appearing at fixed times of the day on a mobile basis;
- Vendors are mainly located in public spaces such as community public spaces, sidewalks, marketplaces, and entrances and exits of subway stations;
- T-Vendors mainly utilize urban fringes and grey spaces and often secure their survival by appropriating various types of public space;
- Easy to cause problems such as traffic congestion, crowd confusion, poor public order and sanitary environment.
- Vendors are mainly located in public spaces such as community public spaces, sidewalks, marketplaces, and entrances and exits of subway stations.



Figure 1. Current situation of vendors on Shuyuan Street.

The study found a high demand for vendors on Shuyuan Street, and residents visit the street from 12:002:00 pm to 5:00-10:00 pm. In the afternoon, most vendors rest or move around under the influence of the city administrators. In terms of the structure of goods sold, the main categories are food (55%), daily necessities (20%), and services (24%); in terms of the types of vendors, they can be broadly categorized into seasonal vendors, part-time vendors, and full-time vendors with a wide range of distribution areas.

Table 1. Vendor Type Chart.

Type of vendor	Description of activities	Type of vendor
Seasonal vendors	They are mainly migrant workers who work at home during the busy farming season and go to the city to set up stalls to increase their income during the non-busy farming season.	Seasonal vendors
part-time vendor	Low-income urban wage earners use off-duty hours or weekends to set up stalls and trade cheaply. They usually sell their goods at wholesale markets in cities and use night and morning markets. Part-time vendors also purchase their mobile vans for food and beverage sales.	part-time vendor
Dedicated vendors	Their work is relatively stable, mainly operating on a full-time, fixed-term basis and moving around at different times according to the needs of the people in the vicinity, which can generally be categorized into three time slots: morning, midday and evening.	Dedicated vendors

A more specific example: this study follows up on Auntie Wang, a sweetened fruit vendor in the venue, who epitomizes the many vendors in Chengdu, and thus a case study of her is universal and valuable. Auntie Wang, a resident of the Shuyuan community, aged 59, has been making sweetened fruits since she was laid off from her job, and the tools she needs to go out to the stalls are a wheelbarrow, horse zipper, umbrella, power supply, light bulb, thermos box, cooking utensils, and ingredients, etc. During the whole day's behavioural proceeding, there are a total of four kinds of behaviours involved, which are: preparing ingredients, going out to the stalls to look for stalls, setting up the stalls for sale, and closing the stalls for home, and in the process of selling, Auntie Wang, along with the different other actors and needed to change at any time.

Stage 1 is the preparation of ingredients, which is difficult to determine due to the vendor's inability to estimate the number of customers, resulting in the preparation of ingredients in a problematic quantity.

Stage 2, the stalls are looking for stalls. In this process, the location of the vendors changes with the flow of customers and the "surprise inspections" by city managers, resulting in the phenomenon of moving around and having no place to stay.

Stage 3, the most prominent part of the problem, in the process of finding a suitable location to settle down and set up a stall to sell, the vendor's constantly moving with the changes of other actors, and at the same time, the change of emotions from finding a location to breathe a sigh of relief, to the pleasure of selling, to the anxiety of being evicted by the city administrator, in this stage of the contradiction between the city administrator, the vendors and the consumers more and more prominent, and even many times In this stage, the conflict between the city manager, the vendor and

the consumer becomes more and more apparent, and there have even been many cases where the vendor has been expelled by the city manager in the middle of the food preparation process after the consumer has already paid for the food, thus forcing him to end his business, which is a kind of invisible harm to both the consumer and the vendor, while the city manager is only fulfilling his responsibility and work.

Stage 4, closing the stalls and going home, is also characterized by a greater degree of randomness, with vendors deciding whether to finish for the day or not as the flow of customers gradually diminishes. This shows the gradual increase in conflicts between vendors and city managers over time, and the mobile change of selling locations has become a daily routine for regular operators.

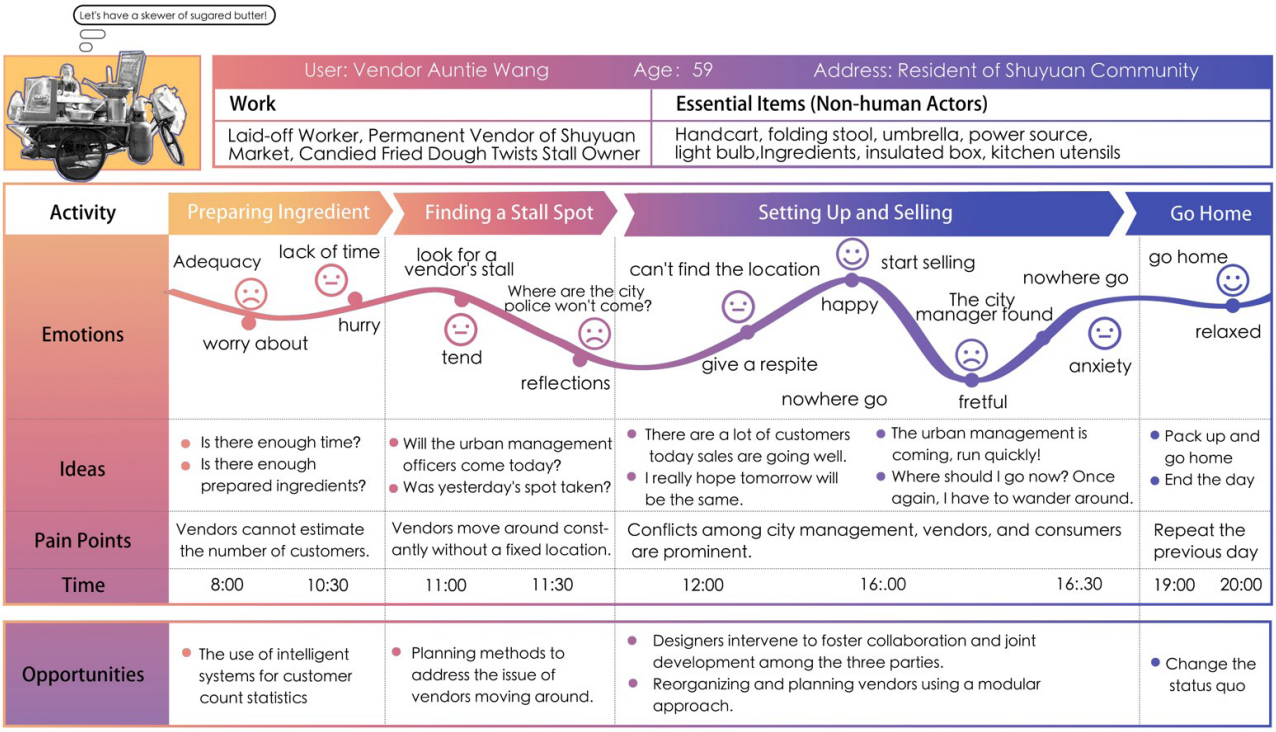

Figure 2. Journey map of vendors and users on Shuyuan Street.

In terms of the existing spatial distribution of vendors, on the one hand, vendors tend to be close to formal stores with consumers of the exact nature, enjoying the externality benefits of spatial proximity and sharing the market through price differences and product complementarities, e.g., cell phone sticker vendors have been selling in the vicinity of cell phone stores for a long time, and snack vendors are closer to the vicinity of the basement of the snack bar; on the other hand, vendors spontaneously form a particular scale of concentration, or On the other hand, vendors will spontaneously form a particular scale of concentration or distribution to attract consumers. New entrants can then identify the existing consumer market by entering the cluster.

The clustered vendors adopt differentiated marketing strategies, which will not lead to vicious competition with homogeneous products. At the same time, vendors are vigilant in observing and capturing the crowded consumer market, waiting for the opportunity to emerge at the city's boundary line, where they can capture the flow of people, avoid city administrators, and balance their interests.

4. Findings

The findings of this paper involve two main parts. In the first part, the actor-network theory is applied to reveal the contradictions and conflicts of existing hawker bazaars in the context of consumption downgrading, which are

1. the interaction between hawkers and the design space,
2. the relationship between hawkers and consumers,
3. the coordination between hawkers and city managers.

In the second part, the study reveals which design strategies can effectively dissolve the current problems and thus promote the development of hawker bazaars in consumer downgrading. The findings in this part include (1) optimizing stall design, (2) enhancing consumer experience, and (3) promoting tripartite collaboration. The main findings of each part will be described in detail below with specific pictures.

4.1 Images Network Of Actors In Vendor Bazaars In The Context Of Consumption Downgrading

The study analyzed the data of Chengdu Shuyuan Street and deeply combined it with actor-network theory to excavate and analyze the inner causes of its problems, and responded to the question of (RQ1) How does actor-network theory explain the complex interactions of the vendor bazaar? The following diagram of actor-network relationships is derived in response to the question.

Interaction problems between vendors and designed spaces

Vendors currently face limited space, resulting in stall designs that do not meet functional needs or affect the consumer experience. Existing vendors occupy many public transportation spaces, generating problems such as road congestion, affecting the regular use of sidewalks or driveways, and a lack of flexibility in design, with stall designs unable to adapt to changes in vendor needs, such as seasonal demand or business expansion. Moreover, This produces a large number of environmental health pollution problems; all kinds of pollution often in the vendors go away after still stay in place, and even more because of the fumes and other long-term pollution caused by the ground discolouration and other irreversible impacts affecting the appearance of the city.

Vendor-consumer relations

There is a mismatch between consumer needs, and vendors' design may not fully consider consumer needs and preferences, resulting in a poor shopping experience. Different vendors have different carts and use different physical facilities, most of which are freely designed and then processed by factories, resulting in various carts of various colours. This informality inadvertently destroys the image of the original formal presence of streets and stores. Some even use stronger colours or abrupt images to differentiate themselves from other merchants, attract customers, and increase recognition. The interactive design of the stalls is also too simple to attract consumers or enhance shopping convenience effectively.

Problems of coordination between vendors and urban managers

Urban management policies place excessive restrictions on the business activities of vendors, affecting their flexibility and ability to innovate. Existing management measures have not been adapted to vendors' actual needs and design, resulting in difficult or ineffective implementation.

Actor-network theory emphasizes that interactions between human and non-human actors constitute social phenomena. The actor-network theory used in the study of vendor bazaars first helps to identify the various types of actors, including non-human actors, key actors, and the shifting roles of actors in the process, which in most social science theories refers to vendors or consumers and city administrators, and that "effective management of a marketplace requires cooperation among vendors, consumers, and city authorities. " (Bhowmik, 2005, p.2256) But the fact is that for vendor bazaars it is more than that. The business activities of vendors are not only influenced by human actors but also by conditions such as nonhuman actors. The actors of the vendor bazaar come first from vendors, consumers, city managers, residents, designers, and suppliers, who are the core subjects of the vendor bazaar, i.e., human actors. Secondly, feed, back systems, communication platforms, digital payment systems, weather and waste management, i.e. non-human actors. These heterogeneous actors interact with each other in complex ways, influencing and constraining each other. Therefore, to solve the current problems of vendors, systematic thinking should be used to intervene with the following actors in the network of actors in the hawker bazaar.

Table 2: Human and non-human actors in vendor markets

Human actors	act	non-human actor	act
stall-keeper	Responsible for preparing and selling merchandise.	Modular booths	Provide a platform for vendors to sell their wares and facilitate quick set-up and dismantling of stalls.
consumers	Purchase of goods or services provided by vendors.	feedback system	Collect and analyze feedback from vendors, consumers and other relevant parties to facilitate optimization of management measures.
city manager	Responsible for regulating and supervising the activities of vendors to ensure their legal compliance.	Communication platform	Establishment of communication channels between vendors, consumers and city managers to facilitate timely transmission of information.

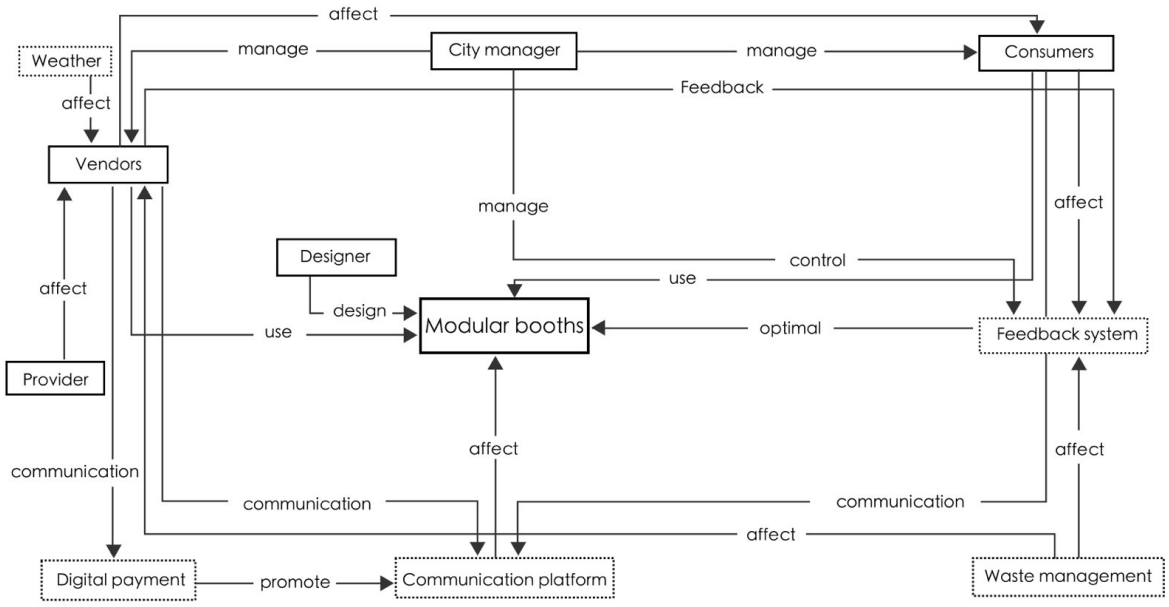

Figure 3. Map of the network of actors in vendor fairs

4.2 Modularized Vendor Concept Design

This section focuses on (RQ2) How can modular design strategies address the spatial problems currently faced by vendor bazaars? A response is provided. Existing actor-network theories have analyzed the relationship between stakeholders, so in terms of design practice, the physical space of the stalls is taken as the leading actor, and the contradictory relationship between different actors is gradually resolved to start from the planning and design of the stalls. Firstly, the capital attribute of the stall unit is weakened, and the use function of the stall is emphasized. Secondly, it is designed to be a more everyday and accessible commodity, reducing costs and creating more customizable modular spaces. The following design strategies were used to reorganize the planning of its vendor bazaar in terms of specific program design.

Optimize booth design

Research has been conducted that indicates that “modular market structures can be customized to meet the specific needs of different vendor types.” (Brand, 1994, p.17). “The use of sustainable materials in modular designs can reduce the environmental impact of markets.” (Lehmann, 2013, p.1). “Modular market designs can improve urban spaces’ overall aesthetics and functionality” (Jacobs, 1961, p.29). This study again builds on the development of stall units that can be flexibly combined and adapted. This design allows vendors to adjust to actual needs, improving space utilization and functional suitability. A 3*3 m3 prefabricated unit block is used as the base module, on which more than ten deformations are carried out. Vendors can choose according to their needs or increase and decrease the modules according to the changes in demand; recyclable and environmentally friendly fibre-reinforced composites (FRPs) are chosen to reduce the impact on the environment and enhance the sustainability of the modularization. Stacking the modules up, flexible updating and fast flow, the apparent mould moment relationship can present a high degree of visual order, solving the problem of vendors disturbing the order and affecting the appearance of the city, looking upward for space, forming a large number of staggered platforms, allowing the building body to produce a novel sense of dislocation, and ordering the use of space in the order of the premise of a more diversified and flexible. Rapidly build recyclable temporary buildings to help vendors combine on-site when in use, easy to dismantle and assemble so that they can be used and moved more flexibly, and at the same time, solve the problems of damaging the city’s image, leading to environmental pollution and security hazards.

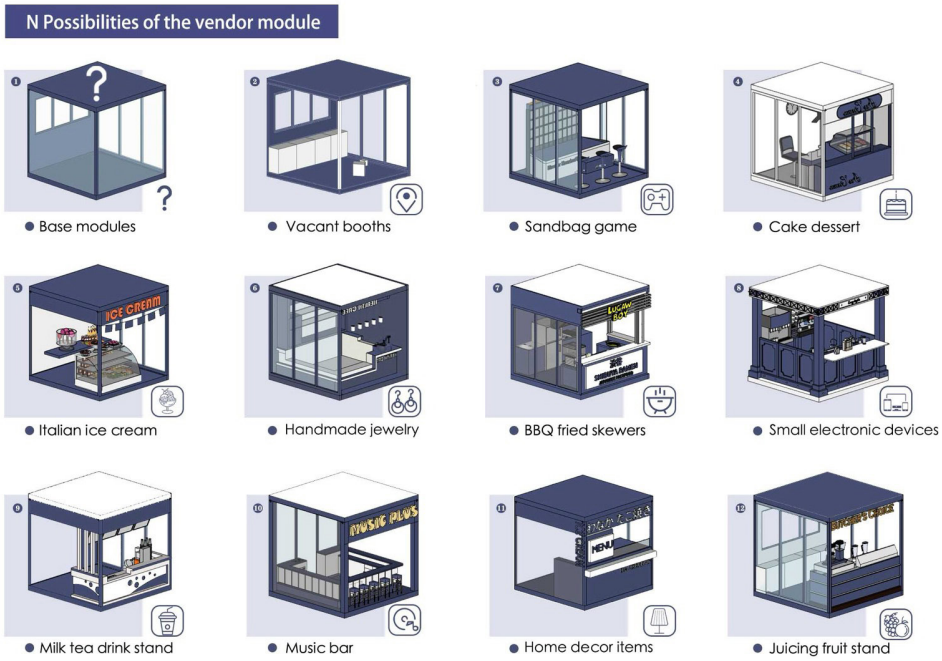

Figure 4. Vendor bazaar module module design

Enhance the consumer experience

The modular design can quickly gather more different types of vendor spaces to meet the diverse choices of contemporary people and design stall layouts and interactions that meet their needs, providing more support for consumption downgrading. On this basis, IoT technology is introduced to monitor and manage the use of vendors in real-time. With an intelligent system, vendors can book, adjust and maintain their stalls more efficiently, while the management can allocate resources and maintain order more efficiently. Transform the various negative impacts caused by the confusion and mobility of existing vendors. Design attractive, interactive elements to open up new experiences in the consumer scene.

Promoting triangular collaboration

Combined with the results of the analysis of actor-network theory, vendor bazaars, due to their unique attributes of complex systems, can establish communication platforms between vendors, consumers and city managers to facilitate information exchange and problem-solving. Track and assess the impact of feedback (actors) on design and management measures and make appropriate adjustments and optimizations. Establish a continuous improvement and innovation mechanism to encourage vendors and managers to develop new ideas and suggestions for improvement. Through this mechanism, the attractiveness and competitiveness of the market can be continuously enhanced. Organize regular

cultural activities and community involvement projects in the modular design space to attract more consumers and increase the flow of people to the market. These events could include musical performances, craft demonstrations and food festivals. In this way, they can be co-located to resolve the tensions and contradictory relationships between the three. To find a balanced and symbiotic path for vendors between top-down policies and bottom-up demands.



Figure 5. Conceptual design rendering of vendor market.

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SUSTAINABLE CHOICES, FRESH APPROACHES: REDESIGNING MEAL KITS USING ACTIVITY THEORY

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ABSTRACT | "Cook and eat" meal kits from pre-packaged food delivery services provide exact portions of ingredients required for specific recipes, promoting sustainability by eliminating food waste in the cooking process. However, these services often overlook some of the current consumer behaviours associated with their use. This study aims to explore consumer behaviour regarding the use of meal kits in the Swedish context, with a particular focus on the sustainability of these behaviours. Applying activity theory as the theoretical framework, this study explores how consumers interact with meal kits during the ordering, cooking, storing and disposal and identifies potential areas for service and packaging improvement to promote sustainability. The methodology used includes a combination of qualitative survey (24 answers), in-depth interviews and observations with 4 households to gather data about consumer cooking practices and perceptions and self-reporting from 3 of the authors. Specifically, the study focuses on the operational layer of activity theory, analysing the routine actions and adjustments consumers make while interacting with meal kits, which directly and both consciously and unconsciously impact food waste and its sustainability. Considering the harmonies and tensions found between the consumer, the meal kit, including the recipe, the food, and the packaging, and the homemade meal, the findings show that while meal kits ease the cooking process and save time, they are perceived as having excessive packaging and do not completely eliminate food waste as promoted. Design suggestions include considering returnable packaging systems, offering ingredient replacement options, providing freezable and microwavable recipes, and including new cooking guidelines such as taste-testing steps. These changes can better align them with consumer needs, and potentially reduce the impact of consumer use, reducing food waste and increasing the sustainability perception of the system.

KEYWORDS | MEAL KITS, ACTIVITY THEORY, DESIGN FOR SUSTAINABLE BEHAVIOURS, FOOD WASTE, PACKAGING

1. Introduction

In recent years, meal kits have risen in popularity as a convenient and efficient way for individuals and families to prepare home-cooked meals without the hassle of grocery shopping. These pre-packaged food delivery services provide consumers with exact portions of ingredients required for specific recipes, thereby promoting sustainability by potentially eliminating food waste in the cooking process (Sharda et al., 2024). Companies such as HelloFresh, Marley Spoon, or Linas Matkasse follow this trend, offering diverse menus and easy-to-follow recipes that provide for a variety of dietary preferences and cooking skills (HelloFresh, n.d.; Linas Matkasse, n.d.; Marley Spoon, n.d.) Consumers can choose from many options that change from week to week, including vegetarian, traditional diet, and low-calorie meals, among others, suitable for both lunch and dinner. These meal kits also present different difficulty levels, allowing consumers to select recipes based on their cooking experience and the amount of time they have available. For example, the service HelloFresh offers "Rigatoni with Goat's Cheese" as an easy and vegetarian option or "Oven-Roasted BBQ Chicken" as a medium-difficulty option for a traditional diet (HelloFresh, n.d.).

We can identify four main categories of meal kits available today in the market, presenting them into four types: cook-and-eat, heat-and-eat, ready-to-eat, (Global Market Insights, 2023) and nutritional meal replacements. The "cook and eat" kits include raw ingredients and recipes for consumers to make meals from scratch. The "heat and eat" kits include pre-cooked ingredients that require only minor heating before consumption. "Ready to eat" kits provide fully prepared meals that can be consumed immediately. Lastly, meal replacements, which come in powdered or liquid form, offer a quick alternative to traditional meals, with a focus on nutritional content and meal replacement. This study focuses on "cook and eat" meal kits, which require the preparation of meals using raw ingredients provided in specific portions. Figure 1 presents the four types of meal kits just described.

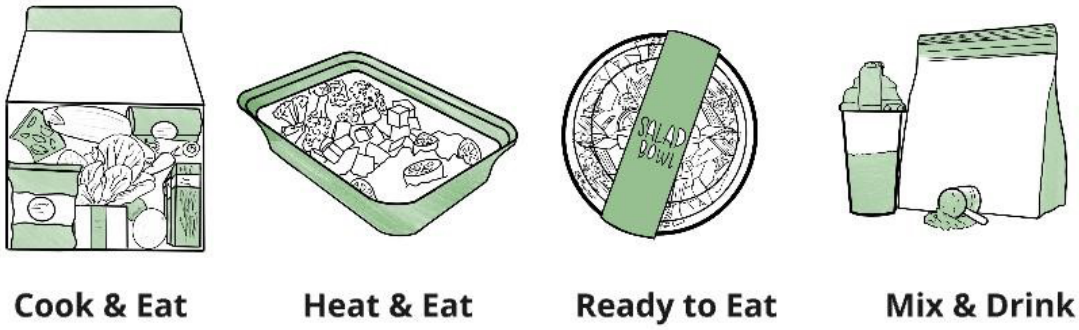

Figure 1 Type of meal kits

However, while "cook and eat" meal kits offer several advantages, including convenience and the reduction of food waste (Cho et al., 2020), they also introduce new sustainability challenges. For example, the significant amount of packaging required to keep ingredients fresh and separate can lead to increased waste if not properly managed. Additionally, the unflexible structure of pre-determined ingredients may not align with all consumers' eating habits or cooking styles, leading to food waste despite the intention of meal kits to minimise it. Thus, understanding the full impact of meal kits on sustainability requires a comprehensive analysis of consumer behaviours and perceptions associated with their use.

Activity theory, a framework originally developed by Soviet psychologists Vygotsky and Leont'ev, offers a valuable lens for examining these behaviours. Activity theory focuses on the interaction between individuals and their environment, emphasising the tools and community involved in any given activity (Leont'ev & Hall, 1978; Vygotsky, 1978). By applying this framework to the context of meal kits, we can gain insights into how consumers interact with these services during different stages such as ordering, cooking, storing, and disposal. This theoretical approach helps identify contradictions and harmonies within these interactions that may contribute to sustainable or unsustainable practices, guiding design strategies to develop functionality and user engagement towards sustainable outcomes (Chu et al., 2021).

Building on this, this study looks into consumer behaviour regarding "cook and eat" meal kits in Sweden, with a particular focus on sustainability. Using activity theory, we look into consumers' routine actions, both consciously and unconsciously, and their impact on food waste and sustainability, making use of a mixed-methods approach, including qualitative surveys, in-depth interviews, and observations, to identify areas for improvement in service and packaging. The goal is to provide new recommendations for meal kit services that will better align with sustainable consumption patterns.

2. Methodology

To uncover the unsustainable behaviours behind the "cook and eat" meal kits, the lens of activity theory is used. This framework allows us to understand the motives behind the use of meal kits, the goals that users aim to achieve, and the conditions and routines that influence their use. By employing a combination of surveys, observations, interviews, and self-reporting, we seek to capture insights into the different levels of activity theory as they relate to meal kit usage.

For this study, we used four different methods to gather comprehensive data. A qualitative survey was conducted among both users and non-users of meal kits. The objective was to understand the motives behind the decision to include meal kits in their grocery shopping routines. The survey gathered data from 12 users and 12 nonusers on their perceptions of sustainability, food waste, and the user-friendliness of meal kits. The questions were designed to uncover conscious behaviours and preferences. Through the survey, participants were also asked if they would be willing to take part in cooking observations for the next phase of data collection.

Observations of the meal kit used were carried out with four households recruited from the survey. During these sessions, we monitored the participants' actions from planning to cooking and storing or eating the food. This method provided insights into the operational layer of activity theory, focusing on routine procedures and the conditions under which these actions are performed. Following the observations, in-depth interviews were conducted with the participants right after the use of the meal kit, to look deeper into their goals and conscious decisions regarding the use of meal kits. These interviews helped to capture the participants' immediate reflections on the cooking process and their overall perceptions of the service.

The authors also engaged in self-reporting by using the meal kits themselves. This approach provided firsthand experience and insights into the different stages of meal kit usage, from ordering to cooking. Self-reporting helped to identify any potential biases or unique insights that might not be captured through observation alone.

The data collected from surveys, observations, and interviews were analysed qualitatively (Hashim & Jones, 2014). An affinity diagram was used to compile and categorise the data, highlighting common themes, tensions, and harmonies. This process facilitated understanding the participant's experiences and the identification of areas for potential improvement in meal kit services. The study was conducted within a Swedish context, involving consumers with varying diets (traditional diet, vegetarian, and with allergies) and household compositions, predominantly single or two-person

households. The group of consumers who agree on participating aligns with the current common household types most likely to use meal kits (Schoenbauer, 2019), as these services are particularly popular among single individuals and small households due to their convenience (Choi et al., 2023). Additionally, the diverse dietary preferences of participants reflect current diet trends (Global Market Insights, 2023), ensuring a more realistic spectrum of preferences.

3. Activity Theory Framework

For this study, activity theory is applied as a theoretical framework to better analyse the behaviours associated with meal kit services. Activity theory provides an approach to understanding human behaviour by breaking it down into a hierarchical structure of activity, action, and operation. The methods selected for this study align with these levels, enabling a detailed examination of the motivations, goals, and conditions that shape consumer interactions with meal kits.

Activity theory involves subjects, objects, and artefacts, together with the rules, community and division of labour, for this study we will be analysing the relation between the three first elements. The subject refers to the individual or group who performed an action. In this context, the subjects are the consumers using meal kits. The object is the goal or purpose that the subject aims to achieve, such as preparing a meal with minimal food waste. The artefact or tool is the means through which the activity is performed, which in this case includes the meal kits themselves, along with any associated packaging, instructions and online app or website. (Kaptelinin, 2024)

To analyse the different layers of activity theory and find the improvements within "cook and eat" meal kit alternatives, we focus on uncovering the tensions or contradictions. Tensions and contradictions are conflicts within the activity system that can hinder the achievement of the object (Engeström, 2015). They are relevant for identifying opportunities for improvement.

For this study, we reveal secondary and tertiary contradictions, focusing particularly on the secondary type. The four types of contradictions (Engeström, 2015) are:

1. Primary Contradictions:
These occur within each component of the activity system, such as within the subject or the artefact.

2. Secondary Contradictions:
These arise between components of the activity system, such as between the subject and the artefact or between the object and the community.

3. Tertiary Contradictions:
These occur when a culturally more advanced form of the activity is introduced into the current activity system.

4. Quaternary Contradictions:
These emerge between the central activity and its neighbouring activities.

Additionally, the study examines the harmonies within the system, which are the aspects users perceive as positive and that function well within the service. Understanding these harmonies helps in retaining effective elements while addressing the tensions.

This study also focuses on the improvement of the artefact within this system. Through the lens of activity theory, the cognitive evaluation and the potential for behaviour change in neighbouring activities are also discussed, as a result of using these services.

By applying activity theory to consumer behaviour with "cook and eat" meal kits, we aim to understand how consumers interact with the service at different stages. The activity level helps us identify the overarching motivations, such as convenience and sustainability. The action level allows us to explore specific goals, like following a recipe or reducing food waste. The operation level focuses on the habitual practices and conditions under which these actions are performed, such as cooking techniques and storage methods.

We collect data through surveys, observations, interviews, and self-reporting to gain insight about consumers' conscious and unconscious routines, allowing us to identify and classify specific tensions and harmonies within the meal kit service. This classification helps us to redesign and reduce secondary contradictions, such as resolving tensions between sustainability goals and packaging or maintaining harmonies like the convenience of pre-portioned ingredients, better aligning the service with user needs and environmental objectives.

4. Findings and Analysis

4.1 Findings from the Methods

Survey Results

The survey conducted among both users and non-users of "cook and eat" meal kits aimed to understand the motives behind the decision to include meal kits in their grocery shopping routines, their perceptions of sustainability and food waste, and the user-friendliness of meal kits. Most respondents highlighted the convenience of using meal kits, noting time savings and the ease of having pre-measured ingredients as significant advantages, aligning with the results of other studies (Moir, 2021; Shin et al., 2024). Users generally felt that meal kits helped reduce food waste because they provided exact portions needed for recipes. Additionally, meal kits were appreciated for introducing new recipes and adding variety to users' diets. Some users felt that meal kits encouraged healthier eating habits by providing balanced meals with fresh ingredients, and they enjoyed the simplified meal planning process as they did not have to think about what to cook each day.

However, there were significant tensions identified. A major concern among users was the excessive packaging associated with meal kits, which contradicted their sustainability

goals. When asked if the meal kits were considered a more sustainable option, one of the users pointed out in the survey:

“Hard to say. It is good that I don’t waste food but bad that everything is packed in individual packaging and the door delivery (increased transportation needs).”

Some respondents found meal kits to be expensive compared to traditional grocery shopping. Users also noted a lack of flexibility in meal kits, as they could not easily substitute or skip ingredients without creating waste. Additionally, some users felt that the meal options became repetitive over time, reducing their interest in the service and the only option of delivering is not perceived as a sustainable option in the service.

Observations and Interviews

Observations were carried out with four households using meal kits, monitoring participants’ actions from planning to cooking and storing the food. Following the observations, in-depth interviews were conducted to delve deeper into their goals and conscious decisions regarding the use of meal kits. Participants generally found the meal kits easy to use, with clear instructions that made the cooking process straightforward. Some participants perceived the service to ease the planning process. The quality of the ingredients was often highlighted, with users feeling that they were getting fresh and high-quality products. Users appreciated the time efficiency of meal kits, noting that they could prepare meals more quickly than if they had to measure and prepare all ingredients themselves.

Despite these positive aspects, several tensions were identified. Some participants found that the instructions could be unclear particularly when indicating different quantities in the recipe, leading to mistakes or inefficiencies during cooking.

Additionally, participants felt that they were completely trusting the recipe without any taste recommendations along the steps, making it hard to judge if the flavour was as expected. There were mixed feelings about portion sizes; some found them too large, leading to leftovers, while others found them insufficient. Issues were perceived with the storage of ingredients and their freshness, particularly if the kits were not used immediately upon delivery. Occasionally, users found that certain ingredients did not meet their quality expectations or wondered about the source of the products. Even with pre-measured ingredients, some users ended up with waste from components they did not use fully or did not prefer. Lastly, it was perceived that some recipes were more complex than anticipated, requiring more time and effort than expected.

Self-Reporting

The authors also engaged in self-reporting by using “cook and eat” meal kits themselves. This approach provided firsthand experience

and insights into the different stages of meal kit usage, from ordering to cooking. The self-reporting confirmed that the meal kits provided a comprehensive service that covered all aspects of meal preparation, from ingredient delivery to cooking instructions. The meals prepared were generally satisfying in terms of taste and variety, matching the expectations from the meal kit service. Authors noted that using meal kits introduced them to new ingredients and cooking techniques they had not previously used.

However, some tensions were identified. There were logistical issues with delivery times and conditions, which could affect the freshness and quality of the ingredients. Managing and disposing of the packaging materials was seen as overpacked, and the need for them was questioned. Additionally, there were occasional mismatches between the expected and actual contents of the kits, such as missing ingredients or incorrect quantities. When not selecting your order for the next week, the order will be selected automatically, leading to recipes that might not match the user's diet or food not planned to get delivered.

4.2 Analyses of the findings through Activity theory

Contradictions in the traditional grocery shopping

Traditional grocery shopping involves several tensions that motivate consumers to seek alternatives like meal kits. To prepare a fresh homemade meal, individuals require *cooking skills*, which many may lack, leading to repetitive meal choices and *limited culinary variety.* According to Hill and Maddock (2018), the lack of *time* and *cooking skills* can lead consumers to opt for convenience foods, which often discourage cooking from scratch and can result in a society lacking in food preparation skills (Hill & Maddock, 2018). Additionally, purchasing ingredients in larger quantities often results in food waste, as consumers struggle to use up all the items before they spoil. Another significant tension is the desire to try new recipes and ingredients without ending up with *leftover ingredients* that they don't know how to use in future meals. Meal kits can provide a structured approach to cooking, reducing the cognitive load associated with meal planning and preparation (Hill & Maddock, 2018). These tensions push consumers towards meal kits, which offer pre-measured ingredients and easy-to-follow recipes, potentially reducing food waste and making the cooking process more accessible, offering a meal plan, creative cooking experience, help in the cooking process, and quick and easy solutions, main attitudes among meal kit buyers according to Numerator Psychographics data (Schoenbauer, 2019).

Considering the interaction between the subject, the goal which in this case might be to have a fresh homemade meal, and the instrument, in this case, the system of traditional grocery shopping, is represented in Figure 2 the tensions that can lead the subject to try a new grocery system.

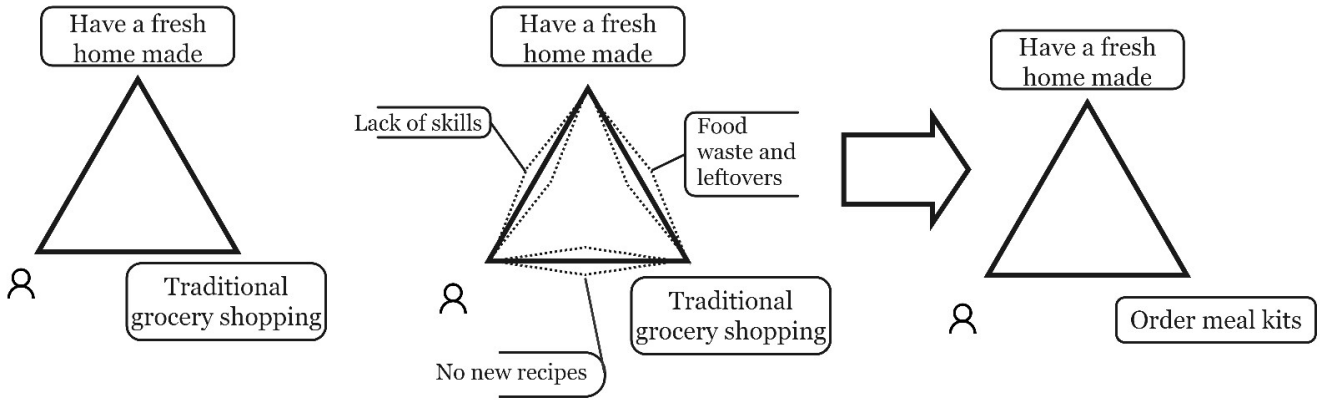

Figure 2 Tensions within traditional grocery shopping

Tertiary contradictions between systems

While meal kits offer a solution to these tensions within traditional grocery shopping by providing pre-measured ingredients and easy-to-follow recipes, they introduce their own set of contradictions. Traditional grocery shopping is generally cheaper, whereas meal kits, despite being more convenient, come at a higher cost. This creates a tertiary contradiction where consumers must balance the cost-effectiveness of traditional grocery shopping with the convenience offered by meal kits. This tension can lead to a combination of routines from both systems, promoting new behaviours. These tertiary contradictions are represented in Figure 3.

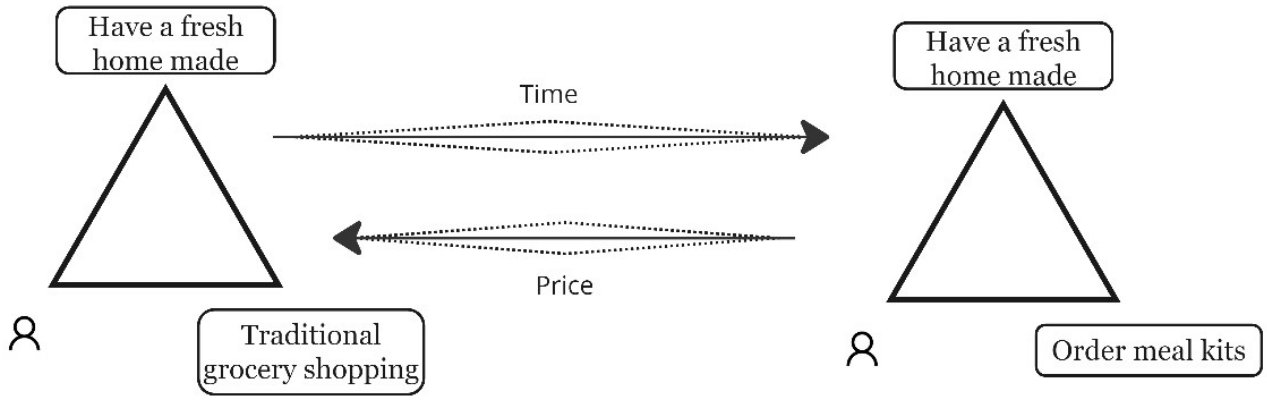

Figure 3 Tensions between traditional grocery shopping and meal kits

Considering the internalisation and externalisation principles of activity theory, consumers can internalise new knowledge about ingredients and recipes by incorporating meal kits. They then apply this knowledge when grocery shopping, potentially buying only the quantities needed and reducing waste. The variety of recipes tried through meal kits also could enable consumers to remember and retry these recipes, using ingredients more efficiently. Research indicates that meal kits can promote healthy dietary behaviours by improving cooking skills and confidence (Fraser et al., 2024), which can be translated into long-term use to more efficient and less wasteful traditional grocery shopping practices.

Additionally, after an internalisation process through the use of meal kits, consumers might no longer require them if we consider the tensions of cooking skills, recipe variety and food waste. By buying products in the exact quantities needed, learning through the use of the meal kits and avoiding food waste and unnecessary extra food, they might transition and depend on other types of systems, such as packaging-free systems. Therefore, meal kits could be used as a transition, helping consumers internalise quantities, products, and new recipes while allowing more flexibility in cooking. This could lead to more efficient grocery shopping and the potential use of packaging-free grocery systems, where consumers can reuse or return packaging and buy food products in bulk quantities, adjusting themselves the amount of ingredients they need in their households. However, the combination of the use of both ways of grocery shopping is outside the scope of this study and it has not been studied with the participants.

Tensions and harmonies within meal kits

The operational layer in activity theory focuses on the routine actions and conditions under which these actions are performed. In the context of meal kits, this layer includes the practical aspects of cooking skills, trying new recipes, and avoiding food waste and leftovers. Each of these objectives involves interacting with specific artefacts: meal kit recipes, meal kit food, and meal kit packaging.

Figure 3 illustrates the operational layer in activity theory for meal kits, showing the transition from traditional cooking to potential improvements. Initially, traditional grocery shopping and home cooking are associated with issues such as a lack of skills, the absence of new recipes, and food waste. The introduction of meal kits presented in the new approaches aims to address these issues by providing fresh home-cooked meals, improving cooking skills, introducing new recipes, and reducing food waste through pre-measured ingredients, bringing their own sets of harmonies and tensions.

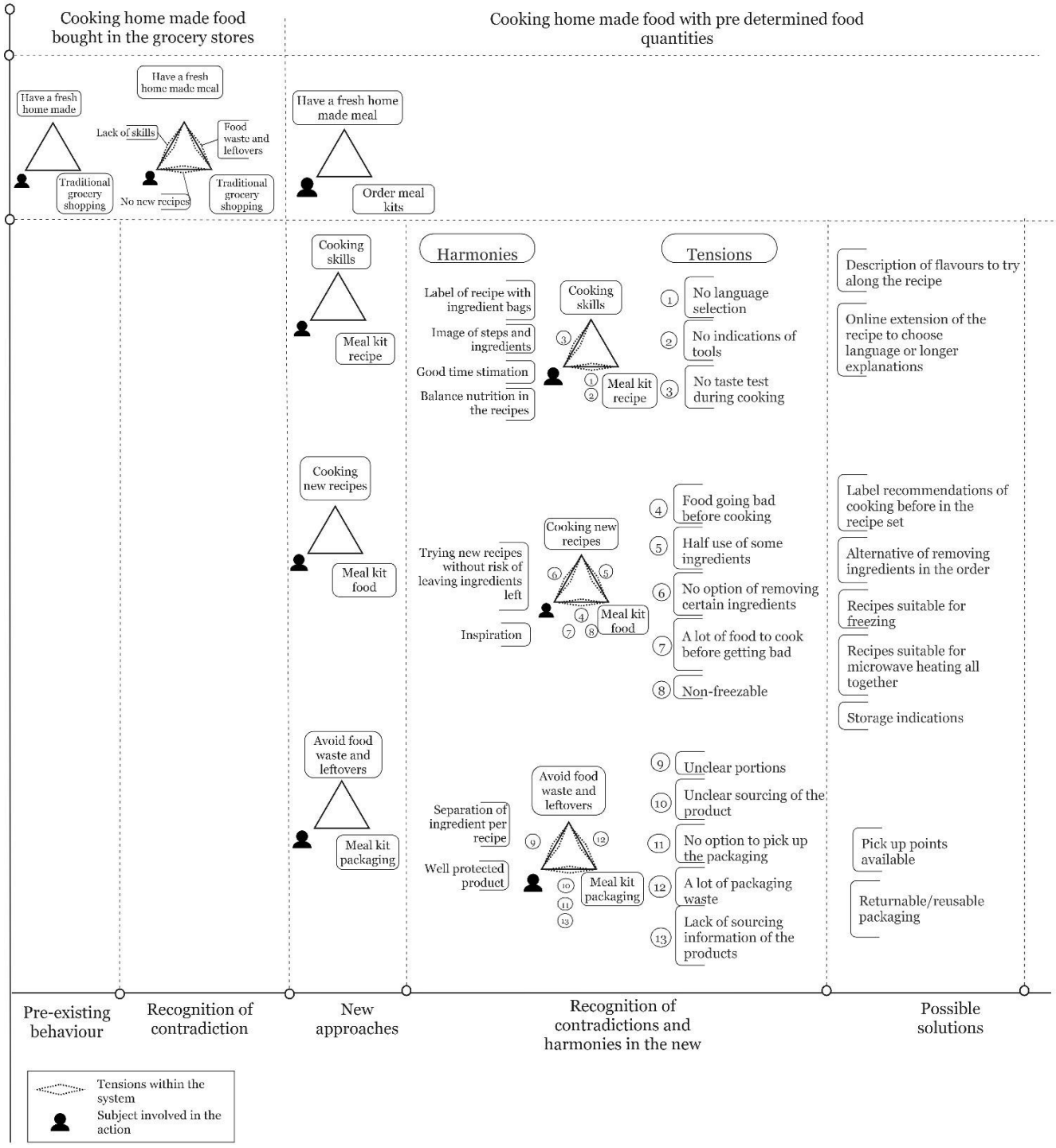

Figure 4 Layer analyses of the meal kit use

Cooking Skills

The artefact of meal kit recipes is important when developing cooking skills in this service. Users benefit from clear labelling of recipes with corresponding ingredient bags, which helps them easily identify what they need for each step. Additionally, the use of images for steps and ingredients provides visual guidance, making the cooking process more intuitive. Good time estimation within the recipes allows users to manage their time effectively while cooking, and balanced nutrition ensures that they are preparing healthy meals. However, there are several tensions present. The lack of language selection options limits accessibility for non-native speakers, and the absence of indications for necessary tools can confuse preparation. Furthermore, the lack of indications to conduct taste tests during cooking might lead to meals not meeting taste expectations.

Cooking New Recipes

When it comes to cooking new recipes, meal kit food serves as the key artefact. Meal kits inspire by offering new recipes that users might not have tried otherwise, encouraging culinary exploration and reducing waste by using exact quantities needed. This harmonises with the users' desire to try new dishes without the risk of leftover ingredients. However, there are significant tensions. Ingredients might go bad before they are used, leading to food waste. Additionally, some ingredients are only partially used, leaving users with half portions that are difficult to incorporate into other meals. The limited options for substituting or removing ingredients that users will not use in their recipe due to food restrictions or preferences are perceived as restrictive, and non-freezable recipes limit the ability to store leftovers for future use or to cook every recipe at the same time to avoid fresh food to get bad.

Avoiding Food Waste and Leftovers Ingredients

The artefact of meal kit packaging is relevant to the goal of avoiding food waste and managing leftovers. Separation of ingredients per recipe helps in organising and using ingredients efficiently, while well-protected products ensure that ingredients remain fresh until they are used. Despite these harmonies, excessive packaging is perceived during the observations as excessive waste. Portions can sometimes be unclear, leading to either insufficient or excess food. The sourcing of products can be unclear, raising concerns about sustainability and quality. Additionally, the lack of options for picking up is presented as inconvenient for some of the participants.

4.3 Proposed Solutions

To address these tensions, several potential solutions can be considered. Improving cooking skills through meal kit recipes, including language selection options and clear indications of necessary tools can enhance accessibility and ease of use. Providing tastetesting guidelines during cooking can help ensure that meals meet users' taste expectations.

For cooking new recipes with meal kit food, offering ingredient substitution options and recipes that can be frozen for later use can increase flexibility and reduce waste. Ensuring ingredients are fresh and appropriately portioned in all cases can also help minimise food waste. Showing indications of which recipe to cook first depending on the food's current condition could allow consumers to prioritise meal recipes which can get bad sooner and indications on storing for both after and before cooking would ensure better food handling.

To avoid food waste and manage leftovers with meal kit packaging, using returnable packaging can reduce the amount of packaging waste. This implementation could be used as an internalisation process for consumers to later on apply these routines to new habits making use of other types of packaging-free systems. According to recent research, shifting away from plastic packaging is challenging and requires significant changes within the value chain, but experts suggest that returnable packaging presents a feasible alternative to meal kit services (Sharda et al., 2024). Clear labelling of portion sizes and transparent sourcing information can help users make more informed decisions. Additionally, implementing a system for packaging pickup and using just one type of packaging material to facilitate recycling can further promote sustainable routines. Indications of storage before and after cooking could also ensure that food has lasted longer if needed.

By addressing these tensions and implementing these solutions, meal kit services can better align with consumer needs and sustainability goals, providing a more balanced and effective solution to the combination of grocery shopping and cooking challenges.

5. Discussion and conclusions

Meal kit services offer an alternative that allows for a reduction in food waste at different phases of the cooking process. By providing pre-measured ingredients and easy-to-follow recipes, they help users manage portions more effectively and reduce the likelihood of unused food going to waste. (Shin et al., 2024) However, while these services address some of the tensions found in traditional grocery shopping, they also introduce new tensions, particularly within the operational layer of meal kit usage.

The proposed solutions to address the tensions in the operational layer, such as language selection, tool indications, and taste testing guidelines, aim to improve user experience and the overall effectiveness of meal kits. Similarly, offering ingredient substitution options and recipes suitable for freezing can provide users with greater flexibility and reduce food waste. Implementing returnable packaging, easing recyclability, providing clear labelling of portion sizes and sourcing information are also other steps towards making meal kits more sustainable.

However, these modifications could potentially introduce quaternary contradictions within the production and logistics phase before the food reaches consumers. For instance, the implementation of returnable packaging may disrupt existing supply chains, bringing in more variety of packaging to the logistics. To understand the practicality of these proposed changes, it is necessary to analyse their impact on the current logistics systems. This involves evaluating how these solutions might affect existing harmonies and identifying any new tensions that may arise in the order preparation. Some other changes which might create this contradiction are the personalisation of meals, such as removing elements, the assessment of which recipe should be cooked first when food is not labelled with expiration dates or the implementation of returnable packaging.

To ensure the possibility of implementing these solutions, it is important to find a balance between maintaining current operational harmonies and removing the presented tensions. This might involve redesigning supply chains to accommodate more personalised recipes and developing new logistics strategies to handle the return of packaging or the assessment of the food.

Another important area to explore is the realistic context of combining meal kit usage with traditional grocery shopping. This hybrid approach can offer a more sustainable and cost-effective solution, balancing the strengths of both systems. Understanding how these two modes of grocery shopping interact can provide insights into new behavioural patterns and identify potential areas for improvement. For instance, consumers might use meal kits to learn about portion control and new recipes, and then apply this knowledge to traditional grocery shopping, further reducing food waste and enhancing meal planning efficiency.

By exploring the combination of meal kits and traditional grocery shopping, it is possible to identify synergies that can lead to more sustainable consumption practices. This involves examining how users adapt their routines when integrating both systems and assessing the long-term impact on their shopping and cooking behaviours, anticipating new possible services into the picture as packaging-free grocery alternatives. Following recent categorisation, if packaging-free alternatives are considered in “cook and eat” meal kits, these could fall into the category of businessowned packaging, picked up at home by the company, bringing new sustainability questions to the current packaging-free classification (Jiménez Romanillos et al., 2024), but easing consumers to transition to other types of packaging-free options, such as refill or repurpose choices. This move could also encourage consumers to a broader adoption of packaging-free alternatives in other areas of consumption, and promote new practices.

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RESEARCH ON DAILY SPATIAL PRACTICES IN TRADITIONAL CHINESE VILLAGES: A CASE STUDY OF FUJIAN TULOU VILLAGES

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ABSTRACT | In 2008, the Fujian Tulou was officially inscribed on the World Heritage List, becoming China's 36th World Heritage site. Since then, as a form of residential and daily life architecture, the Tulou has been maintained to a certain extent under protection and unified planning. However, the daily "spatial practices" of Tulou residents in their living spaces reveal that the existing spatial planning fails to fully meet the diverse needs of its users. This phenomenon warrants in-depth investigation. This study is based on the theory of everyday life practices by French scholar Michel de Certeau. Through field investigations and documentation, it examines the traditional villages of the Tulou in Yongding District, Fujian Province, China. The research focuses on analyzing how Tulou residents adapt and modify their daily living spaces to meet their needs under top-down spatial restrictions and management planning. The findings show that faced with the top-down spatial restrictions set by government authorities and designers, Tulou residents exhibit high flexibility and creativity. They engage in a series of bottom-up spatial practices to adapt and optimize their living environment. These adaptive design strategies include: Spatial Morphology Expansion: Extending and renovating the exterior and courtyards of the Tulou to create additional usable space. Spatial Function Integration: Merging multiple functions within a single space to better utilize limited resources. Spatial Production Methods: Creating new spaces that meet modern needs by replicating successful spatial models and integrating different functions. The study concludes that the practical wisdom of Tulou residents in their daily living spaces can be transformed into valuable design resources. This also provides a basis for higher-level planners to modify design recommendations, addressing the shortcomings of standardized planning. This research offers a new perspective on the spatial practices of traditional villages.

KEYWORDS | SPATIAL PRACTICES, TRADITIONAL VILLAGES, FUJIAN TULOU, PRODUCTION OF SPACE

1. Introduction

Over the past 40 years of urbanization in China, villages have long been regarded as subordinate to cities and have not received sufficient attention. To change this perception of urban-rural relations and narrow the urban-rural gap, the Ministry of Housing and Urban-Rural Development of China began leading the selection of "Traditional Chinese Villages" in 2012. A series of policies and funding initiatives were subsequently introduced to curb the decline of traditional villages (Ministry of Housing & Urban-Rural Development of the PRC, 2012). In 2018, the Chinese government introduced the "Rural Revitalization Strategy Plan," marking the beginning of a development era driven by both rural revitalization and new urbanization (Central People's Government of the PRC, 2018). With the implementation of this policy, an increasing number of traditional villages have not only emphasized the protection and inheritance of cultural heritage but have also gradually shifted their development focus to industrial prosperity and ecological livability.

Endowed with heritage values and emotional significance as "places carrying traditional culture" and "homesickness spots," the rural tourism industry has become a priority choice for many traditional villages (An, et al., 2022). Simultaneously, tourism development has brought a new wave of spatial development, design, utilization, and transformation. Power and capital entities continuously attract resources, technologies, and other elements into rural areas, while also introducing phenomena such as planning and constructive destruction, unfair distribution of interests, and spatial alienation, including the displacement of spatial subjects (Cao, et al, 2018). In this process, the role of villagers is noteworthy. Lefebvre and de Certeau emphasize that ordinary people and daily life, seemingly mundane, can drive the production of space through implicit or explicit forms of resistance (Sun & Zhou, 2014).

Against this backdrop, this study selects Hongkeng Village in Yongding District, Longyan City, Fujian Province—a representative Hakka village—as the research subject. Using an

empirical approach, the study explores how residents, through their daily lives, resist the spatial representations manipulated by the government and capital entities, thereby fostering corresponding spatial practices and demonstrating the creativity of daily life. It is hoped that this research will provide a flexible planning design basis for higher-level planners.

2. Theoretical Foundation

2.1 Interpretation of Spatial Operations: The Theory of the Production of Space

In 1970, Henri Lefebvre proposed the theory of the production of space, emphasizing that "space is produced through purposeful social practice" and is a product of social relations, focusing on the reproduction of implicit social relations. This theory applies to exploring complex factors such as the operations of power and capital and the transformation of social relations during the transition of traditional villages (Duan et al., 2023). Lefebvre classified space into three types: "Physical Space"—tangible and measurable; "Mental Space"—constructed by thoughts, consciousness, and ideas; and "Social Space"—formed by social factors such as relationships, social organization, and power structures.

Lefebvre later developed these three concepts into the "trialectics of spatiality," positing that space is constituted by "spatial practice," "representations of space," and "representational spaces." This framework provides an analytical tool for understanding space production and reproduction at different levels. In traditional villages, spatial practice reflects human material practices and their outcomes, forming external physical space composed of the village's layout, buildings, and public facilities. Representations of space refer to the abstract space created by planners and engineers, who convert knowledge into a reflection of production relations and order. This space is envisioned, outlined, and constructed, with ideology being re-coded, translated, and received. Representational spaces are the lived spaces, tied to the complexity and uncertainty of daily life, encompassing residents' experiences. These spaces are constrained by representations but, due to diverse individual needs, often require adjustments and adaptations (Lefebvre, 2014).

The theory elucidates the dialectical analysis of the three types of space, where design, domination, and resistance are constantly in play. This continuous generation of contradictions drives the evolution of daily practices among villagers, shaping and reconstructing their living spaces.

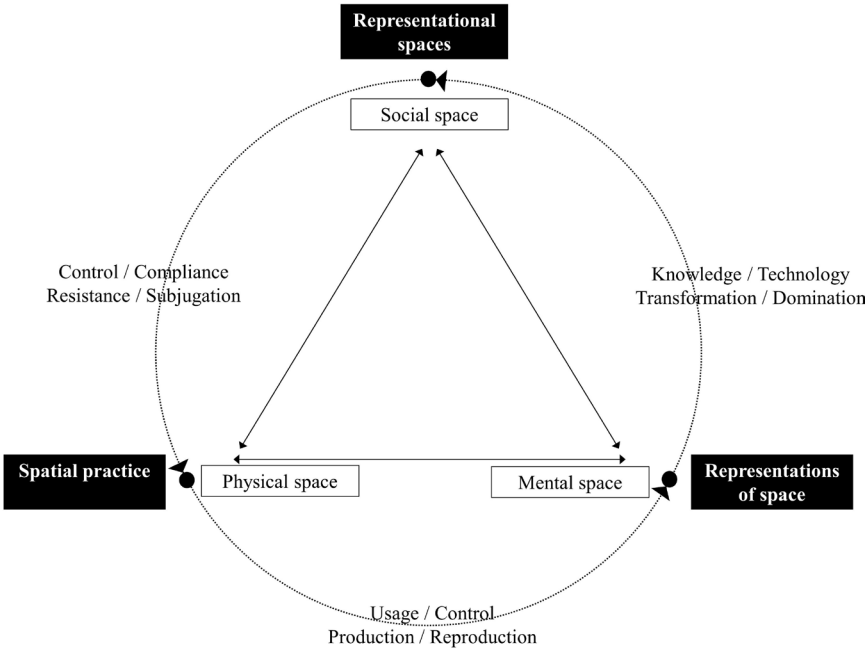

Figure 1. Theoretical Framework of the Production of Space (Source: Drawn by authors)

2.2 Weapons of the Weak: Individual Daily Life Practices

Lefebvre's "trialectics of spatiality" provides a macro-level explanation of the mechanisms and practices of spatial operations, serving as a practical tool for spatial analysis. In line with Lefebvre's discussion on the resistance inherent in representational spaces, contemporary French sociologist Michel de Certeau offers a micro-level perspective by elucidating the specific behavioral strategies of space users, which forms the basis of this study's viewpoint. De Certeau posits that, in the face of alienation brought about by dominant discourses such as capital and political power, the weapons of ordinary individuals, as the weaker party, are embedded in the seemingly insignificant, mundane practices of everyday life (Certeau, 1984).

De Certeau identifies four main aspects of individual daily life practices. First is resistance: ordinary people employ "tactics" as indirect methods within the dominant's space, seeking opportunities for minor yet clever resistance to counter top-down forces and ideologies (strategies). Second is spatial practices: the public engages in creative production through fluid and informal practices, transforming the symbolic and institutionalized spaces provided by ruling elites into alternative forms. Third is making do: the resistance of the weak is not radical revolution or complete overthrow but minor resistance through recombining, modifying, and utilizing products, forming a flexible network that counters the dominant

economic order. Fourth is silent production: consumers engage in creative secondary production through selection, rewriting, and subversion, bestowing new meanings to texts and products and forming unique cultural production methods (Certeau, 1984).

The theories of Lefebvre and de Certeau highlight the rich creativity and spatial shaping ability of ordinary people, who drive the production of space through implicit and explicit forms of resistance. In tourism-oriented villages, villagers use their daily life creativity to reinterpret and rewrite the "representations of space" designed by the government and capital, ultimately constructing the "representational spaces" of traditional villages (Qin & Leung, 2021).

3. Overview of the Case Study Site and Research Methods

This study selects Hongkeng Village in Yongding District, Longyan City, Fujian Province as the case study site. The village is located in the southwestern region of Fujian Province, surrounded by mountains on the east, west, and north sides, with Liulian Village to the south. The village is built along both banks of the Hongchuan River in a north-south direction, forming a strip layout. Due to its elongated shape, the village is customarily divided into two parts, Upper Village (the northern village) and Lower Village (the southern village), with the Lin Family Ancestral Hall as the central point. The village entrance is on the south side. Formed during the Ming Dynasty, Hongkeng Village is home to many well-preserved Tulou buildings, representing a typical Hakka Tulou village. After being listed as a World Heritage Site in 2008, Hongkeng Village adopted a development model that combines heritage protection with tourism development, leading to rapid growth in the tourism industry (Liu, 2022). Concurrently, the village has faced issues such as residential spaces being converted into commercial spaces and challenges in preserving authenticity, leading to subtle changes in villagers' sentiments (Yan, 2015). Therefore, selecting Hongkeng Village as a case study for examining villagers' daily life practices is quite representative.

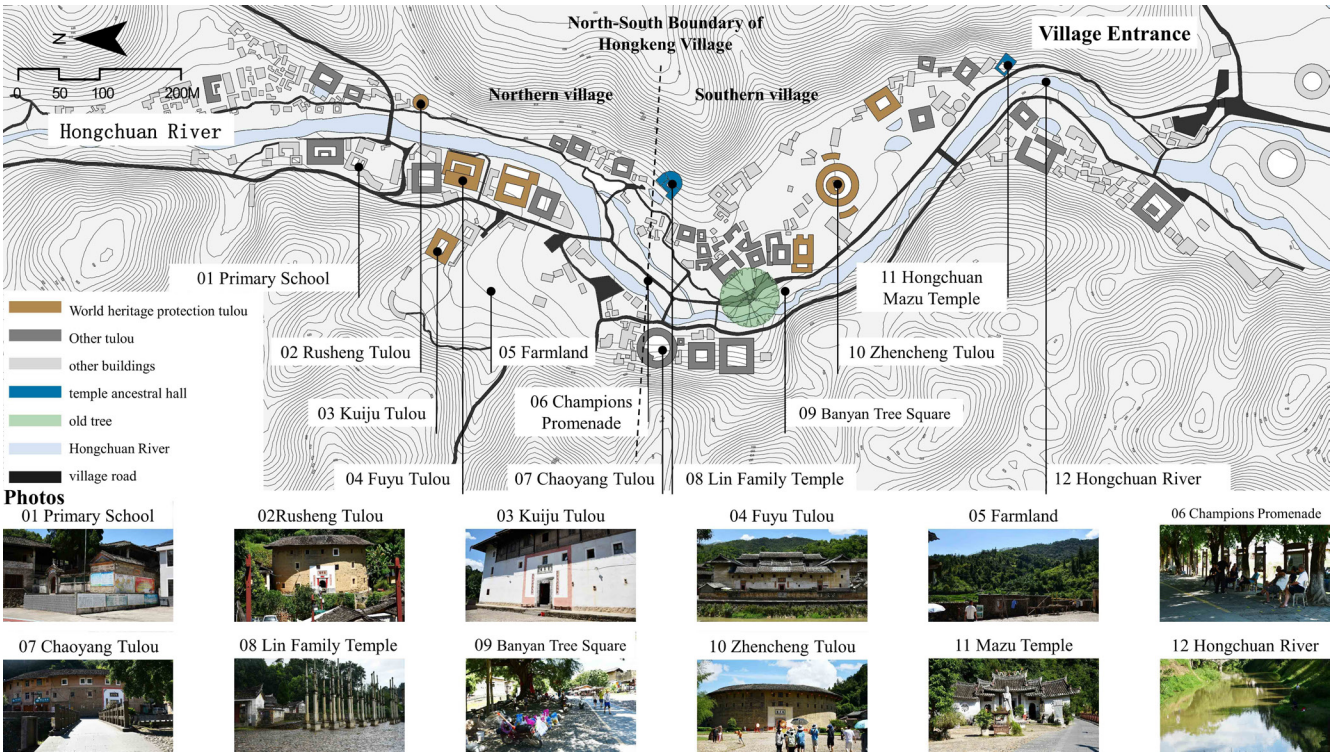

Figure 2 Plan and Current Overview of Hongkeng Village (Source: Drawn by authors)

The most famous structures in Hongkeng Village are the Tulou cluster, represented by the "Prince of Tulou," Zhencheng Building. Zhencheng Building is a four-story circular Tulou, currently housing around 40 residents. The entire ground floor has been converted into retail shops, and daily performances take place outside, making it a "front-stage space" in the eyes of the villagers. Fuyu Building, a courtyard-style Tulou, has had portions of its interior converted into a hotel and restaurant to meet tourism demands. Hongchuan Tianhou Temple, located at the village entrance, serves as an important site for villagers to worship Mazu during the Lunar New Year, while the Lin Family Ancestral Hall at the village center is the venue for ancestral worship, holding the collective memory of the villagers. Banyan Tree Square, also located at the village center, is the most popular gathering place for villagers, often used for resting and socializing.

Today, many of the Tulou buildings in Hongkeng Village are listed as cultural heritage sites. Although these buildings still serve as residential units, their renovation and modification require strict approval, and construction activities throughout the village are subject to stringent regulations and limitations. It can be said that the current state of Hongkeng Village is a product of top-down governance, with phenomena in its daily spatial practices aligning with de Certeau's theory of everyday life practices. Driven by their own developmental needs, villagers consciously engage in adaptive or resistant daily spatial practices, grounded in their own requirements and the limited spatial resources available.

This study conducted two field visits to Hongkeng Village in August 2022 and December 2023. Through non-participant observation and interviews, it gathered information on the distribution of Tulou, farmland, public spaces, and tourism facilities, as well as the living conditions of the residents. Adopting the "thick description" method, the research analyzed the village's daily spatial practices from two perspectives: "top-down constraints" and "bottom-up adaptations," revealing the underlying logic of villagers' daily lives.

4. Top-Down Spatial Shaping

4.1 Definition of Village Environmental Style

Tourism development is closely integrated with management and conservation efforts. To protect and reutilize these architectural heritages, the Yongding government in Fujian Province has delineated a World Cultural Heritage core protection area, a buffer zone, and key protected individual buildings. Based on these architectural heritages, they have designed tourist routes, and the areas along these routes have undergone comprehensive environmental renovation. Traditional agricultural production has been largely abandoned: only a small piece of farmland near Kuiju Building is preserved for tourism promotion, while the rest has been converted into construction or landscaped green spaces. Chickens and ducks are no longer raised inside the Tulou, sacrificing some conveniences of daily life. For example, the vegetable garden in front of Zhencheng Building, once used by villagers for production, has been transformed into an open square with a pebble-paved surface. This large, empty square not only accentuates the majestic image of Zhencheng Building but also facilitates daily performances such as "Tulou Drum Beating" and "Hakka Music."



Figure 3: New Waterwheel and Open Square (Source: Photo by authors)

Additionally, bamboo groves and ponds have been installed on one side of the square, transforming the ordinary, life-oriented village scene into a "beautiful village" that aligns with the aesthetic values of tourist landscapes. To restore the ancient charm of the village, self-built houses are encouraged to be painted in uniform colors. The exterior wall finishing materials are either yellow face bricks or paint, and exposed components of steel-structured canopies are painted with wood-like finishes to maintain harmony with the overall village atmosphere. The government and capital, as dominant forces, have engaged in the production of space over the original village space, realizing their envisioned "representation of space" for a "heritage tourism site." This management extends into subsequent administrative efforts. For instance, while non-protected buildings within the heritage site are allowed to be renovated or rebuilt in their original form, traditional craftsmanship and materials must be used. Their appearance, size, color, and height must be consistent with the protected buildings, with a height limit of four stories or 12 meters.

4.2 Relocation of Residential Space

The development of tourism has brought benefits to the villagers but also created a series of problems, with housing issues being foremost. According to the "Fujian Province Traditional Architectural Style Protection Regulations" and the "Yongding District Hukeng Town Hukeng Village, Hongkeng Village, Liulian Village Village Plan (2021-2035)," to protect the authenticity and integrity of the World Cultural Heritage site, no new housing construction projects are allowed in the core protection area of Hongkeng Village except for necessary municipal infrastructure (Standing Committee of the Fujian Provincial People's Congress, 2021). This makes residential space within the village very limited. Some villagers choose to continue living in the Tulou where their ancestors have long resided. For Tulou that are not cultural relics, they can improve living conditions by adding necessary spaces (such as kitchens and bathrooms) in the central courtyard. However, for protected buildings like Zhencheng Building, villagers have to live within the limited space available. Other villagers choose to live outside the village and convert the ground floor of the Tulou in Hongkeng Village into small shops or tea rooms, operating during the day and returning to rest outside the village at night. In such cases, the concept of the Tulou as "home" is gradually being diluted.

To address this issue, the Yongding government has planned an area outside the village as a new settlement to accommodate villagers facing residential shortages in Hongkeng Village. However, this plan is generally not accepted by the local villagers for two main reasons: first, living outside the scenic area means they cannot directly benefit from the tourism activities, and villagers are likely to be marginalized by tourism companies, unable to participate in tourism development and thus losing vested interests. Second, daily commuting between inside and outside the scenic area brings

many inconveniences, such as transportation and ticketing, which increases living costs for villagers who depend on tourists. Therefore, local residents are reluctant to relocate outside the scenic area, making the housing issue a challenge for both residents and tourism development companies.

4.3 Non-Homogeneous Development of Village Space

Hongkeng Village is spread along both banks of the Hongchuan River in a north-south direction, forming a narrow, elongated plan. Local villagers customarily divide the village into Upper Village and Lower Village, with the Lin Family Ancestral Hall as the central point. This was originally a geographical division, but the intervention of the tourism industry has created a division in consumption space. Due to the designated tourist routes within the village, Hongkeng Village has gradually formed a core area (main scenic area), a secondary core area (secondary scenic area), and a marginal area (Upper Village with minimal tourism development).

Tourism development within the village primarily expands from Zhencheng Building as the core towards both ends. The area around Zhencheng Building is rich in tourism facilities, including high-end homestays, a Tulou bookstore, a Hakka brewing culture museum, and a series of street stalls. The Banyan Tree Square north of Zhencheng Building is not only a place for tourists to enjoy the water but also a core public space for villagers to gather, rest, and sell goods.

With the combined efforts of the government, capital, and tourists, Zhencheng Building and its surrounding Tulou buildings have become the consumption core space of the village, rich in facilities and bustling with people. In contrast, the Upper Village north of the Lin Family Ancestral Hall has not seen significant changes in its internal form, infrastructure, or ecological environment since the early stages of tourism development. The Upper Village receives few tourists due to two main reasons: first, it lacks historically significant Tulou with high viewing value, making it less attractive to tourists; second, tourists have limited time, and reaching the Upper Village from the southern village entrance requires considerable time and effort. As a result, it has become a “marginal area” in tourism development, with only a few villagers participating in tourism activities, while most engage in external labor or agricultural production. Compared to the Lower Village, the Upper Village has few tourism facilities, and public facilities for villagers, such as pavilions and corridors, are also relatively scarce.

The serene pastoral landscape of the Upper Village contrasts sharply with the bustling scenes of tourists, villagers’ greetings, guides’ explanations, and various performances in front of Zhencheng Building in the Lower Village. Upper Village villagers, unable to benefit from tourism, face construction restrictions and express dissatisfaction with this phenomenon. The spatial division caused by tourism has disrupted the originally harmonious and unified atmosphere of Hongkeng Village.

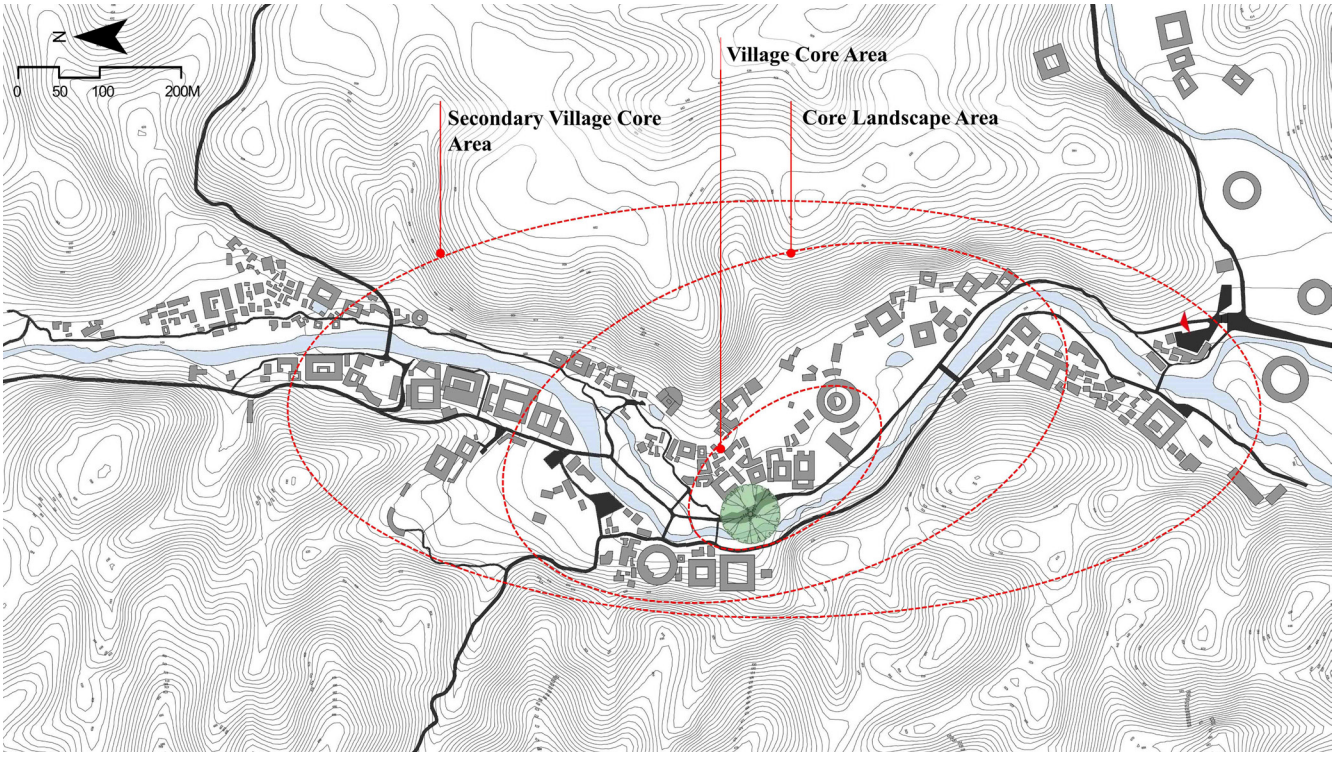

Figure 4: Non-Homogeneous Development of Village Space (Source: Drawn by authors)

5. Bottom-Up Daily Life Practices

5.1 Cooperation and Participation

In Yongding Tulou, the cultural self-awareness of villagers is reflected in their renewed understanding of Tulou culture and changes in their behavior. Villagers have come to realize that Tulou culture is not only a part of their daily customs but also a means of livelihood. This shift in awareness has motivated them to actively participate in the spatial production of landscape symbols. Specifically, some villagers have transitioned from farmers to full-time or part-time performers in live cultural shows about Tulou. Many female villagers have obtained tour guide certifications and become full-time guides, contributing to the shaping of Hongkeng Village's "front-stage space."

Additionally, villagers have responded to government initiatives by maintaining the architectural features of the Tulou, renovating facilities, and transforming them into homestays. Houses along the main street have been converted into restaurants, small shops, and specialty stores to increase household income. The tobacco industry in Hongkeng Village has a long history, with several shops still selling homemade tobacco and demonstrating traditional tobacco-making techniques to tourists. In their daily lives, villagers actively engage in cultural construction through their physical actions, which involve not only preserving traditional architectural features but also learning and applying tourism-related skills. Those directly involved in the tourism industry participate by providing goods and services, while others gradually adapt to new lifestyles and production habits through indirect exposure.



Figure 5: Villagers Participating in Cultural Performances and Spatial Expansion (Source: Photo by authors)

5.2 Transformation of Spatial Functions

1. Embedding

Embedding new functions within existing spaces, such as business functions, is the most common form of spatial conformity. For example, the Banyan Tree Square opposite Fuxing Building, which features a 600-year-old banyan tree considered sacred by the local Hakka people. Beneath the tree is a small temple dedicated to the Earth God, frequently visited by villagers for worship. This originally singular worship space is also the most popular resting spot for villagers in summer, where they cool off and chat. Due to its prime location along the tourist route, it also serves as a site where elderly residents of Fuxing Building set up small stalls to sell local delicacies. The embedding of leisure and sales functions has transformed this site from a place of worship into the village's most popular spot.

2. Coexistence

Faced with the strategic discipline of capital and power under tourism industry intervention, some villagers do not resist but adopt a "making do" approach. They avoid direct confrontation but remain within the space, using covert production to subtly infiltrate their differences. Coexistence is a behavioral pattern that emerges when the planning party's spatial use and the villagers' needs do not conflict, with both parties using the same space at different times. Despite large-scale chicken and duck farming no longer being permitted in Hongkeng Village, ducks can still be seen in the Upper Village's river. Conversations with villagers reveal that this is partly because their Tulou are not protected buildings and thus face fewer restrictions, and partly because the area is relatively remote and less frequented by tourists, allowing them to avoid busy tourist periods.

3. Derivation

Spatial derivation aligns with de Certeau's concept of "silent production," referring to newly created spatial functions and activities due to industrial intervention. Villagers do not just passively accept changes; they creatively engage in "secondary production" through selection, rewriting, and subversion. This silent production occurs quietly in daily life. For example, the open space at the south entrance of Hongkeng Village, after being modified by villagers with soft lighting and beautiful water features, has gradually become a popular spot for collective dancing. This once forgotten, desolate place has been revitalized into a lively gathering spot, demonstrating how regulated industrial space and villagers' daily practices jointly create new places.



Figure 6: Tulou Characteristic Elements and Banyan Tree Square (Source: Photo by authors)

5.3 Expansion of Spatial Form

1. Expansion for Functional Needs

The most direct spatial reproduction by villagers is evident in their modifications to the Tulou, which can be categorized into three major types. First are modifications driven by functional needs. Many Tulou buildings make use of courtyard space to construct auxiliary rooms, such as kitchens and bathrooms, or expand existing structures based on practical requirements. Second are modifications for commercial purposes. Many Tulou buildings have been transformed into homestays or shops, with some residents hanging shop signs outside to attract tourists. To increase natural light, some villagers have added new windows or modified existing ones. Finally, there are modifications utilizing existing conditions. In cases where parts of old Tulou have deteriorated, villagers use the remaining earthen walls as a foundation for new buildings. This approach not only reduces construction costs but also preserves traces of the Tulou's historical character.

2. Creating New Landmarks

To avoid the homogenization of Tulou landscapes, residents of each Tulou strive to uncover unique features and form distinct cultural landmarks. For example, Yucheng Building has undergone a series of meticulous modifications, successfully transforming into the “Fragrant Wine House,” a landmark showcasing Hakka rice wine culture. Outside the building, a group of sculptures vividly depicts the traditional winemaking process, while inside, the focal point is the arrangement of large wine jars, creating a strong visual impact and reinforcing the winemaking theme. The ground floor has been specially designated as a winemaking workshop, including functional spaces such as a “rice steaming room” and a “fermentation room,” providing visitors with the opportunity to observe and experience traditional winemaking techniques. Red lanterns not only provide illumination but also add a festive atmosphere, aligning with tourists’ expectations of local culture. The preservation and renewal of Yucheng Building follows a strategy of “small-scale modifications with strong cultural emphasis,” ensuring that the building’s historical and cultural value is sustained within modern tourism development. This practice of local representation through subtle adjustments and cultural integration demonstrates the creativity of Hongkeng villagers in resisting the homogenization of space.

6. Discussion

6.1 From Structured to Lived Space: The Redefinition of Village Centers

Before the intervention of the tourism industry, the spatial structure of Hongkeng Village was centered around the ancestral hall. The Lin Family Ancestral Hall, located at the village’s core, served as a site for ancestral worship and important ceremonies, reflecting the strong clan culture and community cohesion. However, with the advent of tourism, the village’s spatial structure underwent significant changes. Zhencheng Building and Banyan Tree Square gradually replaced the ancestral hall as the new focal points of the village. This shift not only represents a physical reconfiguration of space but also signals a deeper transformation in economic activities and social relations, as the villagers’ daily lives have shifted from being primarily centered on clan-based activities to those driven by economic pursuits. Zhencheng Building, with its unique historical and architectural value, has become a symbol of tourism in Hongkeng Village, attracting large numbers of visitors. Meanwhile, Banyan Tree Square, with its natural environment and accessibility, has become the main gathering place for both villagers and tourists.

While the ancestral hall continues to fulfill its traditional clan functions, its social role has weakened; it is no longer the primary space for villagers’ daily interactions and decision-making, but rather a symbolic reminder of history and culture. The reconfiguration of

Hongkeng Village's center reveals a shift in lifestyle and the repositioning of spatial priorities driven by economic forces.

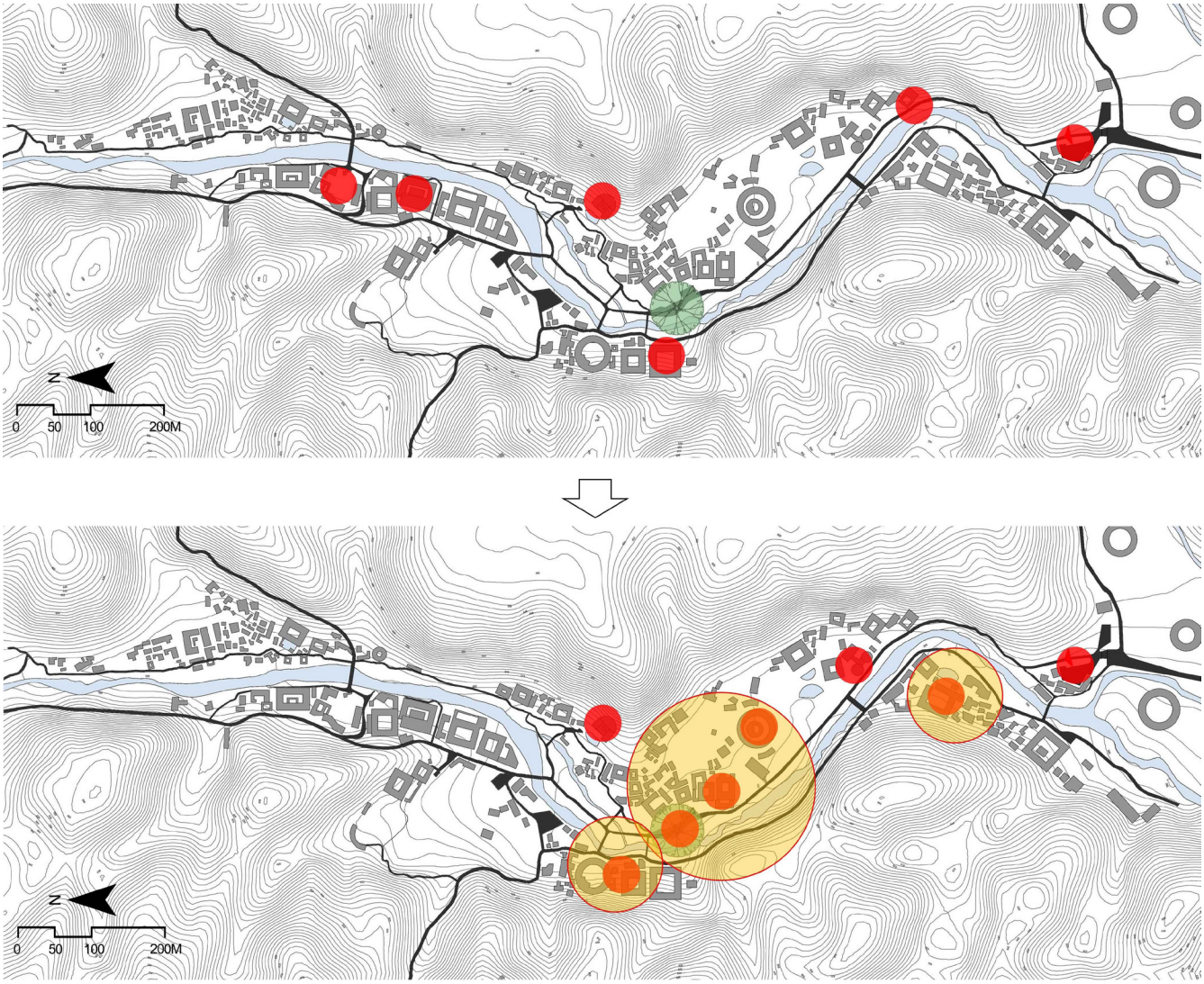

Figure 7: Reconstruction of Village Spatial Order (Source: Drawn by authors)

In rural development, what resonates with people are the traces of time and the authenticity of daily life. Therefore, in tourism development, planners should focus on restoring the essence of everyday life by fostering emotional connections and creating lived landscapes. These landscapes should not only meet the practical needs of villagers but also combine functionality with aesthetic appeal, deeply integrating everyday living spaces with tourism spaces. This approach can enhance cultural appeal and achieve a balance between cultural preservation and economic benefits. Additionally, improving the quality of public spaces is crucial. The case of Hongkeng Village demonstrates that public spaces should serve multiple functions, catering to both villagers

and tourists. Planners should emphasize the integration of natural and cultural elements, optimizing existing resources such as ancient trees and streams, improving pathways and rest areas, and ultimately enhancing the quality of life for villagers while providing visitors with an authentic rural experience.

6.2 The Scenic Transformation of Villages and the Alienation of Vernacular Architecture

With the rise of tourism, the architecture and spaces in Hongkeng Village have increasingly taken on a scenic, tourist-oriented character, detached from their original social context. In response to tourist demands, both the government and the market have introduced decorative elements unrelated to the village's traditional life, such as red lanterns and imitation ancient waterwheels. These additions have gradually transformed the core areas of the village into standardized tourist attractions, with the large open square in front of Zhencheng Building serving as a typical example of this scenic transformation. This approach to spatial development has directly influenced the villagers' architectural practices and perceptions.

Following the success of the "Duluo" homestay model, many villagers began to imitate these designs, hoping to attract tourists by modifying their Tulou. However, this imitation has led to the alienation of vernacular architecture, resulting in spaces that are increasingly symbolic and homogenized. One prominent example is the widespread adoption of the "wooden house" style. Some homestays have incorporated traditional wooden elements from the Tulou, particularly in the flooring and wall decor, in an attempt to create a personalized aesthetic. However, excessive imitation and replication have caused many Tulou in Hongkeng Village to lose their original vernacular characteristics, resulting in a uniform "wooden house" style that lacks architectural diversity. This homogenization and symbolic design erode the cultural richness of the village, making it difficult for visitors to experience authentic local culture. Meanwhile, the cultural depth of the area is being gradually diminished by the forces of commercialization. Over-reliance on symbolic design not only threatens the integrity of cultural heritage but also allows market forces to replace traditional lifestyles and cultural practices.

In response, the government should shift from being the primary driver to acting as a facilitator, establishing diverse design guidelines that encourage villagers to incorporate local architectural styles and culture into their homestays and commercial buildings, avoiding blind imitation. By providing professional guidance, the government can support villagers in innovating while preserving local characteristics. Additionally, it is crucial to promote education and cultural awareness, guiding tourism operators and visitors to respect local culture, reducing superficial design trends, and maintaining the cultural depth and uniqueness of vernacular architecture.

6.3 The Decline and Persistence of Family and Religious Spaces

Nearly every Tulou in Yongding has a Guanyin Hall, located on the central axis directly facing the main entrance, where families pray for peace. To this day, residents continue to conduct worship rituals on the first and fifteenth days of the lunar month. Historically, the Guanyin Hall served as a dedicated space solely for religious practices, without merging with other functional spaces. However, with the rise of mixed residential and commercial lifestyles, the religious function of these spaces has increasingly merged with everyday activities. For example, the Guanyin Hall in Kuiju Building now serves as a storage area and has been furnished with tea tables and benches, transforming it into a space for relaxation and entertaining guests. Similarly, the Guanyin Hall in Yucheng Building incorporates elements of alcohol culture into its decor, reflecting a trend towards commercialization. Despite these changes, the villagers of Hongkeng remain steadfast in their traditions. While the significance of religious spaces has diminished, they remain a crucial part of village life. Even as these spaces are compressed and integrated with daily activities, losing their independence and centrality, they are preserved, reflecting the deep-rooted ancestor worship and the villagers' "unconscious resistance" to the pressures of commercialization.

In addition to the transformation of religious spaces, intimate family spaces within the Tulou are also shrinking. Driven by economic interests, portions of residential spaces have been converted into homestays, where tourists occupy the main areas of the house, while villagers, as service providers, retreat to secondary spaces. This shift results in a phenomenon where "self-use space" gives way to "other-use space." For instance, the side courtyard of Zhencheng Building, originally a space for family relaxation, has now been repurposed into a tea-serving area for guests, significantly reducing family interactions. The Tulou, once a vital living space for familial and social connections, offered residents a sense of belonging. However, this concept of "home" is gradually fading as the Tulou becomes a commercialized space.

The preservation of religious and family spaces remains crucial for maintaining residents' sense of identity. To address these challenges, village administrators can revive traditional rituals through cultural or festive activities, allowing these spaces to regain their significance in daily village life. Furthermore, villagers can be encouraged to integrate family culture into tourism services. For example, involving tourists in traditional family activities, such as making local specialties, can provide an authentic Tulou experience for visitors and prevent the erosion of the concept of "home."



Figure 8: Integration of Religious Space with Other Functions (Source: Photo by authors)

7. Conclusion

This paper uses Hongkeng Village in Yongding District, Fujian Province, as a case study to explore the daily spatial practices of villagers under the context of tourism development. Through a top-down approach, the government and capital forces have shaped the envisioned space of Hongkeng Village by enhancing infrastructure and defining architectural styles. While these measures have increased the village's appeal to tourists, they have also led to spatial segregation within the village. In response to external spatial planning, villagers have demonstrated a variety of coping strategies in their daily lives. Through career shifts, they actively participate in tourism development. By embedding, coexisting, and deriving new functions for old spaces, they have expanded spatial forms and avoided homogenized production, showcasing their adaptability and innovation in the face of modernization and tourism.

The intervention of the tourism industry has significantly altered the spatial structure of Hongkeng Village, with the village center shifting from the ancestral hall to public spaces, reflecting a transition from order to everyday life. However, the homogenization and symbolic transformation of homestays by villagers have weakened the local culture of Hongkeng. Additionally, within the Tulou, self-use spaces have been replaced by spaces for others, leading to the decline of both

family and religious spaces. To address these issues, planners should first establish a more inclusive framework that avoids imposing external subjective preferences on the village's development process and instead prioritize villagers' spatial needs and lifestyles to create public spaces that align with residents' daily lives. Additionally, village administrators should promote diverse design standards and cultural education, encouraging the preservation of local architectural features and preventing excessive commercialization. At the same time, cultural identity should be strengthened by reviving traditional rituals and everyday cultural activities, enhancing villagers' sense of belonging and connection to local culture, and fostering a win-win development between culture and economy.

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EXTENDING THE LIFECYCLE OF DESIGNED PRODUCTS FOR SUSTAINABLE DEVELOPMENT: INSIGHTS FROM ZISHA TEAPOT

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ABSTRACT | Against the backdrop of diverse global consumer demand and intensified market competition, products are rapidly updated and iterated to maintain competitive advantages, offering consumers more choices. However, this also results in design homogenization, quality degradation, and shortened product lifecycles. The “Zisha” from China can provide valuable insights for solving this problem. As the foremost of China’s four famous potteries, its representative product, the Zisha teapot, has a history of over 600 years. It combines practical functions with design features that integrate poetry, calligraphy and painting, making it widely appreciated worldwide. This paper employs interdisciplinary research, historical deduction, and field studies to explore why the Zisha teapot has remained popular despite limitations of time, space, and cultures, and extracts useful elements for modern product design. Research indicates three key lessons in the sustainable development of Zisha teapots: First, selecting materials with local characteristics and using handmade production processes can impart geo-cultural features to the product and inject personalization and human elements.

Second, expanding from the practical and aesthetics functions to interactive features ensures it meet users' actual needs, and integrates social and interactive features aligned with users' lifestyles, which increases product use frequency through multi-dimensional value creation. The third and most important strategy involves cross-border collaboration with the art world, uniting creativity to imbue products with uniting creativity cultural connotations and contemporary aesthetics. This approach aims to establish spiritual resonance and emotional engagement with users, ultimately achieving sustainable product development. This research begins by reflecting on historical experience and contemporary theory, providing a multi-dimensional practical path and scientific framework for extending the life cycle and sustainable development in modern product design.

KEYWORDS | ZISHA POTTERY, ZISHA TEAPOT, SUSTAINABLE DESIGN, PRODUCT LIFECYCLE, CROSS-BORDER COLLABORATION, EMOTIONAL CONNECTION

1. Introduction

In today's rapidly evolving market, shorter product lifecycles has become commonplace(Cooper, 2010; Koenig, 2023). The main reasons for this include rapid technological iteration, fierce market competition and changing consumer needs(van der Laan & Aurisicchio, 2019; Yamamoto & Murakami, 2021). Statistics show that over 1.5 billion smartphones are sold annually around the globe(Statista, 2024), but they are very often replaced before they are broken, with an average replacement cycle of less than two years(Cordella, Alfieri, & Sanfelix Forner, 2020). In China, the average lifespan of mobile phones has decreased from three to five years in 2015 to 2.2 years in 2018(Hou, 2022). In addition, it has become more common to buy new TVs instead of repairing old ones, reducing the average lifespan of TVs to just over seven years and accelerating the pace of replacements(Wieser & Tröger, 2015). Similarly, the actual lifetime of washing machines has fallen below the average consumer expectation of 12.5 years(Boyano et al., 2017). Additionally, the European Environment Agency (EEA) reports that the average actual lifespan of products like smartphones, TVs, washing machines, and vacuum cleaners is at least 2.3 years shorter than their designed or expected lifespan(European Environmental Agency, 2020). This trend of shorter product lifecycles not only leads to excessive resource consumption and environmental pollution but also poses challenges for enterprises in terms or cost control and market stability. Therefore, extending product lifecycle has become an urgent issue.

Existing research on extending product life cycles focuses on two main aspects: First, extending product life cycles through technological and design innovation to ensure that products are more durable and easier to upgrade and maintain. Specifically, designing modular products using durable materials and structures makes them easy to replace and upgrade, thereby maintaining the highest utility and value of products, components and materials(Agrawal, Atasu, & Ülkü, 2016; Bakker, Wang, Huisman, & Den Hollander, 2014). A design that facilitates maintenance and has rich spare parts supply can also significantly improve product repairability and

service life(Vonplon, 2020; Wilhelm, 2012). Clothing brands such as Patagonia, Eileen Fisher, and Filson promote recycling fashion by encouraging consumers to buy high-quality clothing that can be repaired rather than replaced. They point out that repairing clothes can create an emotional attachment, thereby extending the life of the clothing(Diddi & Yan, 2019). These methods have merits to reduce waste generation by extending the product's physical or functional service life, and contribute to resource conservation and environmental protection due to the design with ease of repair and upgrade. However, these innovations often require high R&D costs and technical investment, and are more challenging in design and production.

Secondly, promote product recycling and remanufacturing through recycling business models. The product service system (PSS) (Olesen, 2016) and collaborative consumption model in the recycling economy improve product utilization through sharing and leasing, which reduces the new materials demand and waste generation(Nußholz, 2017; Tukker, 2015). For example, the performance economy proposed by Stahel et al. decouples resource consumption from economic growth and creates more jobs through a fully service-based society(Cooper, 2010). Additionally, integrating reverse logistics into traditional supply chains allows companies to efficiently recycle end-of-life products, making them available for reuse and recycling, thereby optimizing profit potential through product (or material) value retention(Masi, Day, & Godsell, 2017). However, shifting from traditional sales model to a service model requires significant operational and managerial adjustments, which can be challenging. Meanwhile, some consumers, particularly in the B2C market, may be reluctant to adopt collaborative consumption or service models.

Existing research on extending product lifecycles focuses on technology and design innovation as well as business model innovation. These studies start from product design, product use, and reuse, and propose diverse and practical solutions to reduce resource waste and promote sustainable development. However, many researches face challenges in technology, cost, and consumer and market acceptance in practical applications, indicating room for further solutions.

We find that most current research focuses on drawing practical experience from modern products, lacking analysis of historical cases, and full utilization of historical experience as a guide in modern design and practice. The Zisha teapot from Yixing, China, is an example with an exceptionally long lifecycle. With a history spanning over six hundred years, it has seen its rise and fall, but has never ceased to exist, demonstrating its remarkable vitality. The Zisha teapots have been exported to Japan, Southeast Asia, Europe, and other regions, and has become a model for pottery design, production, and culture, demonstrating their unique charm across time, space, and cultures.

As such, this paper focuses on the design history of Chinese Zisha pottery and systematically discusses the reasons for its success in maintaining a long product life cycle from multiple perspectives of material selection, process changes, design concepts, and cultural value. Combined with modern product design and lifecycle management theories, this paper analyzes the scientific nature and originality of Zisha pottery design, and summarizes ideas and methods that can be used for reference to provide substantive guidance and support for the modern product sustainable development.

2. Overview: The Essential Features of Zisha Teapots

Zisha pottery is one of the most famous pottery varieties in China (Figure 1), and is known as the foremost of the four famous Chinese potteries(Y. Dong, 2018). It comes from Yixing City, China. With its unique material technology, functional use, and cultural connotation, it has become a collectible and luxury item with distinct artistic and cultural value. Zisha pottery is unglazed pottery made from clay with high iron and manganese content, which is unique in Yixing(Qu, 2015). It is made using a unique swatting cylinder or clay sheet inlay technique, before being fired in a kiln of over 1000 degrees Celsius(Wu & Shi, 2006). The production process has been selected as one of China's first batch of national intangible cultural heritage. Its outstanding product, the Zisha teapot, has superior breathability, is not easy to burn hands, resists scale deposit, remains fresh overnight, and gradually absorbs the aroma of tea during long-term use, making it an excellent tea device. Moreover, it has good plasticity to be painted, written on, carved, or engraved, so that people can incorporate poetry, calligraphy, and seals from traditional Chinese art into the pot. Zisha teapot has become an important representative of Chinese culture and art.



Figure 1. Teapot incised with floral design and verses, Guangxu period, Qing Dynasty (Geng, 2010)

The Zisha pottery can be traced back over 7000 years to the Neolithic Age when Yixing residents began making rough daily pottery such as sand-containing gray pottery. From the Song Dynasty (960-1279), Yixing potters discovered and utilized the unique local Zisha clay ore to create the famed Zisha pottery(Editorial Committee of Cultural Relics, 1984), with the Zisha teapot being the most influential. During the Ming (1368-1644) and Qing (1644-1911) Dynasties, the popularization of tea-making methods, changes in the craftsman system, and the participation of literati led to the great improvement in the Zisha teapot making craft, featuring continuous artistry and culture improvements. It was appreciated by literatis and dignitaries, and entered the court and

royal family as a tribute. Highly and widely praised, Zisha teapot enjoyed the reputation of “the best tea set in the world”(Lin, 1992). Its image often appears in ancient paintings, demonstrating its popularity (Figure 2).

Since the late Ming Dynasty, the Zisha teapot has been exported for about 400 years, becoming an important reference model for ceramics production in the Netherlands, Germany, and the United Kingdom. During the time, Portuguese merchants introduced Zisha teapots to Europe, where they became known as China’s “red porcelain” and quickly gained popularity among European consumers. In the 1760s, British aristocrats began using Yixing Zisha teapots(Petttigrew, 2001). According to Dutch East India Company records, about 1635 pieces of Zisha teapots arrived in Amsterdam in 1680. By the late 17th century, Zisha teapots, along with tea, became fashionable items in aristocratic households. By the end of the Edo Period (1600-1867), it was introduced to Japan and quickly became a staple of the Japanese tea ceremony(Huang, 2007). Japanese tea practitioners pride themselves in using Yixing Zisha teapot utensils and have collaborated with Zisha clay artists in making teapots, which promoted the aesthetic trend of Japanese Zisha teapot culture. During the Republic of China, Zisha teapots customized according to the customs of various countries were sold to the United States, Britain, Germany, France, Italy, Thailand, and the Philippines (Figure 3). A small number of them were sold to Latin American countries like Mexico and Peru, showcasing its long history and global popularity.

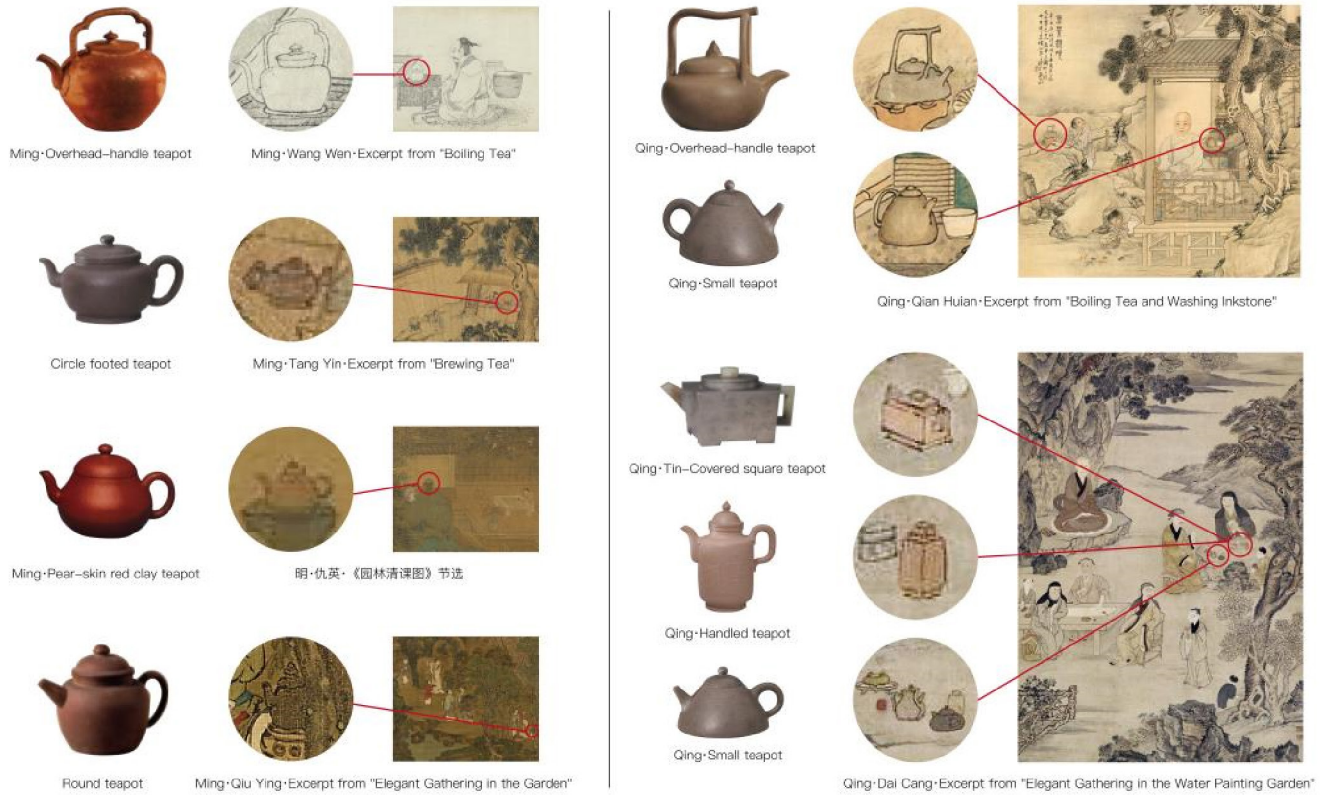

Figure 2. Zisha teapots in ancient paintings



Figure 3. Unknown, Zisha teapot Exported to Europe. Purchased from Brown, accessioned in 1853. Handformed in Yixing. V&A collection. (V&A collection)

Nowadays, with the economic development, the rapid pace of life, and people's increasing attention to spiritual well-being, Zisha teapot appears more timeless and exudes new vitality. Despite industrialization and marketization changes, Yixing Zisha teapot has consistently adhered to traditional handmade methods while continuously innovating design concepts. This pursuit of high-quality products has kept it vibrant in modern society and on the international stage, and deeply valued and sought after by Zisha teapot enthusiasts worldwide.

3. Exploration: The Reason for Zisha Teapot's Longevity Enduring popularity

The enduring popularity of Zisha teapots is closely linked to the uniqueness of the materials, the craftsmanship of the production, the functional practicality, and the profound cultural significance. This section will delve into these factors to comprehensively explore the reasons behind its popularity in more than six-hundred-year history.

3.1 Unique Zisha Clay from the Yixing

Materials determine the basic characteristics and development potential of products, and Zisha clay is a prerequisite for the success of Zisha clay art(Zhang, 2017). The acquisition of Zisha clay is fundamentally linked to its surrounding ecological environment. Yixing, with its long history of pottery making, has seen local artisans gradually master the properties of various clay types through years of practical experience and innovative experimentation in crafting everyday ceramics. During this process, these artisans identified Zisha clay, which possesses unique physical and chemical properties. They discovered that the finest Zisha clay originates from the mountains near Dingshu Town in Yixing (Figure 4).

Zisha clay possesses multiple excellent characteristics, and teapots crafted from Zisha clay are more capable of preserving the fragrance of tea during tea making. It is this unique, regionspecific clay that has brought fame to Zisha teapots. First and foremost, Zisha clay possesses excellent permeability. Research shows that the surface of Zisha pottery has many tiny pores, with a porosity over 11%(Sun & Ruan, 1993). From material perspective, this is due to the granular structure of Yixing Zisha clay mud ore. After sintering, a dual pore structure forms inside the Zisha clay body, providing good breathability to retain the tea fragrance. Second, Zisha clay material resists sudden heat changes and has low heat conduction. Therefore, when boiling water is poured into the Zisha teapot in winter, it has no risk of cracking, and has good insulation to stay cool to the touch(Zhao & Zhou, 1998). Moreover, with long-term use, the surface texture of the teapot becomes warmer and smoother, allowing consumers to experience its gradual transformation, which further enhances the enjoyment of daily life.

All in all, the reputation of Zisha teapots is inseparable from the craftsmen's emphasis on exploring and utilizing regional materials. Zisha clay material has strong regional attributes, and high-quality Zisha clay products cannot be made outside Yixing City. This regional specificity ensures product scarcity in the market, making it more valuable, so that consumers cherish them more to indirectly extend their service life.



Figure 4. Distribution Map of Zisha Clay Mining Area

3.2 Handicraft-centered Zisha processing

The uniqueness of Zisha teapots is also rooted in their purely handmade craftsmanship. The entire process, from the preparation of Zisha clay raw materials, the production of individual components to the final shaping, relies heavily on handcrafting. The Yixing potters believe that only hand-made Zisha teapots can reflect the pot makers' thoughts and emotions, and have vitality, humanistic atmosphere, and the delicate beauty of hand-imprinted marks. The preparation of Zisha clay involves a series of meticulous steps, including manual selection of materials, sun drying, impurity removal, crushing, sieving, water mixing, kneading, and aging, all of which are carried out by hand. Zisha teapots are typically composed of several basic components, with clay sheets being one of the fundamental elements. the precision of hand control over the clay is pushed to its limits. When creating clay sheets, the process begins by using fingers to round the corners of a square clay block. Then, one hand holds a tool to forcefully strike the clay into a flat disc, while the other hand's thumb and middle finger grip the center of the disc, rotating it on a workbench to ensure that the edges become compact and smooth, thereby preventing cracks during further processing (Xu, 2017; Yang, 2013). Throughout this process, both hands must coordinate effectively; with each strike, the disc must be rotated, ensuring that the angle of rotation and the force applied are consistent, resulting in a flat and even clay sheet. Additionally, the number of strikes must be carefully controlled, as too many or too few will fail to achieve the desired outcome.

Judging from the forming techniques of Zisha teapot, hands play a crucial role in these processes. Taking the most distinctive mud sheet-making technology in the Zisha clay process as an example, handcrafting experience and skill are essential. This forming technology is based on the local pottery beat forming technique (Figure 5). The craftsman use one hand to support the interior of the vessel to control its shape, while the other hand presses and taps the exterior with a paddle. This coordinated technique shapes the vessel into various forms. During tapping, the craftsman must carefully balance the support strength of the hand and the impact force of the paddle, requiring both precision and control. Additionally, the craftsman must maintain the vessel's steady rotation to ensure stability through inertia. Although Yixing Zisha teapot once attempted to follow the trend of industrialization by adopting mechanized and mass production methods, these efforts ultimately failed to achieve the refined quality of traditional handcrafted techniques. Moreover, they struggled to preserve the original cultural significance and artistic essence inherent in Zisha teapot. Clearly, craftsmanship is crucial in achieving the teapot's unique quality and is a key factor in its long-term popularity.

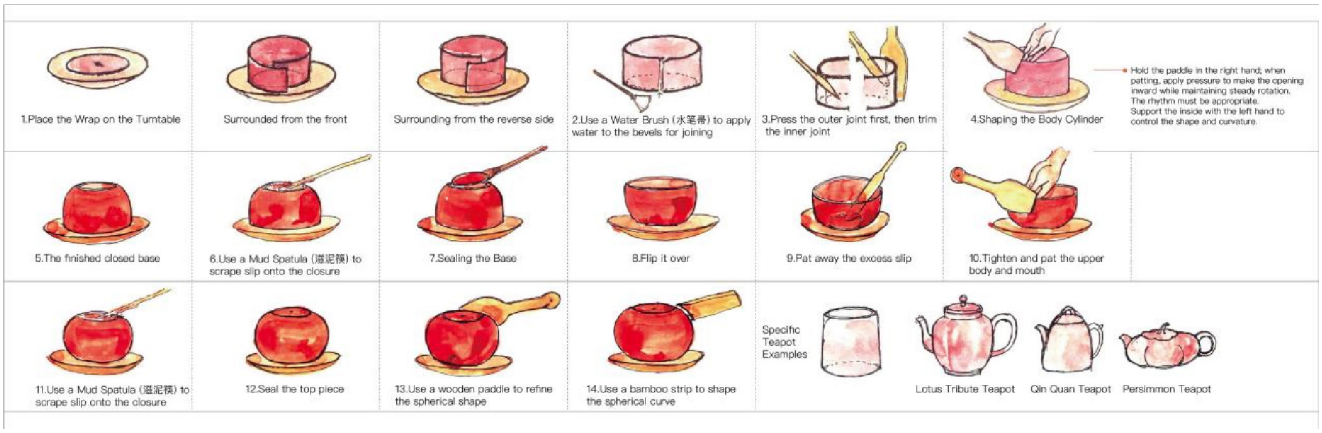

Figure 5. Diagram of the Beat Forming Technique of Zisha Teapots (Xu, 2017)

3.3 Expanding from Practical Tea Tasting to Aesthetic and Interactive Functions

The popularity of Zisha teapots is inseparable from their practical use, aesthetics, and interactive functions. The practicality of Zisha teapots can be observed from their shape design. Each component designed for practicality constitutes a complete Zisha teapot. As a tea appliance, the Zisha teapot's shape design is constrained by its function. Specifically, the Zisha teapot's shape must facilitate the handling, water pouring from the spout, filling water between the mouth and lid, and adding and removing tea leaves during brewing (Figure 6). The teapot is composed of the body, lid, lid button, handle, spout,etc. (Figure 7) Each component serves a distinct function, while collectively contributing to a harmonious and cohesive design. For instance (Yang, 2013), the filter holes at the spout have been continuously optimized to address practical challenges. Early singlehole designs frequently caused tea leaves to block the spout or enter the cup. The introduction of multi-hole sieve-like designs effectively resolved this issue. However, in smaller teapots, the limited space between the body and the spout can cause expanded tea leaves to block the sieve holes. To address this, artisans developed hemispherical ball-shaped holes, increasing the spout's surface area and further improving the tea brewing experience.

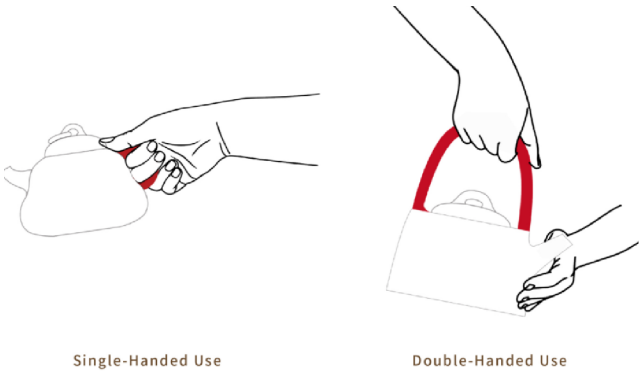

Figure 6. Diagram of the Handle Usage for Zisha Teapots (He, 2018)

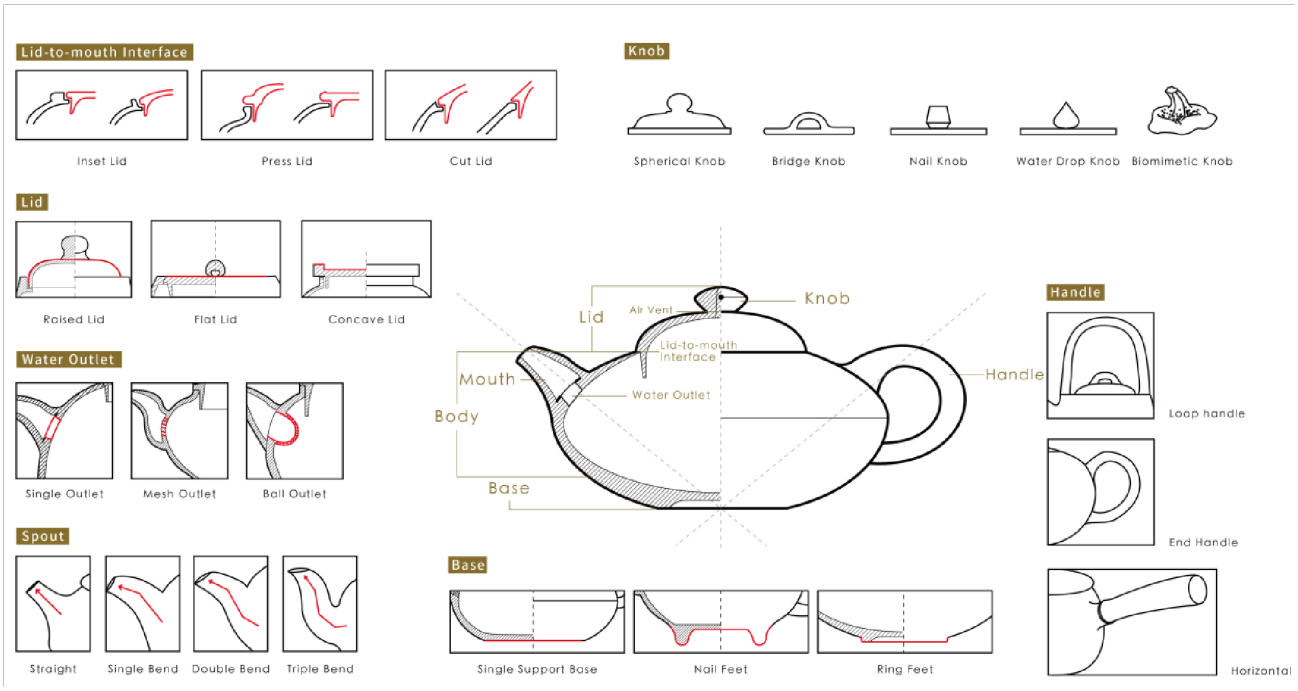

Figure 7. Diagram of the Structure of Zisha Teapots

Secondly, while focusing on the practical shape design, Zisha pottery makers also comprehensively considered aesthetic factors to enhance the visual appeal of Yixing tea sets. In crafting traditional round and square Zisha teapots, emphasis is placed on clarity of form and well-proportioned structure. In contrast, Zisha teapots inspired by natural organic shapes or ancient artifacts, known as "floral wares," adopt more creative design approaches. Some teapots ingeniously transform elements like plant vines and branches into functional components such as spouts or handles. Others mimic the forms of ancient bronze vessels, incorporating features like shoulders and feet to evoke the solemnity and ceremonial significance of ritual objects. As such, the teapot design clarifies the practicality as the basis and aesthetics as an important auxiliary. It not only offers exceptional practicality in daily use but also appeals to individuals unfamiliar with tea utensils, thanks to its distinctive aesthetic charm and cultural significance. It can be said that the shift from a focus on utility to a balance between functionality and beauty is a key factor in the teapot's enduring appeal and continued evolution.

Finally, the teapot has strong interactive functions, which is primarily reflected in its social attributes. People often meet friends with tea, discuss philosophy, exchange feelings, and appreciate arts, so using teapot enhances interaction and connection. Historically, literatis often combined tea drinking with other elegant and leisurely activities, such as banquets, exhibitions, and tea tastings in bookrooms and teahouses. Nowadays, the use of Zisha pots adds

fun and ritual to modern life. People exchange experiences in tea making and pot appreciation through tea parties, enhances their emotional connections through participation and sharing.

3.4 Tea Culture and Value Empowerment of literati Culture

The widespread influence of Zisha pottery relies not only on its excellent quality but also on China's long-standing tea culture and literati culture (Figure 8). From the perspective of tea culture, Yixing Zisha teapots, as a uniquely Chinese tea-brewing vessel, have a design and development closely intertwined with the evolution of tea culture. Since the Tang and Song dynasties, tea gradually became a daily beverage, and tea appreciation emerged as an important activity, reflecting refined taste. As tea drinking gained popularity, the selection of teaware became a symbol of personal cultivation and aesthetic sensibility, which in turn stimulated the diversification of ceramic and porcelain teaware. By the mid-Ming dynasty, Yixing Zisha teapots gained widespread recognition, a trend linked to the expansion of tea cultivation and the transformation of tea-drinking practices.

Yixing, the birthplace of Zisha teapots, was renowned for its production of Yangxian tea as early as the Tang dynasty. The Tang poet Lu Tong vividly praised the tea's exceptional quality in his poem "Running Brush to Thank Councilor Meng for Sending New Tea," where he wrote, "Even the emperor should taste Yangxian tea, and no other plants dare bloom before it." (Peng, Chen, & Zhou, 2021) The flourishing tea culture not only advanced the practice of tea drinking but also inspired local potters to innovate teapot designs tailored to the needs of tea preparation. By the Ming dynasty, the founding emperor Zhu Yuanzhang considered the production of compressed tea cakes (tuancha) too labor-intensive and costly, leading to a shift toward the simpler production of loose-leaf tea. This change transformed tea-drinking practices from the "whisking" method to directly steeping tea leaves in boiling water. Zisha teapots, with their excellent breathability and water absorption, became the ideal vessels for this new method, allowing tea leaves to fully release their natural aroma. Consequently, Zisha teapots have remained popular from the Ming dynasty to the present day.

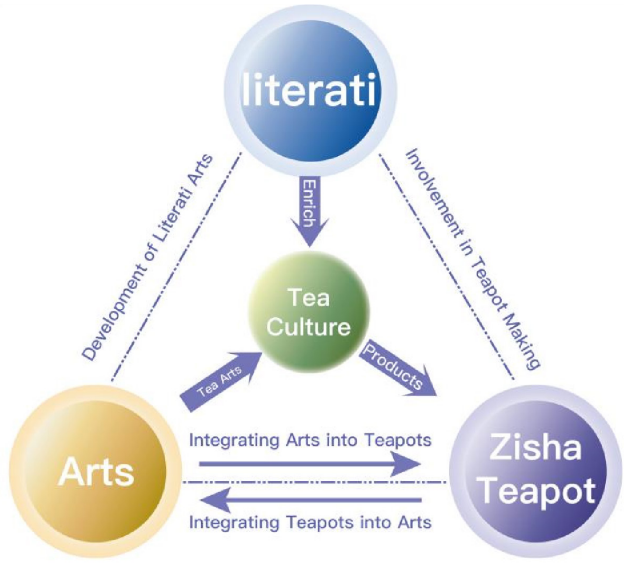

Figure 8. Diagram of the Relationship between Zisha Teapots, Tea Culture, and Literati Culture

From the perspective of literati culture, the cultural achievements and aesthetic tastes of ancient Chinese artists represented by the literati group have significantly enhanced the decorative and cultural aspects of the teapot. During the Ming and Qing dynasties, literati not only formed an indirect connection with Yixing Zisha teapots by praising them, but also collaborated with artisans to engrave their favorite poems and writings on the teapots, thus participating directly in their creation. For example, the Ru Ding teapot co-created by literati Chen Mansheng and craftsman Yang Pengnian features poems: "The milk spring is full of snow, and it shines on my cheeks." It describes tea soup gushing out like stalactite spring water, penetrating the heart. This verse not only describes the freshness and sweetness of tea but also conveys the joy of drinking it, inspiring poetic sentiment and a love for tea, as well as the pursuit of beauty. Moreover, on another teapot engraved with the phrase "I love my ding, strong food and strong drink," the verse is inscribed in running script on the teapot's surface, with certain strokes thickened, especially those of simpler characters. This variation in stroke thickness gives the surface a more rhythmic aesthetic (Figure 9) (He, 2018). When using such a teapot, the user can simultaneously appreciate its visual form and recite the inscribed verse, generating boundless imagination and reflection through the combined enjoyment of sight and sound.

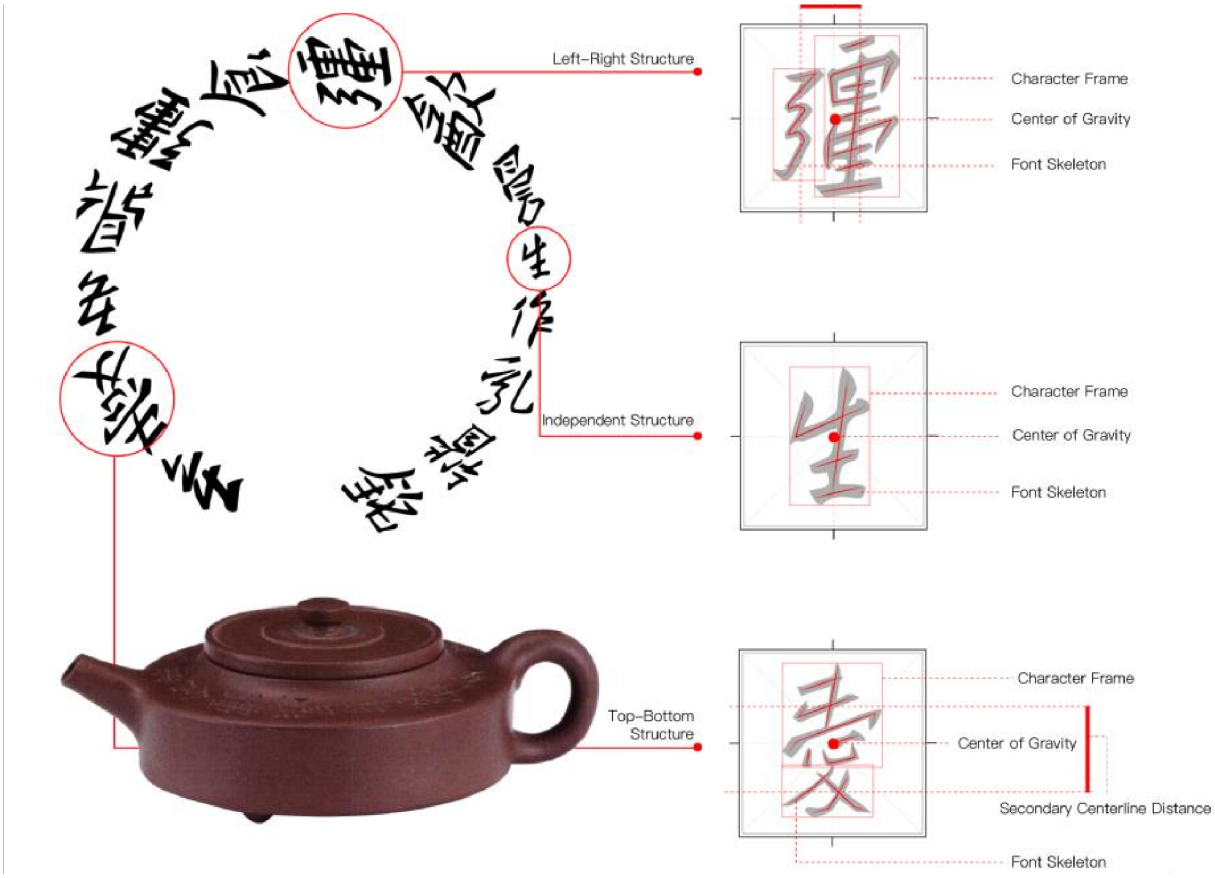

Figure 9. Analysis Diagram of Running Script Poetry on Zisha Teapots: Example of Inscription on Chen Mansheng and Yang Pengnian's Ru Ding Teapot(He, 2018)

Since the mid to late Ming Dynasty, the decoration of teapots has gradually expanded from texts to paintings. Chinese painting, as an important decorative theme, enhances the unique artistic characteristics and cultural connotation of the teapot. For example, the overhead-handle calabash teapot by Chen Mansheng and Yang Pengnian features a Taihu Lake stone drawing (Figure 10). Using landscape painting techniques, the spatial sense of Taihu Lake stone is outlined with thick and thin lines, and the texture and structural transitions are expressed with “dry brush technique”(He, 2018), showing the natural beauty of Taihu Lake stone and the literati’s aesthetic interest in natural landscapes. It can be said that the intervention of literatis, represented by Chen Mansheng, has provided a deep two-way interpretation of the teapot, poetry, and painting (Figure 11), and introduced new expressions in art form and cultural inheritance. The teapot is not just a daily appliance but also an art form, serving as a medium for literatis to express their emotions and feelings. Conversely, this cross-disciplinary collaboration has allowed teapot design to intersect and merge with Chinese poetry, calligraphy, painting, and other arts, transforming it into a medium for expressing the aesthetics, cultural psychology, and aesthetic concepts of the era. This cultural charm, condensed from traditional Chinese art, gives it an enduring spiritual appeal.

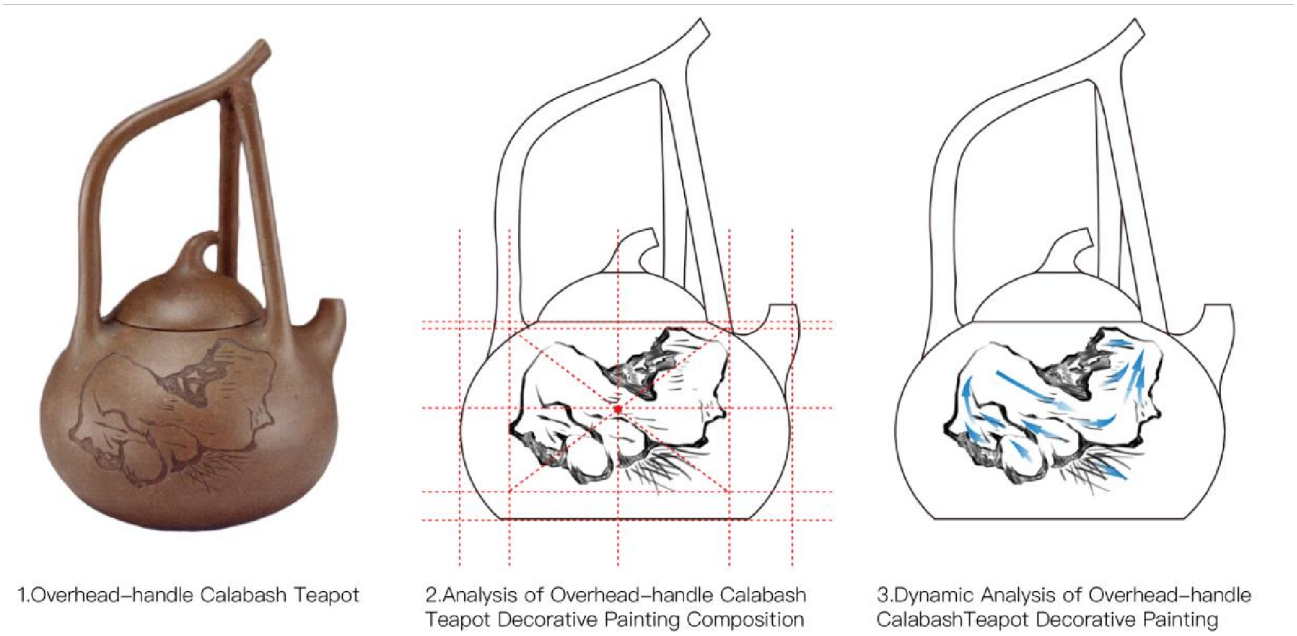

Figure 10. Analysis Diagram of the Painted Decoration on Chen Mansheng and Yang Pengnian’s overheadhandle calabash Teapot(He, 2018)

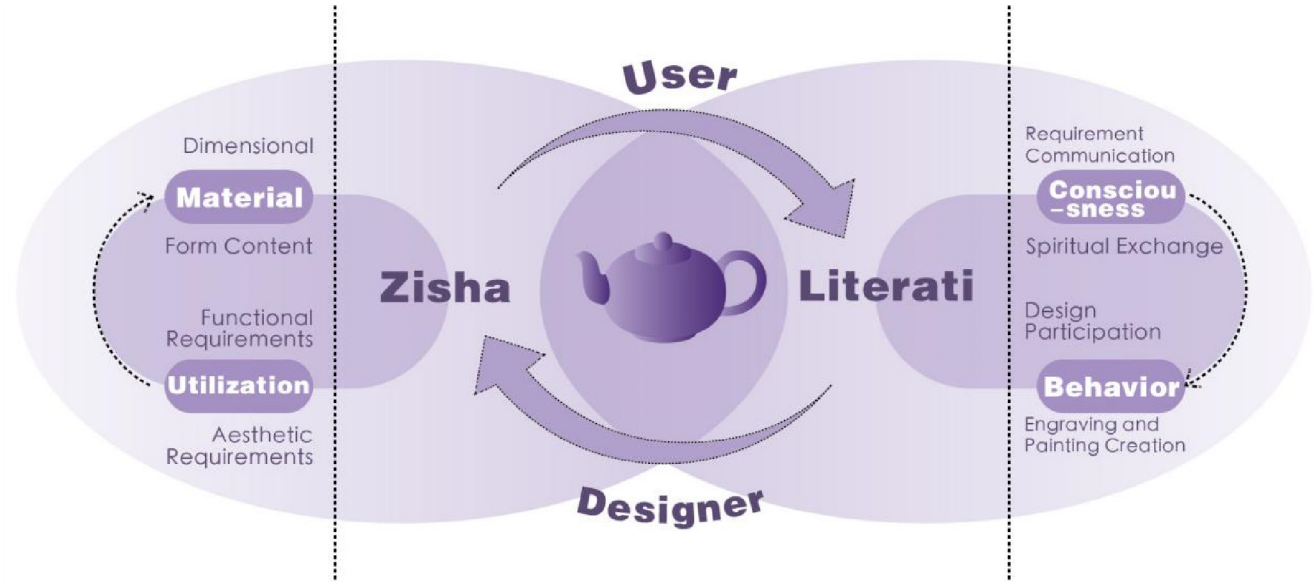

Figure 11. Diagram of the Role of Literati in the Creation of Zisha Teapots

4. Insights: Exploring Multi-dimensional Methods in Product Lifespan Extension

Focusing on the reasons behind the long lifecycle of China's Zisha teapot, this paper conducts a comparative analysis and discussion using modern product design and lifecycle management theories, as well as relevant practical cases. It aims to interpret successful cases of traditional Chinese creations using contemporary and international design languages, to better apply historical experience to modern product design. This paper discusses the design concept of Zisha teapot and its application in modern product design across three categories and six aspects: materials and craftsmanship (locality, handicraft), functions and their extensions (practicality, interactivity), and culture and emotion (culture, emotion) (Figure 12).

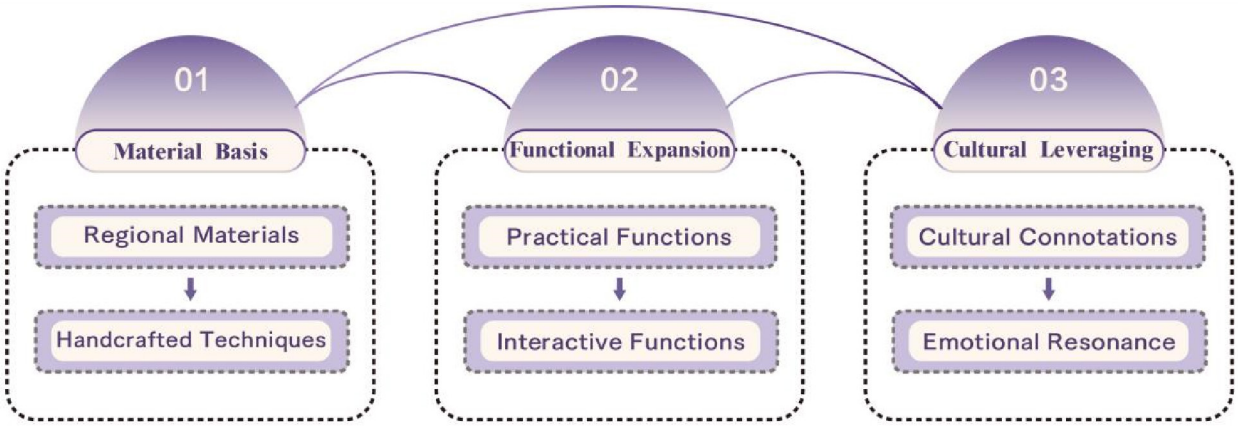

Figure 12. Diagram of the Refined Design Concepts of Zisha Teapots

4.1 Local Materials and Handmade Craftsmanship

1) Regional: Unique Expression of Local Materials

Local materials refer to those obtained within a specific geographical area, emphasizing their local characteristics and cultural background. Local product designs often showcase the unique charm of combining local personalities and customs with specific natural conditions and cultural environments(Hu, 2007). Zisha teapots utilize the unique Zisha clay found in Yixing City, Jiangsu Province. This material possesses local cultural characteristics, natural adaptability, and resource sustainability. On one hand, it can reduce production costs, energy consumption and pollution by minimizing transportation and processing, and supports local economic development, and the inheritance of traditional crafts and cultural heritage. On the other hand, unique regional materials can give products natural advantages over similar products from other regions. Take Zisha teapots as an example. When discussing Zisha teapot, Yixing is inevitably mentioned. Using Yixing's local Zisha clay is almost a baseline in the marketing of Zisha teapots(Zhou, 2017). Local elements are embedded in products, and this geo-cultural advantage strengthens consumer recognition and loyalty to the brand(Qian & Zhu, 2011).

The traditional Chinese design concept of adapting to local conditions emphasizes selecting locally suitable materials for design and manufacturing based on the natural conditions and resource characteristics of different regions, aiming to achieve harmonious coexistence between humans and nature. Ecological design and Sense of Place Design theories in modern product design also emphasize using local materials. It encourages designers to utilize local resources and cultural elements to create products with unique local characteristics, thereby enhancing their cultural value and market appeal. For example, traditional Japanese washi paper emphasizes using natural materials such as mulberry bark ark and tree bark from Mino City, Gifu Prefecture. Traditional Chinese rice paper emphasizes using sandalwood bark and sand field straw from Jingxian, Anhui Province. Swiss watch manufacturers also emphasize high-quality movements and unique designs originated from Switzerland. These practices highlight the uniqueness and superiority of the materials' origins, enhancing the products' geographical, cultural and historical value.

2) Handicraft: the Continuation of Craftsman Spirit

Handicraft refers to the process of making through manual craftsmanship, which relies on the skills and experience of craftsmen rather than standardized machine production. It differs from modern mass production theories. Lean Manufacturing pursues efficient and low-cost standardized production, while handicraft production focuses on personalization and high value added. Handmade craftsmanship is unique,

with distinct textures and details, often following the concept of excellence to produce high-quality products. For example, Italy has a long history of handmade leather goods. Traditional handicrafts produce high-quality and uniquely designed leather goods with high market value. Additionally, handmade products often incorporate the unique aesthetic and artistic expressions of craftsmen, possessing strong historical and cultural value. As Li Yanzu said, "Handicraft skills are an unforgettable and painstaking cultural accumulation. They are based on the practice of countless workers and rooted in the cultural and artistic will of the entire nation, involve the processing and transformation of objects, and represent the mental journey of the entire nation."(Li, 2009) In a postmodern society full of hightech products, craftsmanship, through its emphasis on skill and the creative process, fulfills the human need for emotional connection, meaning, and individual expression. It effectively harmonizes the relationship between technological advancement and the spiritual, psychological, and emotional needs of humanity.

4.2 Expanding from Practical Functions to Interactive Experiences

1) Practicality: Core of Functionality and Efficiency

Practicality is the most fundamental aspect of a product that ensures its long-lasting appeal. In the early stages of creation, any artifact was made for utility. Over time, it has evolved from solving everyday problems and providing greater functionality to incorporating aesthetic value. In ancient China, products related to the national economy and people's livelihood were always the mainstream in design. These designs maintained a concept that prioritized people, emphasized functionality, and upheld humanitarianism(Y. Dong, 2018). Regardless of their design, Zisha teapots consistently maintain excellent tea-brewing functionality and remain connected to daily life, thus avoiding being purely ornamental or becoming useless, which ensures its continued vitality. In modern product design theory, practicality also holds an important position. User-Centered Design emphasizes that the design process should center on user needs, ensuring that product design focuses on practicality and user experience. Functionalism further advocates that design must first meet functional requirements, as form follows function. Therefore, we recommend that designers place practicality at the core of product design, ensuring that their products can truly solve users' problems through an in-depth understanding of user needs and usage scenarios, thereby extending the product's service life.

2) Interactivity: Key to Engagement and Experience

Interactivity enhances user experience and interest in product design by improving interactions between objects, people, and others. The interactivity of Zisha teapot is mainly reflected in the tea culture extended by its tea-drinking function, which enhances

interactions between people and objects, as well as among individuals. During use and tasting, users share their experiences with others through tea ceremonies and tasting activities, conveying profound culture and emotions (Figure 13). This transforms the teapot from a mere tea-drinking tool into a medium for cultural exchange and emotional transmission. Collaborative design emphasizes user collaboration and interaction in product design, while interactive design enhances the social interaction and collaboration experience among users. Modern design can enrich the social and interactive nature of products by incorporating multi- dimensional interactive functions. For example, Nintendo's Switch game console allows users to play alone or interact with friends and family, enhancing communication and connection between people and objects, and among individuals.

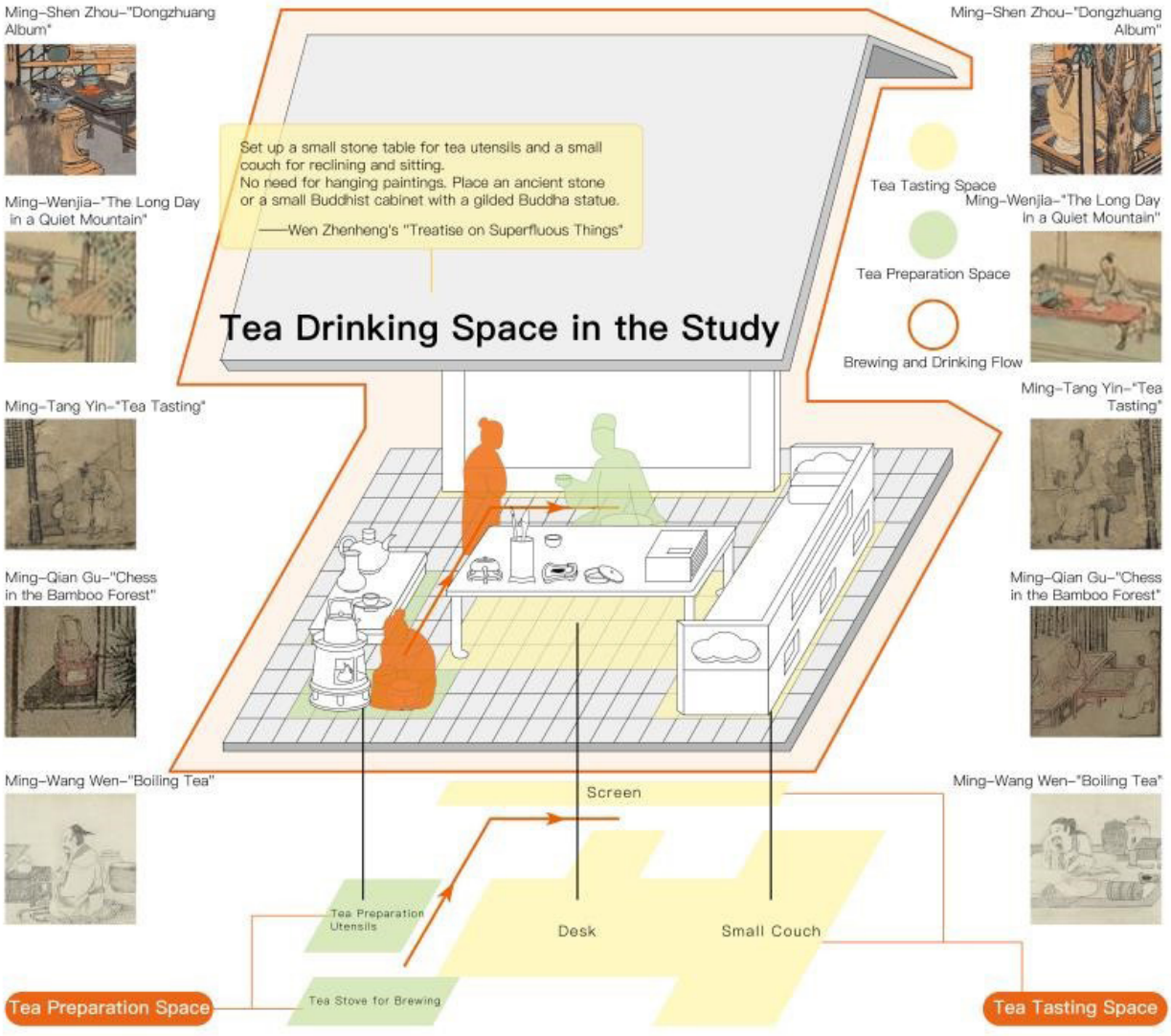

Figure 13. Diagram of the tea drinking space in painting

4.3 Riding the Cultural Empowerment and Emotional Resonance

Culture reflects the connotation and artistic value of a product in design. By integrating specific cultural backgrounds, historical heritage, and artistic expression, it enhances the product's unique charm and market value. By incorporating the Chinese tea culture and fine arts represented by literatis, Zisha teapots gain profound cultural heritage and artistic value, which not only stimulates users' emotional resonance but also enhances their experience.

Brand Culture theory emphasizes that a brand's uniqueness and market appeal can be enhanced by incorporating specific cultural elements. It is an efficient way to empower the brand by seizing cultural elements, giving the brand unique symbolic meaning, leveraging these elements' connotations, making the brand superior to its competitors, and aligning with the target consumer group's awareness(Ye, 2020). Every nation, ethnicity, and region possesses its own unique cultural symbols and cognitive associations, such as the dragon and panda in China, the Statue of Liberty and Uncle Sam in the United States, and the pyramids and Sphinx in Egypt. These cultural symbols can empower brands by enhancing their cultural significance, thereby increasing their market competitiveness. For example, Maserati adopts the trident of Poseidon from Greek mythology as its emblem, symbolizing power and prestige, while Marlboro uses the image of the Western cowboy to embody its brand's "masculinity." (Ye, 2020)

Similarly, the design of Yixing Zisha teapots leverages China's rich cultural heritage to enhance their market recognition and enduring appeal.

Modern product design can enhance the artistic value, cultural connotation, and even collection value of products by incorporating specific cultural elements or collaborating with the art world. It should be noted that if the reference to culture remains at the surface level, such as merely using patterns from a certain culture, it is essentially superficial. When Japanese graphic designer Kazu Nagai was inspecting art design in China, he said: "Japanese design was once influenced by Chinese religious paintings, patterns, and animal motifs. However, Japanese designers refined it by adding decorative changes and symbolic values, elevating them to a mature and aesthetic level rather than applying them mechanically." In the early stages of modern Japanese design, designers combined Japanese aesthetics refined from Chinese culture with Cassandre's posters, Bauhaus theory, and later American advertising and editorial design skills, forming the foundation of modern Japanese graphic design. (Li, 2009) In modern product design, the key to successfully leveraging culture lies in thoroughly understanding the intangible, symbolic, and spiritual dimensions behind it. This allows designers to imbue traditional art and culture with effective, innovative forms of expression, while also infusing products with profound vitality.

In addition, the charm of culture and art also lies in their ability to touch people's innermost emotions. Artistic forms such as music, dance, and painting convey feelings through various mediums, transcending time and cultural boundaries to resonate with audiences. For example, Chinese opera and American jazz, with their unique vocal styles and melodies, evoke powerful emotional responses. Similarly, Argentine tango and Austrian Viennese waltz convey complex emotions and energy through movement and gestures. Likewise, Chinese ink painting and European oil painting, using techniques such as color, line, and composition, express rich emotional layers and artistic moods. In consumer experiences, people seek more than just material fulfillment—they also desire emotional resonance. When a product is infused with positive emotions, it bridges the emotional gap between the consumer and the product, fostering cultural identification and influencing purchasing behavior(Lu & An, 2017). Therefore, in modern product design, it is also crucial to focus on addressing the emotional needs of individuals. By integrating emotional elements such as specific symbols, colors, and materials, designers can achieve cultural expression that stimulates deeper emotional responses(S. Dong, Wang, Xu, Wu, & Yin, 2011), thereby contributing to the sustainable development of products.

It is worth further discussing that the sustainability of Yixing Zisha teapot is attributed to its simplicity in material selection, traditional craftsmanship, and its expansion in functionality and cultural significance. However, directly applying this historical experience to the design of modern electronic products, such as televisions, computers, and smartphones, presents significant challenges. Modern electronics are composed of various complex materials, including rare metals, plastics, glass, and multiple chemicals. These materials consume substantial energy during manufacturing and are often difficult to recycle or degrade at the end of their life cycle. Nevertheless, despite the differences in material use and waste management, the design principles of Zisha teapot can still provide valuable insights for the sustainable design of modern electronics. For instance, designing interactive electronic products can enhance users' social connections and interactive experiences, while culturally resonant designs can evoke emotional engagement, thereby extending the product's lifespan. Additionally, exploring more environmentally friendly material alternatives and improving product reparability can also help mitigate the environmental impact of electronic waste.

Furthermore, the rich sustainable design concepts embodied in Zisha teapot are not only applicable to product design within the context of Chinese culture but also have the potential for broader application in other cultural and contextual settings. Firstly, compared to other highquality handicrafts across different cultures, the design principles of Zisha teapot possess a certain universality. For example, Japanese tea utensils, like Zisha teapot, emphasize the essence of materials, exquisite craftsmanship, and the emotional

bond between users and objects. This dual focus on product functionality and cultural significance makes the design philosophy of Zisha teapot replicable in a cross-cultural context. Moreover, the sustainability principles in material selection and craftsmanship of Zisha teapot offer valuable references for product design in other cultural contexts. The use of natural materials and meticulous craftsmanship in Zisha teapot resonates with Scandinavian design, particularly in the application of minimalism and natural materials. Similarly, the slow fashion movement can draw inspiration from Zisha teapot's emphasis on material durability and emotional value to develop clothing and accessories that align with sustainable development principles. These cross-cultural applications demonstrate that Zisha teapot is not only a representative of Chinese culture but also a significant reference in global sustainable design. By integrating its design principles with product development in other cultural contexts, we can promote broader sustainable design practices and foster global cultural exchange and technological innovation.

5. Conclusion

This paper aims to extract useful elements from China's iconic long-life product, the Zisha teapot, and analyze the feasibility of their application in modern product design to help extend product lifecycles. This multi-dimensional research not only inherits traditional wisdom but also actively explores and practices future product design strategies. Although Yixing Zisha teapot has been explored in cultural and historical studies, integrating it with contemporary design theory and examining its cross-cultural adaptability on a global scale is the unique contribution of this research. Research shows that the uniqueness of Zisha teapot in materials and processing, functional and aesthetic expansion, and culture and emotions is key to their sustainable development over several hundred years. These characteristics offer important insights for developing products with extended lifecycles. First, the local nature of materials can reduce production costs and impart geo-cultural characteristics to the product. Applying numerous handicrafts in the production process injects personalization and human elements into products, mitigating the monotony and indifference of standardized products. Second, all designs must be based on practical functions, and then add aesthetics to ensure the product meets consumer needs. Meanwhile, creating diverse usage scenarios and increasing the product's social attributes and interactivity during use will enhance product usage frequency, thereby creating multidimensional value. The third and most critical factor is injecting cultural elements into the product through cross-border collaboration, giving it profound cultural heritage and artistic value. This stimulates users' spiritual resonance and optimizes their use experience. In addition, the charm of culture lies in its ability to touch people's innermost emotions. Cultural expression through specific symbols, colors,

materials, and designs stimulates deeper emotional reactions, establishes a bond between products and users, enhances psychological attachment, and contributes to sustainable development. The significance of this research lies in creatively drawing inspiration from tradition and seeking solutions to current design dilemmas. More importantly, systematically analyzing successful historical cases constructs a multi-dimensional scientific framework, providing dual references for the sustainable development of contemporary product design from historical experience and realistic theory.

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“DESIGNED BY WOMEN (DPM): APPROACHES FOR A HISTORICAL, NON-SEXIST, AND CO-CREATIVE STUDY ON PIONEERING WOMEN DESIGNERS IN CHILE”

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ABSTRACT | Publications on the trajectories of designers, whether biographies, micro-stories, or side notes, have articulated and enriched multiple histories of design in the Southern Cone. However, these histories reveal a persistent pattern: in the case of Chile, most published works primarily focus on male designers. This bias accentuates gender differences and perpetuates patriarchal power dynamics. The presence of women designers has been only partially addressed in local histories of design and applied arts or in the disciplinary training at university design schools. To address this gender imbalance in the construction of a comprehensive history of women designers who paved the way and created new paths within the national scene, the research project “Designed by Women: Pioneers of Design in Chile” (DpM) was undertaken. The project’s objective is to highlight the trajectories of women who contributed to the professionalization of design—from both professional and academic perspectives—during its formative phase. The study incorporates research methods from design, history, and anthropology. In this article, we emphasize the theoretical framework and discussion that shaped the DpM project rather than presenting its concrete results as a replicable methodology. The proposal, in its documentary phase, introduces the concept of the “pioneer” and methodologically characterizes a non-sexist perspective, which is a necessary approach for studying women who forged the design profession in Chile within a system where positions of power were predominantly held by men (in universities, design offices, design publications,

design event organizations, etc.). In the exploration phase of the project, we examined the trajectory of the distinguished designer Ximena Ulibarri—who is still professionally active—to co-construct her pioneering journey from a non-sexist perspective. Methodologically, through reflection during the research process, we tested a prospecting approach that distances itself from dominant androcentrism by incorporating a gender perspective. The research resulted in an initial systematization of experiences, enabling the replication of this process to explore the trajectories of other female designers. This approach is not intended to commodify a historically subaltern identity, but to challenge the traditional and objectivist canons used to construct the history of design. The aim is to fully recognize women's relevance in the professionalization of design and to contribute to the generation of transformative knowledge.

KEYWORDS | GENDER AND DESIGN, NON-SEXIST RESEARCH, PARTICIPATORY RESEARCH, LOGICS OF POWER, SYSTEMATIZATION OF EXPERIENCES

1. Introduction
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Within the framework of the project "Designed by Women: Pioneers of Design in Chile" (DpM), which aims to highlight the trajectories of local design pioneers through documentary, exploratory, and project-based research, a preliminary study is being developed on Ximena Ulibarri, one of the women who helped forge the design profession in Chile within an overwhelmingly male-dominated power system. Approaching this from a non-androcentric perspective, the project has produced a methodological tool as its first outcome, with results published on https://disenadopormujeres.cl. The purpose of this article is to outline the methodological and theoretical framework used for the systematization of experiences and the coconstruction of the career, work, and thought of the prominent national designer Ximena Ulibarri, recognized as a pioneer of the discipline and an active professional designer. This is particularly significant as it positions the pioneering designer as an active agent in the gathering of information and the interpretation of her own history. In this way, her professional trajectory is historicized, situating her within various contexts and historical moments in the non-linear manner characteristic of personal memories.

In this proposal, rather than presenting concrete results, we offer a discussion and a potential methodology— considering its feasibility—for investigating the work and trajectory of a woman designer from the Southern Cone, potentially applicable beyond these borders. This research framework seeks to transcend the purely structuralist or positivist dimension of history, which is often expressed through different structures (material, social, economic, mental) "within which individuals could be perceived… framed in more or less homogeneous groups, where personal profiles and characteristics are completely blurred" (Morales, 2005, p. 76). Thus, the aim is to distance ourselves from modern and objectivist canons in the construction of a history of design pioneers, with the goal of contributing to the generation of transformative knowledge within the

discipline and profession, beginning with the initial question: How can the practices and discourses used in research processes subvert androcentric narratives in the memory of design?

2. Theoretical Perspectives.

2.1 On the Notion of "Pioneer": Toward a Visibility of Female Designers

The concept of pioneer, from a general historical perspective, originates from the French term pionnier (12th century) and, as it transitions into modernity, it acquires the meaning of initiator. This notion also takes on various bifurcations depending on its subject and context: from a group of animal or plant organisms that begins the colonization of a new territory; a person or collective that starts to explore or exploit something unknown (Todorov, 1982); an individual capable of seeing potential opportunities and making the most of them; someone who does something that has never been done before, marking a before and after; to an agent participating in the formation and expansion of something.

In historiographical terms, the concept of "pioneer," in the masculine form, became canonical with Nikolaus Pevsner's book Pioneers of Modern Design (1936), which is often considered the first publication on the history of design in the Western world. This text has been critiqued by subsequent generations of design researchers for, among other things, its teleological construction of a modern design narrative led by "heroes" rather than "heroines." However, it must be understood within the historical and social context in which it was written. From a broader perspective, in the major Euro-American publications on the history of design that followed (Banham, 1960; Ferebee, 1971; Heskett, 1980; Lucie-Smith, 1983; Meggs, 1983; De Fusco, 1985; Sparke, 1987; Satué, 1988; Bürdek, 1991; Forty, 1995; Campi, 2007, Eskilson, 2007; Jury, 2012; Margolin, 2017, etc.), women occupy a less prominent role. Nevertheless, as this type of research advances, their presence becomes more significant (Breuer and Meer, 2012; Drucker and McVarish, 2020; Herder, 2015; Kirkham, 2000, etc.). A noteworthy and controversial aspect is that in recent studies written by female designers (Kirkham, 2000; Menéndez, 2021), there is an insistence on the thesis that the women who contributed to the construction of modern design worked solely for well-known male figures with their own studios (e.g., Lilly Reich, Charlotte Perriand, Cini Boeri, and Franca Helg in the offices of Ludwig Mies van der Rohe, Le Corbusier, Marco Zanuso, and Franco Albini). However, we find it important to highlight that, in DpM, this historiographical claim does not apply literally: it was not until the implementation of the neoliberal model in Chile that leadership positions in professional design teams began to be increasingly occupied by men.

On the other hand, in constructing narratives about trajectories in the historiographic field of design, "women are excluded from historical references on the industry simply because these narratives are often written by and about men" (Connory, 2020).

Consequently, women's contributions are undervalued due to the variables of "success" and "significant contribution" present in design histories, which align with the production and work of male pioneers and their broader dissemination for the teleological formation of the canon. Authors like Buckley (2020) argue that the omissions of women, both in the past and present, are systematically ignored, and these silences are not accidental but rather the direct consequence of specific historiographic methods. Although her thesis might be debatable, as the historiography of design did not deliberately aim to exclude women designers, her interpretation makes sense by challenging those research methods that involve the selection, classification, and prioritization of certain categories of design and designers, styles and movements, and modes of production, which bias the presence of women.

Against the "historical invisibility of the character," beyond their gender, the issue of biographical constructions arises. Although we are in a different time from the events we study, which allows us to know some (but only some) of their potential outcomes, our present remains an open horizon to various possible futures. To some extent, a purely biographical recognition or visibility of a pioneer—who may also resist being designated as a "pioneer"—can detract from the ontological, epistemological, and methodological priority of social structures—extra-individual entities—based on a scheme of "objective" determinations (Revel, 2015). While biographical constructions can contribute, they present obvious limitations. The creation of a list of authors, whether men or women, may constitute an obsolete epistemology as it does not facilitate the understanding of the deeper forces and stereotypes that underpin cultural systems limiting women's access to the design profession (Beuer and Meer, 2012). Gorman (2003) argues that filling lists with women excluded from the design chronicle is erroneous; instead, he proposes eradicating the pervasive classism, sexism, and racism in the global design field since enumerating heroines, rather than challenging the canon, confirms it by establishing hierarchies. As López Carmona suggests, "the attitude of most feminists has been to recognize or reincorporate the biographies of women who have played an important role in the history of design into the historical narrative" (2016, p. 3). Although challenging, with DpM we strive to distance ourselves from the modern-patriarchal canon that compels us to focus on certain achievements typically monopolized by men, such as leadership positions, company directorships, mentions in publications, guild awards, and so forth. If we were to adopt these dominant—and inherently binarist—criteria through a process of 'reverse engineering,' we would inevitably reproduce a male-dominated history of design, shaped by a male-defined construction and taxonomy.

The question of who qualifies as a "pioneer" within the various domains or specializations of Design is open to debate (Luna Rodríguez, 2019). From a non-sexist perspective, DpM proposes certain criteria that should be considered to address the historical invisibility of women designers: a) Women who pursued the early stages of a design career in Chile, who identify as designers but not necessarily as pioneers, using the term as an "adjective"; b) Women who contributed in various ways to the formation of design as a modern profession; c) Women whose work subtly influenced and shaped the discipline of Design in Chile through their professional practice and within the fragile academic environment; and d) Professionals who created a body of work distinct from the visual arts and advertising.

2.2 Historizing Gender Imbalances and the Pioneering of Design

According to García Parada (2020) in her research Maestras del diseño gráfico en Chile, addressing design from a gender perspective does not necessarily entail establishing a strict demarcation between two domains: design oriented towards market needs and practices focused on social responsibility, often understood in a binary framework, with the former considered masculine and the latter feminine. Instead, the work of early cohorts of Chilean professional female designers sought to achieve a certain discursive and practical transversality—balancing private and social demands with the need to cater to a new type of "urgent" client who drove the neoliberal economy in Chile during the transition from the 1970s to the 1980s—often without the time or possibility for adequate reflection. The neoliberal structure, dominant to this day, aggressively promoted consumerism and the development of financial and commercial services, prompting reflection on those who become visible and the agencies and practices that remain less recognized in the design field. However, from a feminine and care-oriented perspective, as we observed in interviews with members of design groups predominantly composed of women—such as Publicidad UC, Paula, and INTEC—these designers promoted working conditions and environments that constituted the profession, even while responding to the exponential increase in demand for professional design services as part of the new market requirements.

During the development of the still-dominant neoliberal and patriarchal system, the environments created by women pioneers of design in Chile came under pressure due to new business structures and logics. While the demand for design solidified their presence in companies, institutions, and universities, it did not prevent positions of relevance and power from being predominantly occupied by their male counterparts. When occupations gain prestige, as we observed in the case of design in Chile from the 1960s to the 1990s, men tend to colonize them. This occurred with the imposition of the neoliberal model in Chile, a scenario where the productive trajectory, the quality of work, and the progress of each designer operated in contexts localized and overseen by social

institutions: competitions, universities, companies, sponsorship systems, and so on (Lupton and Tobias, 2021). Additionally, the multiplicity of roles between the public and private spheres has been another determining factor. For those women who forged their paths during the early stages of the design profession, establishing their own independent professional businesses was, in fact, almost a heroic act. This was especially true if the profession was accompanied by conventional social and cultural roles: being a wife, mother, and caretaker of the household (Guida, 2020). However, as observed in our research, the logics that prevailed in the early design studios led by women allowed for the coexistence of roles within structures that could be described as more horizontal and cooperative rather than vertical and competitive, qualities that are often recognized in feminism as differences between patriarchal and matriarchal logics (Harding, 1987; Kirkwood, 2001; García Dauder and Ruiz Trejo, 2021).

Researching and historicizing the pioneers who established the design profession in Latin America is a complex task. When the focus is on the work of women designers, design has often been mischaracterized— for instance, as illustration or interior decoration—and not fully recognized as an autonomous profession with its own distinct field of knowledge. Anyway, more challenging were the efforts of women designers who refused to confine themselves to reproductive labor. However, during the 1980s and 1990s, when design and visual arts intersected with postmodern sensibilities and poststructuralism (Álvarez and Neira, 2020; Pelta, 2004; Poynor, 2003; Walby, 2002), new and more flexible discourses emerged, challenging monolithic approaches such as psychoanalysis, Marxism, or structuralism (Anderson, 2006). In this context, female historians began publishing previously unknown material about active women in the creative fields, challenging the prevailing selection and quality criteria in art, architecture, and design by offering more pluralistic perspectives (Sellers, 2018). Belatedly, the Western world has begun to acknowledge the professional trajectories of some women who made significant contributions to the field of design in the 20th century. Though, this recognition often lacks a historically situated, non-sexist perspective that critically examines the role of women. While biographical accounts and analyses of their work are valuable contributions, they are insufficient to fully explain the development of these trajectories, as previously mentioned.

The historiography of Chilean design still recognizes a clear imbalance between the publications of male and female monographs regarding the construction of narratives, experiences, and trajectories of design academics and professionals. The latter—those about women—are scarce, which is even more paradoxical given that women have been the majority in university classrooms in the discipline (Vargas and Rodríguez, 2019; Vidal, 2022). This is evident in the higher number of enrollments in design schools, where many pioneers who pursued academic or professional careers, or both,



Figure 1. Sample covers of monographic books about national designers or proto-designers, all men, 21st century. Source: Pedro Álvarez archive.

were trained. This paradox reveals that design has been rapidly acquiring greater symbolic value and, consequently, increasing influence in organizations and positions of power. When men from bourgeois families begin to study design, it indicates that the discipline is moving away from a position of "symbolic deprivation" (Jaffe-Dax, 2024).

2.3 A Non-Sexist Perspective for Making Female Design Pioneers Visible

The DpM research perspective is grounded in the premise that all knowledge is produced in a situated manner, meaning it is shaped by the context and subjectivity of the producer (Haraway, 1995; Harding, 1987). In line with feminist epistemology, we hold that the gender of the researcher influences research practices (Buenahora, 2016) and propose the feminist viewpoint as an alternative for generating significant and transformative knowledge for women and their contexts (Arango Marín & Cardona González, 2023; Blazquez, Flores & Ríos, 2012).

Following Harding (1987), one of the pioneers of gender-conscious research, feminist methodologies aim to incorporate women as empirical and theoretical resources, have a political

purpose of transforming women's reality, and place researchers on an equal critical footing with the people studied. Additionally, they focus on questioning binary categorizations (Preciado, 2022)—such as the division between subjects who research and objects of research—seeking active collaboration between researchers and those researched (Biglia, 2014). This approach also promotes women's access to knowledge, alongside a critical reflection on their role in the social fabric, without being limited to highlighting aspects considered important by men (Harding, 1987; Blazquez, Flores & Ríos, 2012). Thus, it questions the hegemonic hierarchy that places roles, practices, and social positions historically assigned to masculinity at the top of the social pyramid, challenging patriarchal myths about female 'passivity' in history (Kirkwood, 2001).

By distancing ourselves from the androcentric biases that still shape part of History—those that render stories invisible—we incorporate a gender perspective as a starting point to understand the worlds and environments in which these pioneers have situated themselves. But a non-sexist approach is not synonym of a feminist approach. While both address sexist and androcentric biases (Bartra, 2012), feminist research must also be explicit in its political stance and commit to advancing gender equity. Margrit Eichler argues that, unlike non-sexist research, feminist research focuses on improving the condition of women. Both the gender approach and the feminist viewpoint allow us to observe and describe the world from perspectives that highlight power inequalities and inequities. The non-sexist approach seeks to eliminate gender biases, while the feminist perspective aims to recover the history of marginalized groups of women (Kirkwood, 2021). However, in this case, it is not obvious to claim that the first generations of professional designers trained in Chile were particularly marginalized women, as most came from bourgeois or middle-class families. From this position, they accessed university education, confirming their belonging to the classes with access to elite professional training and practice.

Political commitment is a distinctive feature of feminist methodologies, which imposes on any research that proposes this inscription to be explicit in applying its principles at all stages of the work (Maffia, 2012). While a non-sexist approach does not require its practitioners to have as explicit a political commitment as the feminist one, in investigative terms, feminism and non-sexism, as situated approaches, take a critical distance from the canonical epistemology and methodologies of modern science. The latter, in its practice, hides its political interests under the pretense of possessing supposed neutrality, camouflaging its political practices of power production with the notion of objective knowledge. Situated research seeks to expose and question the existing —yet concealed— power relations and interests that favor certain investigative agendas.

In practice, the feminist and non-sexist situated approach in research is defined and recognized by its discourse but legitimized by its daily practices; that is, how research tools are applied, how the team is organized, how its sensitivity addresses gender inequalities, and its commitment to reducing the identified inequities. While it is not obvious to assert that there are inherently feminist or non-sexist research instruments, the careful and conscious realization of the inequities in semi-structured interviews and oral histories has been privileged in the social sciences that participate in this perspective (Bartra, 2012). Consequently, the relationship between researchers and the researched develops differently due to a certain awareness of historical sex-gender relations, which constitutes the type of mediation each inquiry instrument deploys, how it is conducted, the findings obtained, and the willingness to return the research results to the communities worked with for their empowerment.

This approach responds to its democratic vocation. Situated, feminist, and non-sexist research actions return data, results, and findings to the communities involved in the research, as facilitating access to knowledge has been one of its central concerns (Kirkwood, 2021). Its commitment to social transformation entails an effort to make the knowledge derived from the research experience available to enrich and contribute to the autonomy of those who made the research possible, thereby promoting the critical capacity of the displaced in intellectual, political, and affective dimensions (García Dauder and Ruiz Trejo, 2021). It is important to note that situated research questions traditional forms of communicating results, as the modern scientific conviction of producing objective knowledge imposes it using expert and distant language (Bartra, 2012), which favors the marginalization and subjugation of non-experts. Feminism and non-sexism agree that the objective and subjective, the rational and emotional, can coexist and enrich each other within a clear, critical, straightforward, personal, and compelling discourse.

Recently, design historiography has aimed to identify the causes that exclude women from the canonical narrative of the discipline. This effort has helped reveal and address the evident imbalance between research, exhibitions, and publications about male and female designers. However, the omission of women compels us to rethink the logic and methods of data collection, narrative construction, and the use of categories and variables that operate when documenting the disciplinary present of design and writing its histories.

The development of the project materializes the assumption that the historical narrative is itself an object that can be designed, thereby rejecting the hegemony that objective knowledge, claimed by a particular discipline or method, has over how history should be constructed. We establish this criterion to foster a dialogue among investigative modalities from different disciplines, aiming to construct ways of understanding and

narrating history that are pertinent to the studied context and to recover the memories and trajectories of pioneers whose work and influence have been undervalued (Miquel Mallol Esquefa, 2019).

3. Methodological Approach to the Subject of Study

3.1 Applying a Non-Sexist Perspective

Although this project does not necessarily articulate itself as a form of "resistant female subjectivity" (Schraut and Paletschek, 2008), it does align with studies on the underrepresentation of women in various fields of design (Buckley, 1986 and 2020; Meer, 2012; Gorman, 2001). Cheryl Buckley, recognized as an "academic pioneer," highlighted this issue in her work "Made in Patriarchy: Toward a Feminist Analysis of Women and Design" (1986).

The historical dimension of the pioneer (past, present, and future) addressed in DpM focuses on the analysis of the autobiography, professional trajectory, and technical record of Ximena Ulibarri' work. We understand DpM research as co-creative, due Ulibarri actively participated in the analysis of her own biography and production. This involves a historiographic review of the

PRIMARY SOURCES			SECONDARY SOURCES
ORAL SOURCES	**VISUAL SOURCES**	**WRITTEN SOURCES**	**DIGITAL SOURCES**
Pioneer designer (actors related to her career)	**Photographic records of the period:** Personal dimension	**Writings/manuscripts of the designer**	**Netnography work:** presence of the pioneer in online media, websites, blogs, digital social networks, etc.
Family circle of the designer	**Photographs of the designer's work and projects:** from sketches to commissions and finished works.	**Printed bibliographic material on the designer** (articles, interviews, written columns, awards, prizes, etc.).	
Colleagues and teachers during her university education	**Photographs of teaching activities:** Academic dimension		
Professional and academic peers			
Bosses and collaborators			
Students			

Figure 2. Diagram of the use of primary and secondary sources for documenting the work and trajectory of the pioneer designer. Source: own elaboration.

designer and her ways of doing and thinking through oral sources (interviews, conversations) and evidence found in printed and digital documents, both primary and secondary (bibliography, netnography, and archival work). This includes records of graphics, products or services, as well as images related to her private sphere, professional development, and/or academic trajectory. It is important to emphasize here that the research integrates significant historical moments (key events) and chronological temporal arcs (e.g., years or decades) based on both plausible

and subjective events of the past (the pioneer's trajectory), present (the current situation of the pioneer), and future (the pioneer's projections, for instance, her legacy). Thus, the non-sexist aspects —which intersect with historical ones— are evident in the construction and application of a qualitative data interpretation, approaching the process critically to avoid sexist and androcentric biases. This approach is mindful of the fact that power structures and gender norms can influence how data is collected, analyzed, and interpreted.

In line with the previously described perspective, the project sought to identify the various key actors and communities that should be considered, promoting their active participation in the construction of the research narrative. This initial phase materialized during the investigative process through activities in which the participants could influence the research process and the preliminary approach of the team. The research addresses a phenomenon where personal and political, organizational and productive dimensions intersect, based on research in and through design (Findeli et al. 2008), but also as action research (Fals Borda 1988; Colmenares, 2012), from a non-sexist interpretative matrix, as a possible way to approach and make visible the trajectories of the pioneering women in design.

We, as researchers, intertwined two perspectives: the biographical (experiences of the pioneers) and the contextual (events that occurred in Chile as experienced by the subjects). Integrating these two approaches interweaves the qualities and circumstances of these designers' trajectories, employing a methodological approach that acknowledges research as inherently political. This approach allows us to address issues such as the concerns and beliefs of the subjects under study, their affections and emotions, as well as their actions and rituals (Mollenhauer, Hormazábal, & Molina, 2018).

Within the typologies of "case" studies, we find those that focus on a particular fact or subject (Santamaría and Lecuona López, 2016). Regarding the type of subject, a single case can be considered as a person, a family, or a group. As Ottenberger (2001) states, the "single case design" originates from action research as a dual experience between researcher and researched subjects, allowing for testing general hypotheses that can be used or referred to particular cases. These interactions between researcher and researched subjects naturally enrich the investigation by presenting differences and subjectivities; but, if systematically analyzed, these differences can facilitate the detection of certain patterns. Furthermore, the application of horizontal investigative work in conjunction with the pioneer allows for a more comprehensive understanding of their trajectory and affections from a situated perspective. In the context of this research, we employed a multimethod investigative strategy that integrates qualitative and participatory methods, typical of ethnography, historical analysis, and design research. Specifically, the methods

included oral history interviews, which facilitated a deep exploration of the lived experiences of Ximena Ulibarri, and visual elicitation techniques, which allowed participants to engage with and reflect upon their professional and personal histories through visual media. We also utilized documentary analysis, where both primary and secondary sources, including archival materials, publications, and personal documents, were systematically reviewed. Furthermore, ethnography and autoethnography played a critical role in intertwining the researcher's reflexivity with the subject's own reflections, ensuring that the research process remained co-creative and non-hierarchical. These methods were essential in contextualizing Ulibarri's work within broader disciplinary, political, and social frameworks, thereby offering a situated understanding of her contributions to Chilean design.



Figure 3. Instances of research with the pioneer (case study), other pioneers and academics, feminists, and historians. Source: own elaboration.

In line with the project's purpose, we categorized design pioneers in Chile using a non-sexist methodological approach, aiming to broaden perspectives and challenge modern, objectivist research paradigms. We considered the fundamental qualities of the design profession, as defined by its goals, practices, and values (Ashforth et al., 2008). However, due to the gender

biases that dominate the Chilean design field, it was not possible to select a designer based solely on her awards, publications, media appearances, and similar indicators. As previously mentioned, we used four criteria to recognize a woman as a Pioneer of Design: Is she an emerging designer from the early stages of the design profession in Chile? Is she a key figure in articulating design practice in Chile? Has she produced a body of work that significantly contributed to the development of Chilean design? Does her work leave a distinct legacy for Chilean design? These questions allowed us to introduce analytical categories into our method that unequivocally identify Ximena Ulibarri as a pioneer and position her as a reference for new generations. Moreover, we sought to validate this recognition through accounts provided by communities of professionals, educators, colleagues, peers, students, and family members, thereby legitimizing her trajectory as a pioneer due to her impact on the field.

This investigative effort aims to highlight the work and agency of the pioneer Ximena Ulibarri. It proposes her as the subject of study through an ethnographic and methodological approach to recognize and make visible other design pioneers in Chile. This scalable project establishes guidelines to avoid gender biases, as it "leads us to develop the research process somewhat differently, starting with the formulation of different questions about issues that, in general, are not considered relevant by other researchers" (Bartra, 2012, p. 73). Under this approach, it becomes crucial to recognize how and where we position our own subjectivity, acknowledging the impossibility of achieving a neutral stance on the subject and its controversies. In this sense, knowledge production can be understood as a political act, requiring us to position ourselves consciously and responsibly (Biglia, 2014). Thus, during the projective research and through critical reflection on the investigative and interpretative process, DpM develops a research method that gradually distances itself from androcentric research, building its autonomy during the research process itself.

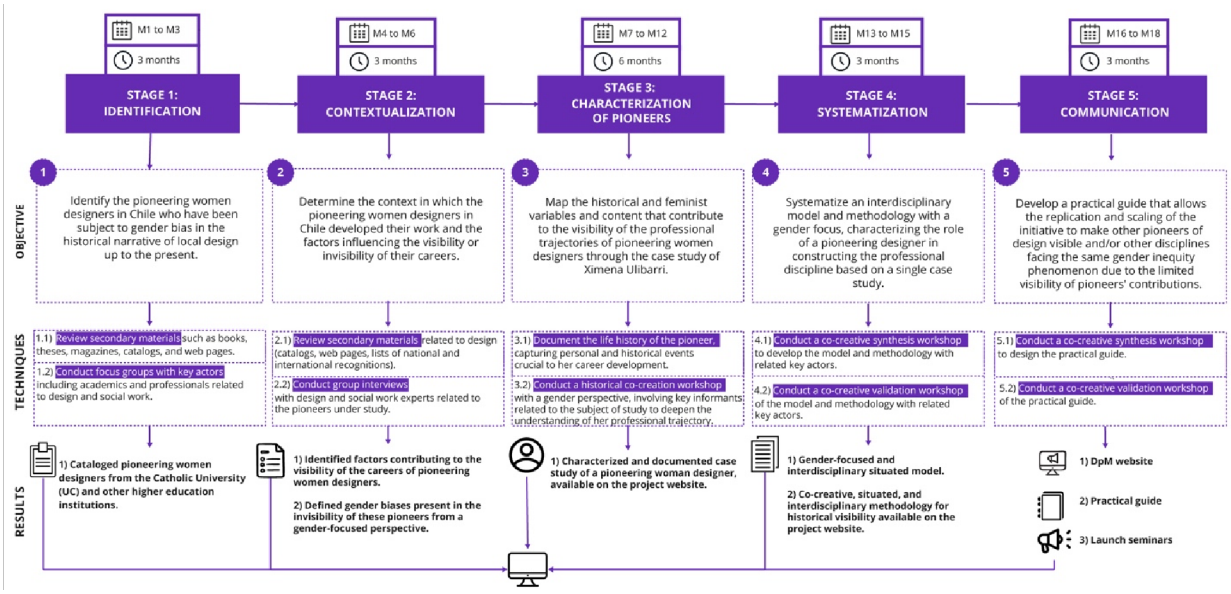

Figure 4. Descriptive Scheme of the Five Stages Constituting the DpM Research.

The critical approach of the DpM project aims to identify the power relations and asymmetries underlying the phenomenon studied. It seeks to critically interrogate the relationship between the research team, the instruments, and the individuals involved in the investigation, without pretending to consider the project as something "completely closed." Therefore, at each stage of the project, the findings are reviewed with the aim of iterating the information gathered with the pioneer and keeping the expectations and particularities of the research experience alive.

The co-creative aspects present in the DpM model are addressed through the review and analysis of bibliographic sources and the collection of visual material carried out during various research activities in the field (interviews, visual elicitations, conversations, group meetings, etc.). These activities were conducted either virtually or in person with various actors, taking into account the pioneer and the researchers, as well as all participants in these inquiry processes (feminist academics, design historians, professional colleagues, academic peers, team members, family members, students, and design pioneers in Chile).

4. CONCLUSIONS

Facing the perception of a gender imbalance in the recognition and inclusion of pioneering female designers in historical and disciplinary publications in Chile, DpM, Designed by Women: Pioneers of Design in Chile, positions itself as a project aimed at making their trajectories visible. It targets both the academic world and a broader audience to generate transformative knowledge about pioneering women designers in the Southern Cone. Additionally, specific dimensions have been identified to consider in creating a method and/or investigative process that proposes alternatives to the traditional and objectivist canons of constructing histories of designers who paved the way. This proposal suggests historical approaches, work stages, methods, and ethnographic inquiries that, according to the authors, are necessary to explore these pioneers' trajectories and construct their history in a shared, informed, and horizontal manner.

Although the purpose of this article is not to present the concrete results of the case study of designer Ximena Ulibarri—available at https://disenadopormujeres.cl—it aims to discuss how her case study highlights the need to incorporate non-sexist criteria in researching pioneering women designers to advance the generation of transformative knowledge for themselves and their contexts. In this sense, it is crucial to emphasize that the interest in studying these professional women implies re-situating the historical

perspective of design at both continental and local levels. This goes beyond the trajectories of European or American designers (all white) who were the first to be examined or become references in global design history books, documentaries, or design magazine articles (e.g., Casey, Eames, Greiman, Grey, Kare, Kruger, Lupton, Pierrand, Reich, Scher). However, the focus here is not on finding a female identity or identities in design but rather on understanding the diverse perspectives in practice while also recognizing the trajectories of women who contributed to the disciplinary and professional construction under conditions of lesser likelihood of recognition.

It has been essential to attempt to understand how, despite a high enrollment of women in technical and professional design schools compared to their male peers—at least in the context of Chile—their presence in design histories has been less prominent. This correlates with their influence in power territories (such as leadership positions in design schools, research centers, and related institutions), although this phenomenon has been gradually changing in recent times. It has also been observable how pioneering women designers "established schools" within sometimes rigid Bauhaus curricula or rebelled against certain programmatic assumptions such as "interior decoration" or "industrial design." They proposed alternative paths, such as integrating objects into environments do not separate from them or clarifying that graphic design was also industrial and therefore difficult to separate in a binary manner, against categories defined and naturalized by male architects or designers.

During our research, we recognized that the pioneers shape the field of design by organizing into work teams based on logics and modes of relationship historically associated with women, such as mutual care, a certain horizontality, and the practical consideration of the affective fabric, among others. This observation allows us to affirm that, in its formation, the professional design field in Chile is organized based on logics and practices that can be described as matriarchal. It has been within these constructions of plural and flexible design histories, without falling into relativism, that this investigative and methodological proposal has sought to generate some approaches to address this ongoing problem. Finally, it should be mentioned that the mere exercise of writing about the trajectory of a pioneer will not succeed in reversing the invisibility of women's work. However, providing an investigative experience and methodological approach that can be scaled constitutes a contribution that allows for reflection during the action and interpretation outside of the action (Findeli & Coste, 2008).

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“CO-CREATION AND DESIGN OF TOOLS FOR CULTURAL MEDIATIONS IN ART MUSEUM OF CIUDAD JUÁREZ”

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ABSTRACT | Today´s museums, rather than simply keepers of artifacts, should be spaces for exploration, education and inspiration. As centers of knowledge and culture they must be accessible to all and encourage both formal and informal learning. Mediation in museums, especially in contemporary art, which is often exclusionary in its complexity, seeks to make exhibitions more accessible and relevant, breaking down barriers between art and audience to facilitate deeper and more participatory understanding. This paper is about considering opportunities to design meaningful experiences that go beyond the content of exhibitions, integrating activities that enhance the visitor experience. Although the Museo de Arte de Ciudad Juárez (MACJ), the only one of the National Institute of Fine Arts and Literature in the north of México, has adapted and opened to the public in recent years, its access and relevance remain limited, facing challenges such as low attendance, limited dissemination and few public resources. This project has revealed opportunities to improve mediation and access through interactive and playful activities in this museum, such as exploring the exhibitions, experimenting, creating in concordance with the art works and learning, all of which encourage greater participation and connection with the community. Experience design and co-creation as a means of transforming visitor interaction could be tools to enhance the visitor’s experience.

KEYWORDS | DESIGN, MUSEUM, MEDIATION, EXPERIENCE, CO-CREATION

1. Education and mediation in museums

Museums, as places to safeguard culture, history, science and art, are now much more than places that preserve and display artifacts. A museum allows people to explore collections for inspiration, learning and fun. It is an institution that collects, protects, and makes objects, artifacts, and specimens accessible, which it holds in trust for society (Association of Museums in EVE Museums and Innovation, 2018). Miremont (2017) explains that museums are today a fundamental piece for the transmission of ideas and stage of the modern concept of cultural entertainment, they are part of the living knowledge of a society and institutions of culture at the service of a community. To complete this goal museums must have their doors open to everyone:

"Museums themselves have recognised [sic] that in order to be considered a valid and active participant in their society, they must be accessible to all, of real use by giving value in terms of providing resources for intellectual refreshment and debate and spaces for contemplation and inspiration". (Woollard, 2004, p. 106)

The museum functions are preservation, acquisition, conservation and collection management but also research and communication (Reinwardt Academie in Desvallées and Mairesse, 2010). Research and communication are intimately related to the exhibition as much as to education, one of its primary functions since museums are places for learning, because they allow people to develop skills and build knowledge in various spaces and moments throughout their lives (Lebrún, 2015).

Following Lewis (2004) "museums have an important duty to develop their educational role and attract wider audiences from the community, locality, or group they serve. Interaction with the constituent community and promotion of their heritage is an integral part of the educational role of the museum" (p. 11). Therefore, education in the museum aims to promote experiences in a formal environment in connection with educational institutions or specific academic projects, but also from non-formal education.

Museum mediation (Castellanos-Pineda et al, 2021; Arriaga, 2019; Alderoqui, 2020; Morales, 2015, Desvallées and Mairesse, 2010; Santacana, 2006) stems from its communicative and educational vocations. Mediating implies breaking the hierarchies that are usually associated with art and museums to make exhibitions more accessible to more people, and proposing activities that support the encounter with the works from different versions. It is a transmission effort that uses different channels and implies a communicative turn; with it, bridges, connections and accompaniments are established through the design of practical, critical and transformative media and activities that contribute to the democratization of culture.

In the contemporary art museography, these strategies also try to break the separation, both physical and intellectual, that is made of artistic and heritage objects with respect to their context (Sabido, 2015). In art museums, especially contemporary art museums, the resources and elements of mediation become fundamental when what is exhibited is experimental or conceptual since it entails an exercise of reflection beyond the obvious.

One of the great paradoxes of 20th century art has been precisely that the rupture with figurative and traditional art, which was proposed from a democratization and de-aesthetization of art, later became an exercise of exclusion. According to Giovine (2015) the works of conceptual art emphasized the epistemological turn in function of art that had already been initiated by the deaesthetization, the anti-art and the rupture, and made evident a new relationship with the spectator, who could not limit himself only to observe nor to relate aesthetically to the work -in a concrete way- but to relate to it by way of the intellect -in an abstract way-.

In this sense, mediation strategies should consider the dimensions of presence and event of the museum as a device for the consideration of the subjects and the ways of exercising knowledge, of knowing the world and, through this knowledge, formulating ideas about social reality (Sabido, 2015). The questions generated by much of today's art are not easy to answer, which is why museums have a fundamental role in mediation as guides to their visitors, but not only to explain it but also to provide access to the rich discussion of the artist with his media and discourse. In a context where the contemporary art museum is concerned with change in art (Debbaut, 1985 in Millet, 2018, p. 18), it is an opportunity for mediation to deal with the dynamic perspectives that art must manifest itself.

2. Experience design and co-creation as tools for mediation

Mediation is not a generalized exercise for any museum, it does not happen in a void, it is imperative to know the audiences. Planning experiences implies identifying the contexts from which visitors come or could come, it also considers access to their ideas, needs, perspectives and expectations, it is to consider

not only in the reception but in the experience of interpretation. Therefore, it depends not only on the content or the media, but on the visitor: on his appropriation as a subject constructor of the experience, linked to the vital and social baggage that he brings with them (Castellanos-Pineda et al, 2021, p. 611).

Visitor participation in museums is an area of conflict and ambiguity about how visitors become part of the museum (Alderoqui, 2015). In a 1967 seminar held in New York with different museum directors and curators in which Harley Parker and Marshall McLuhan participated, were put on the table radical ideas for traditional museums. In words of Alderoqui (2015) they talk about: open museums at night, take some artifacts out of their display cases and create immersive showcases for visitors; museographic devices to touch, scale reproductions, immersive spaces, modulation of lighting to force visitor involvement, visitors as co-producers and co-creators, rooms for children, the design of meaningful experiences in personal and identity terms, a sense of humor, the recreation of sensory environments to mount the artifacts of the collections that could reveal how they had been produced and used, nonverbal rooms, without signs, the deployment of imagination, of multiple languages, tactile, olfactory and acoustic spaces, and nonlinear exhibitions.

After fifty years, how much of this can be said to have happened in museums around the world is a difficult question to answer. In Mexico, great science museums have been created for children, interactive museums such as the economics museum in Mexico City (MIDE), or virtual visits, but some of the museums of history, culture and art financed with public funds are perhaps still far from generating mediations of that level. What do we see is a great opportunity to understand their role as constructors of meaning and educational recreational elements. “Museum collections reflect the cultural and natural heritage of the communities from which they have been derived. As such they have a character beyond that of ordinary property which may include strong affinities with national, regional, local, ethnic, religious or political identity. It is important therefore that museum policy is responsive to this” (Lewis, 2004, p. 12).

When it comes to experiences, design is a fundamental tool given that as an activity it studies access to new interactions with spaces, objects and messages (Campi, 2020; González de Cossío and Morales, 2015; Norman, 2006). As Buchanan (1995) explains: “design is an essential element of a new philosophy of culture directed toward the empowerment of individuals in exploring the diverse and common qualities of comunity experience” (Introduction, p. XVII). Through design, ideas are visualized since it is a projective and prescriptive activity (Lawson, 2006). It is a strategic and methodological activity whose solutions are based on studies of environments, users and recipients to identify needs and opportunities for improvement in different aspects of the development of

individuals, society and territories. The formal properties of an object or product are the result of the study of needs, so it must be done from a responsible perspective with the physical and social environment, always considering people and their realities.

"Human responses to the everyday things of the world are complex, determined by a wide variety of factors. Some of these are outside the person, controlled by designer and manufacturer, or by advertising and such things as brand image. And some come from within, from your own, private experiences" (Norman, 2004, p. 65). Experience design seeks to develop an ideal relationship and interactions between a user and an object. As Norman (2012) explains, objects are containers of experiences and emotions, they recall pleasant and comforting moments and by association have an important personal meaning for their users. But in addition, the object as a unit of material culture, is a temporal mediator, a communicator of the basic elements of a society (Melgar and De Los Reyes, 2019, p. 124).

"User experience design is the creation and synchronization of elements that affect users´experience with a particular company, with the intent of influencing their perceptions and behavior" (Unger & Chandler, 2012, p. 3). And it is an empathic approach of "research, conceptualization, design and development of a vast array of user-centric objects and experience" (Chapman, 2005, p. 94). It is therefore interesting to think about this perspective to understand how a museum configures its space, how it presents its exhibitions and, above all, how it designs routes and builds tools to communicate with its users.

According to Marc Hassenzahl (2010) "experiencing is the stream of feelings and thoughts we have while being conscious—a continuous commentary on the current state of affairs… sights and sounds… motives and actions, all closely knitted together and stored in memory, labeled, relived and communicated to others" (p.1). For Diller, Shedroff y Rhea (2006), there is an "essential human need for meaning" (p.3), that's why is important to "understand the role that meaning plays in people´s lives, how products and services can evoke meaning" (p.4), in other words meaningful experiences modify the user's sense of purpose and significance. Users relate to designed objects in ways that go far beyond their practical function generating a process of affectivity, but this affectivity depends on cultural variability, experience, education and individual differences (Norman, 2012, p.54).

Co-creation as a process of mutual value creation between an entity and its users, generates an active form of coexistence and interaction between them (Alves dos Santos et al, 2018; De Koning et al, 2016; Sanders and Stappers, 2008; Prahalad and Ramaswamy, 2004). Instead of a simple giveand-take it is about having non-passive recipients and contact that ceases to be transactional and becomes an experience. Co-creation is a collaboration that guides the design process,

involves dialogue, access to information about the actors, understanding the benefits of the process and transparency in the development of the actions in which they are involved.

As Busciantella-Ricci and Scataglini (2024) state in their overview, designers cannot "escape from interacting in a (co-)design process" (p. 8) because we collaborate, converse, share goals and carry out practices with different actors, and because in our work creativity is no longer exclusive to us or to a single moment of the design process. In this sense co-design is also "a mechanism for empowering people, namely a mechanism for taking control over their own futures by developing their own ideas, knowledge and skills" (Zamenopoulos & Alexiou, 2018 in Busciantella-Ricci and Scataglini, 2024, p. 9). If design in general already is co-design when works hand in hand with people, participatory design is even more so; is an approach that focuses on considering people's experiences and visions, but also the roles and relationships they might assume during the processes, in other words how they get involved in the generation of new ideas and in the transformation that a design process always implies. This is the foundation of what is understood as a human-centered, user-centered design.

Similarly, Sanders y Stappers explains in Designing to Co-Designing to Collective Dreaming (2014) that:
"Designers and design researchers are exploring the creation of tools that non-designers can use to channel their own creativity. In co-design, designers use the ideas generated by others as sources of inspiration and innovation. Designers are becoming part of teams responsible for the generation, analysis, and interpretation of the "data": the artifacts and models that result from the co-designing process. Design professionals are learning the skills needed to act as facilitators of the collective creativity of others". (2014, p. 19)

Their work shows the evolution over time of the concept of people's participation in the design activity, if at the beginning design was for consumers, and today design is made with users, in the future design will be done by people as a collective activity. Among its various conclusions, we highlight that "everyone can be involved in designing and gains relevant learning experiences throughout their education to enable their participation" (Sanders and Stappers, 2014, p. 33).

Experience design, user-centered design, participatory design and museum mediation concurs in a central element: taking people into account in the processes to generate meaningful products or services. As the experts explain "museums should not abdicate its responsibility as cultural institutions but need to coexist diversity of voices, because when this happens in the context of an exhibition enrichment of both museums and public occurs" (Alderoqui, 2015, Abstract, p. 30). That is why we see co-creation as a key element to implement in the design of tools for people to live and understand what the museum can give them and in turn the museum feeds back and generates another type of work, collaborating with those

who see it from other points of view. Since the emphasis is rarely placed on the visitor subject, on the types of experiences that he/she constructs during his/her visit, on the manifestations of pleasure or of aesthetic gaze or historical understanding (Schmilchuk, 2012), thinking about mediation resources in the museum under the perspective of experience design and co-creation could contribute to produce museographic, informative, communication and dissemination resources that are indispensable to favor the mobilization of preconceptions and leave open the possibility of learning (Schmilchuk, 2012). According to this background, museums can be mediators of emotions, sensations and memories (Melgar and De Los Reyes, 2019), which allows establishing that through the design of experiences and co-creation, objects could contribute to the exercise of memory, learning and recreation in the hands of the public and other actors interested in educational and cultural development.

3. Mediation at the Museo de Arte de Ciudad Juárez

In Mexico, museums are fundamental spaces of its history and identity, but they are still inaccessible or distant for most of the population, distant not only geographically, but also in terms of absence as a cultural and recreational option. Like so many other institutions transplanted from the Old World, the museum in the American Continent is created as a cultural establishment in which conceptual-operational models are extended aimed at developing and disseminating specialized knowledge from objects and collections (Rico, 2018, p. 54). However, that knowledge has not always been at the service of all, even though the museum has changed and has opened its doors it is still an option for leisure, entertainment and education for few people.

There are many reasons why in our country there is still little population that approaches museums and of course it also depends on each region and its recreational options, but we cannot deny that repeatedly museums built as repositories of the great creations of the human spirit continue to play an important role in perpetuating coloniality, highlighting certain subjectivities and knowledge while invisibilizing others, perpetuating hegemonic narratives and worldviews (Guzmán, 2021).

In Ciudad Juarez there is a really reduced offer of museums compared to the size of its population, which exceeds 1.5 million inhabitants, so the Art Museum of Ciudad Juarez, the only museum of the National Institute of Fine Arts and Literature of Mexico (INBAL) that is in the northern region of the country, is an important museum in a city that has few cultural sites. This Museum was built in 1963, as part of the National Frontier Program (PRONAF). It was opened to the public in 1964 to the creation of cultural and entertainment centers along the entire border strip between Mexico and the United States (MACJ, Antecedentes, 2024). It is a museum with three exhibition

spaces, one of them characteristic for being a circular room, the others are part of a half-moon, they have two smaller areas of flexible use as a warehouse or to offer workshops. They do not have a permanent collection, they always receive from INBAL or propose the exhibitions themselves, which usually last three months, although there are shorter ones. Approximately nine people make up the management group: director, administrator, promotion and diffusion coordinator, exhibition and special activities coordinator, educational services coordinator, design and image coordinator, assistant, custodians and assembly, although not all of them are full time.

3.1 Methodology

This proposal is part of the research project Museum as a cultural space and access to knowledge. *Strategies of mediation and new experiences in the Museo de Arte de Ciudad Juárez (INBAL)* funding by UACJ through the call for Research Projects with Social Impact (PIISO). The methodological strategy is approached from a qualitative perspective, the inquiry action is dynamic between the facts and their interpretation (Hernández, 2014). The emphasis is placed on the study of reality and on the respect and fidelity to the perspective of the actors involved in that reality (Sautu, 2005). According to Tesch's classification (Miles and Huberman, 1994; Sautu, 2005) this work falls into the category of studies focused on the search for and social construction of patterns or regularities, and systems of social categorization, since among the theoretical-methodological approaches it covers are the various types of ethnographic studies, grounded theory and emancipatory and participatory studies -action research-.

This paper presents part of the first stage of the project, which consists of a diagnosis of the museum and the exploration of its existing audiences. For this purpose, a survey, open interviews, observation and active participation in museum events were carried out to identify the museum's audiences and the first possibilities for mediation and creation with users.

In March 2024 we began to work with MACJ to understand the dynamics of communication that it maintains with its public, to recognize their ways of working and later to propose, with them, elements of mediation. We have realized that MACJ already has a captured public, belonging to people interested in art and culture, but also to schools, especially elementary schools, or associations for those who make guided visits. Visitors who come on their own to the museum during its regular hours are not many, in the first survey conducted within the museum called Tell us about your experience in the Museo de Arte de Ciudad Juárez conducted during the month of May 2024 to sixty people, we realized that although the museum is recognized as an exhibition space, as well as protection and dissemination of artistic heritage, there are few people who come to the openings (17. 5% almost always, 1.8% always) and to the exhibitions (24.6% almost always, 5.3% always), and even fewer people attend other activities

offered by the museum such as workshops, conferences, guided tours, courses, concerts or events. In general, about 30% of the respondents recognize that they hardly ever go to MACJ and that when they go it is because they receive information about the exhibition or event. Respondents consult little the museum's Instagram and Facebook pages, the Tik tok and the museum's website are more successful. On the other hand, if we talk about the level of satisfaction, most recognize that they have had a good experience in the museum and that it has been thanks to the artists and work they appreciate, as much as to the building itself valued as an architectural piece of good design.

In addition to its exhibitions, MACJ offers the community guided tours, talks, dialogue tables, activations and workshops, and opens its doors to small concerts. It has a person in charge of Educational Services and some activities of its public program are framed in programs of the INBAL such as Night of Museums or A museum for you, or those of the Secretaría de Cultura, as it was in pandemic the program Contigo en la distancia, cultura desde casa from which arose Diálogos de la Frontera from MACJ. They also propose actions on special dates such as Children's Day, the museum's anniversary or the month of pride for sexual diversity, to name a few. Several of these activities are part of the public program that is scheduled every month with the authorization of INBAL and is disseminated through social networks. As a contemporary art museum, it is faced with exhibiting work that may be visually and conceptually difficult to understand for the common public, so it seeks other means of interaction with its audiences and strives to be a voice for art in the crossborder cultural context.

Although visitors to MACJ are professionally attended, we found that few visitors come to the museum or are aware of its networks. In the experience of the museum director, the number of people who visits an exhibition or attend an opening is directly related to the theme of the exhibition or the recognition of the artist. But it also contributes to the fact that on several occasions the dissemination of activities is not launched with time in advance given the type of management required to be part of INBAL, that the public budget is limited and that for the moment there is no board or association in charge of raising other funds. This, together with the fact that most citizens do not consider museums as a common space for recreation, opens the opportunity to think of spaces for co-creation and design of experiences that connect and communicate citizens with the museum for an enhancement of its cultural and educational work.

The first mediation proposals were generated from here, considering that the activities should offer a space for dialogue beyond the presentation and explanation of the art works presented. The tools of mediation make it possible to attend to an incipient process of co-creation that the MACJ could consider for its next activities. The early

stage of the research does not allowed to say if effectively we had address social change yet, but it has certainly broadened the MACJ administrators possibilities.

3.2 Tools for mediation

It is important that state-funded museums put in the foreground: "the needs and expectations of their visitors up to the top of their agenda [because] even if admission is free they wish to be assured that the time and effort they put into a visit will be rewarded through being entertained, learning something new and feeling welcome and comfortable in the surroundings" (Woollard, 2004, p. 106). As experts explain collections are at the service of the museum and the museum is at the service of the community (Miremont, 2017). With this in mind, we find opportunity to engage with the museum understanding that the exhibitions themselves are a great communication tool between the museum and its audiences because, as Miremont (2017) explains, the object alone, isolated, cannot express the research done around it, it needs to be presented in a context, in a communicational system attractive and tailored to the public every time it is presented. Therefore, our idea is to mediate through the contents that their exhibitions have; taking as a subject the same theme that the artistic pieces explore is a way to get the contents across in a different way, since as we saw above the audiences are diverse, not only in terms of age, but of interests, knowledge and skills.

Form and materials used by the artists to represent their themes and generate meanings is another opportunity to interact with the public in a different way. An example is the first activity we proposed and tested with a group of university students who took a guided tour of the museum. The objective was to explore the exhibition looking for specific materials, an exercise inspired by Bingo of the Museum of Modern Art, NY, USA. MoMA (2024). The exhibition at MACJ was a border biennial, meaning that there were very different pieces technically since it brought together several artists. Visitors were asked to use a worksheet called Exploring the Border Biennial with photographs containing parts of the art works, one side of which indicated what type of material they were looking for, such as wood, plastic, fabric, thread, cement or metal, e.g. They had to look among the pieces in the exhibition to find which work that photograph belonged to. This is a different way of looking at the pieces again; looking through the works also allows to pay attention to details, to find the diversity of media an artist has, to recognize the language of the materials, their consistency, malleability, durability, etc.

Two other exhibitions were inaugurated in May, Terrenos by José Villalobos, who presented photography, installation and video from which he speaks of the social and cultural dynamics of rural communities in northwestern Chihuahua, in contexts such as migration, their relationship with gender and land ownership in northern contexts (MACJ, Special Planner, May 2024). And Sentido

Paisaje by César de la Riva, who presents abstract pictorial art work, representations of the landscapes of various towns he visited in the region to create his pieces, which he describes in the titles of his paintings. As can be seen, both artists have the state of Chihuahua as their background.

The first activity that was designed was within the framework of the Night of Museums, which implies opening the doors one Wednesday a month after the usual schedule to offer a different program to the public. Usually this event proposes talks, conferences, concerts and welcomes adult audiences. On this occasion we proposed a playful exercise, an activity entitled Palabras y sonidos del estado grande in which we invited people of all ages to participate in the elaboration of poems through the guided tour of the museum and from two songs that speak of
Chihuahua. The activity began visiting and carefully observing the pieces by José Villalobos and César de la Riva, so visitors can reflect in what they saw, felt, and wondered about the pieces, and then to put those ideas in order in a special way by carrying out a poetic activity inspired by one of the works of art, whichever one they chose.

The public was given a pencil and an activity sheet that invited them to go through the exhibition rooms, choose a work that had caught their attention, and gather a series of words that would later help them to construct a poem. After this activity, a talk was given by anthropologist Francisco Lara Padilla about the different regions of the state, emphasizing its geography and the different cultures that have inhabited it. Then it was time for the collective work, the mariachi Canto a mi tierra from the UACJ was invited to sing Corrido de Chihuahua and Viva Chihuahua live, two songs that speak of the state, its customs and roots. Afterwards, we invited people to create collective poems, the words that make up these two musical pieces were made available to the users in the form of Magnetic Poetry -a creative writing exercise that consists of loose words on magnets that are then combined to generate new phrases and rhythms-, with the variety that they would be placed on displays. One of the most exciting parts was the reading aloud of the constructed texts. This event was attended by more than thirty people, including children, young people and adults, an important figure for the usual numbers (Figure 1).



Figure 1. Activitie in Noche de museos, Palabras y sonidos del estado grade.

In May 2024, a workshop was held with preschool and elementary school teachers to introduce them to some ideas about the museum and a work kit was used, which in itself is an element of mediation and co-creation because it allows them to learn about other experiences through a playful vision. “The play aspect of co-creation also serves to emphasise ‘creation’. Just as play provides the freedom to do things differently on each occasion, so creation does not start with a preconceived end point. The very idea of creating suggests the importance of process” (Ind and Coates, 2013, p. 90-91). The assembly of a landscape with shapes and figures previously cut out allowed them to put together collages that had an important meaning for each of them, making them think of places they have traveled in the region. The letter they wrote to the museum about the degree course they are taking at the Centro Chihuahuense de Estudios de Posgrado, also related to the research project, shows that they are working on including it as part of their formal educational activities.

The fact is that “the educational services offered in the museums generate relationships with educative institutions. These services must be performed by a transdisciplinary team, which possess specific knowledge about the psychological characteristics of the visitor with regard to his/her behavior and learning processes in the exposition, motivations, and interests through a coherent, efficient and effective communication” (Lebrún, 2015, Abstract, p. 26). When museums do not have such large teams to help understand the characteristics of so many diverse visitors, listening to the voice of the docents can help generate more efficient mediation processes that will ultimately lead to co-creation, which is a process that “allows the creation of a design space that lets expert and non-expert designers collaborate” (Busciantella-Ricci and Scataglini, 2024, p. 12).

Finally, based on the artwork of César de la Riva, a permanent mediation is proposed for the last month of his exhibition. This exercise was built in some way as a logical consequence of the previous exercises, which were: exploring the museum to see the works from a different, more playful perspective, interacting with the themes that are exhibited, inviting visitors to participate with their opinions, to create based on the subjects that are offered to them, investigating how to teach and learn from the museum. The mediation took place in the space where the exhibition is located; installed on a couple of tables arranged in the museum, the activity began with the exploration of the art works of César de la Riva, to recognize some of the regions to which his paintings refer. The instruction was to compare the images given to them on a sheet of paper with the paintings, and to collect the name of the work that has the title of the place represented by the artist. Once this was done, they used one of the two wood puzzles of the state of Chihuahua to locate the regions and learn some details of the geography, culture and customs of the municipalities of Chihuahua. The last exercise invited the participants to create their own landscape; they were provided with a series of materials such as cardboard, paper and colored stickers, as well as glue and scissors (Figure 2).



Figure 2. Permanent mediation based in César de la Riva´s exhibition Sentido Paisaje.

This activity allowed each participant to show their work in the museum and to be part of the exhibition on a temporary basis. As Alderoqui (2015) mentions, the objective is the recognition of the reciprocal relationship between society and the museum, which demands a creative use of the collections: to stop being exclusively a "treasure to protect" to become a truly collective resource (2015). Results for both the museum and for us as researchers were very important, they opened up possibilities for the future, the evidence indicates that people were able to come to the activity on their own and execute their exercises with autonomy, but more importantly to broaden the vision of the other mission of the museum, not only to offer artistic works to see, but to help the public to interact with them, to dialogue through mediation. Even though the artist or the mediators are not present, by being in the museum and interacting with the work to make this exercise of self-creation, an exercise of co-creation took place in an incipient way. Co-creation and participation are basic strategies of co-design and help to democratize the processes, in this case, public participation in a space reserved only for artists.

Co-design is considered a "primary strategy for participation, co-creation and democracy in innovation" (Busciantella-Ricci and Scataglini, 2024, p. 1). And it should not be forgotten that the complex society that we currently form "is pushing for using creativity and collaborative practices as collective resources for sharing knowledge, activating co-creation processes and provoking systems changes (Jones 2018; Eckhardt et al. 2021 en Busciantella-Ricci and Scataglini, 2024, p. 9). Therefore, it is relevant that the museum offers more and more spaces to be not only a "thermometer" of society, but also a "microphone" for it and above all spaces for personal and collective creative expression.

To conclude, we would like to stress the importance of museums knowing their audiences and measuring the footprint of their public programs, we agree with the experts that a permanent study of people's needs is necessary, contemplating the socioeconomic and cultural reality and finding and using the appropriate instruments and forms of measurement with the purpose of knowing if the efforts cause the desired impact. Museums must also exist to reconcile and bring people with different ways of understanding life closer together (Roitman, 2019). As researchers, we are grateful that the museum managers allow us to accompany them and that they themselves consider new options as part of our intervention. This summer 2024 they opened a series of talks with emerging artists and offered a series of workshops for children ranging from painting and recycling to poetry and physical exercise within the program Un museo para ti; although the number of beneficiaries is still low, it helps to make visible that the museum has a permanent public program. On the other hand, we have seen an interest in inviting visitors to join their networks through posters in the museum itself and an increase in the museum's publications about its events.

Conclusion

The reflections and exercises presented here are part of a project that aims to design strategies and mediation resources to contribute to the formation of new audiences and participation in the dialogue about the city from the perspective of culture and art. In its first stage, as we saw in this work, it aims to make a diagnosis to understand how Museo de Arte de Ciudad Juárez works and how it is received by its users. At the same time, it generates the first tools to work with audiences and identify resources, means and possible ideas for mediation. It has been an important learning experience that would not have been possible without the openness that the museum has had with us, and we believe that this also helps managers to remember that the experiences of their audiences can be very significant.

Co-creation is an exercise used in many types of companies and instances, museums could benefit from its procedures to generate dialogues between them and artists, the community, associations and educational institutions. The design of different activities is allowing the museum's already captured audiences and perhaps some new ones, to live new experiences, MACJ is an architectural space of great aesthetic value, being in it is already an enjoyment, but if in addition we can not only appreciate the works, but have access to reflection on its contents, to the opinion or to the same action, the experience becomes something extraordinary.

After the diagnosis, we intend to start proposing more permanent activities that will contribute to this communication for the benefit of all. Although monthly activities are planned and workshops, visits and forums are offered, an opportunity is perceived in the search for feedback from users, in the dissemination of events and in the capture of new audiences. All the experiences gathered so far allow us to think of new challenges for the MACJ and its possibilities to generate spaces for design and co-creation that contribute to having a more diverse audience and, of course, a larger one, so that all its efforts and planning have an impact on more people.

To understand how MACJ works, how the exchange relationship with its visitors is, and how they experience the museum, we have implemented qualitative and quantitative instruments. The general analysis indicates that the way in which the museum works has intense periods of planning that then lighten with the day to day of the exhibition, it would be ideal to implement exercises of experience design and participation that allow the museum to listen to the user to be able to take a step forward.

Results obtained so far open positive possibilities for the future, both for the museum and for us as researchers. The evidence indicates that the people who experienced the permanent exercise were able to come to the activity on their own and execute their exercises with autonomy. With this, the museum opened its doors to validate the work and at the same time helped us to

start an exercise to observe it calmly, to learn something from it, to appreciate it beyond its aesthetic appearance, in short, to live it in a different way.

Museum works according to the exhibitions it receives, sometimes they are of recognized artists, others of emerging artists, or even of other disciplinary areas such as architecture, but all of them are a source of inspiration to put on the table different themes, the border, ecology, geography, violence, culture, etc. As a public institution, MACJ has the responsibility to disseminate knowledge in a coherent way and seeking that all the contents can be well assimilated and discussed, it is not an easy task. What we propose is to consider design as a generator of new valuable experiences for its visitors, to foresee its qualities as an engine of change and to help consolidate the museum as an inclusive, participatory and coexistence space relevant to society, which in turn contributes to a better understanding of art and the interaction between creations and their audiences.

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FROM DYSTOPIA TO MICRO-UTOPIA: SOCIETAL CHANGE THROUGH DIGITAL DESIGN INNOVATION.

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ABSTRACT | This research paper combines socio-cultural sustainability with digital product design through a co-design and user experience (UX) approach. It draws attention to the unsustainable relationship between design and technology and proposes a problem-focused approach instead of a solution-focused one. The study showcases the Digital Experience Theatre (DXT), a creative tool influenced by Augusto Boal's Theatre of the Oppressed, customised for digital design. DXT combines speculative co-design and text-to-image AI to urge participants to imagine dystopian situations to recognise and address current societal problems. This approach has been implemented in educational environments, particularly in the Zambujal 360 initiative – the focus of this paper – where students developed digital solutions to tackle issues specific to their community in the neighbourhood of Zambujal in the Lisbon metropolitan area, Portugal. The paper contends that shifting from a dystopian to a micro-utopian mindset can facilitate substantial societal changes by encouraging critical consciousness and cooperative resolution of problems. By fostering a participatory design process that emphasises critical awareness and creative problem-solving, the DXT method has the potential to inspire innovative solutions that address complex social challenges. Ultimately, the paper argues that digital design innovation, when coupled with socio-cultural sustainability principles, can play a pivotal role in driving positive societal transformation and nurturing a more equitable and sustainable future.

KEYWORDS | SOCIO-TECHNOLOGICAL DESIGN, USER EXPERIENCE, IDEATION TOOL FOR CHANGE, SPECULATIVE CO-DESIGN, TEXT-TO-IMAGE AI GENERATION

1. Image theatre for social change

This study stems from the pattern of unsustainability in the design-technology relationship. Sustainability is a concept first defined in the Brundtland Report on the environment in 1987 as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”, integrating environmental goals with economic ones. The use of the term has spread widely in the past four decades, and it can be found alongside most various adjectives, which contributes to its ambiguity (Garcia et al., 2018, p. 242). When digital processes and products are preoccupied with sustainability, they tend to associate social responsibility and environmental standards with economic and business sustainability. Despite their growing role in facilitating human activities within a global-local context, there is a common problem of digital products frequently failing to convey ecological and socio-cultural insights. We argue that the integration of technology in digital devices should be guided not simply by economic sustainability but also by environmental, social, and cultural sustainability.

To do so, our contribution stems from the development of a co-design UX method, using a problem-focused approach. Contrary to solution-focused approaches, which are intimately linked with creative thinking and the pursuit of answers to the “how?”, “problem-oriented thinking is closely linked to critical thinking, and questions like why? and what? help with the formulation of the problem” (Pusca & Northwood, 2018, p. 48). Our ideation tool can be metaphorically described as shifting from dystopian to micro-utopian thinking to drive innovation in socio-technological design. Richard Howells (2014) argues that the very act of design is a Utopian process. And Dystopia is inevitably bound with Utopia. In this sense, design processes and practices that use tools that envisage crisis scenarios for the future can help identify present problems and, ultimately, ways to deal with them. Instead of picturing ideal and hopeful futures, the depiction of desperate and catastrophic alternatives may be more useful as a methodology. Lucy Sargisson suggests that dystopias can stimulate thought and debate and can eventually trigger behavioural change (Sargisson, 2013).

Nonetheless, we drift from the dystopian-centered perspective and try to pay attention to the referred micro-utopias. Instead of focusing on the ideal, unreal, and non-accomplishable prospects of utopias (or their dystopian shadow), micro-utopias, or "utopias of proximity", as the art critic Nicolas Bourriaud called them, are located in the micro-realm of "the concrete, the material and the everyday", or a "space of concrétude" (Blanes et al., 2016, p.9). In that way, they can be not simply thought-provoking but actually useful for application in society.

With his concept of "everyday micro-utopias", Bourriaud wanted to approximate art practices to the processes of ordinary life, with its particular social contexts and human relations. Criticising the objectification of social interactions and the dissociation of the artist from their audience led to his conceptualisation of a type of art practice that should be more flexible, relational, and collective. The artists – in our case, the designers – should not distance themselves from the public if they aim at a more useful and democratic practice. Micro-utopias appear as statements that result from the collective ability to imagine and create in the local and concrete sphere of social life.

This is what Mark Featherstone talks about when he begins his *Planet Utopia* by recalling psychoanalyst D. W. Winnicott, for whom the creativity we learn through childhood play is what will model cultural development in our future. The experience that occurs in a safe family environment that allows the child to imagine an infinite number of possible worlds is the one that we transpose into adult life. For Featherstone, "imagination, creativity, and the invention of the new are absolutely reliant on psychological security defined and provided by others and community" and derive from "experiences that are enabled by groups that create secure spaces to allow them to happen" (Featherstone, 2017, p.2). This idea of community and collective as a driver of new ideas is central to our project.

Within this scope, the research's main goal is to develop a teaching method and ideation tool titled Digital Experience Theatre (DXT) that embodies an approach to integrating social and cultural sustainability into digital product design through the conceptualisation of microutopias. The DXT leitmotif stems from the *Theatre of the Oppressed* (TO), crafted by Augusto Boal (2019), viewing users of digital products as oppressed individuals navigating through a multitude of ineffective solutions whose main focus is related to commercial interests instead of being more useful for society, generating fruitful interactions with human and non-human communities. This paper specifically examines the application of the DXT method in the classroom, focusing on its use in the Digital Interfaces course within the Master's program in Design and Visual Culture at IADE, Universidade Europeia (Lisbon, Portugal).

Augusto Boal's *Theatre of the Oppressed* was influenced by Paulo Freire's Pedagogy of the Oppressed (2014), which involves critical awareness of social reality, enabling

intervention and emancipation from oppressive relations. Paulo Freire's (1921-1997) educational concept can be condensed as a journey of conscientisation toward social realities, enabling individuals to actively intervene and liberate themselves from oppressive structures. Formulated during the 1960s and 1970s amidst Brazil's literacy initiatives, Freire's theory emphasised the necessity of a dialogical relationship between educator and learner for effective literacy programs. True literacy should encompass not only technical skills but also critical thinking capabilities to review different contexts and issues. According to Freire, this process of problematisation is pivotal for achieving liberation (Freire, 1970).

Augusto Boal (1931-2009) had always been a social advocate and consistently viewed art and theatre as inherently intertwined with social and political contexts, essential for fostering participation and activism. Affiliated with Freire's principles, he conceived the *Theatre of the Oppressed* methodology while in political exile during the 1970s and 1980s. This methodology has theatre as its central piece, functioning as a tool accessible to all as a means to escape oppressive relationships. The DXT ideation tool adapts one of the introspective techniques from Boal's book *Rainbow of Desire*, specifically *The Image of the Rainbow of Desire* (Boal, 1994).

2. Speculative co-design method

The study undertaken for the DXT teaching method and the related ideation tool is exploratory, serving as both a process of probe and a way to generate more insights (Cross, 2007). DXT's research through design has been moving forward through several design workshops involving undergraduate and graduate design courses in Portugal and abroad. Design students participate in the process of reflection in action (Schön, 1983) by actively experimenting with the ideation tool for exploring design problems and tackling specific issues, as well as enabling them to explore and generate new ideas for the teaching method and tool. From the start of the research to the final version of the tool presented in this paper, the DXT evolved significantly with contributions from the students who tested it, particularly following observations of their interactions with the process and insights gained through unstructured interviews. At the heart of the research approach is the comparison of several versions of DXT, aiming to enhance the understanding of various theoretical and practical aspects (Gaver, 2012). This is achieved through iterative cycles of design, prototyping, testing, literature review, reflection, and dissemination, spanning from its development in 2021 to the present.

The DXT employs a co-design method where groups of students collaborate to create speculative dystopian scenarios using text-to-image AI generation. In this process,

participants collectively identify a problem and agree on a speculative framework within which they can assume either active or passive roles. Co-design and participatory design are characterised by collaborative discussions among individuals (Manzini, 2015). In this dialogic approach, where listening is as crucial as speaking, the development of the dystopian co-design process hinges on effective dialogue. While critical thinking and creativity are key in the DXT, enhancing participants' dialogical skills is essential for optimising the co-design process. This dialogical approach should facilitate and enrich the co-design process rather than control it (Fuad-Luke, 2009). Although co-design and participatory design are often seen as methods for achieving consensus among participants with divergent perspectives, they can evolve into agonistic design processes, where conflicting viewpoints lead to productive analyses (DiSalvo, 2012). The final phase of the DXT ideation tool and method involves a critical analysis of the created dystopia and a thorough evaluation of potential solutions.

Integrating text-to-image AI models with *The Image of the Rainbow of Desire* (Boal, 1994) approach facilitates the collaborative generation of visual representations. This AI method of generating visual representations of speculative dystopian scenarios enables participants using the DXT to experiment with unexpected situations and further explore the design problem they aim to address. Following Boal's sequential approach, the DXT entails a similar systematic procedure whereby participants are separated into conductor-designers and antagonistdesigners, both essential for the effective functioning of the ideation tool. The conductordesigners take charge of the process and initiate an image-based conversation with the antagonist-designers. The antagonist-designers, in response, challenge the dystopian speculation put out by the conductor-designer, thereby altering an identical image or idea. The DXT process engages participants in both roles in the sequential co-design of dystopian imagery, utilising an adapted version of *The Rainbow of Desire* method (table 1). The end result is that following an iterative cycle of dystopian images related to a problem's worst-case scenario, the group acquires a more profound comprehension of a specific matter and is presumably prepared to put its energy into designing solutions that address the very problem that triggered the conversation.

Table 1. Comparison table showcasing differences between the *Rainbow of Desire* (RoD) and the Digital Experience Theatre (DXT) methods, highlighting RoD omissions and DXT additions.

RoD Rainbow of Desire	**DXT** Digital Experience Theatre
[extra step added to the DXT column]	**Step 1** The group selects the problem to tackle according to threats to the earth's ecology or to societal needs, and the selected community.
Rainbow The protagonist creates the images and presents them, which are subsequently reproduced by the participating characters who play the role of antagonists. The antagonist characters can create new images (from the protagonist's perspective).	**Step 2** A pair of conductor-designers create and present to the antagonist-designers a dystopian image based on the tackled problem (an AI image based on text-to-image generation).
[extra step added to the DXT column]	**Step 3** The antagonist-designers manipulate the created image, deepening the dystopia. Each antagonist-designer creates a new version of the AI image or a different one, but from the perspective of the conductor-designers (thinking the same way they did).
Confidential monologue The images are presented together. The protagonist delivers a brief 'confidential monologue' for each image, emphasizing their thoughts and feelings for each situation. All antagonist characters watch the confidential monologues, analyzing the protagonist's desires.	**Step 4** The AI images are displayed together in a grid. The pair of conductor-designers interfere in each image created by the antagonist-designers with keywords that function as 'a confidential monologue', identifying critical problems and possible solutions.
The part takes over the whole The images created by each antagonist character are presented to the other antagonist characters, following an order devised by the protagonist. The antagonist observing the images reproduced by other antagonists must react to each one as if they represent different characters.	**Step 5** The antagonist-designers incorporate the ideas of the conductor-designers into their images by creating new versions.
The protagonist arranges all the images on the plateau, considering the antagonist's perspective, to emphasize certain characteristics more or less highlighted in each image.	All the images are presented to the antagonist-designers through a specific sequence (GIF animation) thought up by the conductor-designers.
The protagonist takes the place of the antagonist After organizing the images, the protagonist adopts the perspective of the antagonist, becoming aware of how they are perceived.	[no correspondence with the RoD column]
Will against desire The protagonist confronts each of their desires (images), emphasizing those approved by their will and confronting those disapproved by their will.	[no correspondence with the RoD column]
Agora of desires The antagonist characters and their respective images discuss their views of the protagonist in pairs. The meetings repeat until all antagonists have met with their counterparts. The protagonist observes the antagonists in dialogue.	**Step 7** Each antagonist-designer writes a comment for each of the other antagonist-designers' images.

Such as the DXT steps, the text-to-image exercise is a repetitive procedure that relies on combining visual components across consecutive prompts. Chance and the creative's willingness to embrace unforeseen pathways both play important roles in this process of interacting with AI and experimenting with dystopian situations. Within this cyclical text-toimage creative technique, the AI images do not appear instantly in their ultimate form. Instead, they are formed gradually, allowing one to observe the progress of the images as they develop visually. In such a method, it is important to not only create images but also curate them, as the images are made in groups, and creatives choose to delete or further develop some until the most representative one is created.

During the DXT process, participants are made aware that text-to-image AI generation worsens societal stereotypes and contributes to environmental concerns, particularly impacting the climate and humanity. The collective reflection promoted within the DXT teaching method emphasises the social and ecological challenges associated with AI technology and underscores the need for continuous improvement in AI effectiveness to address these challenges and mitigate its negative impacts. It is highlighted that gender, racial, and age expanded prompts may not fully mitigate bias in image generation, leading to incorrect or unusual responses and maybe introducing new biases (Naik & Nushi, 2023). Regarding the effect of AI on climate change, the training and operation of AI systems demand significant computational resources and electricity, leading to the release of carbon dioxide emissions. Furthermore, AI's environmental impact extends beyond carbon emissions to encompass other ecological concerns, such as driving increased consumerism. Therefore, participants in the DXT debate are encouraged not only to reflect on the environmental impact of AI but also to research how AI can be used to address sustainability, climate change, and other environmental issues on both local and global levels.

Prompt expansion strategies effectively broaden or refine the scope of a prompt to elicit a wider range of relevant or varied responses from an AI model. These strategies may differ depending on the circumstances, but their main objective is to promote more detailed and informative responses from AI systems. Thus, the participants of DXT are advised to employ efficient semantics and prompt expansion tactics to attain the best possible results in image generation. The procedures encompass offering comprehensive and elaborate explanations to enhance the interpretation of the intended image, employing specific keywords to depict desired visual aspects more accurately, and integrating textual descriptions with visual references, which clarify demands. Additionally, participants should refine prompts based on initial results and iterate to enhance image quality. This involves balancing specific details with allowing AI model creativity to foster innovative outcomes, among other strategies for understanding model responses and improving image generation.

3. Interaction designs for the Zambujal 360

The Zambujal 360 is in the Zambujal neighbourhood, with a population of approximately 4000 inhabitants. It is located in the Alfragide parish, Amadora municipality, Lisbon metropolitan area. It is an initiative from the NGO Ad Gentes, and the CAZAmbujal association focused on creating an urban art gallery inspired by the 17 Sustainable Development Goals (SDGs) and acting as a social change agent to promote sustainability. Each SDG is supported by a sponsoring organisation that is tasked with conducting global citizenship activities, such as guided tours to the urban art gallery dedicated to the SDGs, providing training for schools and companies, promoting the adoption of sustainable business models, and offering educational programs focused on development (Ad Gentes, n.d.; UNRIC, n.d.). IADE, Universidade Europeia, was involved in this fertile coalition between citizens and entities, mainly through the curricular unit of Digital Interfaces within the Master of Design and Visual Culture from the same institution.

A group of 17 artists, each with a unique background, sources of inspiration, and artistic methods, have been collaborating to finish the construction of the urban art gallery before the end of 2024 (figure 1) (UNRIC, n.d.). The Zambujal 360 aims to establish a paradigmatic SDG route to attract visitors, tourists, and students to the neighbourhood, which was precisely what happened with the group of IADE students and professors that engaged with this local initiative to develop innovative smartphone concepts for applications that contribute not only to boosting local commerce and education through health and art but also to encouraging community empowerment and holistic growth while valuing interrelationships and multiculturalism.



Figure 1. Mural paintings from the Zambujal 360 project. On the left is a painting illustrating SDG 5, Gender Equality, by Mariana Duarte Santos. On the right is a painting by the artist Lígia Fernandes on SDG 2, Eradicate Hunger. Photos by M. Linhares (2023).

The Zambujal 360 is founded on three main principles: (1) supporting local businesses - establishing a network of merchants, promoting their businesses, and fostering sustainable economic practices; (2) promoting health education - addressing the physical, mental, and emotional impacts of the COVID-19 pandemic through physical activity as a means to enhance well-being; and (3) improving art education - establishing an urban art gallery centred around the 17 SDGs, serving as a catalyst for social change, promoting sustainability, strengthening local identity, and challenging external barriers and stereotypes. The initiative aims to comprehensively transform the area by creating value via youth training, establishing a network of merchants, improving urban spaces, and promoting artistic, social, and cultural activities (Ad Gentes, n.d.).

The briefing delivered to students targeted the creation of a smartphone app associated with the brand and visual identity of the Zambujal 360 project – a digital product for mobile devices that considers contemporary visual culture and all the aspects that determine effective communication with the users to be considered, such as the neighbourhood residents, tourists, and other visitors (table 2). Students were asked to select an existing service or propose a new one and develop a touchpoint, the point of contact whose function is to boost a user's service experience. In this case, the touchpoint would need to be an integral part of a smartphone app that users would activate during their experience. Students followed the UX/UI methodology to develop the information architecture plan, the sitemap, and the creation of low-fidelity wireframes, followed by the design system, from the fundamentals to the UI components and patterns. Finally, high-fidelity prototyping, heuristic evaluation, usability testing, and iterative refinement were performed.

Table 2. Annotated portfolio showing three projects from the same DXT workshop related to the Zambujal 360 briefing.

Group	Selected problem	Image technique	Dystopian images	Solution definition
Group 1	Scarcity of shops offering fresh daily food pushes residents to resort to buying cheaper processed food and fast food.	AI images based on text-to-image generation.		An app that lets users find nearby grocery stores selling fresh produce on a map and view video recipes. It also allows shops to advertise unsold items at reduced prices at the end of the day.
Group 2	Children's mental health issues stemming from bullying or other emotional trauma that occur within their social bubble.	AI images based on text-to-image generation.		An app that uses augmented reality (AR) technology to let children explore mural paintings and the culture of the Zambujal community. It features a virtual exploration game where users collect characters and visual references inspired by the paintings.
Group 3	Loneliness and physical vulnerability among low-income older adults place them in difficult situations.	AI images based on text-to-image generation.		App that connects seniors and volunteers residing in a low-income housing community, enabling seniors to request assistance and volunteers to offer their help.

Students were asked to use the DXT approach and take a speculative design tactic as a starting point to represent a vision of the world that focuses not only on the user (user-centred) or on the human being (human-centred) but on humanity as a whole (humanity-centred). However, before using the DXT ideation tool in the Zambujal 360 context, students engaged in the environment described in the design briefing to begin exploring ideas for their mobile apps. They specifically focused on socio-technological sustainability, community empowerment, and holistic development. From this perspective, understanding the design problem and the eventual users started with design ethnography as an early stage to investigate and analyse users' cultural and social contexts to inform and inspire the design process. In our case, design ethnography entailed the systematic observation of social circumstances, analysis, and conceptualisation. Table 2 presents the challenges students addressed using the DXT

ideation tool and its speculative approach to respond to the Zambujal 360 brief, along with the solutions developed by the end of the workshop.

The digital product prototype created by group two, titled *Zambujal 360 Hero: An Educational Game App*, is an innovative application that uses augmented reality (AR) technology to actively involve young people in the neighbourhood mural paintings and multicultural heritage of Zambujal (figure 2). The app transforms traditional sightseeing by providing an immersive experience, which allows users to explore the original artworks and gain knowledge of the local history and culture through compelling augmented reality features.

A key feature of the application is a virtual adventure game that seeks to captivate users by including elements inspired by Pokémon GO. Children can gather different characters and visual references from the artworks as they engage with the murals through a gamified interaction. Each character and reference is complemented with educational content, including informative details and narratives about the local culture and the paintings' significance.

The app aims to enhance understanding and appreciation for art and culture while providing interactive activities to improve education. This educational experience combines augmented reality technology with a gamified approach to exploration. It aims to address mental health issues resulting from bullying or emotional trauma by providing a fun and informative adventure. Additionally, it strengthens social connections and allows easy access to the history and culture of Zambujal for future generations.

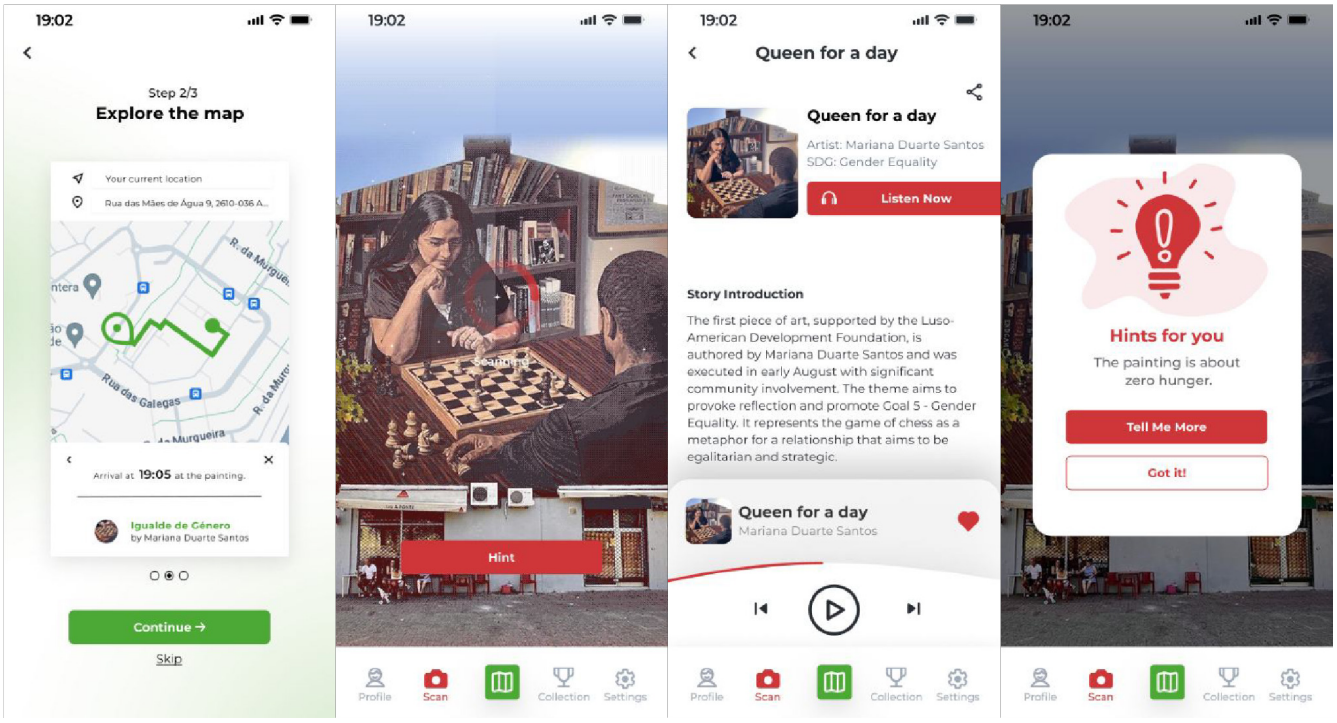

Figure 2. Screenshots from the app prototype titled *Zambujal 360 Hero: An Educational Game App,* by Jiaai Cao & Alexa Fislage, that uses gamification and AR technology to involve users in the mural paintings' interpretation.

4. Assessing DXT's educational and societal outcomes

The present research focuses on the intersection of UX design and societal transformation, emphasising the transformative power of co-design methods and the *Theatre of the Oppressed* methodology to boost sustainability and social innovation. The DXT proposes an uncommon strategy to tackle current socio-technological problems by shifting from dystopian to microutopian scenarios. In this context, it is essential to scrutinise the consequences and results of using DXT, considering its effectiveness in the educational setting and broader societal influence.

Regarding the co-design approach and the practice of creating micro-utopias, the DXT ideation tool and teaching method targets the collaborative recognition and solution discovery of design problems. Such a collaborative approach is consistent with Augusto Boal's *The Image of the Rainbow of Desire* method, which emphasises the significance of critical consciousness and engaged participation in dismantling oppressive systems. DXT involves creatives actively participating in speculative co-design by employing text-to-image AI generation to create and continuously improve dystopian scenarios. This technique stimulates creativity and critical thinking and improves participants' ability to engage in dialogue, facilitating effective communication and collaboration.

The practical applications and societal impact of DXT were exemplified by several student projects, including those undertaken as part of the Zambujal 360 initiative. These projects demonstrate how speculative design can confront real-world issues across different areas, such as food scarcity, mental health difficulties, and social isolation among older adults. Using DXT, students created innovative digital solutions, including a mobile application designed to pinpoint places of local fresh food vendors and an augmented reality game that fosters a connection between users and their local culture. These solutions not only tackle the current needs of the Zambujal community but also contribute to larger objectives of sustainability and cohesiveness.

In the near future, the DXT ideation tool and teaching method have significant potential for broader application in various human and non-human scenarios, where a speculative approach can drive the development of digital solutions with non-anthropocentric objectives. By nurturing a culture that promotes critical awareness and collaborative problem-solving, DXT has the potential to bring about significant societal transformation, turning dystopian realities into small-scale utopian opportunities.

5. Conclusion

The research featured in *From Dystopia to Micro-Utopia: Societal Change Through Digital Design Innovation* highlights the potential of UX and interaction design to face socio-technological concerns by employing a specific co-design method. The study presents the Digital Experience Theatre (DXT) as a research approach, teaching method, and tool for generating ideas, inspired by Augusto Boal's *Theatre of the Oppressed*. Its purpose is to promote collaborative problemsolving and critical thinking among participants. The DXT aspires to bring innovative and sustainable solutions for local-global everyday problems by employing text-to-image AI generation to create speculative dystopian scenarios. The effectiveness of this approach has been demonstrated in educational settings, particularly in the case study highlighted in this paper – the Zambujal 360 project – where students developed digital solutions to address challenges specific to the Zambujal community. The research stresses the significance of incorporating social and cultural sustainability into digital design, favouring a transition from a dystopian to a micro-utopian mindset to facilitate substantial societal change. The possible uses of the DXT extend beyond human situations, indicating a broader influence on many socioeconomic and environmental concerns.

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CRAFTING IMMIGRANT NARRATIVES OF BELONGING: ART AND DESIGN FOR SOCIAL INNOVATION WITH THE LATINO, LATINA, AND LATINX COMMUNITY OF IOWA CITY.

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ABSTRACT |

This paper is based on the fourth iteration of Shifting Ground (SG), an art and design initiative that engages immigrant communities. Established in 2019, the project has hosted workshops in the US and Portugal, using clay as a foundational material to connect with immigrant memories. SG engages in participatory ceramic sculpture workshops that articulate memories and aspirations tied to cultural heritage and unique immigrant skills, fostering dialogue and belonging within a new context. It aims to give local immigrants visibility and voice, valuing their contributions to the community. In 2023, the Ceramics Department at the University of Iowa hosted the SG's fourth iteration workshop on Latino, Latina, and Latinx immigrants, focusing on the evolving concepts of home and identity. The research explores cocreation methodologies, emphasising the relational concept's role as a network of relationships and interactions in engaging participants, ceramic sculptures, and communication for social and cultural integration. Relational thinking challenges the dualistic perspective and advocates for interconnected policies. It emphasises the constant relationships of interdependence between human and non-human. The paper discusses the US immigration process, SG's concept, objectives, and the relational concept. It analyses the project through opinions collected from participants via a survey. Positive feedback validates the initiative's role in supporting immigrants. The authors argue that embracing the commons and relational dynamics is crucial for a socially equitable and sustainable society, urging local organisations to adopt this approach systematically.

KEYWORDS | SOCIAL INNOVATION, SERVICE DESIGN, DESIGNING RELATIONALLY, PARTICIPATION, IMMIGRATION

1. Key factors on immigration and community art practice

At the core of the present paper is the project *Shifting Ground*, which we developed in 2019 and 2023 in collaboration with the American artist Jane Gilmor. The last iteration, in 2023, which is highlighted later in the text, was supported by local institutions in Iowa City (US), including the Ceramics Department of the School of Art and Art History at the University of Iowa, Public Space One, and involved the active participation of Hispanic immigrants.

In 2023, the period in which the fourth iteration of *Shifting Ground* was carried out in the United States, Joe Biden had already (since 2021) assumed the presidency with a mandate to reform the US immigration system in order to end, among other policies, the ban on mostly Muslim immigrants. Despite the presentation of more inclusive immigration policies, such as allowing citizenship to more than 11 million undocumented immigrants, their implementation has been complex (Boundless, 2024).

In 2019, when the *Shifting Ground* project was launched in the United States, the admission processes for refugees and immigrants faced severe threats. The legislative measures adopted were aimed at significantly reducing family-based immigration (Krogstad & Gonzalez-Barrera, 2022). While the US diversity visa programme, created in 1995 to diversify the immigrant population, has been a benefit, Donald Trump has sought to end this programme, along with the Temporary Protected Status (Krogstad and Gonzalez-Barrera, 2022). Authorisations granted to refugees in the US were also significantly reduced during this period, especially in 2019. This decline in refugee resettlement coincided with the highest number of refugees globally since World War II (Krogstad, 2019).

2. Shifting Ground

Shifting Ground is a social innovation art and design service that was launched in 2019 in Cedar Rapids, Iowa (US). It has since had two iterations in Lisbon (Portugal), and another one in Iowa City (US). The project took place in Lisbon between the years 2021

and 2022 and in Iowa City again in 2023. In 2019, *Shifting Ground* received funding from the Iowa Arts Council and the Centre for Art History and Artistic Research at the University of Évora (CHAIA). Additionally, it has garnered support from several institutions, including the Iowa Ceramic Center and Glass Studio, St. Paul's United Methodist Church, and the Immaculate Conception Church. From 2021 to 2022, the project was funded by the Aga Khan Foundation Portugal, the Museum of Contemporary Art, Lisbon, and CHAIA. The fourth and last edition of *Shifting Ground*, held in 2023, received support from CHAIA and was hosted by the Ceramics Department of the School of Art and Art History at the University of Iowa. This edition of *Shifting Ground* specifically addressed the topic of Latino, Latina, and Latinx immigrants (figure 1).

The project's primary impetus stems from contemporary issues of intolerance and social injustice related to immigration policies. These issues are likely to escalate due to the ongoing human and environmental crises, including climate change and war, which compel individuals to migrate in search of a new home with equitable living conditions and prospects for a brighter future. Faced with this situation, a collective of artists and designers, ourselves together with Jane Gilmor, have been exploring a community service aimed at immigrants and new arrivals by holding ceramics workshops, using sculpture as a means of social and cultural integration in their new home. By articulating experiences and goals linked to cultural heritage and distinctive immigrant talents, these participatory ceramic sculpture workshops promote dialogue and a sense of community (Gilmor et al. 2019).

In addition to promoting the emancipation of the participants through creative thinking, the project aims to cultivate a greater understanding among the general public about the power of social art and design, specifically, and culture in a broader context, as crucial tools for embracing diversity. Over its various editions, the *Shifting Ground* community service has engaged immigrants from Mexico, Colombia, Honduras, Indonesia, Angola, Mozambique, and Sao Tome and Principe. It has also included migrants and refugees from Burundi and the Democratic Republic of Congo.



Figure 1. *Shifting Ground* workshop in 2023 at the Ceramics Department of the School of Art and Art History at the University of Iowa. On the left side, Amaris Hurtado (foreground) and Patricia Rodriguez (background); on the right side, Nahid Rivera and Javier Espinosa.

The project incorporates a game named MOT, which stands for memory, object, and talent, with the aim of fostering empathy and facilitating a flexible, customised approach to participant engagement. This game encourages spontaneous participation and supports selfrepresentation by cultivating a creative dialogue between new arrivals and the host community. Throughout the *Shifting Ground* iterations, the MOT game has evolved. During the initial workshops, we asked participants to share a personal narrative, a significant object, and a key skill, ensuring that these elements are interconnected. In the final Lisbon *Shifting Ground*, participants' life stories centred on food-related memories and knowledge, acknowledging that food experiences, whether positive or negative, elicit strong feelings and emotions, which they further explored through ceramic sculptures. In the last Iowa City *Shifting Ground*, the workshop explored how concepts of home and identity shift with repeated moves. To this end, a game – MEMO – was played with the participants, which was made up of the relationship between memories related to food and each person's home. Through MEMO, the personal experiences that each participant explored served as inspiration for the creation of clay sculptures (figure 2).



Figure 2. Alejandra Alvarez's MEMO on the left side, and the sculptures developed from it during *Shifting Ground's* 2023 workshop.

To play the game, each participant was given a sheet with four ordered topics: a memory related to their food culture, a place associated with that memory, a sound that recalled the place and, finally, a significant object linked to the memory and the place. We inquired about the sound because the final ceramic sculptures would be displayed with mixed sounds. For this, they began writing about their own concepts, which they presented to one another. The process involved dialogue about each participant's MEMO, allowing them to share their individual experiences. This established a unified method across all iterations of the service that is based on an empathic methodology of dialogue with the participants. By engaging in collaborative art practices, their know-how transforms elements typically seen as discriminatory and culturally different into opportunities for integration. This process turns differences into a celebration of diversity.

Furthermore, we used photography and video to record the immigrant artists' engagement with the project activities and establish an image repository for the project, in addition to the ceramic sculptures created using the MEMO ludic method. This functions as a fundamental platform in our approach, enabling organised communication with diverse audiences. In addition, the use of installations and happenings creates a substantial and significant space for community self-expression and public involvement. Participants, their friends, and project supporters came together to celebrate the occasion and promote greater inclusiveness and democratic engagement (figure 3).



Figure 3. *Shifting Ground's* show at Public Space One, Iowa City, 2023. On the left site, Nahid Rivera's sculptures (foreground), and the sculptures of Isaac López Torres, Miriam Alarcón Avila, and Amaris Hurtado (background). On the right side, Janet Marcelino's sculpture.

3. Relational services and the commons

The desired outcome of an art and design service for social innovation like *Shifting Ground* is to generate and build settings that occur as situations for social innovation. These services can effectively adapt to a specific context in which they are provided by establishing strong connections with all social actors in the community and incorporating local culture and experience (Joly & Cipolla, 2013). It is a social activity that revolves around human-centric, relational, and societal components (Penin, 2018).

Interactions with services tend to be cyclical and difficult to predict as they evolve over time, influenced by numerous variables, random factors, inherent uncertainty, and spontaneity, which make accurate planning challenging. A common denominator of service interaction occurs whenever a user engages with a touchpoint, which functions as a tangible instance of a service and includes the components that provide the interactions. Touchpoints are crucial in improving the efficiency, effectiveness, and significance of

interactions. They are concrete connections or support associated with a particular object. Like other services, a service for social innovation can be delivered through face-to-face contacts, various types of relationships, digital interfaces, or a combination of multiple methods (Penin, 2018). *Shifting Ground's* MOT and MEMO games serve as crucial touchpoints, encouraging participants to reflect on their sociocultural backgrounds, which ultimately influences the creative process of their ceramic sculptures.

The sphere of art and design services for social innovation is driven by the concept of the commons, offering a profound societal framework for understanding humanity's shared experiences and representing a fundamental sociopolitical perspective. It recognises important connections and offers an alternative method of operating. The commons concept envisions humans as proactive members of larger social groups, participating in diverse collective structures such as local associations, virtual communities, and community services. These relationship patterns do not nullify the unique characteristics of individuals but rather shape how their opinions, beliefs, and actions eventually determine their personal and collective identities (Bollier & Helfrich, 2012).

Humans initiate the construction of a culture centred on the principles of care and shared accountability for their collective resources while protecting their means of existence. In this context, the understanding of the commons enhances the capacity of humans to identify, evoke, and improve these behaviours. The objective is to encourage people to consider the world from a more flexible, integrated, and long-range viewpoint based on the mutual principle that personal development is interconnected with the development of others and that these relationships are an essential part of a broader, interconnected social structure (Bollier & Helfrich, 2012).

Therefore, the most effective way to use shared assets is to establish platforms like *Shifting Ground*, among other social innovation services, for substantial communication and collaboration. This kind of service, focused on commoning, has the capacity to establish social practices and routines that enable individuals to engage in exploring, creating, and discussing alternative generative strategies, working as a medium for bottom-up activities to thrive and have an impact on the existing condition of citizenship and governance.

The collaborative platforms where social innovation occurs usually involve designers, artists, and other social innovation actors and stakeholders. It combines two approaches: working together to implement ideas that address societal needs and showcasing the commitment and ability to take action through various collaborative efforts. Hence, many civil associations, communities, families, and other social groups play crucial roles as valuable collaborators who may actively engage with professionals to test and organise diverse approaches. Establishing the rationale

for societal achievement and common ground is essential since most government policies are insufficient in resolving recurring issues (Manzini, 2015).

Within a social innovation art and design approach that prioritises the creation of subjectivity, creatives serve as catalysts for local communities, while creative sectors collaborate in open networks to provide services. They foster a common understanding of using art and design skills to develop innovative products, services, or communication artefacts, exploring several opportunities to shape cultural attitudes and behaviours.

The relational dimension is equally vital in service design for the purpose of social innovation. Considering service users as relational beings instead of simply customers must be a primary objective. The relational approach depends on being open to others and facilitating interpersonal interaction, which serves as the foundation for potential service opportunities. The effectiveness of people's engagement with the service is significantly determined by the interpersonal dynamics developed between them. Relational services differ from other types of services that rely on pre-established interactions between users and service providers. On the contrary, they are characterised by a connection between participants and service hosts, who facilitate a caring and flexible relationship that encourages an active part of everyone involved in the social innovation service (Cipolla, 2023).

Shifting Ground inevitably relies on the ideas of the commons and the significance of relational dynamics. This kind of service encourages substantial societal change by developing collaborative and flexible services that integrate local culture and actively involve the community. The emphasis on interpersonal aspects and the flexible nature of touchpoints guarantee that these services stay useful and efficient in tackling complex issues in society. By prioritising the establishment of inclusive environments for dialogue and collaborative exploration, individuals are empowered to actively participate in and benefit from the generation of innovative solutions. This, in turn, enhances the social structure and fosters a more cohesive and supportive community.

4. Designing relationally: Shifting Ground's relationships, interactions, and ceramic sculptures

In the context of the *Shifting Ground* project, it is crucial to consider the concept of relationality as defined by Escobar, Osterweil and Sharma (2014). In their book *Relationality: An Emergent Politics of Life Beyond the Human*, the authors scrutinise the concept of relationality as a strategy to combat inequality, climate change and ecological degradation. The authors challenge the prevailing dualistic perspective and argue for a policy that is based on interconnectedness and interdependence. People exist in constant relationships with each other and between them and the rest of the

environment (Escobar, 2014). It explores its epistemological and political implications and provides practical strategies for implementing relationality in various life aspects.

In the authors' opinion, building sustainable societies is based on recognising the diversity of knowledge and the interdependent relationship of all existing phenomena. According to this concept of relationality (Escobar et al., 2024), reality is interconnected, so human beings are no exception and cannot exist autonomously, disconnected from their non-human environment (Escobar 2014, p. 59). In contrast to the dominant modernist worldview, which is characterised by a single universal way of understanding and interacting with the world, this concept explores the idea of designing in a relational manner to promote pluriversal transitions, advocating for the recognition and valuing of a multiplicity of knowledge and ways of being (Escobar et al., 2024). According to the concept of pluriversal transitions, the *Shifting Ground* workshops, conducted through various interrelationships with immigrants from diverse backgrounds and cultures, highlighted the recognition of various epistemologies and practices from different cultures and communities.

Rational thinking aims to counter the egocentric view of human beings based on the idea that they were the creators of the Universe and existed in isolation and independently of other nonhuman beings. The concept of relationality, on the other hand, considers that everything exists in interrelationship and interdependence so that individuals influence but are also influenced by the world. The self is not an isolated, self-centred entity but a conscious being that comes into existence through the act of creation. We mutually mould each other's realities since our personal perceptions and feelings do not arise in isolation. Empowering yourself and reducing the feeling of being at the mercy of an indifferent cosmos provides a greater sense of security. Relationality is a mode of understanding, existence, and action, forming a unique combination of knowledge and ontology, referred to as a new narrative of life (Escobar et al., 2024). The postcartesian notion of the interconnectedness of all life is central to ecology insofar as the relational and interdependent being replaces the autonomous and isolated being (Escobar, 2020; Gablik, 1992).

In the *Shifting Ground* project, we adopted the term designing (Escobar et al., 2024) as a continuous action, methodical process, and creative mindset aimed at improving life and expressing concern. It acknowledges our interconnectedness with one another, the planet, and nonhuman entities. Individuals are complex webs of relationships that involve minds, bodies, feelings, social structures, and information systems. We are interrelated beings with a link to both the future and the present and the stories we create about them. Designing relationally promoted a sense of possibilities in the *Shifting Ground* workshops by emphasising the connectivity and co-creation of life. Designers may enhance their problem-solving abilities by embracing

relationality and pluriversal viewpoints, enabling them to create solutions that are both inclusive and effective in tackling the intricate difficulties of our time.

The sharing of the participants' life stories generated the expectation that each immigrant could develop their individual freedom and make decisions in the creation of their sculptures, thus promoting inclusion and democratic involvement. Using a collaborative artistic approach, relational design contributes to participants' ambitions of knowledge production and cultural understanding.

The *Shifting Ground* shares the logic of the politics of relationality (Escobar et al., 2024) since it is based on the specific and constantly changing local context. The project evolves organically by adapting practices to the different cultures of the various immigrants, fostering new forms of knowledge based on mutual respect. The collective nature of relational politics is echoed in the collaborative practice of the workshops through which participants have a plural experience.

Contrary to categorisation, *Shifting Ground* promotes the coexistence and complementarity of its participants' diverse perspectives as productive knowledge. In this regard, the transformative potential of Shifting Ground is developed through the sharing of each immigrant's personal experiences, which promotes personal enrichment, resilience, and the production of knowledge.

The interactions among participants during the workshop also reflected the holistic perspective of quantum physicist David Bohm (1992), whose aim was to enhance well-being through the appreciation of interpersonal relationships and connections with the environment. Electrons' behaviour plays a crucial role in Bohm's understanding of the interconnected and interdependent nature of the entire cosmos, where everything is in a constant dynamic relationship and cannot be separated from its surrounding context. Bohm (1992) emphasises the importance of dialogue, comparing it to a methodology that can be used to enhance and foster connections between individuals and their surroundings. This approach aims to solve societal problems. In the case of the *Shifting Ground* ceramic workshops, dialogue among participants served as a strategy to promote active listening, strengthen relationships between people, and help address issues such as the social and cultural integration of the immigrants involved in the project.

According to Escobar (2020), relationally designed systems study the interconnection of all things and the ways in which these connections may be used for creative endeavours. Establishing links between individuals with different backgrounds and expertise to create a cohesive whole, the objects they make, and underlying structures like social formations, political systems, and personal subjectivities with the aim of developing creativity is one of the main benefits of the *Shifting Ground* ecosystem. Workshops, exhibitions, and dialogue

served as strategies to assist immigrants in integrating into the new culture. Designing relationally has enabled the project to transcend its material condition, establishing itself as a network of interactions and connections that continually transform and adapt to its environment.

5. Volunteers and participants' view

The *Shifting Ground* conducted a series of interviews with participants in its last iteration, gathering feedback from volunteers involved in the workshops. They acknowledged the project's quality, noting it as a learning experience that showcased alternative approaches to engaging migrant communities.

Everyone enjoyed the PS1 as the local of the exhibition. Alejandra Alvarez highlighted this space as an excellent venue for the *Shifting Ground* exhibition and celebration, as it allowed the Iowa community to learn about the real visions and stories of immigrants. She believed that promoting the project through other "guerrilla" methods was necessary because many immigrants arrive in different ways. She also pointed out that if the exhibition had lasted longer, its impact would have been greater.

Regarding the participants' experience in the project, overall, it was valued a lot. Miriam Alarcón Avila, a Mexican immigrant, activist artist, founder of the collective Immigrant Luchadores, and mentor to the other participants, highlighted the importance of projects involving the Latin immigrant community in artistic activities that enhance integration. From her viewpoint, the *Shifting Ground* project accomplished this by unveiling the individual attributes of every member. The way the workshop combined writing, voice, and touch to explore memories and turn those experiences into a sculpture captivated Alejandra Alvarez. She highly appreciated her involvement in the initiative, deeming it important on both an individual and collective level. Pamela Quintero Rodriguez (Pammie) highlighted the significance of engaging in the ceramics workshop, as it provided her with the opportunity to convey her thoughts and feelings through manual expression, utilising the medium of art. Jose Marentes (Seso), a Mexican immigrant, activist artist, who belongs to the Collective Immigrant Luchadores, was exhilarated by the chance to listen to others' motivations and rationale for their creations. From his perspective, it is not the art itself that adds value to the pieces, but rather the narratives we have shared. Javier Espinosa Momox, a master's student in ceramics, volunteered for the *Shifting Ground* project and helped to facilitate the workshop for other participants. His interest in bringing ceramics to those who would not normally have access to these methods was what inspired him to take part. Nahid Rivera's engagement with the initiative started with the facilitators' explicit request. The explicit invitation served as a catalyst for their engagement in the project.

Regarding how art, such as ceramics and

sculpture, can serve as a means to express both personal experiences and those of other immigrants, and how they contribute to valuing immigrants' memories, skills, and cultures, participants provided positive feedback. Nahid Rivera, admited that ceramics do indeed contribute to the value of memories. Patricia Rodriguez, Pammie's mother, regarded her experience of participating in the collaborative workshop as profoundly enriching. Particularly during the initial phase of dialogue and sharing the participants' life stories, she sensed a strong and beautiful emotional connection among all the participants and the clay. Miriam Alarcón Avila expressed great joy about the use of clay as the primary material in the workshops, noting that it is an ancestral, malleable, inspiring, and effective medium for communicating and valuing immigrants' diverse life experiences. Specifically, it allows the creation of sculptures with significant meaning. Alejandra Alvarez mentioned that initially, she faced some difficulties as she had never worked with clay, but she realised that accepting the material's "life" and her inability to fully control it helped her let the artistic and emotional process flow. For Pammie, the experience of working with clay was highly relaxing. According to Seso, ceramics is the perfect medium for expressing feelings. He articulated a powerful desire to physically seize something when feeling anxious, and perceived clay as the ideal substance to satisfy this requirement. Particularly for Javier Espinosa Momox, ceramics offer a means through which people can engage with the earth's inherent qualities and our shared humanity. Furthermore, ceramics have cultural characteristics unique to certain societies, which contributes to an appreciation of immigrant experiences, talents, and cultures.

Everyone agrees that games should be used as a tool to find their own ideas for creating sculptures. Miriam Alarcón Avila praised the use of the MEMO game to stimulate the sharing of life stories, generate ideas for creating sculptures, and foster bonds among participants. She found this both beneficial and moving. The MEMO game was vital to Alejandra Alvarez because it was lively and generated a powerful, distinct bond. The game's lightheartedness facilitated individuals in expressing and embracing aspects that could otherwise be challenging to disclose or acknowledge. In her opinion, using the game as a strategy for creating a sculpture made the transformation process even more engaging. Pammie regarded the MEMO game as an excellent strategy to help individuals think about what they want to create. For Patricia Rodriguez, using the game MEMO proved to be a highly effective method of eliciting personal memories from each participant and facilitating their sharing. For her, it was a remarkable and beautiful experience, as all participants were pleased to recall their loved ones and other memories, allowing them to momentarily escape their daily concerns. She found it deeply moving to physically engage with the clay and to realise that, together with her daughter, she was creating a sculpture that symbolised the unity among all the members of her family. For her, it was

an extraordinary experience. Seso believes that games are ideal for alleviating our anxieties, thereby enabling our willingness to participate in conversation. Nahid Rivera considers that the use of games is crucial for challenging preconceived notions of what qualifies as “artistic” creations. According to her, games help to remove rigid notions and facilitate a more open approach to generating ideas for sculptures.

Every participant acknowledged the important role that art plays in deepening our understanding of people and their cultures. Miriam Alarcón Avila thinks that one of the noblest ways to foster creativity, share, and shape ideas that are frequently hard to articulate is via art. Additionally, it encourages individuals in discovering their synchronicities and emotions within a community. Alejandra Alvarez highlighted the power of participatory art by promptly enabling all participants to collaboratively establish a communal environment, even without prior acquaintance. She has the belief that art amplifies awareness and facilitates the cultivation of empathy towards others. She holds the belief that art serves as a medium for expressing the thoughts or feelings of something or someone. In the context of *Shifting Ground*, it allows us to immerse ourselves in the viewpoints and realities of others. Although she believes that individuals frequently reject what they cannot comprehend, art delves into uncharted territories that have the potential to be embraced in the future. According to Nahid Rivera, art is vital for comprehending and relating to other individuals and their cultures. Through her participation in the project, Pammie came to the awareness that art functions as a medium for comprehending and acknowledging the multiplicity of individuals and societies. In this sense, the workshops facilitated an appreciation of immigrant culture. According to Patricia Rodriguez perspective, art serves as the finest method of avoiding stress and daily worries. Working on art completely shifts one’s attention towards creation, disregarding everything else. She establishes a clear and strong connection with the other participants in the project. She considers that throughout the process, all the participants had the opportunity to develop their creativity and design their own unique creations. Seso considers that art transcends linguistic barriers, becoming a universal medium of communication. Introduced as a method of expression, art transforms language into a universal tool for conveying meaning. Seso believes that although the participants came from different backgrounds, the art exhibition gave them a chance to momentarily connect and find common ground. Javier Espinosa Momox thinks that art can facilitate comprehension of individuals and their cultures by virtue of the sentiments and emotions conveyed therein.

The concluding event was an exceptional moment, emphasised by the participating immigrants in the *Shifting Ground* project and acknowledged by all those in attendance. Almost everyone emphasised that the exhibition served as a distinct celebration

of immigrant culture and the unity among various communities. They noted that the event showcased the most creative aspects of the involved communities, along with the participation of family and friends. For them, the celebration of immigrant culture was enriched by the fact that participants prepared regional dishes and drinks, featured a curated playlist of Mexican music, and decorated the exhibition space predominantly with Mexican cultural ornaments, all of which were considered exhilarating by everyone. Alexandra highlighted that PS1, the space of the exhibition, was an excellent venue for the Shifting Ground exhibition and celebration, as it allowed the Iowa community to learn about the real visions and stories of immigrants.

The positive feedback we received from participants in the *Shifting Ground* project demonstrates the importance of community-based efforts in fostering a welcoming environment for immigrants. It also signifies that the methodology employed is suitable and beneficial. We assert that collaboration and cooperation among individuals and groups with special interests are crucial determinants for the societal shift towards more fairness and long-term viability in the social and cultural domain. This process should be supported and systematically overseen by local organisations.

6. Conclusions

The *Shifting Ground*, through its iterations in Cedar Rapids, Lisbon, and Iowa City, showed considerable promise as a social innovation art and design service. The initiative demonstrates how effective it is at fostering social and cultural assimilation through the use of art, as evidenced by the success in bringing together immigrants who identify as Latino, Latina, or Latinx, as well as those from multiple international backgrounds. Through ceramic workshops, *Shifting Ground* has created an atmosphere where immigrants can express their abilities, cultural heritage, and personal narratives by utilising the social dynamics inherent in community-based artistic activities. The MEMO game, a crucial element of the campaign, has fostered a sense of community among participants through the promotion of empathetic conversation and artistic self-expression.

Relational services and the commons concept have played a major role in shaping the project's framework. By emphasising human-centred, relational, and societal components, *Shifting Ground* has created environments that are conducive to social innovation. These services integrate local culture and expertise and build strong relationships with community members to tailor their approach to specific problems. The initiative is based on the concept of the commons, which offers a comprehensive social framework for understanding humanity's collective experiences and expressing a fundamental

socio-political perspective. This strategy prioritises the importance of collaboration, adopting established protocols, and taking responsibility for shared resources in order to foster a more supportive and unified community.

The project's focus on creating in a relational manner and prioritising the commons underscores the need for collaborative methods in tackling current social problems. The project's influence in fostering comprehension and inclusiveness is evidenced by the positive responses garnered from participants and the wider community. *Shifting Ground* reflects how art and design can promote social transformation, generating a unified and nurturing society through the celebration of diversity and the promotion of active engagement in cultural dialogue. This initiative highlights the significance of collaborating with local organisations with the aim of attaining enduring social and cultural sustainability.

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ARTISTIC RESISTANCE IN THE POST-PRIVACY ERA: REFLECTION, IMAGINATION, AND RECONSTRUCTION UNDER LIQUID MODERNITY

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ABSTRACT | In an era marked by rapid digital transformation, contemporary artists adeptly utilize digital media to interrogate and redefine the essence of human connections. This research paper delves into the dynamic interplay between art, technology, and society, exploring how digital art forms critique surveillance, dismantle digital control systems and forge new pathways for communal interactions and shared experiences. By examining the works of Aram Bartholl, Trevor Paglen, and Jonas Lund, the study highlights artistic practices reflecting the erosion of traditional notions of privacy, public space, and personal autonomy within the fluid and ever-evolving frameworks of "liquid modernity." Employing theoretical insights from scholars of Zygmunt Bauman, Jürgen Habermas, and Michel Foucault, this research navigates the complexities of the "post-privacy era," investigating how artists reimagine public space, cultivate communicative rationality, and open avenues for personal and communal liberation. These artistic endeavors are positioned as crucial interventions that foster social cohesion and collective empowerment amidst fragmentation and uncertainty. This research contributes to broader discussions on the transformative potential of art in challenging entrenched power structures and envisioning more connected futures. It underscores the vital role of artistic engagement in maintaining and enhancing the social, cultural, and political connections essential for thriving in our interconnected world.

KEYWORDS | SURVEILLANCE CRITIQUE, POST-PRIVACY ERA, LIQUID MODERNITY, ARTISTIC RESISTANCE

1. Introduction

In an era where digital surveillance has permeated every facet of society, the notion of privacy is being relentlessly redefined. This phenomenon, often referred to as the "post-privacy era," marks a significant shift in the way personal information is accessed, used, and controlled. As rapid technological advancements blur the boundaries between the public and private spheres, individuals grapple with an unprecedented erosion of privacy. Concurrently, the societal framework described by Zygmunt Bauman (2001) as "liquid modernity" underscores these transformations, characterizing modern life by its fluidity, where traditional structures dissolve, and new forms of social instability emerge. Multiple phenomena parallel and contribute to each other while complicating the question of privacy and the public for many.

The intersection of these phenomena creates a fertile ground for artistic exploration and resistance. Contemporary artists utilize digital media as both a tool and a subject, expressing critically while navigating these shifts. They not only reflect on the gradual erosion of privacy and the pervasive influence of surveillance but also actively participate in the reconstruction of public spaces and reimagine personal and collective identities. This paper seeks to explore how artistic practices encapsulate and resist the challenges posed by liquid modernity and the postprivacy era. This study aims to unravel the complex dynamics between art, technology, and societal change through a detailed analysis of the works of artists such as Aram Bartholl, Trevor Paglen, and Jonas Lund.

In a nutshell, we argue that contemporary artists employ digital media to critique and resist the erosion of privacy and the expansion of surveillance; art attempts to reconstruct public spaces and foster new forms of communicative rationality and social engagement; art has the potential to imagine new possibilities for personal and collective liberation in the face of ongoing societal transformations. By addressing these issues, this paper aims to contribute to the broader discourse on the role of art in confronting contemporary challenges and envisioning

alternative futures against a critical backdrop of technological advancements and uncertainties. Through the lens of artistic resistance, we strive to understand not just the impact of digital media on privacy and identity but also the potential of art to instigate meaningful societal reflections and transformations.

2. Theoretical Framework

The theoretical underpinnings of this paper rest on two main pillars: Zygmunt Bauman's concept of "liquid modernity" and the socio-cultural implications of the "post-privacy era." It supports an exploration of how contemporary art deals with the fluid social structures and pervasive surveillance that characterize modern life. This article builds on these two pillars and supplements these theories by providing an artistic solution to a dystopian vision.

2.1 Liquid Modernity and Artistic Expression

Zygmunt Bauman's concept of liquid modernity provides a critical lens through which to view the transient, precarious nature of social forms and personal identities in contemporary society. In liquid modernity, change is the only permanence, and uncertainty is the only certainty. This fluidity infiltrates the artistic world, influencing contemporary artworks' form and content. Through their works, artists often reflect on the disintegration of longstanding social structures and the impact of these changes on individual autonomy and identity. In the context of art, liquid modernity challenges artists to navigate and respond to these transient conditions, often pushing them towards innovative, ephemeral forms of expression that mirror the instability of the era.

Liquid modernity seems to be associated with modernism, and then conceptualism, and then global contemporary art, by suggesting and expressing the unstable nature of truth and knowledge, which slip, assemble, and reconstruct new meanings and, thus, new forms. For example, both Cubism and Surrealism highlight the fluidity of vision and symbolism which according to Foucault (1978), were two major foundations of Western modernity by a structural order of knowledge. However, the alienation and problems brought by modernity throw them into question, and turns art no longer representation of truth and knowledge, but of their fluid nature and boundaries. Following this vein, another two strands of theories related most to liquid modernity and its relevant art forms are deconstruction and poststructuralism, which produce enlightenment and emancipation by "focusing on the ambiguities between knowledge and belief" (Harcourt, 2007, p.21). By contrast, deconstruction spearheaded by scholars like Derrida never attempts to offer an explanation, a social theoretic, while poststructuralism tries to provide an explanation of how the distribution of power leads to the construction of knowledge and develops a "social theoretic, historical, or genealogical account of how we come to take that central leap of faith" (Harcourt, 2007, p.23).

Harcourt (2007) considers poststructuralism as the penultimate stage of modernity, while deconstruction as the ultimate, linking back to Bauman's idea of liquid modernity as the most recent and new phenomenon. However, what Bauman fails to mention as what comes after the liquidation, just like Derrida, is what Harcourt (2007) recognizes as the "turn to randomization" (Harcourt, 2007, p.23). Going back to the original problematic of privacy erosion, many have identified this phenomenon as an erosion on power, liberty, humanity, and equality predominantly, but what artists have adopted can be seen as mostly a poststructuralist approach, which chooses to resist this erosion by either providing, or gesturing to provide a critical genealogical account of what we believe as privacy and public, or fighting this erosion with a performative type of "artistic erosion," that is randomization of process and symbol, all the defining bedrocks of algorithm, and sometimes both (ironically, Cubism and Surrealism were termed "erosion" at the time of their nascence).

Moreover, the term "Post-Privacy" can be also understood as profoundly poststructuralist. It is a term firstly and coherently put forth by Kosinski (2018) as he previously claimed, "There is going to be no privacy," and that "we are already living in the post-privacy" world through his previous study (2013) which finds that algorithm may be more effective and accurate than humans in predicting one's behaviors. This statement provocatively questions the superior position of autonomy and individuality in dealing with private matters (Kosinski, 2013). In addition, "privacy," or the rational boundary between the public and private sphere, as put by Arendt (1958), is now being eroded, but not for the automatic reactivation of the public sphere, which leads to the collective action of group liberation (Arendt, 1958). The liquidation of modernity can be seen as a deepening of Arendt's (1958) conception of modernity as the rise of the social over the previous distinction between the public and private sphere-and it is no longer an institutionalization of alienation and violence, but a transformation of such by digitization into ubiquity, invisibility, and benignity (Arendt, 1958).

Therefore, it is crucial to place liquid modernity, and its relevant forms of art into this critical context of deconstruction and poststructuralism, which calls for new and creative solutions to more complex problems of modernity represented by surveillance culture.

2.2 Surveillance and Artistic Expression

In the digital age, surveillance has become a ubiquitous element of everyday life, with technologies tracking and archiving endless streams of personal data. This pervasive monitoring raises profound questions about privacy, freedom, and control - increasingly prominent themes in digital and contemporary art. Theoretical perspectives such as Michel Foucault's panopticism and Gilles Deleuze's societies of control are pertinent here, as they describe mechanisms through which power is exercised in modern societies. New theories include Zuboff's (2022) idea of surveillance capitalism, which points out the collection, utilization, and

commodification of personal data without individual permission based on algorithmic surveillance, an all-time monitoring of digital activities (Zuboff, 2022). Most critically, Zuboff (2022) indicates that it ruptures the organic integrity of collective and individual behavior, jeopardizes personal autonomy, and imposes new power over human life (Zuboff, 2022).

However, these theories have fallen short of providing a timely explanation to what artists and netizens are experiencing at an unprecedented pace. Art, by contrast, tends to respond to these problems in a more premonitory and tangible way. Specifically, artists respond to these dynamics by critiquing surveillance practices and reappropriating surveillance technologies to explore and expose their implications. This dual approach highlights the invasive nature of these technologies and reclaims them as tools for artistic and political resistance. Essentially, this approach also corresponds to the diagnostic of fluid modernity by, on the one hand, showing a genealogical account, reverse engineering, repurposing, revelation, and imitation of the "rational" logic behind the surveillance idea and practice, and on the other hand, using this idea and practice in a randomized way to perform and inspire enlightenment, hence, echoing the theoretical kernels of deconstruction and poststructuralism.

2.3 Resistance Theories in Art

Artistic resistance in the context of liquid modernity and the post-privacy era can also be framed through various resistance theories that explore how culture and art can oppose dominant power structures. Theories of hegemony by Antonio Gramsci, for instance, suggest that cultural production is a battlefield where societal norms and ideologies are both established and contested. Artistic resistance, therefore, can be seen as a form of 'counterhegemonic' practice that challenges prevailing power dynamics and opens up spaces for alternative narratives and forms of social engagement. Additionally, as discussed by Judith Butler, the concept of "subversive repetition" in art points to the potential of repeating norms in altered contexts to undermine their authority.

In addition, it is important to highlight other theories. For instance, Wendy Chun's (2008) critique of the Internet as a bifurcating duality of total freedom or control deserves our attention. She attributes this misconception to reducing the political problem to a technological one, while reminding us that the relationship between control and freedom in of the Internet is experienced and negotiated through sexuality and race. Therefore, to use the Internet as a liberating tool lies in not the illusory promises of individual empowerment as promoted by tech media and corporations, but in the multitude of unexpected ways the Internet can expose us to other humans and machines. Again, this theory calls for a

randomization of the Internet technology. Moreover, not reducing the political problem of the Internet to a technological one, and reintroducing the problem of race, sexuality, and other social factors are where artists can make most effective interventions and have been witnessed to have done so for decades.

2.4 Art as a Tool for Societal Reflection and Reconstruction

Art serves not only as a mirror reflecting societal issues but also as a hammer with which to shape them, as famously noted by Bertolt Brecht. In the digital and post-privacy context, artists leverage their platforms to question and reconstruct societal norms and spaces. The role of art in fostering communicative rationality, as theorized by Jürgen Habermas, emphasizes the potential of art to facilitate democratic discourse and rational-critical debate, essential for the functioning of a vibrant public sphere. Art, in this framework, becomes a crucial player in the dialogue about privacy, surveillance, and identity, providing a space to resist, reimagine, and reconstruct the narratives and structures of liquid modernity.

Using art as a tool for societal reconstruction is inextricably related to the idea of public sphere. According to Habermas (1990), it is a domain of social life where public opinions can emerge and circulate (Habermas, 1990). However, the Habermasian conception of the public domain lies in an idealization, which assumes the relative equality and similarity of the citizens to whom the domain is accessible, neglecting the existence and importance of different and personal interests in such a space. Similarly, artists care about the public sphere because art has long been incorporated as a critical tool for reflecting on and reconstructing public opinion and discourse rather than staying as the background as in premodern or early modern epochs. However, they engage the issue differently because heterogeneity often inspires more art than their obverse. Habermas (2022) also updates his own theory by considering the multifaceted aspects of digital technology. He argues that it provides an incomparable opportunity for interactive and deliberative exchanges but it also increases the power of centrifugal forces in the public sphere, so he calls for a political re-regulation of the digital public sphere (Habermas, 2022, in Thiel, 2023).

Nevertheless, artists often take a more microscopic perspective to tackle macroscopic problems because the issues of privacy, surveillance, and identity not only impacts how society as a whole consume media and how corporations and governments use media but also shapes our daily life in a subtle and personal way. A more relevant explanation can be found in Manovich's (2002) idea of "transcoding" which argues that the convergence of the machine and human layers in the age of new media, meaning that "the interpretation of the human 'cultural layer' in computer ontology and the 'computer layer' in human cultural terms" (Manovich,

2002). This background calls for artists to consider an integrated dimension of cultural and computer layers when engaging the issues of a digitizing society. For example, artist resistance should be directed not only to machines and data, but also the integrated layers of digital economy and governance. Specifically, they appropriate and empower the various ways individuals engage with digital networks and seek to express and reconfigure the personal differences as power and liberation against a popular imagination of the digital world as dialectical, homogeneous, or dystopian. They proffer us an alternative imagination of the public sphere in the post-privacy era-liquidation can also be liberation.

3. Case Studies of Artistic Resistance

In this section, we will explore the artworks of Aram Bartholl, Trevor Paglen, and Jonas Lund, focusing on how each artist engages with contemporary digital cultures and surveillance with distinct methodologies and thematic concerns.

3.1 Aram Bartholl

Aram Bartholl (1972) is a Berlin-based conceptual artist renowned for his profound explorations of the interplay between the digital and physical worlds. His innovative art pieces often delve into the complex themes of anonymity and privacy, reflecting on how digital age dynamics reshape human interaction and societal norms.

From "Dead Drops" to "Forgot Your Password?"

Aram Bartholl's works explore the intersection of digital culture, surveillance, and public space. Through provocative installations and interventions, Bartholl seeks to make visible the hidden infrastructures of digital surveillance and challenge the normalization of data collection and monitoring in everyday life.

One of Bartholl's most well-known projects is "Dead Drops (2010 - ongoing)[1]", a series of USB flash drives embedded into walls, buildings, and curbs in public spaces worldwide (see Figure 1). By creating an anonymous, offline file-sharing network, "Dead Drops" encourages audiences to engage in a form of digital exchange that is free from the surveillance and tracking of online platforms. As Bartholl explains, "In the Internet age, city walls have become the last remaining spaces for free and anonymous communication." By appropriating these physical spaces for digital communication, "Dead Drops" challenges the assumption that online interaction entails a loss of privacy and autonomy.

[1] Dead Drops: https://arambartholl.com/dead-drops/



Figure 1. Dead Drops, 2010 - ongoing. ©Credit by Aram Bartholl.

In “Forgot Your Password? (2013)[2]”, Bartholl takes a more confrontational approach, displaying the vulnerability of our data (see Figure 2). This installation consists of large-scale, publicly displayed passwords collected from various online databases and leaks. He seeks to reveal the vulnerability and insecurity of personal data in the age of surveillance capitalism by making these passwords visible in public space. Bartholl explains, “The work is a reminder of how easily our privacy can be compromised and how little control we have over our data.” The scale of the installation, with its overwhelming array of exposed passwords, speaks to the sheer magnitude of this violation and the difficulty of resisting or opting out of a system that has become so deeply embedded in our daily lives.

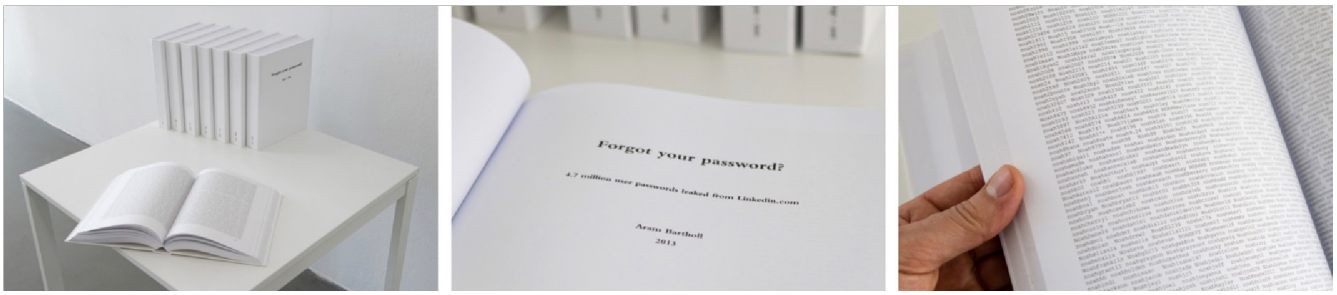

Figure 2. Forgot Your Password?, 2013. ©Credit by Aram Bartholl.

Both his works are characterized by a sense of raw materiality and exposure. In “Dead Drops,” the USB drives are embedded into the walls and sidewalks of the city, becoming a physical manifestation of the hidden surveillance and control networks surrounding us. While in “Forgot Your Password?”, the passwords are displayed in a stark and unadorned manner, stripped of any context or explanation, creating a sense of vulnerability and exposure that is both unsettling and revealing.

[2] Forgot Your Password?: https://arambartholl.com/forgot-your-password/

Bartholl's works build on the past artists who have used their practice to critique and subvert the power structure. In the 1960s and 70s, artists Hans Haacke ("MoMA Poll" and "Manhattan Real Estate Holdings, a Real-Time Social System) (Haacke, 2007b) and Martha Rosler ("Semiotics of the Kitchen[3]") used their work to expose the hidden connections between art, politics, and corporate power (Griffin, 2004). Bartholl's installations continue this tradition, using the tools and techniques of art to reveal the hidden infrastructures of surveillance and control that shape our contemporary moment.

However, what sets Bartholl's work apart is its engagement with the specific technologies and platforms of the digital age, which rely on the active engagement and collaboration of the viewer and make his works highly participatory. In "Dead Drops," Bartholl appropriates the devices and networks typically used for surveillance and data collection and repurposes them as anonymous communication and exchange tools. He subverts the traditional power dynamics of online communication by creating a physical network of USB drives embedded in public spaces. Bartholl creates a space for resistance and autonomy within the very fabric of the city. The work becomes fully realized when individuals connect their devices to the USB drives and share their data and files. This creates a sense of intimacy, collaboration between the artist and the audience, and shared vulnerability and trust. And in "Forgot Your Password?", Bartholl creates a visceral and confrontational experience that forces us to see how easily our data can be compromised and exploited. The viewer is confronted with the unsettling reality of their digital exposure, as the passwords on display could easily be their own. This creates a powerful emotional response that is personal and political, forcing the viewer to reflect on their relationship to privacy and security in the digital age.

Bartholl's works are a powerful and provocative exploration of how our lives are being shaped and compromised by the technologies of surveillance and control. By making visible the hidden infrastructures of power within the digital realm, Bartholl challenges us to confront the reality of our complicity and vulnerability. His works critique the present moment, make a call to action, and show a vision of a more just and equitable future.

[3] Semiotics of the Kitchen, by Martha Rosler: https://www.moma.org/collection/works/88937

3.2 Trevor Paglen

Trevor Paglen (1974) is an American artist, geographer, and author who has been pivotal in exposing and critiquing the pervasive surveillance systems that define our contemporary society.

From "Autonomy Cube" to "ImageNet Roulette"

The growing awareness of digital surveillance has spurred new forms of resistance and critique. Civil society groups and privacy advocates are advocating for greater transparency and accountability in the use of surveillance technologies. Simultaneously, artists and media activists are employing their work to expose the covert infrastructures of digital control and envision alternative futures. As we confront the implications of digital surveillance, it's crucial to recognize that this issue transcends technology, touching deeply on social and political fields.

Paglen explores art's capability to critique and reflect on a surveillance-dominated society, one of his most significant works, "Autonomy Cube (2014)[4]", a collaboration with digital rights activist Jason Applebaum, is a sculpture that doubles as a functional Tor router encased in a transparent cube (see Figure 3). This allows users to connect to the internet anonymously. Paglen and Applebaum counter the notion that surveillance is an abstract or intangible phenomenon by materializing the principles of privacy and autonomy in a physical object. They make the tools of resistance tangible and accessible, empowering individuals to take control of their digital lives. Simultaneously, this work also highlights the critical relationship between transparency and autonomy and suggests a possible solution to fighting surveillance domination as making the power relation more transparent and tangible so that we have no choice but to recognize and negotiate its existence.



Figure 3. Autonomy Cube, 2014. ©Credit by Trevor Paglen.

[4] Autonomy Cube: https://paglen.studio/2020/04/09/autonomy-cube/

"ImageNet Roulette (2020)[5]" sharply critiques the biases inherent in artificial intelligence systems, serving as a provocative tool to demonstrate how AI's visual recognition capabilities can perpetuate racism, misogyny, and other harmful biases (see Figure 4). As a vital and timely intervention in the discourse on artificial intelligence and digital ethics, it uses digital installation as a medium to engage, challenge, and educate its audience about the deep-seated biases within AI technologies.

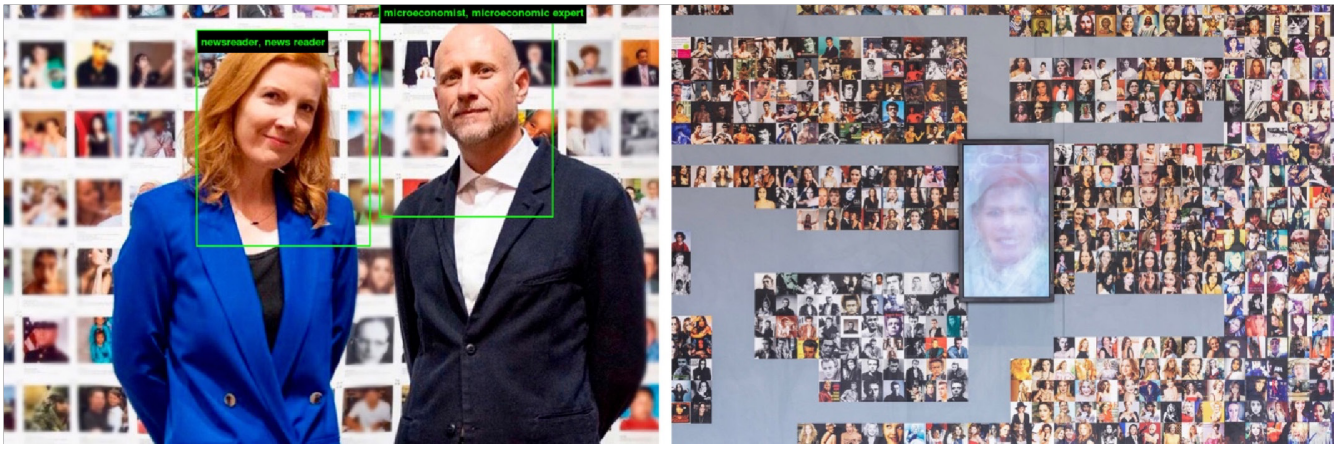

Figure 4. ImageNet Roulette, 2020. ©Credit by Trevor Paglen.

The project utilizes the "person" categories from ImageNet, allowing the AI to categorize users' uploaded images in disturbing and enlightening ways. This direct interaction lets audiences witness firsthand the potential errors and stereotypes AI can propagate, making AI's abstract and often hidden biases tangible and immediate. It demystifies the illusory promise of AI as infallible and neutral, calling for more human intervention by paying attention to the ethical issues of AI. In addition, it also throws into question the sourcing and processing of digital data as purely mechanical, so removed from culture and identity, bringing out again the inseparable relationship between human intent and computer algorithm.

Although physically limited in accessibility, its impact on discussions about digital ethics and the future of AI is far-reaching.

His works remind us to think back to the 1980s, highlighting a long-term artwork of video installations called "Watch (1995-2008)[6]" by David Rokeby. For years, he has been constructing artificial perception systems — electronic systems that are able to see. Deeply rooted in the discourse around surveillance, a prevalent concern in contemporary society, "Watch" extends beyond mere artistic exploration. By manipulating how people are seen or unseen, Rokeby comments on the power dynamics inherent in surveillance technologies and the potential for these

[5] ImageNet Roulette: https://paglen.studio/2020/04/29/imagenet-roulette/

[6] Video installations: Watch: http://www.davidrokeby.com/watch.html

systems to distort reality and influence behavior. There is no doubt that artists have a long history and a predictable awareness of social surveillance. Another example is "Always There – Surveillance Bed (2020)[7]" by Julia Scher, surrounded by four cameras and video monitors; the cameras record the events pictured on the bed. In correlation to her comment, "Power and its abuse is my most important subject matter; how power is misused to harm people," she has been focusing on questions of personal identity within the context of power, such as surveillance and control.

But Trevor Paglen's works are far more than them, he underscores the pervasive nature of surveillance but pushes the conversation into new territories—exploring not only how surveillance operates but also how it's integrated into the broader visual and cultural landscape. His works serve as a critical reflection on the state of privacy, freedom, and human agency in a world where surveillance has become normalized, challenging us to question who watches the watchers and at what cost.

3.3 Jonas Lund

Jonas Lund (1984) is a Swedish contemporary artist known for his critical and often playful approach to systems of art, technology, and information. His works frequently explore themes such as control, transparency, and the dynamics of the art market, utilizing data and algorithms to both critique and rethink modern digital and networked systems.

From "The Fear of Missing Out" to "The Red Telephone"

"The Fear of Missing Out (2013)[8]", an early work by Lund, leverages algorithms designed to forecast emerging trends in the art world, enabling the creation of artworks that resonate with the anticipated preferences of contemporary art experts (see Figure 5). This project underscores the art market's vulnerability to controlled narratives and decision-making driven by data. Through a detailed analysis and classification of a broad spectrum of works by leading contemporary artists, Lund developed a comprehensive set of instructions detailing how to produce the most successful art pieces.



Figure 5. The Fear of Missing Out, 2013. ©Credit by Jonas Lund.

[7] Always There – Surveillance Bed: https://www.estherschipper.com/exhibitions/642-always-there-surveillance-bed-julia-scher/

[8] The Fear of Missing Out: https://jonaslund.com/works/the-fear-of-missing-out/

Following these guidelines, the artist executed the works accordingly. “The Fear of Missing Out” challenges critical concepts within the art community, including authenticity, artistry, talent, and creativity. Moreover, the title alludes to the desire to engage with a transparent, digitally interconnected information society. It also sheds light on the overlooked impact of digital technology by its capacity of connection and prediction through collection and calculation on contemporary artists, especially on its influence on market positioning in terms of what constitutes and defines artist success and on its repercussion on the autonomy of artist in terms of who to decide what to make and how to make an artwork. As a result, it inspires artists to take a more active and critical approach when using digital technology in their artmaking on the one hand, because it shows a surprising ability to impose a new form of normative pressure either from the market to reshape the community or from the individual desire to stay relevant and successful. On the other hand, it also shows the other side of contemporary art by repurposing a manipulative power structure to look back on itself and propose an alternative way of engagement.

The underlying idea of “The Red Telephone (2020)[9]” is innovative and audacious, a recent work by Lund (see Figure 6). The artwork breaks down traditional barriers between the creator and the audience by allowing viewers to directly call the artist and subsequently record these interactions. This direct line to the artist literalizes the concept of accessibility while also playing with the notion of privacy in the digital age. The work questions the limits of artist accessibility and challenges the viewer to reconsider the roles of observer and participant. The physical aspect of the piece - a standard telephone - serves as a powerful symbol of communication and an almost nostalgic callback to the old analog times before digital communication took precedence. The color (red) choice is striking, evoking urgency and importance, which complements the serious implications of the interaction it facilitates. The auto-dialing feature adds an element of unpredictability and spontaneity, enhancing the interactive experience.



Figure 6. The Red Telephone, 2020. ©Credit by Jonas Lund.

[9] The Red Telephone: https://jonaslund.com/works/call-me-maybe-red-telephone/

However, the functionality of automatic dialing and recording calls with the artist without clear, ongoing consent each time could be seen as invasive. Additionally, it challenges the viewer to think about the implications of instant connectivity and the erosion of personal boundaries in the age of digital communication. Furthermore, the gesture of recording conversations and their exclusive availability to token holders introduce a layer of exclusivity and commodification of personal interactions, mirroring concerns present in the broader digital economy. This artwork utilizes a pre-digital symbol to imitate the process of digital connection as an anachronistic gesture to underscore the problematic power relation underlying our times.

Compared to a telephone, digital communication seems to take a more abstract form. The comparison is also strikingly critical: the sacrosanct practice of how to call someone properly and what deems as privacy to be respected during the pre-digital times is now stripped bare under contemporary gaze, and the caller-receiver relationship has been replaced by an artistaudience, or observer-participant relationship, which remains dynamic and unstable during the communication. Consequently, this work performs this relationship to highlight an irony embedded in the technological advancement from analog to digital, and from telephone to computer.

4. Privacy, Surveillance, and Modernity

In summary, three artists have adopted both poststructural and deconstruction approaches to analyzing and reconfiguring a post-privacy reality. Specifically, they conduct artist resistance to a pervasive practice of surveillance culture and privacy erosion from two aspects: imitating the power structure through its technological and administrative structure to arrive at a revelation that our knowledge about digital networks is an unstable belief that requires reflection and expansion; repurposing the structure through performance and randomization to arrive at an enlightenment and empowerment of the same technologies and agents, no longer the passive victims of power relations, but participating subjects to embrace the unpredictable connections opened up by the technologies and direct them toward more collective, political, and reflexive courses to counteract the problems.

Respectively, the exemplified artists have their emphases. For instance, Aram Bartholl engages privacy anxieties and transforms this anxiety by revealing its nature while using the technology to make more meaningful and intimate connections with the city and its residents. Trevor Paglen criticizes and reflects on the surveillance society but he does not stop there and proposed for more transparency and tangibility in our

connections. Finally, Jonas Lund reveals the worrying degree of information control on the artist community, and its clutch on all technology users alike. He provokes us to pay more attention to the issues of accessibility, consent, and commodification underlying our daily exchanges of information, masquerading as equal interactions.

5. Approach to Liquid Modernity

The ability of individuals to navigate, understand, and resist the pervasive and often opaque forces of control in liquid modernity is significantly enhanced by the critical interventions of contemporary artists. Their work provides a vital critique and a counter-narrative to the dominant discourse on surveillance and control, offering new perspectives and empowering public discourse.

Bartholl, Paglen, and Lund each tackle the contemporary issues of digital surveillance and privacy through their unique artistic approaches. Their creations stimulate a critical dialogue at the intersection of technology, privacy, and societal control, encouraging public engagement and resistance to omnipresent digital structures. Bartholl's works, characterized by their tangible rawness, initiate conversations about digital privacy and carve out niches of resistance within the surveillance landscape. Trevor Paglen's projects lay bare and challenge the infrastructures of surveillance that shape our modern society. He critiques these systems and prompts the public to consider emerging technologies' broader ethical and political ramifications. Meanwhile, Lund's art playfully yet incisively interacts with the mechanisms of control and transparency that define the digital era, prompting viewers to contemplate their own engagements with these pervasive systems.

In liquid modernity, the paramount importance of reflexive engagement cannot be overstated. Art's role in resistance is transformative—it does not merely represent or reflect reality; it also challenges and redefines it. Through their creative expressions, artists critique existing systems and propose innovative ways of seeing and interacting with the world. In addition, the ethical and political implications of technologies and their surveillance capacities are brought to the forefront through these artistic endeavors. Artists demand accountability and transparency from those who wield control over digital and surveillance technologies, challenging the status quo. From this aspect, liquidation calls for more responsible, reflexive, and creative users of technology which do not reduce themselves to the passive objects submitting to the ferocious flows of the dissolving forces of digital economy and culture, but as acting citizens of a new public sphere which entails the efforts to uphold difference, flexibility, transparency, audacity to learn, and a critical porosity to recycle increasingly complex data and technologies toward public opinions. This realization also ties back to the Habermasian theory of the public sphere, but a more realistic and porous one.

6. Conclusion

In summary, each artist brings a unique perspective to themes of privacy, surveillance, and modernity, using digital media to represent and actively question and resist these forces. Their works foster a critical dialogue that encourages viewers to reconsider their roles and rights within the digital age. Through their distinct artistic strategies, these artists contribute significantly to the discourse on digital rights and the pervasive reach of technology in contemporary life. Against the contemporary backdrop of our post-privacy era and liquid modernity, this article answers the question of how digital art can resist and respond to the issues of privacy, surveillance, and information and power control by examining the case studies of three artists through textual and visual analysis, and critical theory interpretation, especially poststructuralism and deconstruction. By discovering that artists can make effective interventions through the revelation and repurposing of biased technologies and problematic conceptions of how they are used and should be used, the article brings light to the significance of transparency, flexibility, and criticality in our engagement with digital technology. Furthermore, it reaches beyond the field of art and expands the study of ethics, sociology, economics, and computer science by providing an artistic perspective into the stolid landscape of digitization. It also calls more understanding and collaboration between artists and technologists in this direction.

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EMPATHY ENGINE: USING GAME DESIGN AND REAL-TIME TECHNOLOGY TO CULTIVATE SOCIAL CONNECTION

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ABSTRACT |

This study examines the game “Takeaway Rider” to demonstrate the integration of cognitive psychology and game design theory for fostering empathy. By analyzing related works, we designed a game. We investigated how this real-time interactive game, driven by a sophisticated user interface, enables players to navigate the challenges of delivery work, facilitating emotional engagement and bias reduction. In this role-playing, parkour-style game, players adopt the perspectives of takeaway riders, engaging with the narrative and a system of rewards and punishments to develop perceptual empathy. We conducted semi-structured interviews during gameplay, which confirmed the effectiveness of this game genre in enhancing player empathy. This finding opens new paths for future research focused on empathy development among diverse groups through games. We also discuss potential developments using Unity to create a more immersive interactive model. The goal is to strengthen the connection between players and the game, thereby personalizing the gaming experience and optimizing educational impacts. Our study underscores the value of an interdisciplinary approach that combines cognitive psychology and design, enhancing the problem-solving capacity of educational games aimed at social issues. This approach provides valuable experiential insights for academics, game developers, and educators working to improve group empathy skills.

KEYWORDS | SERIOUS GAMES, EMPATHY, GAME DESIGN, REAL-TIME INTERACTION, TAKEAWAY RIDERS

Introduction

In the contemporary gig economy of China, takeaway riders represent a significant segment of labor engaged through digital platforms (Jinyang, 2022). The onset of the COVID-19 pandemic has exacerbated existing tensions between these riders and consumers, leading to increased visibility of their disputes in digital and social media spaces. Notable incidents such as "takeaway rider injures customers[1][2]" (; Guangming.com, 2021) and "takeaway rider threatens door-to-door with a stick[3]" have surfaced prominently, highlighting this intensifying conflict. Through the interviews of twelve consumers (C=12) and six takeaway riders (R=6) before the project, we uncovered that the principal catalyst for these altercations is the stringent delivery timelines imposed on riders. These workers are required to navigate complex and frequently changing urban traffic conditions, which can unpredictably extend delivery times, thus exacerbating the situation. Such demanding job requirements' logistical and psychological burdens are substantial[4].

These findings elucidate a significant discrepancy in consumer understanding and empathy toward takeaway riders' challenges. There exists a pronounced disjunction between the expectations set by the rigid operational protocols of digital platforms and the actual human capabilities of the riders. This disparity often culminates in unrealistic expectations from consumers, who remain largely unaware of the intricacies involved in fulfilling their orders under such constrained

1 上海独居女子点外卖给差评，第二天遭外卖员砸门辱骂：我弄死你！(Woman living alone gets "death threats" in retaliation for giving a bad review). https://new.qq.com/rain/a/20210201A07DGJ00

2 因超时近30分钟起冲突，深圳一外卖员砍伤订餐者！饿了么致歉 (A takeaway worker in shenzhen slashed an orderer after a conflict over a nearly 30-minute overrun!). https://m.gmw.cn/baijia/2021-08/29/1302520079.html

3 外卖骑手，困在系统里 (Takeaway rider, stuck in the system). https://baijiahao.baidu.com/s?id=1677231323622016633&wfr=spider&for=pc

4 女子称给外卖员差评后 外卖员持棍上门威胁要投毒 (Takeaway man was threatened with a stick after giving him a bad

circumstances. So consumers' lack of empathy and understanding often leads to friction and misunderstandings. To address this, we integrated an educational add-on game into existing takeaway applications, using a digital approach that offers scalability, interactivity, real-time feedback, and widespread accessibility to eliminate the gap between takeaway riders and customers as much as possible.

Our "Takeaway Rider" project is a real-time parkour game in a 2.5D visual style, integrated into delivery software to synchronize with customers' experiences after ordering. The 2.5D visual design balances the detailed environment of 3D with the simplicity of 2D graphics, thereby reducing production costs and complexity. It enhances user immersion and realism while ensuring compatibility with existing takeout software such as Meituan and Ele.me. This game is designed to simulate the challenges takeaway riders encounter, providing players with a deeper insight into the riders' daily hurdles. By enhancing consumer awareness of these workers' conditions and pressures, we aim to reduce tensions and create a more empathetic and supportive environment for gig workers. This method improves relationships between consumers and service providers and uses digital technology to foster a greater understanding of the gig economy. This paper' s most original and outstanding contribution is the application of real-time interaction techniques to game design to enhance empathy toward delivery riders. It incorporates Experiential Learning Theory (ELT) to provide a structured framework for cognitive and affective empathy and evaluates the feasibility of this design model through rigorous quantitative testing.

2. Related Theories and Projects

Developing empathy is crucial for the survival of our species and increases the likelihood of maintaining social groups. It is a unique social personality trait for humans (Archer et al., 1981) and is essential to promote harmonious co-existence, mutual understanding, and cooperation between individuals (Bošnjaković & Radionov, 2018; Gonzalez-Liencres et al., 2013; Oliveira-Silva & Gonçalves, 2011). However, the rapid proliferation of mobile social networks has inadvertently reduced the richness of natural emotional cues in face-to-face interactions (Terry & Cain, 2016). This evolution in communication, coupled with contemporary societal conflicts and technological advances, underscores the urgency to reinvigorate empathy within human interactions. In this context, games emerge as a powerful tool for educational efforts, offering immersive experiences and role-playing games that can effectively promote empathy skills (Belman & Flanagan, 2010). Their interactive nature can simulate real-life scenarios, allowing individuals to practice and deepen their empathy. This paper uses the conflict between a takeaway rider and a customer as a case study to explore a novel approach to cultivating cognitive empathy through gameplay and promoting the development of emotional empathy in the process.

2. 1 Empathy: Concept, Types, and Importance

Empathy is the ability to place oneself in another' s shoes (Rolbin & Della Chiesa, 2010) and understand their situation (Decety et al., 2007). Empathy is often categorized into emotional and cognitive empathy. Emotional empathy involves experiencing and sharing the emotions of others, emphasizing emotional alignment. In contrast, cognitive empathy requires setting aside one' s perspective to understand and speculate on the mental states and behaviors of others, focusing on understanding their thoughts and feelings. It is important to note that emotional and cognitive empathy are intertwined developmental processes that should not be examined in isolation. The affective component is the essence of empathy, while the cognitive component is the process through which this essence is formed (Hollan, 2012).

Advances in neuroscience and psychology have also significantly enhanced our understanding of empathy. Current research indicates that there is no universal neural model for empathy, but the discovery of "somatosensory neurons" (Gallese et al., 1996) provides a physiological basis for linking self- and other-emotion perception and action (Decety, 2011). Decety and Jackson identify three main components of empathy: emotional reactions to others, adopting others' perspectives, and regulating emotions to distinguish self from others (Decety & Jackson, 2004; Decety et al., 2007).

Carl R. Rogers' cyclical model of empathy includes three stages: empathic resonance, expressing empathy, and receiving empathy (Rogers, 1975). Although descriptions of the empathy generation process vary due to differences in context and methodology, most scholars agree that fostering awareness of others and their environments is central to empathic training. The differentiation of intersubjectivity between self and others is crucial (Singer & Lamm, 2009; Walter, 2012; Watt, 2007) for effective empathy training design and assessment.

2.2 Cognitive Learning Theories Underpinning Empathy Research

Cognitive learning is essential for empathy training as it helps subjects better understand others. This type of learning involves acquiring and processing information through mental processes such as thinking, memorization, and problem solving (Kolomitro & Lam, 2011). It emphasizes understanding and knowledge construction rather than just behavior change (Richmond et al., 1987). Unlike behavioristic learning, cognitive learning focuses on internal mental processes and the formation of knowledge structures. Complex tasks and situational simulations provide players with rich cognitive learning opportunities in games. For example, players must analyze customer needs, plan optimal routes, and solve unexpected problems. These activities demand a high level of cognitive engagement and reflection.

Experiential Learning Theory can be a theoretical framework to support research on empathic play, promoting cognitive transformation and thereby reducing prejudice through enhanced empathy. ELT, proposed by psychologist David A. Kolb, offers a solid theoretical foundation and practical guidance for enhancing empathy through game design. It outlines a four-stage learning cycle: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Kolb et al., 2014).

Immediate or concrete experience serves as the basis for observation and reflection. These reflections are assimilated and refined into critical concepts, leading to new insights for action. These insights can then be actively tested and used to create new experiences. This theory supports the validity of enhancing empathy through game design, providing valuable empirical insights and practical guidance for future research focused on developing empathy among diverse groups through play.



(a) "PeaceMaker "by ImpactGames (b) "Nevermind"by Lobel, et al. (c) "A Breathtaking Journey",by kors, et al. (d) "AS IF",by Tong, et al.

Figure 1. The Related Works of Horizon of Khufu, Notre-Dame de Paris and China Grand Canal Museum.

2. 3 Review of Empathic Games

Empathic play is a cognitive education tool with great potential. It enables players to inhabit the roles and perspectives of other individuals or groups in an immersive way, improving empathy through innovative interactions and narratives (Hudnall & Kopecky, 2020). One notable example is "PeaceMaker", a real-time strategy game addressing the Israeli-Palestinian conflict (see Figure 1a). Players assume the role of a side' s president, navigating complex decisions and stakeholder considerations. The game incorporates real-life news visuals, fostering emotional and cognitive empathy (Belman & Flanagan, 2010). Lobel et al. designed the horror game "Nevermind" to explore adjusting the difficulty of the game by monitoring the player' s heart rate and improving immersion through biofeedback (2016) (see Figure 1b). Kors et al. focused on narrative persuasion and developed "A Breathtaking Journey," a mixed reality game that simulates the experiences of refugees (2016) (see Figure 1c). Another motion sensing game, "AS IF" by Tong et al., allows players to inhabit the virtual body of a patient with cerebral palsy, offering insight into chronic pain experiences (2017) (see Figure 1d). These diverse approaches contribute to the evolving landscape of empathic game design, exploring varied strategies to evoke empathy in players. These games are not isolated experiments but

represent a collective endeavor to harness the immersive potential of gaming to deepen our understanding of others' lives. They challenge the player to confront complex social issues and internal emotional landscapes, proving that games can be both mirrors reflecting our humanity and windows into the lives of others. The above efforts pioneer a path towards a more empathetic form of interactive entertainment that resonates with the deepest aspects of our social being, urging us to connect, understand, and ultimately care more deeply for one another.

However, researchers frequently confuse games offering empathic experiences with empathic games that aim to enhance empathy. Moreover, the absence of theoretical models that address empathy in existing games introduces uncertainty about the validity of research findings that provoke empathic responses (Schrier & Farber, 2021). Thus, we employ the "Takeaway Rider" game as an example to demonstrate how interactive real-time game design can resonate with consumers. We designed the game mechanism based on Kolb' s ELT. Additionally, we investigated the efficacy of achieving emotional resonance across different groups through the transformation of real-time game data (Belman & Flanagan, 2010). In the end, we evaluate the impact of the primary 2.5D game on players' empathic abilities using IRI scores and then enhance it to a VR-based game to acquire a deeper immersive environment for players.

3. Design Process

In our project, we have implemented a 2.5D visual style in our mobile gaming application to enhance user immersion and realism while ensuring compatibility with existing mobile platforms like Meituan and Eleme. This design balances the detailed environments of 3D and the simplicity of 2D graphics, resulting in lower production costs and reduced complexity.

This game demonstrates the potential of interactive, real-time design to engage and influence consumer perceptions. This game reflects the potential of interactive, real-time design to engage and influence consumer perceptions. It fosters empathy for the situation of the takeaway rider by immersing the customer in the delivery context. Its main objectives were to enhance the connection between the target audience and the game, create a personalized game experience, and enhance the interactive model' s primary goal, which is to deepen the player' s emotional connection (see Figure 2).

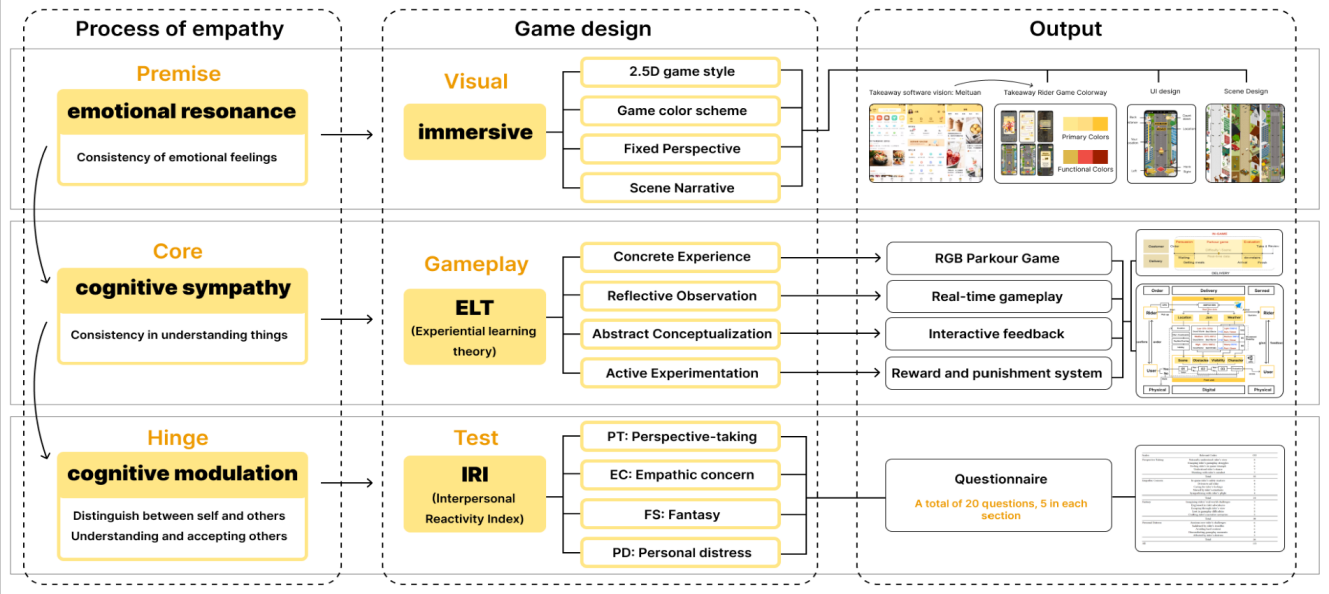

Figure 2. The Theoretical Framework for Empathy in Game Design.

3.1 Design Concept

Based on the four-stage model of ELT (Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation), we designed and built the framework for the game "Takeaway Rider." This framework provides players with opportunities for authentic experiences, self-reflection, and practical application to enhance their empathic abilities.

Firstly, the authenticity of concrete experience is crucial for effective engagement (Yardley et al., 2012). "Takeaway Rider" is positioned as a real-time role-playing game (RPG) to simulate concrete experiences within the game. Parkour games, which involve players controlling characters to perform running, jumping, rolling, and climbing actions to overcome obstacles, align well with the daily work of delivery riders (Gilchrist & Osborn, 2017). Players can immerse themselves in these workers' daily challenges by role-playing as delivery riders in a real-time, synchronized parkour game. The game is designed as a mobile mini-game integrated into takeout software, allowing customers to experience it during delivery. This stage provides rich sensory and emotional inputs that enhance the player' s sense of realism regarding the character' s situation.

Secondly, the game' s mechanics are designed to assist players in reflectively observing their behavior and decision-making. The interactive plot encourages a focused, empathic stance, prompting reflection on choices and behaviors, such as responding to customer requests and handling transportation issues and time pressures. A key mechanism is the real-time synchronization of game difficulty

with actual conditions like weather and road conditions, creating a sense of unpredictability and anxiety. Reflecting on their actions and feedback, players gain a deeper understanding of the work and emotional experiences of the riders.

Furthermore, the game helps players differentiate between self and role self-consciousness (Watt, 2007), transforming their concrete experiences and reflections into broader cognitive understandings. This abstract conceptualization process enables players to recognize commonalities between new and previous experiences and understand the reasons behind differences (Yardley et al., 2012). This includes recognizing professional bias and social injustice faced by delivery drivers. Post-game visuals and narratives can remind players to return to reality, and questionnaires can facilitate feedback and organization of their in-game experiences.

Finally, the game encourages continuous experimentation through rewards. An achievement system and convertible virtual currency motivate players to try new strategies and methods, optimizing their performance. This phase helps players consolidate their learning and apply it to various contexts.

3.2 Prototype

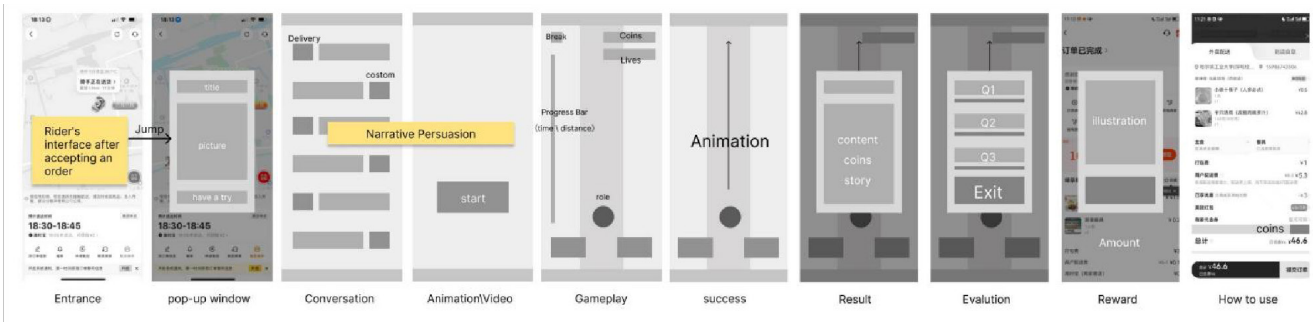

Figure 3. Real-time interactive game “Takeaway Rider” interaction prototype design.

We prototyped the game based on the real takeaway process from the previous interviews. The prototype of the delivery rider game was designed to test the effectiveness of the parkour mechanism and the empathy plot, ensuring that players could genuinely experience the daily work and emotional challenges of a delivery rider. We established the game’ s interaction flow and functional design through several discussions and iterations from start to settlement and evaluation (see Figure 3).

Players enter the game from the takeaway order window, transitioning into the role through narrative persuasion. During the game, players control the character’ s movement with left

and right buttons, and the screen displays a progress bar, life value, and the number of gold coins. Collisions with obstacles incur penalties; for example, hitting a car may stun the player for 10 seconds, affecting delivery efficiency, while stepping on a banana peel may cause slipping, making control more difficult. Upon successful delivery, an animation shows the rider entering the neighborhood. The settlement session informs the player of their game performance (game level score, number of gold coins gained). It provides context about real events or statistics, such as takeaway riders being penalized for late deliveries or damaged meals. The final evaluation session assesses the player' s awareness and reflection on the takeaway rider' s experience and the empathic effect of the game through a question-and-answer format.

The interaction prototype enhances situational realism, promotes player reflection and cognitive deepening, and motivates players to keep trying new strategies and consolidate their learning through the reward mechanism. The preparation of narrative persuasion, obstacle design, and evaluation sessions in the early stages was crucial to ensure the game' s educational effect.

3.3 Visual Design

Emotional resonance is a prerequisite for players' willingness to empathize. The game enhances players' immersion through its visual design, scene, and interface to help them better connect with the object of empathy. The game adopts the 2.5D visual style, balancing real environments' detail and three-dimensional effects with reduced complexity and production costs. This style increases realism and immersion while maintaining accessibility and real-time information transfer speeds, especially in a 5G environment (Shen & Gopalan, 2022).

The yellow palette conveys a bright, positive, and friendly atmosphere, attracting players and maintaining an enjoyable gaming experience. This palette allows for smooth integration with the Meituan Takeaway mobile application. The red buttons of action contrast strongly against the yellow background, emphasizing their importance and helping players quickly identify and tap the buttons, thus improving operational efficiency. The interface and scene design maintain color consistency, enhancing the overall visual style. The contrast of different colors and layered design increases the sense of hierarchy and clarity of information.

The game uses a fixed perspective, allowing players to control the character' s left and right movements with one thumb, creating a forward motion as the scenes on both sides of the road move backward (see Figure 4a-a). Maintaining a stable speed helps players earn rewards and reduce shipping costs. Additionally, the game includes scenes and obstacles based on the visual elements of the actual delivery areas. Urban areas feature cafes, skyscrapers, and schools, with obstacles like garbage, pedestrians, and cars. Rural areas include pastures, forests, and wooden

houses, with animals posing challenges for delivery. The game is regularly updated with visual elements corresponding to festivals, honoring local cultures and enticing players to explore and continue engaging with the dynamic game environment, such as the themed map designed for Christmas (see Figure 4a-b).

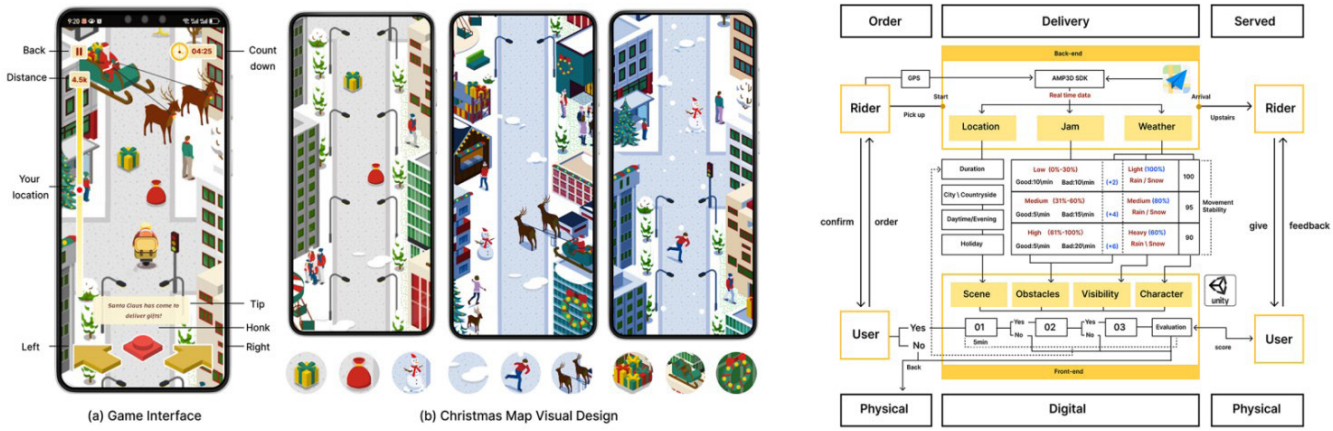

Figure 4. (a) Visual Design of Christmas in “Takeaway Rider”; (b) The Workflow of “Takeaway Rider”.

4. Technical Implementation

The mobile vertical screen game “Delivery Rider” is developed using Unity version 2022.3.16f1. The game’ s development encompasses several key modules, including player control, obstacle and coin generation algorithms, collision detection, UI design, sound effects, and animation processing. This game’ s technical challenge and innovation lie in transforming real-time data from actual delivery riders into obstacle and coin generation algorithms. This is the core mechanism that supports the game’ s empathy, as it integrates real-world elements into the gaming experience.

4.1 Framework And Mechanism

In the game, the narrative guidance and game mechanics enhance realism and tension, and optimizing reward systems heightens empathic engagement, impacting individuals’ attitudes and behaviours. To prevent leisure gameplay from prevailing, the game emphasized the goal of the game at the beginning. It provided details of the deliveryman’ s job to help players engage consciously and empathetically (see Figure 5b, c). Also, the game uses a wireless map mode in a parkour environment where the player needs to constantly analyse the effects of terrain, weather, and obstacles. Passing through intersections requires quick decision-making, obeying traffic signals, and adapting to adverse weather conditions to ensure the mission is completed within the allotted time. If a car accident occurs, the delivery

time will be delayed, affecting the final delivery score and rewards (see Figure 5h, j). It includes gold collection on the road, challenge completion, and end-of delivery rewards, fostering player enthusiasm through ingame currency exchangeable for delivery software coupons (see Figure 5g, i).



Figure 5. The Game of "Takeaway Rider" 1.0 by Unity, Allows Consumers to Empathize with the Delivery Riders' Difficulties.

And in-game interactions trigger guidance prompts, sharing takeaway riders' psychological experiences. For example, suppose a special static obstacle, such as snow, is encountered in bad weather. In that case, the system prompts players to hit the honk button quickly within ten seconds to ensure they don' t think the road is slippery and roll over while stepping on a normal obstacle. If a dynamic obstacle is encountered, the system will prompt the player to honk their horn to signal them to get out of the way, but a person or animal may pass quickly because players warn them. This is randomized and simultaneously simulates real traffic (see Figure 6a).



Figure 6. (a) Interaction Mechanism for Players Encountering Static/Dynamic Obstacles; (b) The Design of Scenarios and Obstacles for Different Regions and Time Periods.

4.2 Interactive Method

This game establishes rules by translating real-time weather and traffic data into the game using the AMAP30 SDK development interface (see Figure 4b). It integrates AMAP map data, extracting information to determine key game parameters like location, obstacle density, and weather visibility. The system maps real-world data to game metrics, confirming content based on delivery rider order details. It confirms map size for rider delivery time, determining timeslots, environment, and architectural style for a visually consistent representation (see Figure 6b). Game difficulty processing logic correlates congestion level with delivery speed

impact, influencing obstacle frequency, such as congestion levels (low: 0-30, moderate: 31-60, high: 61-100) define obstacle density (low: 10, moderate: 15, high: 20), while rain or lighter snow adds penalty obstacles like puddles or snowdrifts. The game classifies obstacles by severity. For example, low blockages are small obstacles, and high blockages introduce movement obstacles. Obstacle placement rules consider spacing, randomness, and road alignment. Weather conditions affect visibility; for instance, moderate rainfall reduces visibility to 80. The game uses a data structure to represent defined parameters, updating obstacles every two minutes for a 30-second smooth transition between configurations. Visual and audio feedback, including HUD elements and color changes, informs players of congestion level changes and obstacle difficulty.

Table 1. Main Themes and Relevant Codes, and Number of Code Occurrences(OC).

Scales	Relevant Codes	CO
Perspective Taking	Naturally understood rider' s view	8
	Grasping rider' s gameplay struggles	7
	Feeling rider' s in-game triumph	6
	Understood rider' s stance	7
	Thinking with rider' s mindset	7
	Total	35
Empathic Concern	In-game rider' s safety matters	6
	Driven to aid rider	4
	Caring for rider' s feelings	5
	Moved by rider' s emotions	5
	Sympathizing with rider' s plight	4
	Total	24
Fantasy	Imagining riders' real-world challenges	7
	Engrossed in rider adventures	7
	Escaping through rider' s view	6
	Lost in gameplay difficulties	5
	Crafting rider' s narrative scenarios	5
Personal Distress	Anxious over rider' s challenges	6
	Saddened by rider' s troubles	5
	Avoiding hard content	6
	Discomforting gameplay moments	4
	Affected by rider' s distress	5
	Total	26
All		115

5. User Feedback And Improvement

Building upon the Interpersonal Reactivity Index (IRI) principles (Davis et al., 1996b), this study implemented an empathic ability assessment after the gameplay. The IRI is the most widely and frequently used measure of empathy (Hall & Schwartz, 2019). At the same time, it is considered to be the most comprehensive measure of self-reported empathic tendencies. Moreover, the scale is relatively small and thus easy to collect and administer (De Corte et al., 2007). It encompassed four scales: perspective-taking (PT), empathic concern (EC), fantasy (FS), and personal distress (PD) (Bošnjaković & Radionov, 2018), to measure the broad spectrum of empathic responses with five targeted questions per scale (20 questions in total). Participants were required to respond to each item using a 5-point Likert scale, where a score of 1 signified "it does not describe me well," and a score of 5 represented "it describes me well." Higher average scores for each subscale indicate a stronger self-reported inclination toward the corresponding empathic trait.

Our study consisted of a pre-and post-game survey of 12 participants (see Appendix Table 1). They were college students between the ages of 18-25 (M=5, F=7), of which six participants rarely played games (once or twice a month), three participants played games regularly (two to three times a week), and three participants were heavy gamers (played almost everyday). Results showed that the PT and FS scales were significantly enhanced after gaming for the majority of participants, indicating significant increases in cognitive empathy and imaginative engagement. Eight participants reported an increase in their understanding of character dilemmas, especially the male participants. The six participants who rarely played the game and the one participant who played the game regularly affirmed that their ability to imagine similar dilemmas in real life had improved.

Conversely, the EC and PD scales did not demonstrate statistically significant shifts, implying stable affective empathic responses and consistent levels of personal distress in empathic situations. The scores for EC and PD remained relatively unchanged, suggesting that the gameplay did not significantly alter the participants' affective responses or levels of discomfort when confronted with others' distress. This was further exemplified by the fact that half of the participants could not grasp the full extent of the safety concerns faced by the characters, indicating a potential gap in the game' s ability to convey the emotional gravity of such situations. This indicates that while the players understood and could imagine the challenges faced by the characters, the game did not sufficiently personalize the characters' experiences to evoke a deeper emotional connection.

This led us to reflect on the importance of neglecting emotional empathy in the game design framework. Emotional empathy can

activate players' emotions and beliefs to motivate them to participate in the game narrative (Belman & Flanagan, 2010). So as a next step towards improvement, we will consider enhancing immersive experiences in virtual reality environments.

To investigate the enhancement of players' empathy in alleviating tensions between takeaway riders and consumers, we will develop the VR game "Takeaway Riders" 2.0. While 2.5D games exhibit high user acceptance and accessibility, their limitation lies in a lack of truly immersive experiences, hindering the target group' s deep emotional connections and empathy. Immersive virtual environments lead to more pronounced behavioral changes than mere observation (Yee & Bailenson, 2009). Recent advancements in immersive VR technology have created affordable 3D environments for enhanced role-playing exercises. Participants will be reinvited to participate in the VR game demo. We believe that the VR game will offer insights into the emotional experiences of actual delivery riders, significantly elevating participants' empathic caring (EC). This approach includes additional interactive devices to heighten their real-time perception of couriers' emotions in the physical world by engaging their other senses.

6. VR Application As Future Development

Technological advancements are pivotal in expanding the capabilities of VR, significantly enhancing its ability to cultivate empathy; this provides us with a new direction for enhancing our game. Better Hardware brings advancements in VR headsets, offering higher resolutions, improved field of view, reduced latency, and lighter designs. These improvements enhance user comfort and realism, making prolonged VR engagements more feasible and enjoyable.

Advanced Software capabilities provided by platforms like Unity and Unreal Engine continuously evolve to support more realistic physics and complex interactions. This evolution allows for the creation of more nuanced and emotionally engaging narratives. Haptic Feedback technologies provide tactile feedback that mimics real-world sensations, adding a layer of realism that enriches the immersive experience. Users can feel the texture of objects or the impact of their actions, deepening their connection to the virtual environment. AI Integration enhances the responsiveness of characters within VR, enabling them to react more naturally to user inputs. This improvement is crucial for fostering believable social interactions and enhancing empathetic connections. Increased Accessibility and Affordability of VR technology, as it becomes more widespread, reduces costs and expands access to a broader audience. This democratization of technology enhances the reach and impact of empathy-driven VR experiences, making them a powerful tool in fields that benefit from enhanced empathetic understanding.

Thus, the future development of our VR game "Takeaway Rider 2.0" aims for an advanced

immersive experience. We will employ the Meta Quest VR headset as the platform for our game by Unity. This version will provide us with a framework to test an immersive environment. When designing the control mechanics, we will utilize the XR Interaction Toolkit, a suite of tools available in Unity that simplifies the development of user interactions within VR environments. This toolkit will allow us to create intuitive and responsive controls that players can easily adapt to, enhancing the overall user experience. Additionally, we will focus on the aesthetic and functional aspects of the game' s environment by using Spline to smooth curves and complex shapes. With Spline, we will design the game' s assets, including the architecture of the virtual cityscape and the characters that players encounter within the game levels. This will enable us to construct a detailed and visually appealing world that supports the narrative and gameplay.

The following prototype of our VR game illustrates four challenging scenarios encountered by a takeaway rider, each crafted to enhance player empathy and engagement:

- **Driving to pick up points** Imagine the rider, helmet streaked with raindrops, as they navigate slippery streets to reach a pickup point. The sound of rain patters against the backdrop, and the visuals of blurred lights and wet asphalt immerse the player in the struggle against inclement weather.

- **Find an order** In a frantic rush against time, the rider must sift through a confusing flurry of orders. The table fills with multiple orders, each ticking down its timer. The player must quickly identify and select the correct order, feeling the pressure of potential penalties looming with each passing second.

- **Delivering orders** As the rider speeds through the city, they encounter a number of obstacles-each dodge and swerve is a test of the player' s reflexes and decision-making, simulating the real-life perils of urban delivery.

- **Making a call** Upon arrival at a customer' s house, the rider faces the unexpected challenge of an angry dog barking fiercely by the doorstep. The player must navigate this tense situation, figuring out how to calm the dog or safely alert the customer, adding a layer of unpredictability and urgency to the delivery experience.

Each prototype is designed to challenge the player and plunge them into the everyday realities of a takeaway rider, fostering a deep sense of empathy and understanding through vivid, immersive gameplay.

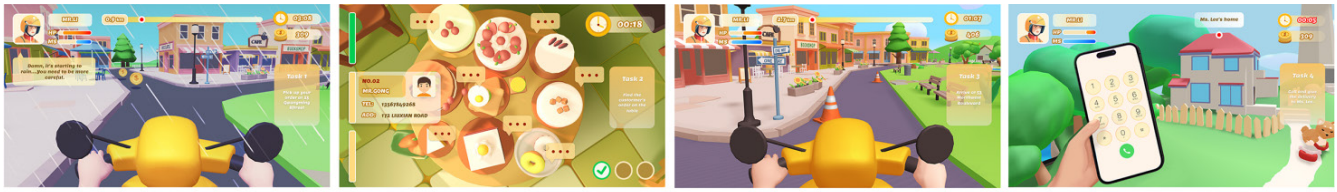

Figure 7. The VR Game of "Takeaway Rider 2.0", Four Main Sections of the Game Process.

7. Discussion And Limitation

This study examines "Takeaway Rider," a real-time interactive game that fosters team cohesion, accountability, and improved empathy. Plans include the development of interactive devices to enhance sensory experiences and real-time player-group interactions. Building on Alotaibi et al.' s electrotactile stimulation (2022) and Lu et al.' s chemotactile device (2021), multi-sensory tools will be employed for a richer empathic experience. Additionally, insights from Nacke et al. (2011) will guide the incorporation of biofeedback design to enhance real-time inter- actions between players and takeaway riders in the physical world, utilizing Arduino-based biosensors for heart rate and data synchronization in VR games. This approach aims to increase players' ability to interact with empathic groups during gameplay.

However, the study faces certain limitations that could affect the integrity and applicability of its findings. The primary concern is the limited sample size, which might introduce a bias based on individual subjectivity, potentially skewing the experimental outcomes. Moreover, the sustainability of the induced empathy effect remains unassessed, posing a question about the long-term impact of the game' s empathetic engagements. Addressing these issues, future efforts will focus on expanding the sample size to include a more diverse group of participants. This expansion will provide a more robust dataset for analysis, helping to mitigate individual biases. Additionally, continuous monitoring and follow-up studies will be implemented to assess the durability of the effects of empathy. By taking these steps, the project aims to ensure that "Takeaway Rider" fosters immediate empathetic responses and contributes to lasting empathetic development among its players, making it a valuable tool in enhancing social cohesion and interpersonal understanding in gaming communities and beyond.

8. Conclusion

Enhancing empathy within the “Takeaway Rider” game plays an important role in achieving the game’s overarching goals, including fostering team cohesion, improving accountability, and enriching the player’s overall immersive experience. Empathy will allow players to step into the shoes of others-specifically, the daily challenges faced by a takeaway rider-providing a profound understanding and connection to the characters and scenarios depicted in the game. Players who connect emotionally with the game’s narrative and characters are likely to find the game more compelling and engaging, which can lead to increased player retention and satisfaction. The emotional depth added by empathy makes the narrative more immersive and transformative, turning a simple gameplay experience into a powerful, resonant story that mirrors complex real-life emotions and situations. Beyond entertainment, “Takeaway Rider” is an educational tool that fosters essential life skills such as emotional intelligence and perspective-taking. These skills are beneficial beyond the game, improving real-life personal and professional relationships. Moreover, by exposing players to the life of a takeaway rider, the game enhances awareness about different lifestyles and the challenges within them, promoting greater social sensitivity and inclusivity.

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DIGITAL DROPLETS: SHAPING THE APPRECIATION EXPERIENCE OF “SPRING WATER” AT JINAN QUAN-SHUI CULTURAL HALL

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ABSTRACT | The rich tapestry of spring water culture in Jinan, with its roots deeply embedded in the local history, offers a unique cultural heritage that has been celebrated since the Tang and Song dynasties. Despite its profound historical significance, contemporary engagement with this heritage has often been superficial, lacking the depth and interactivity that modern audiences crave. This study introduces an innovative approach to cultural immersion through the Quan Shui Cultural Experience Hall, a pioneering initiative in Lixia District, Jinan. By integrating advanced technologies such as Augmented Reality (AR) and Virtual Reality (VR), this initiative aims to bridge the gap between traditional cultural appreciation and the expectations of a digitally attuned audience. This paper outlines the theoretical foundations of immersive cultural experiences, reviews current methodologies in cultural engagement, and proposes a new model that leverages technology to enhance visitor interaction and educational outcomes. Through a study of the Quan Shui Cultural Experience Hall, this research assesses the potential impacts of these technologies on visitor engagement, knowledge retention, and cultural preservation. Preliminary findings suggest that this approach increases visitors’ interest and understanding and facilitates a deeper connection with the cultural essence of Jinan’s spring waters. This study enhances the extensive scholarly dialogue concerning the preservation of cultural heritage, providing perspectives and theoretical models that may apply to analogous cultural contexts worldwide.

KEYWORDS | Cultural Experience, Mixed Reality Technology in Museums, AR and VR in Cultural Tourism, Cultural Experience Center Design, Digital Empowerment in Cultural Spaces

1. Introduction

Jinan, the capital city of Shandong Province, often referred to as "Spring City," is distinguished by its seventy-two artesian springs, which have been the lifeblood of the city throughout its history (Hu, 2020). These springs, including famous ones like Baotu Spring and Black Tiger Spring, are natural wonders and pivotal cultural symbols (Luo et al., 2020). Historically, they have been gathering places for the community, sources for daily water use, and inspirations for poets and artists. The well-known writer Lao She used to use "Baotuquan" as a setting in his writings to depict the serene and culturally rich life in Jinan (Laoshe, 2000). The culture surrounding these springs encompasses folklore, traditional practices, and a deep-rooted reverence for nature, which has been integral to Jinan's identity and development, such as the Lotus Art Festival, which provides new urban nighttime experiences. This unique cultural heritage, woven around the natural springs, positions Jinan distinctively on both historical and cultural tourism maps.

However, the current cultural engagement with Jinan's spring water predominantly relies on conventional methods, such as static museum exhibits and guided tours. These traditional formats are increasingly inadequate for capturing the attention of a generation accustomed to digital interactivity and immersive experiences. Further compounded by rapid urban development and technological progress (Chen et al., 2008), Jinan's springs' physical and cultural visibility has diminished, leading to a growing disconnect among younger residents and visitors. Therefore, there is need to adopt more dynamic and engaging methods that resonate with contemporary audiences. Innovatively integrating technology to revitalize and preserve this rich cultural heritage while also educating, engaging, and entertaining effectively is crucial. Such an approach is critical to re-establishing a connection with the historical and ecological importance of the springs, ensuring the continuation and prosperity of Jinan's cultural legacy within a contemporary framework.

This study aims to develop a new framework for cultural engagement that harnesses modern technology to provide immersive and interactive experiences centered around Jinan's spring water culture (Lin et al., 2020).

- Enhance educational value by integrating interactive technologies that provide users with hands-on learning experiences about the ecological and historical significance of the springs in the physical museum space (Jakobsson & Davidsson, 2012).
- Revitalize interest in spring water culture by offering augmented reality (AR) tours, virtual reality (VR) experiences (Kamel & Elshiwy, 2022), and interactive digital exhibits that allow deeper exploration of historical and cultural narratives.

2. Related Works

This section provides a comprehensive overview of the methodologies and technological advancements implemented globally in cultural heritage preservation and engagement. It explores how modern technology is being harnessed to enhance and revitalize these experiences and emphasizes the role of water as a central theme in cultural expressions across various regions.

2.1 Global Perspective

We initiate our design from a global perspective, focusing on how cultural projects around the world have successfully integrated novel technologies to enhance visitor engagement and understanding (see Fgure 1). This approach allows us to draw upon a rich array of international examples and best practices, ensuring that our installations are locally relevant and globally competitive (see Table 1).

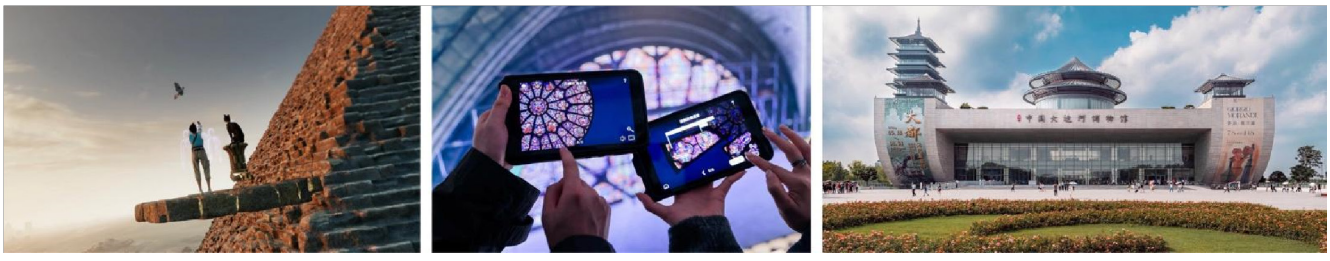

Figure 1. The Related Works of Horizon of Khufu, Notre-Dame de Paris and China Grand Canal Museum.

1 Horizon of khufu: https://immersive-expeditions.io/en/horizon-of-khufu/

Horizon of Khufu

The "Horizon of Khufu[1] (2024)" initiative by Excurio Productions epitomizes the convergence of technology and cultural heritage. Utilizing Virtual Reality (VR), this project revolutionizes the appreciation experiences of participants by transporting them to the era of ancient Egypt, facilitating an immersive exploration of the Giza Plateau. This technological approach allows for a vivid educational experience transcending traditional learning methods, making inaccessible historical sites reachable and engaging for a global audience. This project allows participants to explore areas of the Giza Necropolis that are typically inaccessible to the public. The journey begins at sunrise over the Giza Plateau. It sets a dramatic backdrop with the three Great Pyramids and their surrounding mastabas, which are tombs of the monarchs' families and inner circles. Transformed into virtual avatars, participants navigate this ancient landscape, eventually reaching the majestic Sphinx and proceeding to a unique nighttime exploration of the Pyramid of Giza.

Despite its benefits, the project also highlights limitations, such as the potential for technological disparities that could restrict access to such experiences for underprivileged populations or regions with less technological infrastructure. Additionally, the need for continuous updates and maintenance of digital content to reflect the latest archaeological findings can pose challenges. Nevertheless, this initiative inspires future projects by demonstrating how technology can preserve and animate cultural heritage in captivating and accessible ways, potentially transforming education and increasing cultural appreciation worldwide.

Augmented Exhibitions of Notre-Dame de Paris

The use of AR in exhibitions like "Notre-Dame de Paris: The Augmented Exhibition[2]" represents a transformative approach to cultural preservation and visitor engagement (Allal-Chérif, 2022). By integrating AR devices such as the Histopad, historical sites, and their stories are vividly brought to life through immersive reconstructions and interactive displays, allowing visitors to deeply engage with historical events and architectural nuances. For instance, visitors at the Shanghai exhibition could scan "Time Portals" to witness events like the spire's collapse and the cathedral's subsequent structural damage. This technique not only showcased the capabilities of the Histopad but also emphasized the fire's emotional and cultural impact on Parisians and the global community. The exhibition also detailed the restoration process, including using 2,000 solid oak trees for the new frame, underscoring a harmonious blend of historical preservation and modern engineering.

2 Experience Notre-Dame de Paris in a visual way : https://www.shine.cn/feature/art-culture/2212083791/
3The China Grand Canel Museum: https://canalmuseum.net/English.html

However, this technology-driven approach has its drawbacks, primarily its dependency on digital devices, which may lessen the authenticity of directly experiencing a heritage site. Despite these limitations, the successful fusion of AR and heritage preservation serves as a compelling inspiration, demonstrating how modern technology can enrich our understanding and appreciation of cultural landmarks, stimulate broader public interest, and ensure that the stories and significance of historic sites are conveyed to future generations in innovative and impactful ways.

The China Grand Canal Museum

The China Grand Canal Museum[3], led by Academician Zhang Jinqiu from the Chinese Academy of Engineering, showcases the fusion of technology and cultural heritage through its innovative design and implementation. The Nanjing Museum oversees planning and operations, while the Xenario Company manages the integrated construction. The project employs immersive techniques such as 360° projections, real-time rendering, and interactive AR to vividly bring the historical narrative of the Grand Canal to life in a contemporary and engaging format.

The museum employs omnidirectional projections and real-time rendering to create an immersive interactive theater experience, enveloping visitors in the history and culture of the Grand Canal from all angles. This experience is augmented by live-action games and interactive puzzle-solving elements that enhance visitor engagement and make learning both educational and entertaining. Additionally, AR displays animate scenes of boats on the canal, offering insights into the structural design of ancient vessels and highlighting the craftsmanship of ancient Chinese shipbuilding. The environment within the museum is designed to make visitors feel as though they are aboard a traditional boat, surrounded by scenes of ancient life and traditional performances, with interactive features that further draw visitors into the content.

Using VR, AR, and other immersive technologies in cultural heritage exhibitions represents a promising frontier that can transform educational experiences and increase accessibility (Buonincontri & Marasco, 2017). These projects highlight both the potential and the challenges of integrating modern technology into the preservation and appreciation of cultural heritage, providing us valuable insights for project development.

Table 1. The Comparison of Technological Integration in Cultural Heritage Exhibition Spaces.

Project	Horizon of Khufu	Augmented Exhibition of Notre-Dame de Paris	China Grand Canal Museum
Technology Used	Virtual Reality (VR)	Augmented Reality (AR) using Histopad	360° projections, real-time rendering, Interactive AR
Educational Value	Offers an immersive exploration of the Giza Plateau, enhancing learning about ancient Egyptian structures.	Uses interactive AR to allow users to experience historical events and the restoration of Notre-Dame de Paris.	Provides an engaging way to learn about the history and culture of the Grand Canal through immersive and interactive experiences.
Accessibility	Makes inaccessible historical sites reachable globally.	Requires digital devices which may limit access for some visitors.	High-tech installations that can be both physically and geographically accessible depending on the availability of the necessary technology.
Pros	Dynamic learning tool Global accessibility	Enhances user engagement with interactive elements Detailed insights into restoration processes	Multisensory engagement Immersive cultural experience
Cons	Requires advanced technology Needs continuous updates	Potentially less authentic experience Dependent on specific digital devices	Requires ongoing maintenance and updates Resource-intensive
Impact on Cultural Appreciation	Enhances appreciation through vivid educational experiences.	Stimulates interest and educates about historical preservation and modern engineering.	Increases understanding and appreciation of historical contexts and cultural impacts.

2.2 Water Related Projects

We also explored water-related projects as water is important for human beings (Everard & Moggridge, 2012), particularly within domestic museums (see Figure 2); we have observed a diverse application of traditional and modern methods to spread awareness and knowledge about water-related topics. This dual approach ensures that our exhibition educates and connects with visitors on multiple levels, bridging historical contexts with contemporary issues.



Figure 2. The Related Works of The Yellow River Museum, The National Water Museum, and The Chongqing Baiheliang Underwater Museum.

The Yellow River Museum

The Yellow River Museum[4] in Zhengzhou, China, established in 1955, is the first river-themed museum in the country, focusing on the natural evolution, socio-cultural development, and management of the Yellow River. It serves as a modern museum that collects and preserves cultural relics and educates and enlightens the public. The museum adopts traditional exhibition methods, including pictorial and text introductions and historical artifacts, to help visitors understand the Yellow River. Additionally, it collects and exhibits Yellow River-themed calligraphy and traditional Chinese paintings. A distinctive interactive element of the museum is the provision of Yellow River clay, enabling participants to engage directly in the design and creation of pottery. This hands-on approach offers a profound experiential insight into the Yellow River culture, facilitating a deeper understanding and appreciation through active participation.

The National Water Museum

The National Water Museum of China[5] guided by the Ministry of Water Resources and managed jointly with the Zhejiang Provincial Government, is a unique national museum in Hangzhou. Unlike traditional museum structures, the main building is designed in the shape of a pagoda, which not only serves the purpose of storing artifacts but also symbolizes the historical challenges of water management through its form. This design integrates ancient architectural styles with modern materials and advanced technology. The museum features extensive immersive environments and displays related to ancient hydraulic architecture and tools, effectively merging space, history, and knowledge. It also houses a specialized Zhejiang Water Management exhibit, utilizing advanced multimedia and remote connectivity to innovate its displays, directly linking to a water management database to access relevant regional data, transcending traditional exhibition limitations, and pioneering integrating water culture exhibits with modern technology. Despite some areas retaining conventional exhibition methods, such as introductory text and image presentations, the museum's innovative approach serves as a valuable reference for the development of cultural exhibits focused on water themes.

4 The Yellow River Museum: https://www.watermuseums.net/network/yellow-river-museum
5 National Water Museum of China: https://www.watermuseums.net/network/national-water-museum-of-china
6 The Chongqing Baiheliang Underwater Museum: https://www.watermuseums.net/network/chongqing-baiheliang-underwatermuseum

The Chongqing Baiheliang Underwater Museum

The Chongqing Baiheliang Underwater Museum[6], recognized as the world's first museum of its kind, embodies a unique architectural and conservation approach through its underwater structure and the use of a non-pressure container. The museum's design features an innovative non-pressure container that isolates the relics from the Yangtze River using a reinforced concrete cover. This cover is filled with filtered river water to maintain hydrostatic balance and prevent long-term erosion of the relics by the river. Inside the cover, a visitor corridor constructed with pressure-resistant metal and 23 glass observation windows allow close-up views of the Baiheliang inscriptions. The museum also includes an advanced air monitoring system with sensors for temperature, humidity, and CO2 levels, enhancing the air quality for both the displays on the surface and the underwater visiting area. This pioneering museum protects significant historical inscriptions and serves as an inspiring model for integrating cultural heritage with modern technology in water-related projects.

We identified these common paradigms and limitations by comparatively analyzing existing cultural experience centers across China (see Table 2). These projects and museums advocate for a departure from traditional museum formats, which rely heavily on static displays and textual information, towards a more dynamic and interactive approach. The research inspired us to develop our project further.

Table 2. The Comparison of Water-themed Museums in China.

Criterion	Yellow River Museum	National Water Museum of China	Chongqing Baiheliang Underwater Museum
Architectural Design	Traditional building design	Pagoda-style building symbolizing water management challenges	Innovative underwater structure using non-pressure container
Exhibition Methods	Traditional methods (pictorial, text, artifacts), interactive clay pottery workshop	Immersive environments, multimedia displays, connection to water management database, traditional methods in some areas	Underwater viewing corridor with glass observation windows, advanced air monitoring system
Technological Integration	Low; mainly hands-on pottery experience	High; multimedia and remote database connectivity	High; uses technology to create a controlled environment for underwater relics
Focus of Exhibits	Natural evolution, socio-cultural development, and management of the Yellow River	Ancient and modern water management, water-saving technologies	Historical inscriptions and underwater cultural preservation
Unique Features	Hands-on experience with Yellow River clay	Pagoda structure, integration of traditional and modern exhibition techniques	World's first underwater museum, hydrostatic balance technique to protect relics
Limitations	Relies on traditional exhibition methods which might not engage a modern tech-savvy audience	Some areas still use conventional exhibition methods despite innovative efforts	Accessibility might be limited due to the unique structure; maintaining the technology-intensive environment might be challenging and costly

3. Project Description

Our project of Jinan Quan Shui Cultural Hall is designed to elevate and reinterpret Jinan's rich and distinctive spring water culture, blending traditional cultural experiences with digital technology. This design project aims to revolutionize the way spring water culture is presented and appreciated by integrating it into the fabric of local life and showcasing it through advanced digital interfaces. We aim to create an immersive cultural experience that educates visitors about Jinan's unique springwater heritage and engages them through innovative interactions and digital visualizations of the dynamic springwater landscapes. It has the following features:

Cultural Integration:
The hall will highlight how Quan Shui (spring water) is intertwined with the daily lives of Jinan's residents, presenting historical and contemporary uses and the cultural significance of the springs (Stevens et al., 2021). Artifacts, photographs, and narratives will depict the evolution of spring water utilization in local customs, crafts, and community practices.

Interactive Experience:
The project will offer digital visualizations that include AR and VR immersive environments (Harrington et al., 2021) where visitors can explore environmental impacts and understand the hydrological cycle specific to Jinan.

Cultural Impact:
By merging traditional cultural insights with modern technology, the Jinan Quan Shui Cultural Hall will serve as a beacon of cultural preservation and innovation. It will attract visitors from around the world and serve as an educational platform for the local community, enhancing their appreciation and understanding of their natural heritage (Selkani, 2023).

4. Design Process

Our design process integrates a blend of traditional methods and modern technology, centered on the theme of Jinan's spring water. We start with a foundation built on strong design concepts and principles that emphasize immersiveness, educational enrichment, and cultural preservation. Traditional design methods guide our material and aesthetic choices, ensuring authenticity and a deep respect for cultural heritage. In Hall 1 and Hall 2, we harness advanced AR and VR technologies to create dynamic, interactive experiences. At the same time, the exhibition's design is carefully crafted around a color scheme inspired by the clear, refreshing hues of spring water, promoting a serene and engaging environment.

4.1 Design Concept and Principle

The Quan Shui Cultural Experience Hall is specially designed to reflect Jinan's unique spring water culture and urban vibrancy, often referred to as Quan Cheng (City of Springs).

The project leverages innovative design strategies that integrate advanced design techniques with traditional cultural symbols and regional characteristics. The goal is to provide a more tangible and interactive form of expression that introduces new forms, new technologies, and new experiential emotions to Jinan's renowned spring water culture.

The design principles of the Quan Shui Cultural Experience Hall masterfully integrate Jinan's historic spring water culture with modern technological advancements, creating a seamless blend of tradition and innovation. We combine traditional cultural motifs and elements from Jinan's ancient architecture with contemporary materials and digital interfaces, bridging the gap between past and present. State-of-the-art immersive technologies such as AR, VR, and interactive multimedia installations are employed to enhance emotional and educational experiences, deepening visitors' connections to the spring water narrative. These technologies and meticulous spatial designs make the cultural content vivid and engaging, offering an immersive glimpse into the life surrounding Jinan's springs. Interactive elements encourage active participation in the cultural narrative, transforming visitors from passive observers into engaged contributors, thereby enriching the collective understanding of the culture. Additionally, the project introduces innovative interpretations and recreations of traditional elements, using modern design techniques to dynamically present Jinan's spring water culture in ways that resonate with both contemporary audiences and traditional values.

4.2 Design of the Cultural Hall

Our design of the museum is planned to be a large, three-story structure, with the design focus primarily on Halls 1 and 2 as exemplary cases. These two halls are crafted to showcase the breadth and depth of the museum's offerings, each occupying a distinct level and embodying a unique thematic and technological approach to the exhibition of Jinan's rich spring water culture. This structuring optimizes space within the expansive museum and allows for a coherent, immersive journey through the cultural and historical narratives that define Jinan.

Hall 1: Historical Culture Exhibition Hall (First Floor)

The museum's first floor is designed as the Historical Culture Exhibition Hall (see Figure 3). This hall is dedicated to educating visitors about the spring water culture, offering a traditional exhibition style that provides ample time and space for a deeper understanding. The main hall collects historical photographs and artifacts from Jinan to give visitors an introductory understanding of the city. A cultural display wall is strategically placed within the hall, arranged chronologically to depict Jinan's history through a combination of text and imagery. This traditional setting is similar to many cultural museums and is designed to facilitate knowledge dissemination and enhance visitors' comprehension of local culture.

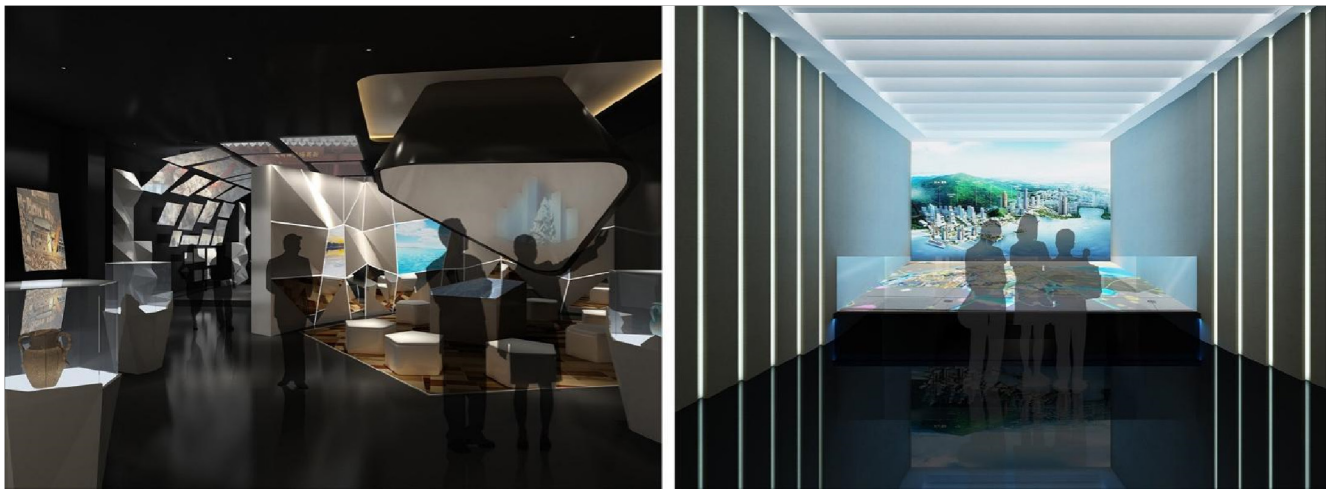

Figure 3. The Design of Hall 1.

Hall 2: Immersive Experience Exhibition Hall (Second Floor)

The second floor hosts the Immersive Experience Exhibition Hall, which features two distinct immersive works utilizing VR and AR technologies:

VR Installation:

The centerpiece of this installation is a virtual spherical screen surrounded by interactive displays designed to create an immersive, dynamic visual experience that captivates the senses (see Figure 4). Visitors are equipped with state-of-the-art VR headsets, such as the Apple Vision Pro, to explore global water resources uniquely engagingly. This VR experience presents the Earth in a stunning 360-degree panorama, providing viewers with an encompassing view of the world's water distribution, including both surface freshwater sources and hidden underground springs.



Figure 4. The Display of VR in Hall 2.

As part of the VR journey, the historical development of these water sources is explored in depth. Visitors can witness the geological processes that have shaped these springs over hundreds or even thousands of years, displayed through rapid visual presentations that combine high-definition graphics and interactive timelines. This installation educates and allows visitors to experience the sensation of traveling through time and space to understand the evolution and importance of water resources on our planet.

AR Interactive Exhibit:

Adjacent to the VR installation, the AR Interactive Exhibit offers a different but complementary experience (see Figure 5). This part of the hall features a large, interactive platform outfitted with multiple digital screens arranged along a historical timeline. These displays invite visitors to engage directly with the exhibit by tapping on specific time nodes. Each tap reveals detailed narratives about old Jinan's historical context, cultural significance, and the daily life surrounding its renowned springs.



Figure 5. The Display of AR in Hall 2.

Visitors can utilize a specialized app or an iPad to activate the exhibit's AR features. Scanning images on the displays triggers real-time videos and 3D animations of Jinan's springs, virtually transporting visitors to each location. This AR experience enhances the viewers' understanding of Jinan's unique water culture. It bridges historical data with modern technology, allowing a deeper appreciation of how Jinan's culture has evolved around its water sources.

These two halls within the museum preserved the rich history of Jinan's spring water culture and used modern technology to create a more engaging and interactive visitor experience. The VR and AR installations form a comprehensive and interactive exploration of water cultures, both globally and locally. By integrating advanced digital technologies with educational content, the exhibits aim to transform how cultural heritage is experienced, making it more accessible, engaging, and informative for visitors of all ages. The design integrates educational content with interactive technology to create a dynamic environment that caters to both historical enthusiasts and tech-savvy visitors.

4.3 Exhibition Design

The Spring Water Cultural Hall adopts a color palette that mirrors the natural hues of its theme, predominantly using shades of blue and white, such as 0AAFF1, 72A2C0, F2EAED, 80ADD7, F1F3F2 and C2D3DA (see Figure 6). These colors were chosen to evoke the clarity and purity of water, aiming to create an atmosphere of tranquility and freshness that enhances the thematic focus on spring water within the museum.



Figure 6. The Selected Colors.

The original layout intended to replicate the spread of Jinan's 72 springs but was revised to focus on the city's old streets and alleyways for richer content and practical implementation. This design approach allows visitors to traverse a path that mimics walking through Jinan's historic streets, providing an immersive experience that highlights the cultural and historical context of the area (see Figure 7). The first hall's design is inspired by Jinan's renowned Black Tiger Spring, featuring curved LED screens and winding paths alongside water flow simulations. This setup is crafted to give visitors a lifelike experience of Jinan's environment, making it feel as though they are exploring the city itself, complete with the sights and sounds of its bustling streets and flowing springs. And the wall panels are strategically designed to narrate Jinan's historical stories, display scholarly references about the springs, and showcase distinctive photographs of the local water sites. The background of these panels uses irregular white surfaces to symbolize the fluid movement of water, aiming to visually convey the dynamic and ephemeral nature of Jinan's spring waters and enhance the visitor's sensory experience of the exhibition.

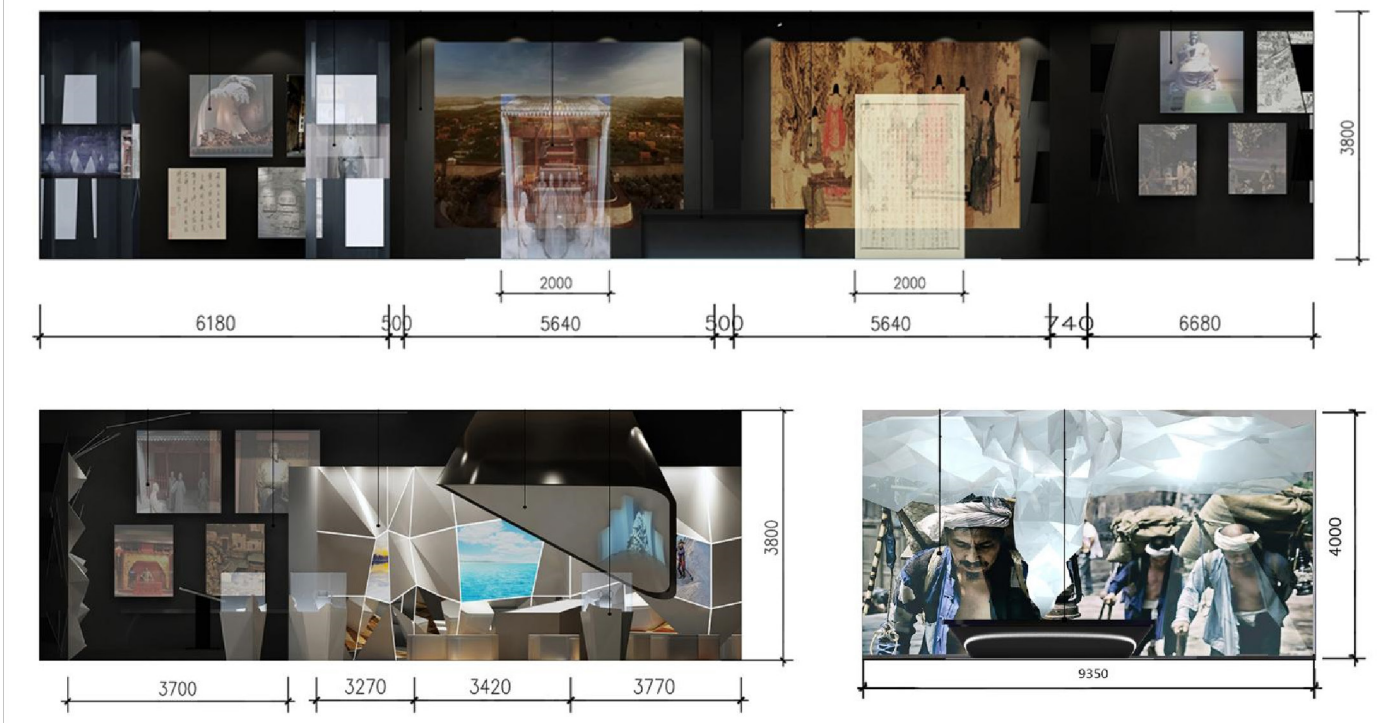

Figure 7. The Exhibition Display.

5. Limitation and Further Development

The current design of the Spring Water Cultural Hall, while innovative, encounters certain limitations, primarily in the scope of interactivity and the depth of narrative delivery. Despite their technological enhancements, the first two exhibition halls have confined the visitor experience to visual and minor interactive elements. These limitations may hinder the depth of engagement and comprehension among visitors with varying interests and technological comfort levels.

Integration of Film and Digital Media in the Third Hall

A third exhibition hall will be proposed (see Figure 8), focusing on the use of film and digital media to advance cultural dissemination. This hall would utilize cinematic presentations to tell the stories of Jinan's springs, combining historical footage, reenactments, and digital storytelling to create a multi-layered narrative experience (Liu & Lan, 2021). This method can help bridge the gap between traditional cultural transmission and modern media consumption, offering visitors a more dynamic and engaging way to interact with the content (Nie et al., 2023).



Figure 8. The Hall 3.

Technological Enhancements in VR and AR

On the technological front, significant enhancements are planned to elevate the interactivity within the exhibition spaces. VR setups will be upgraded using Unity software for high-fidelity modeling, with testing conducted on Apple Vision hardware to ensure a seamless and realistic user experience. This will allow for a more immersive portrayal of Jinan's spring environments that visitors can explore virtually.

Further, AR components will be advanced through the implementation of motion capture technology. This will enable the system to detect and respond to visitor movements, adjusting the visual effects of the spring water accordingly. Such responsive AR experiences will enhance visitor interaction and deepen the educational impact by dynamically demonstrating Jinan's spring waters' natural properties and cultural significance, thereby providing a truly interactive and personalized museum experience.

6. Discussion and Conclusion

Digital technologies, particularly AR and VR, have revolutionized the way cultural heritages are preserved and experienced (Barbara, 2022; Xu et al., 2024). As demonstrated by the Quan Shui Cultural Experience Hall in Jinan, these technologies enhance the visitor experience and serve as vital tools in the education and preservation of cultural heritage. Integrating AR and VR into the Quan Shui Cultural Hall has proven to bridge the gap between traditional cultural appreciation and the expectations of today's digitally attuned audiences, ensuring that the cultural essence of Jinan's spring waters is preserved and revitalized.

The findings from this study underscore the importance of interactive technologies in engaging modern audiences. Immersive technologies have facilitated deeper connections with the heritage and ensured that these traditions are passed down to future generations in an engaging manner (Mendoza et al., 2023). Furthermore, the case studies of similar projects around the world, such as the Horizon of Khufu and the augmented exhibitions of Notre-Dame de Paris, provide compelling evidence of the global applicability of these technologies in cultural heritage conservation. These projects highlight the potential of digital media to make cultural and historical education more accessible, engaging, and comprehensive. However, challenges such as technological disparities and the need for continuous content updates and maintenance also need to be addressed to fully realize the potential of these technologies.

In conclusion, the application of AR and VR in cultural heritage sites represents a series of narrative shift towards a more interactive and engaging form of cultural preservation. The Quan Shui Cultural Experience Hall's success is a testament to this approach's effectiveness, providing a framework that can be adapted and implemented in other cultural contexts. This study contributes to the broader discourse on cultural heritage preservation, offering insights and practical frameworks that can enhance visitor interaction and educational outcomes across the globe. As we continue to advance technologically, it is imperative that we remain mindful of our cultural roots and harness these innovations to ensure they are preserved for future generations in a manner that is both educational and engaging.

Finally, it is worth to initiate a discourse on the sensory aesthetics of VR and AR in relation to real-world visual experiences in future scholarly dialogues. This exploration will involve a thorough investigation into perceptual nuances, facilitating the utilization of data-driven environments to establish spatial narrative contexts. The findings from such research are poised to significantly contribute to the advancement of innovative curatorial practices within museums and gallery spaces.

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CARE OF NEW KNOWLEDGES — EDUCENE.

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ISIA Roma Design

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ABSTRACT | **Care of New Knowledges – Educene.**

Education I.e. the idea of ducere, in the sense of guiding and therefore of e-, which indicates a movement towards the outside, in the sense of "bringing out, extracting", Instruction, I.e. derives from in and strùere (to stack, erect), is construction, formation of the person, as clearly appears in the German 'bildung'. Knowledges, I.e. Sanskrit noo as kwnon and Greek gnoos as intellect.

It is the era of change, among the twenties of the twenty-first century we stay with a trouble in the Anthropocene and the Chthulucene. We are all in the time of the right choice at the right moment (the greek-christian time of kairos) which is why the care of new knowledge becomes necessary. Knowledges is not fixed anymore is more related to the ability to speculate. We are obliged to deconstruct imaginaries. We must abandon the rear-view mirror syndrome and analyze the present-future with the artist's posture.

Speculative design returns, heir to the Italian Radical Design. Speculative narratives retrieves the science-fiction so it's a fiction-theory and narrative. We must see if the future will be utopic, distopic, or ucronic.

We are in Spaceship Earth facing new imaginaries. We all are turning into maintainers of a cosmic wreck, planetary engineers. Design is facing the challenge of new imaginaries.

At the center resides the teacher-student dyad, the teacher understood as the 'guardians of the ruins' and the youngsters students as 'the creators of new narratives'. The creation of these two rhetorical figures allows the triggering of a speculative dynamic (mirror) that produces analysis of the present.

The artistic side of design fight back, because It is necessary assume a mind-divergent posture to deconstruct scenarios in search of submerged futures and with the aim to produce new nonnewtonian cartographies.

The Care of New Knowledges aims to think a connection between the artificial and the natural. It is inspired by the work of the keen international artist Michelangelo Pistoletto with his “Formula della creazione”, based on art-sign Trinamics, towards a multidisciplinary approach to the future. It is a new pedagogical model of design resulting from, as chair of Sociology of Change, designing new courses at the Intituto Superiore Industrie Artistiche -ISIA Roma Design in Rome/Pordenone, from personal research developed among the years as founder director of the Scuola di Nuove Tecnologie dell’Arte alla Nuova Accademia di Belle Arti di Milano, NABA, from expereinces with the English educator Roy Ascott and and today with the artist Michelangelo Pistoletto and his academy of art & design.

For the sake of designing Habitus, Politics, Meetings, Architecture, Theatre, Art, Information, Music, Science, Design, Religion, Market, Economy, Literature, Food, Philosophy (Progetto arte, M. Pistoletto, 1995-96)

KEYWORDS | ART & DESIGN, THIRD PARADISE DESIGN, TRINAMIC, DYAD TEACHER-STUDENT, SPECULATIVE DESIGN, NEW IMAGINERIES, NARRATIVE EDUCATION.

Care of new knowledges — Educene

0- proem — prooemium

Education, from latin *ducere*, in the sense of leading and hence e-, which indicates a movement outwards, in the sense of 'to bring out, to extract'; hence Istruction, which derives from latin *in* and *strùere* (to stack, to erect), is construction, the formation of the person, as appears clearly in the german 'bildung'. All for Knowledge, i.e. Sanskrit *noo* as kwnon and Greek *gnoos* as intellect.

In Italy, Academies of Fine Arts are organised in similar way to universities and award equivalent degrees. The curriculum is divided into a first three-year cycle - BA - which is followed by a two-year master's degree - MA - and a third research cycle - PhD - (which can also be carried out in association with other institutes). In Italy there is also the ISIA Istituto Superiore per le Industrie Artistiche - Higher Institutes for Artistic Industries- which were born like the Academies of Fine Arts, but with a vocation towards Design and contemporary research. In fact, they represent the first and original schools of Italian Design and have authority to activate chair on call.

My work in the first decade of the 2000s at the New Academy of Fine Arts in Milan, NABA, was foundational (among other italian academies) for the establishment by the Italian Ministry of Universities of the Academic Degree Class in 'New Technologies of Art'.[1] It was an important training ground for the elaboration of art and design education and research. Ideas, theories and practices of contemporary Italian art & design education were derived from this experience.

In 2005, a doctoral programme in Art & Media was introduced. It was, in fact, transdisciplinary, replicating the model developed by cybernetic artist, curator

[1] This foundation was part of the establishment by the Italian Ministry of University and Research, MUR, of the Class DAPL08- School of New Technologies of Art, the NABA School of New Technologies of Art was founded and directed by me from 2001 to 2013.

and educator Roy Ascott. This was first implemented at the University of Whales under the name CAiiA - STAR and subsequently at Plymouth University known under the name Planetary Collegium.[2]

The PhD M-Node Planetary Collegium Programme was established in Milan at NABA.[3] In fact, the offer was expanded both quantitatively, i.e. by endowing the School with the complete cycle of study, i.e. BA, MA and PhD, and qualitatively in a circular scheme in which doctoral research fell on teaching at BA and MA level, thus emphasising the frontier role of Art and Design transforming the School into a very sensitive apparatus for education and research in the global 21st century.

The design of the full-cycle Art & Design academic courses was a practice field of research and experimentation on a new pedagogy, a design that continued in 2013 when I move to collaborate on the design of the School of New Technologies of Art at the Accademia Costume e Moda di Roma[4], which materialised in 2018. (In addition to these activities of design and teaching, academic direction and research, there are a whole series of academic experiences in doctoral and various schools to which I refer elsewhere as they are not included in this essay). Then the Chair in Sociology of Media at the Istituto Superiore per le industrie artistiche ISIA Roma Design, Pordenone branch - later doubled by the Chair in Sociology of Change at the Rome branch - and the design of the Academy Unidee of Fine Arts, an academy that is an expression of the international contemporary artist Michelangelo Pistoletto.

These experiences have been a training ground for research into the forms of the new education for the 21st century. This care of new knowledges deals with a new pedagogical model of design as a result of teaching and of the design of new courses at ISIA Roma Design in Rome/Pordenone, and from the research carried out over the years mainly of the School of New Art Technologies at NABA in Milan, and from the experiences, at PhD level, with the English educator Roy Ascott and today with the artist Michelangelo Pistoletto and his Academy Unidee of Art and Design.

To design Habitus, Politics, Meetings, Architecture, Theatre, Art, Information, Music, Science, Design, Religion, Market, Economy, Literature, Food, Philosophy (Progetto arte, M. Pistoletto, 1995-96)

[2] This doctoral programme, labelled M-Node (in Milan) and then T-Node (in Trent), ran from 2005 to 2018, doctoring over 15 researchers including artists, designers, sociologists, musicians and even anthropologists. It was characterised by a more theoretical dimension than the original model; this specificity was due to the continental tradition of the Italian academy, which differed from the english pragmatic tradition.

[3] My PhD thesis was a thesis in education for the 21st century, the supervisor was the Director of the Planetary Collegium Prof. Roy Ascott himself. The thesis titled *Outline of a Subversive Technopoetic: for a Libertarian Pedartgogy*, was the subject of a mention by Leonardo Isast MIT in 2013, Top-Rated LABS Abstracts – https://direct.mit.edu/leon/issue/49/5.

[4] Again Class DAPL08- School of New Art Technologies, MUR, Italy.

I — when - quoniam

The 20st century are over and a quarter of the 21st century has ended, is this the century of **the end of the modern**?

The modern was born with the mechanical reproduction of the book in the mid-15th century. This invention allowed the conditions for the establishment of calculating thought and the industrial revolutions to appear. (1) With the first industrial revolution mercantilism related to production was born, the consequence of which was the exploitation of resources within a neoMalthusian environmentalist vision: the more people are born the more they consume the more there is waste. (2) With the second, the exploitation of the planet's resources increased exponentially and a global, ubiquitous world characterised by a planetary market was generated. (3) Then it was atomic energy, astronautics and information technology that characterised the third revolution. (4) With the fourth revolution, we enter the 21st century under the hallmark of autonomous systems and artificial intelligence (Schwab, 2016).

We are in the midst of the **Anthropocene**, an era in which the environment becomes transfigured by the accelerated effects of progress. And we are in the Capitalocene, which is a useful reference to say that 'anthropocene' is a theme that obscures rather than clarifies the understanding of socio-ecological changes. It represents the inequality and multi-species violence of capitalism, suggesting that human beings would be responsible for the problems created by capital. It is therefore the capitalist structure and its socio-ecological transformation activities that must be called into question to understand the 21st century (Moore, 2016) We are also in the Chthulucene, from the etymology of H.P. Lovecraft's tentacled monster Cthulhu and the spider Pimoa Chthulu, a spider that actually exists unlike the imaginary creature of the famous American writer.

An hendyad appears between the fictional monster and the real spider: on the one hand the unavoidable catastrophe, the weird, the eerie, the unheimlich, (Fisher, 2017) on the other hand the slow and patient work of weaving, reconstructing the web, the skein game, the common web, the sympoiesis.[5] From the Greek khthon, a word referring to that which belongs underground, hence chthonic, obscure. It is therefore the era of subterranean connections. (D. Haraway, 2016) This new era no longer considers the

[5] This concept is mutated by Haraway from the work of one of her students, Beth Dempster, who coined it in the 1990s: the notion that living systems are not self-sufficient, or autopoietic, but that the living, the inorganic, nature and culture co-evolve in constant intra-action. Haraway is sympathetic to foundational Lynn Margulis's idea in Symbiotic Planet (1998) that life emerges through symbiosis and symbiogenesis which leads to the increasing complexity of life forms. Haraway defines her notion of sympoiesis as a specific practice of "making-with," or "becoming-with" in D. Haraway The Companion Species Manifesto (2003) and in Staying with the Trouble (2016). In Italy in F. Timeto, Bestiario Haraway, per un feminismo multispecie, Mimesis, 2020, sympoiesis implies a shared responsibility-responsibility, a becoming-with, and this is what seems to emerge in the dialogue between two thoughts in this case.

human as the only player on Earth, but as part of a whole of life, animal and plant, which now also involves computer algorithms. The Cthulhu monster is the artificial abomination that has taken up residence on Earth in the 21st century to manage new semantic, cognitive and productive functions, i.e. life plus the Internet of Things (IoT) and artificial intelligence (AI).

Thus we have arrived at the Anthropocene, Capitalocene, C(h)thul(h)ucene with the planet reduced to a burning spaceship adrift in space. (Buckminster Fuller, 1968) As the launch of the Chat **Generative Pre-trained Transformer large language model (LLM)** - GPT - on 30 November 2022 closes the modern era and opens the era of Hypermodernism.

II — what - quid

This is the era of change, with the end of the first quarter of the new millennium we remain with difficulty in the Anthropocene and Chthulucene. We are all in the time of the right choice at the right time (the Greek-Christian kairos time) and that is why the Care of New Knowledge becomes mandatory. We are thus obliged to deconstruct imaginaries, and knowledge is no longer fixed, but is determined by the ability to speculate.
We must abandon the rear-view mirror syndrome (McLuhan, 1964) and analyse the present-future with the posture of the artist. **Speculative Design**, heir to Italian Radical Design, is back. Speculative narratives reclaim science fiction so they are a theory and a narrative of fiction. We must see if the future will be utopian, dystopian or uchronic.

It is the coming of hypermodernity that has produced a fragmentation and targeting of truths (Stiegler, 2021). Since the 16th century, the centrality of the dialectic reappears (Culianu 2006). Education can no longer lead to a single goal and can only be a continuous dialectical tension between several truths. Educere no longer has only one destination, but consists of many landing points of truth or destinations of knowledge. This is because the aesthetics of victory, the foundation of truth that was realised after the world wars as the popular form of the ideological framework of human socio-political cultures, falls apart because the very ideological framework on which it was founded no longer exists. Today we no longer have a telelological point of arrival, but undetermined and recursive global liquid cartographies.

We live in the age of verisimilitude and truthfulness: according to Critical Theory, history ended with the fall of the Berlin Wall in ‘89, a single thought is created based on a hyper-progressive and economic view of life (Fukuyama, 1995). In this ‘pandemonium’ of verisimilitudes and narratives, the political system describes a super-democracy within a Western modernist tendency, whose techno-scientific, economic, socio-political currents are increasingly interrelated by causal connections produced by the fiction of narratives of a corporate-managed public (Kotler, Sarkar, 2021).

This leads to a demo-bureaucratic culture

grounded in zealous ideological memes that lend their bias to a plot-driven fiction that sees industrialisation as the basis for progressive democratisation. This produces cycles of reinforcement of a folkloristic social science theory, for which the maturation of societies in a democratic direction is determined by wealth thresholds. In this context, technology spreads a system of information that envelops the planet in a curtain of global effects. Truth multiplies in a babel of truths that produce the multiplication of imaginaries and makes the old forms of knowledge obsolete.

The *Care of the New Knowledges* aspires to contemplate a connection between the artificial and the natural. It is inspired by the work on socially based art of the international artist Michelangelo Pistoletto with his Trinamica-based 'Formula of Creation' towards a multidisciplinary approach to the future that hybridises with speculation in the age of technology, i.e. techno-ethics, by the British artist Roy Ascott.

Ascott's work defines a never-ending dynamic relationship between the human being and technology, defining a moist, emulsified environment, i.e. where the vital wet element is indistinguishable from the technological dry, composed of the wet , life and human, and another element, the dry-, technology (Ascott, Shanken, 2007).

Michelangelo Pistoletto's Trinamics, is founded on the dynamics of the three that always represents a birth, which occurs by chance, or intentional combination, between two subjects (teacher and learner). Trinamics happens in the process of: joining, connection, combination, conjugation, interaction, fusion of two elements that are simple or complex in themselves. The Trinamic phenomenon occurs in chemistry and in physics, extends to the physiology of bodies and can even be applied to social life in its cultural, political, economic and religious aspects. The sign-formula of Trinamics, also used as the symbol of the Third Paradise, and named today as 'Formula of Creation', consists of three circles in a line. The two outer circles represent all opposites and any kind of duality. In the also called Theorem of Trinamics the middle circle, generated from the conjunction of the two outer circles, represents a third and previously non existent subject. Trinamics acts in the natural sphere as well as in the artificial one, including every area and aspect of human society. We find it at work for example in the reaction between oxygen and hydrogen that gives rise to water; in the interaction between masses of warm and cold air, causing thunderstorms; in the connection between positive and negative poles which produces electric power; in the union between male and female that generates a new being; in the dialectic between thesis and antithesis that produces synthesis; in the fusion of the opposing political models of absolutism and anarchy out of which democracy has developed.

The Formula of Creation is the science of

relationships and equilibrium. But it is first and foremost the principle of intellectual, artistic, political and cultural design for the 21st century. It is the method that every educator and designer must take as the basis for all research, teaching, artistic and aesthetic practice, making it the design science of relationships and equilibriums. (M. Pistoletto, 2017 and 2022) In a global world where truth is multiplied, planes intersect and multipolarism is produced. The most convenient operation is to assume, like an artist, a 'multiple point of view'. Here the educational method is precisely a **multipolar method**. It is the combination of two units that gives rise to a third, distinct and unprecedented unit.

III — everywhere - ŭbĭcumquĕ

The primordial human, faced with the so-called 'numinous', i.e. the terror caused by the anguish of nature, creates art, which he already had as an instinct, and constructs the imaginary worlds where he shifts to live. And one thing is the Earth where he lives but also dies, one thing is the World where he lives and never dies because then there is Paradise or there is another life (Monico, 2020). Humanity inhabits three places: the earth, the world and the planet. In fact today there is also the possibility of a world-without-us, i.e. the Planet, the earth without the human being, which is only conceivable by abstraction or through predictive models, which tell us what it will be on a geological and conceptual level. It is therefore a spectral and speculative world like deep space and dark matter. It is not reducible to the human species and it is not in the human species. The importance of the Planet concept lies in its being a negative concept, that which remains after the human (Thacker, 2011-2015).

Here appears the precious artistic concept of Michelangelo Pistoletto's: the Third Paradise (Pistoletto, 2003). It is the fusion of the first and second paradise. The first is the one in which human beings were totally integrated into nature. The second is the artificial paradise, developed by human intelligence to the global dimensions reached with science and technology. This paradise is made up of artificial needs, artificial products, artificial comforts, artificial pleasures and every other kind of artifice. A veritable artificial world has been formed that, with exponential progression, generates, parallel to the beneficial effects, irreversible processes of degradation and consumption of the natural world. The Third Paradise is the third phase of humanity, which is realised in the balanced connection between artifice and nature. The Third Paradigm means the transition to an unprecedented stage of planetary civilisation, indispensable to ensure the survival of the human race. To this end, it is first necessary to reform the principles and ethical behaviour that guide our common life. The Third Paradise is the great myth that leads everyone to take personal responsibility in the global vision. The term paradise comes from the ancient Persian language and means 'protected garden'. We are the gardeners who must protect this planet and care for the human society that inhabits it. The symbol

of the Third Paradise, a reconfiguration of the mathematical sign of infinity, consists of three consecutive circles. The two outer circles represent all diversity and antinomies, including nature and artifice. The central one is the interpenetration between the opposite circles and represents the generative womb of the new humanity.

IV — the story became flesh - verbum caro factum est

This dialectic of the Formula of Creation is a real engine because the dynamic between two elements produces an interaction, the mechanical one of the action, reaction, reciprocal influence of causes, phenomena, forces, elements, substances, natural agents, physical, chemical, and, by extension, psychological and social, and thus a relationship when it begins to generate a discourse on this primordial interaction; in fact, the biosphere and the individual are not two separate realities, but rather two aspects of the same fundamental natural reality.

The biosphere is not simply a series of lifeless mechanisms, but is inherently a dynamic creative force in a continuous process of self-development, which, through various stages of complexity, encompasses and is encompassed in the basis of life and human being consciousness (Emerson, 1849). This progressive development can thus be seen as nature becoming increasingly self-aware (Schelling, 1804). The concept of polarity is fundamental, as in the Third Paradise and the Formula of Creation. All things exist in a dynamic tension between opposites, such as attraction and repulsion, light and darkness, matter and spirit. These polarities are not static but generate interaction which in a state fitted with artistic imagination becomes relationship. The narration thus possesses a kind of intelligence that manifests itself in its relational processes and structures. This intelligence develops until it becomes thought and thus structures a consciousness. In this sense, story 'becomes thought' when it is reflected in the human being by producing an imaginary that is the relationship produced by interaction insofar.

The human being inserted in a polar dialectical scheme manifests itself in a narrative process, because this same narrative process founds its binding to things by producing precisely the World (imagination). The emergence of human consciousness therefore represents the point at which narrative becomes capable of reflecting on the human. **Narrative** is a formidable system of adaptation and pre-adaptation to the world, arising from the biosphere and simulating environments in the biosphere has allowed humans to accelerate and differentiate their evolutionary response to the biosphere In this way, human perceptions are largely based on prediction, which allows them to read the world through speculative images to which a small amount of immediate sensory information is added with minimal cognitive effort (Gottschall, 2005).

Traditional scientific definitions of intelligence

take the human being as the yardstick against which all other species in the biosphere are measured, so that, according to these anthropocentric definitions, the human has always been ranked first, followed by animals such as the so-called superior primates - chimpanzees, bonobos, gorillas - then the other 'superior' animals, and so on, in a hierarchy of intelligence formulated by the ancient Greeks and which constitutes the backbone of modern Western thought. This controversial hierarchy, still one of the foundations of modern thinking, begins to falter in the Anthropocene because by questioning it, the disastrous approach with which we relate to the Earth may begin to change. Indeed a human, ergo a speculative designer, is made up of more microbes than cells and there are more bacteria in our guts than stars in the galaxy (Costello et All, 2009). We are in symbiosis with the biosphere, which is a collection of ecosystems among which we are embedded. To understand the scope of the narrative, we have to remember the way contemporary physicists describe the universe: the universe is about 13.8 billion years old, Homo Sapiens about 300,000 years old, and only since 100,000, with the discovery of the first forms of burial, i.e. the 'aesthetic' act, can we say that it has become a speculative animal, hence a narrative animal. We are in fact telling a story backwards from a percentage representation such that we are in the knowledge for 0.0007246% of 13.8 billion. And if that were not enough, again for physicists, more than 95% is 'dark matter and dark energy' of which we know nothing, although we know it is there, and includes dark biology and therefore dark life. A large number of scientific concepts, e.g. time, or those of chemical bonds - Goethe's famous 'Elective Affinities' - lack definitions, but are fundamental categories for thinking. "We" are ecosystems that transcend boundaries and transcend categories. Our thinking emerges from a complex tangle of interrelationships. Narrative can thus be seen as one of the forms through which the biosphere becomes self-aware, through intelligere, that is, binding itself to things, where 'biosphere' and 'culture' are two sets that blur into each other and vice versa. The emergence of the in-intelligere, or bonding to things, which is the opposite of rationality as a sequence of measured inferences that moves away from things towards their subjugation and exploitation. The intelligere, not only in the sense of its traditional etymology, from the Latin "intus"-"legere" "to read within", but as an "intus"-"ligare", a binding oneself intimately to things (Monico, 2020).

And so it is all a matter of Imagination, which in scientific circles is called 'speculation': the tangle of our conjectures, fantasies and metaphors has helped shape our knowledge because imagination is the foundation of the humanbeings (Vico, 1710 and 1725-1744). Imagination is part of the everyday work of investigation and scientists, as humans, are emotional, creative, intuitive people who bring together things that cannot be associated. Imagination is analogical thinking, i.e. it is the ability to associate things that cannot be associated, and it is shaped through storytelling. The development

of the biosphere is, at the same time, the development of the imagination. Human knowledge is, therefore, a form of self-knowledge of nature itself and its form is narration.

This is why a fundamental axis of the Care of New Knowledge is narratives. And it is precisely narration that we observe in the above-mentioned School of New Technologies of Art at NABA in 2005, and then always returned to in the courses of narratology and creative writing in the subsequent teaching and speculative design programmes in which there were collaboration and direction, such as the Isia Roma Design.

V — how - quo modo

This is because the end of the modern means the end of an entire way of thinking, educating, designing, imagining. The modern has embraced calculative-rational thinking and a teleological view of human thinking and doing, which is speculative - therefore science fiction - and technoscientific. It is a metaphysical approach, which represents things abstractly and rationally and thus enables calculative-rational thinking and thus techno-scientific acceleration, the thought of technology and science. That is to say, modern theory is an analytical approach that separates and externalises problems, producing technoscience, which is why the Anthropocene, Capitalocene, C(h)thul(h)ucene came about.

We are domesticated, that is, we do to humans what we do to animals; anthropotechnics is the practice by which humans transform themselves through cultural and disciplinary techniques. The Theory of Anthropotechnics focuses on the idea that human beings continuously modify themselves through cultural, technical and disciplinary exercises, reflecting a process of selfdomestication and self-optimisation. Anthropotechnics is thus the set of exercise-based mental and physical behaviours by which human beings have attempted to optimise doing and thinking in the face of the need to think about themselves. It not only concerns the use of technical tools, but also and above all the set of educational practices that shape the individual. Thus adolescents (which are the humanbeing's present participle), i.e. those (students) who are not yet adults (which are the humanbeing's past participle), are domesticated to rational thinking with an average of 10 years of compulsory schooling followed by as many years of higher education and research. By means of anthropotechnics, the human involves the self-production, maintenance or improvement of performance in a true *Humankind-Design*.

In the 21st century, the problem of thought becomes a dialectic of non-thought and selfproduction, this dialectic becomes critical and urgent because of the Anthropocene, Capitalocene, C(h)thul(h)ucene. In fact, in today's world, the only fact of universal ethical significance is the idea, increasingly widespread everywhere, that things cannot go

on like this any longer (Ibid., 2010). We are in Spaceship Earth facing new imaginaries. We are all turning into planetary maintainers of a **cosmic wreckage** (Buckminster Fuller, 1969). Design is faced with the challenge of new imagery. There is no escaping this imperative, for with the appearance of Spaceship Earth, a new configuration of the absolute imperative has appeared in the world, which is addressed to all and sundry in the form of a stern warning: change your life! Otherwise, sooner or later the complete unravelling of the crisis will show what was missed at the time of the preliminary signs.

The Anthropocene is the product of a devaluation of a natural and sensitive Earth in favour of a transcendent and progressive World. We can argue that this devaluation has directly led to the current systemic collapse of the Earth.

As a remedy to this transcendence, here is **the teacher-learner dyad**, or rather the adolescents who in the 21st century become central, no longer an higher education based on the authority of the teacher towards a learner who listens, but a teacher who assumes the role of witness to the ruins of the anthropocene while dialoguing with the adolescent learner who is an active participant in the same process of education because he is the creator of new narratives in a circular process that without denying theory does not overheat it in an absolute and mere transcendence but recovers praxis.

At the centre lies the teacher-learner dyad, the teacher intended as ‘guardian of the ruins’ and the learner as ‘creator of new narratives’. The implication of these two rhetorical figures triggers a speculative (mirror) dynamic that produces a speculative analysis of the present. The artistic side of design reacts because it is necessary to take a mental divergent attitude in order to deconstruct scenarios in search of submerged futures and with the aim of producing new non-Newtonian cartographies.

Students as adolescents are central to the process of creating new narratives and visions for the future. They possess an innate energy and creativity that make them capable of imagining and building new worlds. This ability to generate new narratives is particularly important in an era of rapid social and technological deconstruction such as the 21st century. Adolescents, freed from the constraints of past traditions, can explore new ideas and solutions, contributing significantly to cultural and social deconstruction and reconstruction.

The teacher, on the contrary, is adult, that is the past participle of the learner who is the present participle, the adolescent, the making of the new. The teacher is an adult and for this reason is a witness to the ruins, the guardian of facts, projects, and imaginaries that are now ruins and like all ruins - this is a very Italian thing - are testimonies and teachings. But these ruins have no force if not inserted into new narratives, which we must activate in collaboration, in the creation of a ‘whole’ with

the learner-adolescents.

In this scheme, adults are described as guardians of the ruins, custodians of past traditions and knowledge. This role does not imply a simple passive preservation, but an active action of safeguarding values, memories and social structures that, although they may seem obsolete, still contain valuable lessons. Adults act as a bridge between the past and the future, offering stability and continuity while integrating the innovations proposed by adolescents.

To imply innovation we must rely on the learners, in the sense of relying on the new narratives that in their completed form are always studies of the ruins. The theory emphasises the importance of the interaction between these two groups. Adolescents bring change and innovation, while adults offer experience and models. This continuous dialectic between innovation and preservation is essential for a society that wishes to advance without losing sight of its historical and cultural roots. In the encounter between new imaginaries, the students, and ancient knowledge, the teachers, a new imaginary of the 21st century will emerge (Monico, Campagna, 2021).

VI — why - quārē

The Earth is collapsing, if we do not change we will witness the appearance of the Planet, i.e. we will no longer have a chance to inhabit the Earth (Thacker, 2011). Human society is called upon to radically change its actions; to do so, we must change our thinking, and designers have a mandatory responsibility. Today, the imperative is sustainability directed towards a general ecology, which is the reason why design turns into Socially Engaged Design and triggers the question: what if to de-construct and re-construct a new imaginary for the 21st century we used the techniques of Design, no longer applying them to products, but to society itself? What if we built strategic tools of public utility, to help society and the politics that govern it recover what progress has produced, causing damage to the planet and all its inhabitants, some of which is already irreversible? Systems Design has the ability to decipher complexity and devise open and resilient solutions. The same design languages and techniques that lead us to compulsively consume can guide society to become aware and change its patterns of life. An urgent reversal is needed, because time is running out and the consequences could be dramatic for all inhabitants of planet Earth, be they humans, animals or plant species. We are all in the same wreck together.

This is why we developed the Tippe-top design in our work at ISIA Roma Design (Monico, Datti, Damiano, 2022). The ISIA training model is functionally characterised by a selected and motivated student body, which guarantees efficiency and performance, and by a teaching staff made up of professionals and artists selected not only on the basis of the curriculum, but also with respect to the emerging needs of teaching, production, the spread of new technologies, and social change. The didactic experience of the

students of the three-year course in Design, suggests that the point of the new generations should be in tune with deconstructing and reconstructing the imaginary, i.e. changing the point of view. This led to the idea of a seminar + workshop. The participants were third-year students of the three-year ISIA Roma Design course, academic year 2020/2021. Members of Generation Z with a background in design, who debated with the lecturers of the same institute and the Italian Minister of University and Research, Prof. Lorenzo Fioramonti, the Member of Parliament and scholar of educational forms Alessandro Fusacchia, and Dr. Michele Torsello of the Italian Ministry of Infrastructure, this meeting aimed to work on *"The political role of systemic design in contemporary society"* and offered a new point of view to imagine the new "welfare systems" (Isia Roma Design, 13 September 2021).

Because values determine human choices, both individual and collective, not necessarily in a rational manner (in branding this is well known and the induction to targeted consumption is the consequence), Tippe Top's methodology is Speculative Design and thus aims to identify those practices consistent with the value field generated by the insertion or production of a **new imaginary** with respect to the previous one. The value field traces the types of route we take to move from one Imaginary to another.

The aim of the Tippe Top methodology is to induce positive change, both shared and radical, gradual but intensely progressive, capable of re-forming compromised systems, particularly from an ecological (in its broadest sense) viewpoint. Nowadays, the axis of the imaginary is in precession to the axis of technology, from which we assume our needs, desires and expectations. The more we use technical devices, the more this precession prevents us from grasping change and becomes stronger. That is why we no longer have to solve the problem within the conditions posed by the problem itself, i.e. in a convergent manner, but rather analyse and design in a divergent manner, beyond the conditions posed by the problem itself, which means widening the range of possible solutions by generating ideas without fear and restrictions. Today, in the 21st century, we must think of the world not with our eyes turned towards the past, but with our eyes projected towards a contemporary that is not yet given. *Tippe Top Design* is founded precisely on the speculative effort to see things from opposite points of view, according to the logic that we have to get out of an obsolete imaginary in which we are immersed and put ourselves in a position to act out an always already new 21st century. It is a design-perceptual artifice that aims to bring the designer 'out of the automatism of perception'.

It is a deliberate disorientation of the designer, the purpose of which is to accustom the subject to a mental openness towards new, unexpected and alienating aspects of a project. It is a training that allows new perceptions and aesthetic experiences through which subjects and objects are reconfigured. Design thus becomes the

occasion for a transformation, also political, of the designer, who is therefore endowed with a new awareness.

The name is derived from the particular *Tippe Top* spin, which, unlike 'normal' spins, adds the effects of frictional forces to the forces of rotation and gravity, so that the spin suddenly turns over on its own axis of rotation. The rotation axis of the Tippe Top is not fixed, but free. This is why the spinning top turns in the same direction for the outside observer and in the opposite direction for the gnome inside. This led to the theorisation of Tippe Top Design, i.e. a particular design method that deals with changing freedomly the point of view of the observer-designer, which is to say that the designer, whether a senior designer or a student, must change his or her imagery in order to equip himself or herself to face the 21st century. Where the inner gnome of the spinning top is the configuration of the background of effects, the reality of a present that we are not normally given to perceive, since we are immersed in the shared cultural narrative and therefore always obsolete.
In fact, Tippe Top Design is a speculative radical systems design that overturns points of view and seeks to be re-volutionary, that is, to reverse the point of view on things by updating it

conclusion - fīnītĭo

Faced with the end of the 20th century narrative, with the coming of globalisation and thus the redefinition of socio-economic arrangements, we have entered the 21st century and must reformulate new narratives, this task belongs to the artist and designer. Everything is either true or untrue, true and untrue, neither true nor untrue; there is no more truth because the future has run out and we cannot look back because it is that backwardness that has led the world to its decline, we must therefore rewrite the future and rethink the world.

Today we have to cure new knowledge inside an empty space, a dialectical place between opposites, a process of a continuous becoming of theses that become antitheses and immediately mutate into new theses. Because as the modern ends, ideological visions and attachment to an idea of truth come to an end. Truth becomes an empty space at the centre of opposing tendencies (dialectics), it becomes the space for the negotiation of new knowledge. It is a positive nihilism insofar as it consists in the transvaluation of all values in the discovery of submerged futures and is to be implemented **in fashion, politics, architecture, theatre, art, information, music, science, design, religion, the market, economics, literature, food and philosophy**. (Progetto arte, M. Pistoletto, 1995-96)

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summary

1. Everything is either true or untrue, both true and untrue, neither true nor untrue;
2. Adults are the guardians of the ruins, teenagers are the creators of new narratives;
3. There is no difference between thinking and doing, the design of thinking and tools as well as society and the human itself belongs to the same whole;
4. Education and thinking, artifice and theory are thus the same thing;
5. Product design and speculative design must act together;
6. We are stories, the mind defines itself in narratives. Education is narrative;
7. The *Formula of Creation* as a thesis-antithesis-synthesis scheme that therefore produces theses that immediately imply an antithesis, is the continuous dialectic of the process, is the space for the negotiation of new knowledge, and is the most viable method for 21st century design.

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CO-DESIGNING FOR EQUITY: ADDRESSING ANTI-BLACK RACISM IN THE ARTS IN CANADA- A WORKING PAPER

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ABSTRACT | The Make Some Noise: Hidden Stories of Black Creatives in Canada was a co-design research study with Black creatives across Canada that represented diverse disciplines of design, visual and performing arts, film and spoken word. The central research question of the study was, "What are the barriers that Black creatives encounter in Canada?" The study mapped the ecosystem across Canada of barriers and facilitators affecting the progression of the creative practice of Black creatives. The study gathered perspectives from artists and designers self-identifying as emerging, mid-career, or established.

In total, 68 Black creatives participated in ten virtual co-design research consultations. They were asked to map their journeys from emerging creative to established creative and to map the locations where they encountered structural barriers or the facilitators on their journey map. Twenty-two of the Black creatives also took part in speculative co-design sessions to inform the design of a resource tool that would support their creative practice, strengthen their creativity and overcome the barriers they reported. Participants in the speculative co-design sessions worked in small teams in which they envisioned the shape, content, and key functions of a resource tool. In addition to identifying essential characteristics of the resource tool, they speculated on how the tool would be accessed and how it might be used now, and in the future. All consultations were conducted using the online collaboration tools, "MIRO," and "Microsoft Teams" between October 2023 and January 2024.

This research unraveled the stories of the lived experiences of Black creatives through the practice of Endarkened Storywork. The inclusion of their stories and their voices was central to the co-design of a resource tool. Key themes that emerged from the stories they shared are: 1) institutional anti-Black racism, 2) lived experience with racism, 3) protective factors and empowerment, 4) creating opportunities for ourselves, 5) overcoming institutional barriers, 6) finding creative solutions: opportunities, successes, economic sustainability, and 7) resources needed.

The study provided the evidence needed to create an equitable landscape and create funding opportunities and other resources to support Black creatives. The study also investigated the feasibility of co-designing a "crowd-sourced" resource tool. The participatory design approach recognized participants as subject matter experts with lived experience knowledge to inform best practice. The study empowered participants to be agents of change.

This study contributes to the discourse on design's role in fostering positive societal change.

KEYWORDS | CO-DESIGN, RACISM, EQUITY, PARTICIPATIVE DESIGN, CANADA

1. Background

The work of Black creatives is underrepresented in Canadian art galleries, museums, theatres, music venues and the design industry. It is crucial to understand why Black creatives are underrepresented in various art forums to advance diversity and inclusivity within cultural and artistic spaces in order to pave the way for more vibrant, creative cities in Canada (Canada Council for the Arts, 2021). Black creatives have reported experiencing barriers to accessing resources to support their creative practice and opportunities to showcase their work (Toronto Arts Council, 2023). Therefore, the central research questions of this study were, 1) what are the characteristics of the barriers that Black creatives encounter in Canada and 2) at what stage in their creative practice are barriers encountered?

The United Nations Proclamation of the International Decade for People of African Descent 2015 - 2024, was adopted in recognition of the fact that people of African descent experience many forms of discrimination (United Nations 2014). In this research, we sought to uncover the hidden stories of Black creatives' experiences as they navigated structural barriers when attempting to access resources needed to advance their creative practice in Canada. The research also investigated the relationship between barriers encountered and racism. Moreover, the research sought to examine the cultural ecosystem to identify whether the barriers are structural by design. Cabana et al (2020) found a gap in the literature of studies of cultural ecosystem mapping, highlighting the underrepresentation of arts categories in ecosystem mapping studies. This study addresses the gap by engaging Black creatives in the process of mapping the arts landscape to provide evidence for reforms needed for equitable support of Black creatives.

Using co-design, a participatory research method, the research mapped the arts ecosystem barriers in five Canadian regions and their impact on the creative practice of Black creatives across Canada. Factors that supported and strengthened career progression and creativity were also studied using codesign. Co-design research

emphasizes collaboration, inclusivity, and shared decision-making. According to the literature on co-design, this approach is more beneficial for driving systemic change than other forms of research because it allows diverse perspectives to be included in the research process, leading to more innovative and effective solutions (Calvo & Sclater, 2020). Codesign research can play a vital role in driving systemic change by providing evidence of and challenging inequalities to inform policies that foster a more equitable and inclusive cultural landscape (Calvo & Sclater 2020).

Findings from this research can inform policy aimed at addressing disparities (Blomkamp, 2018), promoting equity in the arts, advancing strategies for increasing representation, improving access to resources, and fostering inclusive artistic environments. Furthermore, exploring the experiences and perspectives of Black creatives contributes to a deeper understanding of cultural identity, community resilience, and the role of art in social change. Research aimed at co-designing for equity in the arts sector is essential for enriching cultural discourse and ensuring that artistic spaces reflect the diversity of society. This study contributes to the discourse on design's role in fostering positive societal change. The research was approved by OCAD University Research Ethics Board REB number 2022-70.

2. Theoretical Framework

The theoretical frameworks underpinning this research are Critical Race Theory (CRT) and Nguzo Saba. The multilayered barriers revealed in the shared stories of the participants are explained in the context of CRT. CRT explains that racism is structural and is a means by which society allocates privilege and status (Stefanic & Delgado, 2017). The economic landscape and social fabric have racism as its roots, and therefore, racism is hardwired into racial inequality (Carbado & Roithmayr, 2014). CRT provides a critical analysis of the dynamics of power and privilege characterized by white supremacy (Delgado & Stefanic, 2017) that impact the experiences of Black creatives.

Nguzo Saba is an African framework that comprises seven principles (Figure 1). They are Umoja (Unity), Kujichagulia (Self-determination), Ujima (Collective Work and Responsibility), Ujamaa (Cooperative economics), Nia (Purpose), Kuumba (Creativity) and Imani (Faith). The Nguzo Saba framework encompasses African diaspora epistemologies such as Ubuntu. The framework's guiding principles are grounded in Kawaida Theory, a liberatory ideology for social change (Karenga, 2000, 2017; IBW21, 2012).

The research is also viewed through a lens of the African philosophy of Ubuntu. Ubuntu is anchored in community, interdependence, compassion and belonging (Muwanga-Zake, 2009). Ubuntu embraces collective responsibility to contribute to

humanity (Muwanga-Zake, 2009). Several Black creatives in this study designed and developed creative, culturally based solutions to the barriers they encountered for themselves and fellow Black creatives, for which the Ubuntu lens is explanatory. Ubuntu fosters the inclusion of diverse cultural perspectives. The Ubuntu Indigenous knowledge "is based on the idea that as human beings we depend on other human beings to attain ultimate wellbeing" (Halifax Regional Municipality, 2021).

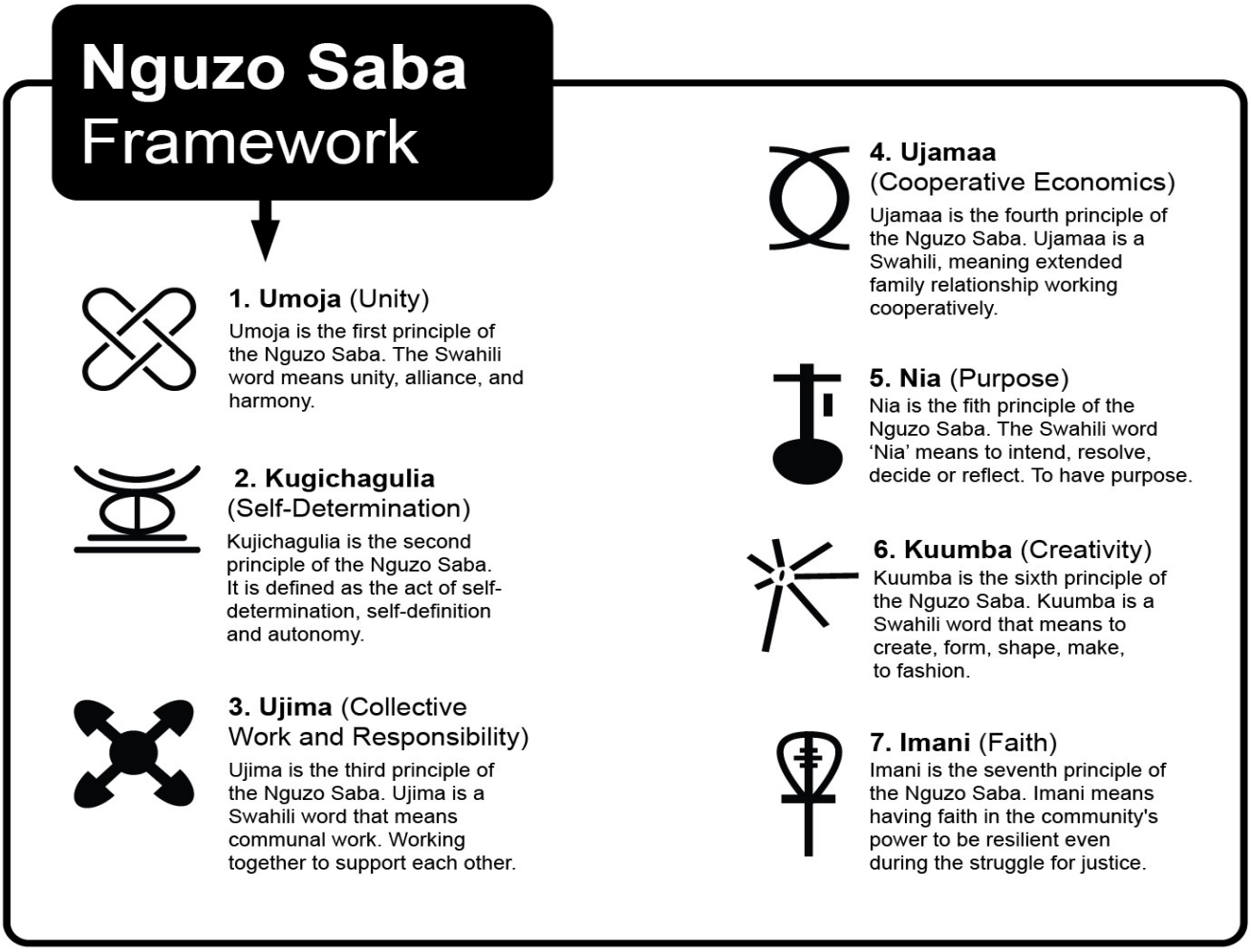


Figure 1. The Seven Principles of Nguzo Saba. Adapted from Nguzo Saba (The Seven Principles), Karenga, M. 1999, Accessed 28 July 2024 from https://digital.libraries.psu.edu/digital/collection/blackhistory/id/16/

3. Methodology

The Make Some Noise study was designed as communitybased emancipatory and liberatory research (Figure 2). A convenience sample of 68 Black creatives across Canada participated in one of ten regional co-design research consultations across five study regions. The 5 study regions were Atlantic Canada, British Columbia, Ontario, the Prairies/Territories, and Quebec. Separate consultations were held with visual artists/designers and

performance artists to investigate similarities and differences between the experiences across a range of creative practices. Performance artists included musicians, DJs, actors, filmmakers, spoken word artists, and singers. The distribution of Black creatives participating in this study by region and creative practice is shown in Table 1.

Table 1. Distribution of Black creatives by region and creative practice

	Quebec	Prairies	Ontario	Atlantic	British Columbia
Visual Arts & Design	8	8	10	5	7
Performance Arts	6	6	7	5	6

All participants contributed to the Phase 1 consultations and twenty-two of the Black creatives also took part in one Phase 2 speculative co-design session that aimed to inform the design of a resource tool to support their creative practice, strengthen their creativity and overcome the barriers they identified. In total, twelve 3-hour consultations were held between October 2023 and January 2024.

All consultations were conducted using the online collaboration tools “MIRO” and “Microsoft Teams.”

The research methods included: facilitated small group discussions, journey mapping, priority mapping, and speculative co-design. Emancipatory research methods, such as speculative co-design, democratize the design process by empowering participant agency, advancing diverse perspectives and fostering participatory design (Calvo & Sclater, 2020). Similarly, Livingston (2023), found that arts-informed research methodologies encouraged experience sharing in their study of Black male’s university experience using mixtape methodology. The research methods selected positioned the participants as subject matter experts whose lived experience and understanding of the world around them could inform policy, resources, and tool development to support Black creatives. As such, study participants served the dual role of consultant and co-designer.

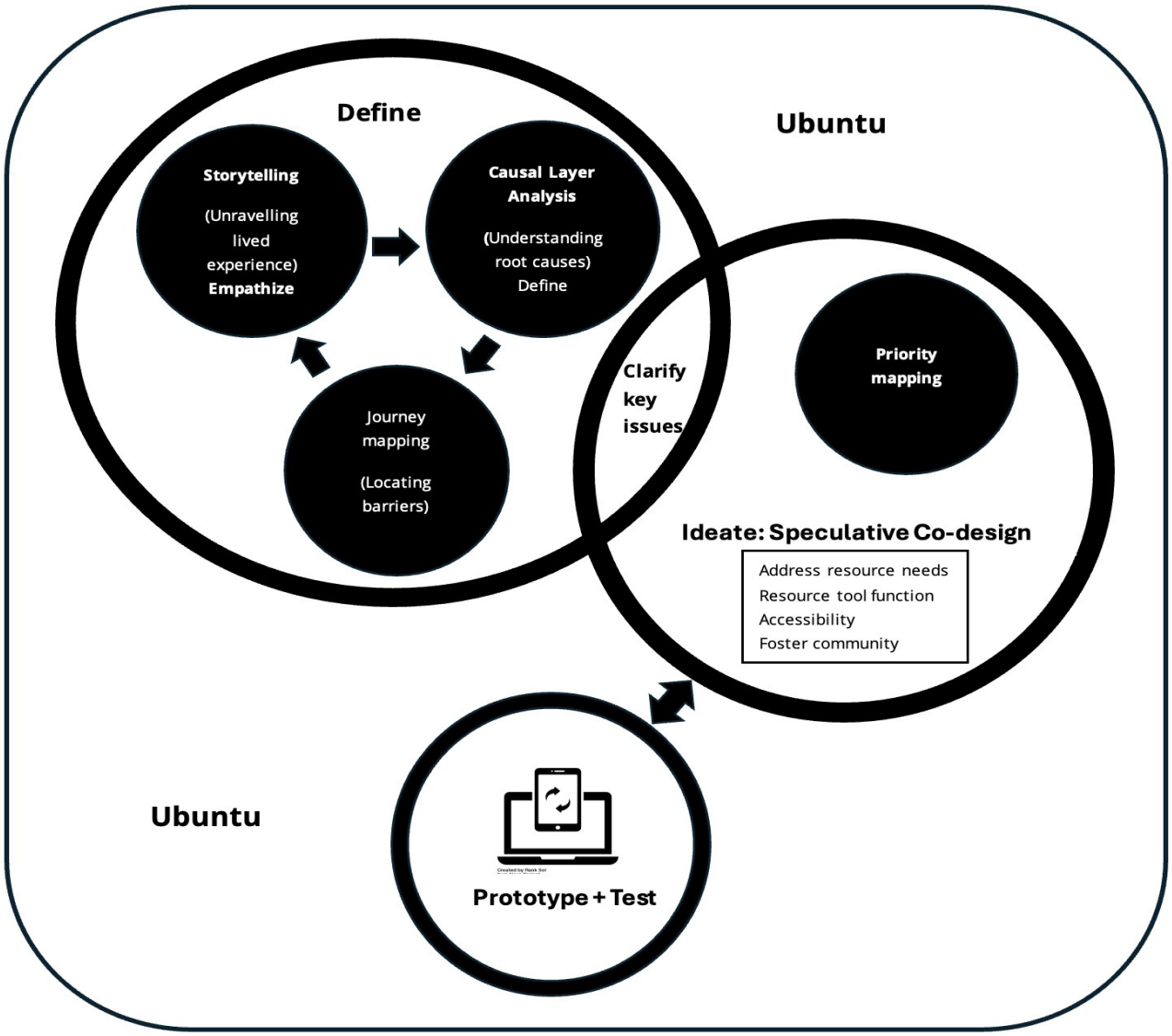


Figure 2: Emancipatory Co-Design Process

Phase 1- Defining the Problem: Black creatives across Canada mapped the ecosystem of the barriers and facilitators affecting the progression of their creative practice. They also mapped their individual journey within the ecosystem. Qualitative mapping is a research method that involves illustrating a journey or process and then describing the illustration in an interview or conversation (Marx, 2023). The research method centers the participants' stories, experiences and perceptions (Marx, 2023). In this study, the mapping activity was employed to understand the characteristics of an ecosystem(s) that is determinant of successful career progression, as well as barriers that disproportionately affect Black creatives' creative practices.

The journey map prompt was:
Reflect on the barriers you have encountered

and create a journey map showing the stage in your creative practice where the barriers were most prevalent. How would you categorize the barrier(s) (e.g., funding, opportunities to showcase work, racism, skill building, access to maker tools, other)? Show on your journey map where policy might remove barriers or support your creative practice.

The individual journey mapping activity was also a story mapping method used to stimulate dialog about participants' overlapping experiences and prompt the cocreation of a list of priority areas for change. Story mapping is an accessible, userfriendly research method. Story maps integrate narrative and visual information (Cabana et al., 2020). They can communicate complex, impactful perspectives and can be created with simple analog tools. Story maps integrate narrative and visual information (Cabana et al., 2020). Through storytelling, participants' ideas, thoughts, suggestions, and recommendations emerge (Tolliver, 2022). In this study, stories were shared, via a "Think Aloud" process (Van Someren et al., 1994), through which participant's designs and ideas for addressing the barriers they encountered were revealed. The inclusion of their stories in their voice was central to codesigning the resource tool.

Phase 2- Co-designing solutions: The participants in the speculative co-design sessions worked in small teams to envision the shape, content, and key functions of a resource tool. Open communication was encouraged, emphasizing a "no bad idea" approach. In addition to identifying essential characteristics of the resource tool, participants were asked to speculate on how the tool would be accessed and how it might be used now and in the future. The speculative co-designed sessions were consistent with Black Feminist Afrofuturism that supports acts of discovery, co-design, crowdsourcing, and documentation of time, history, place, and the expression of freedom through storytelling (Toliver, 2022).
Speculative co-design prompt:
It is the year 2024 and you have been appointed to be a part of a team that is tasked with designing a resource(s) that will support Black creatives at all stages in their career. Your team has been assigned a persona of an emerging creative, midcareer creative, or established creative and asked to reflect on the needs of the creative in the specific stage of their career. You may design the resource(s) using any materials of your choosing.

1. What shape should the resource or tool take?
2. How do users access the resource(s)?
3. How can the resource build community and/or foster networking
4. How do you see yourself and/or other users contributing to user-generated content?
5. How do you keep the resource(s) current?

Qualitative data analysis included content analysis of the co-design group discussions, causal layer analyses and priority sorting data activities. Transcripts were read iteratively and coded, and key themes were identified using Atlas ti v14. Intercoder reliability was checked by assigning 2 or 3 researchers to code each transcript. The key themes that emerged from the stories participants shared were: 1) institutional anti-Black racism; 2) lived experience with racism; 3) protective factors and empowerment; 4) creating opportunities for ourselves; 5) overcoming institutional barriers; 6) finding creative solutions: opportunities, successes, economic sustainability; and 7) resources needed. The key themes emerging from this study are described in the results section. Their intersectional relationship to the Nguzo Saba theoretical and analytical framework is also contextualized.

4. Results

The stories told by Black creatives in this study illuminated the pervasiveness of anti-Black racism in the arts sector in Canada and its effect on the economic viability of their creative practice. This was due in part to barriers to accessing grants and other funding streams, limited opportunities and spaces to showcase creative work, and undervaluation of the creative works they produced.
The research also revealed resilience in overcoming the barriers encountered that was fostered by self-empowerment and Black community support.

4.1 Institutional Racism: Black Creatives Lived Experience with anti-Black Racism

The study found that Black creatives experienced widespread, pernicious, and covert anti-Black racism within the arts sector. This racism impacted their economic sustainability by limiting their access to grants and other funding, reducing their visibility, excluding them from opportunities, and undervaluing their work. Implicit biases and stereotyping also hindered their career progression and viability due perceived gatekeeping and reluctance of arts venues showcase Black-identified work. Black creatives expressed that the emotional toll of anti-Black racism, made them feel marginalized, tokenized, and led to burnout. A comprehensive map of anti-Black racism's manifestations is shown in Figure 3.

Anti-Black racism affected emotional well-being, financial well-being and directly impacted creative practice. Anti-Black racism was perceived as a systemic barrier by participants collaborating in the causal layer analysis mapping activity. They mapped anti-Black racism beneath the surface of the iceberg, highlighting its hidden yet insidious nature. One Quebec performing artist shared that covert antiBlack racism left them feeling uncertain about labelling their experience as racism because no one explicitly stated that racism was the cause for the denial of opportunities.

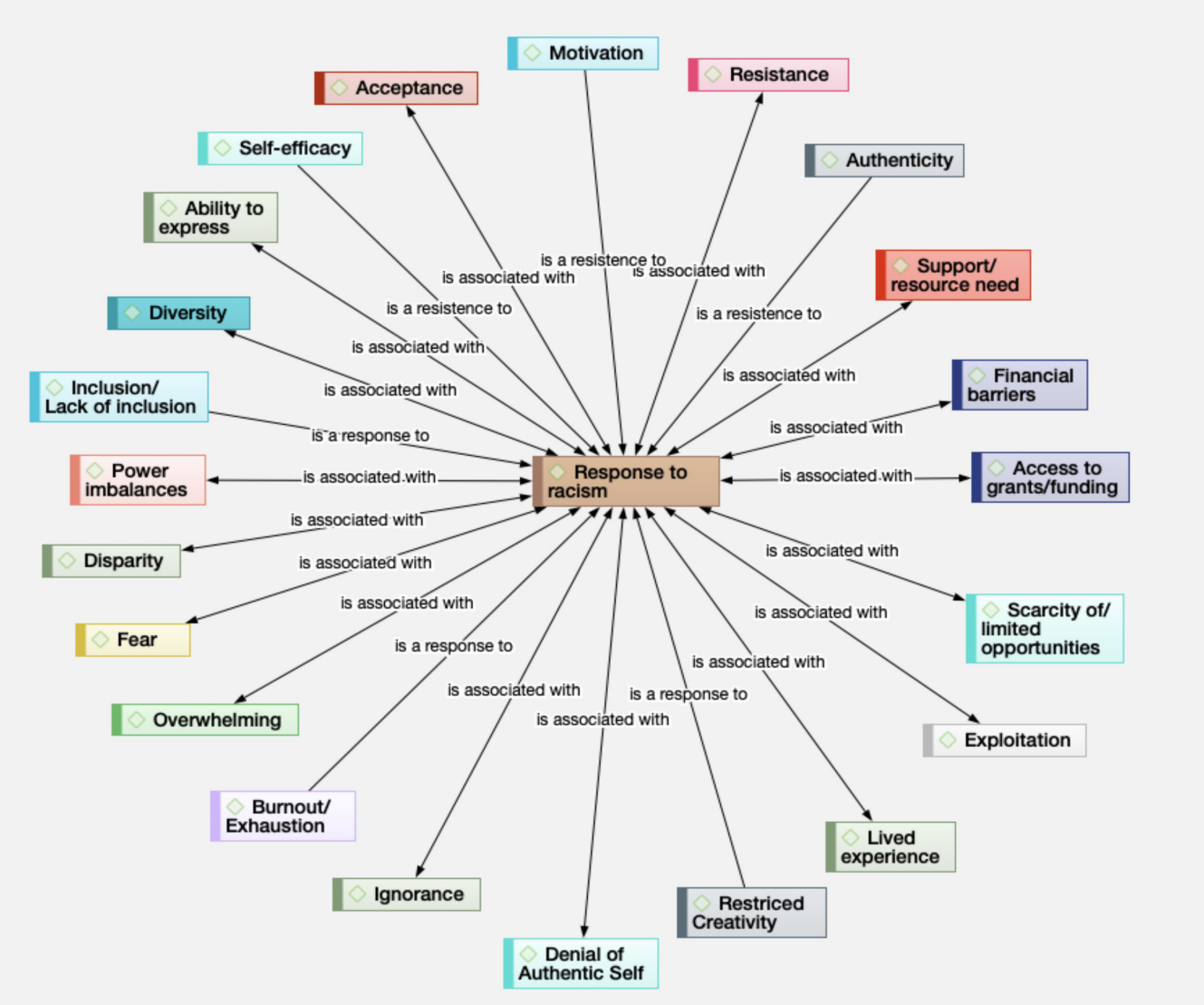


Figure 3. Effects of Anti-Black Racism

"...it's part systemic...the system deprioritizes Black people, Indigenous people and people of colour... one of the things for me about Canada is that racism can be very insidious... like when you're asking yourself, is it because I'm Black? It's usually because they didn't say it's because you're Black."

(QUEBEC PERFORMANCE ARTIST)

Anti-Black racism was described as a reason for creating things that were palatable for [white] people who are supporting the art and predominately white venues and galleries where work might be shown. One British Columbia participant shared that they feared losing opportunities to showcase their work if they were authentic, thereby limiting their artistic expression.

"…it's like a tug of war of like, are you being authentic as an artist and are you, or are you just playing into what everyone wants you to see? And there is kickback and resistance I feel too, especially as a black male within artistic spaces of just obviously don't be too aggressive. Don't be too loud. Like policing my body and policing my expression and then, you know you're not expressing from this the center of who you are…"

(BRITISH COLUMBIA ARTIST/DESIGNER)

They shared experiences whereby predominantly white mainstream galleries and venues outside of urban centres were reluctant to showcase work depicting Black culture because it would not be accepted by their clientele. In contrast, other participants talked about their creative practice being objectified. "Black art" has been reduced to a restrictive category of representational art by a majority White audience, and there is a "failure to understand that we're not cookie cutter. We're not gonna create cookie-cutter experiences of art for our audience to consume." (Quebec Performance Artist).

Microaggressions were encountered regularly by Black creatives participating in this study, which was described as exhausting.

"Having microaggressions and all of that thrown at you constantly and that wears on you. And that really wore me down to a point where I didn't know if I wanted to work in film…if it's this toxic environment."

(BRITISH COLUMBIA ARTIST/DESIGNER)

In the next section, participants' responses to the anti-Black racism that they experienced in their creative practices, are described using the Nguzo Saba African framework.

4.2 Umoja (Unity)

Umoja is the first principle of the Nguzo Saba. The Swahili word means unity, alliance, and harmony. Black unity, cooperation, collaboration, and community were described as important to progress in one's creative journey and were linked to the key theme: protective factors and empowerment. Umoja embodies a practice of coming together as a Black community for mutual benefit. Community was identified as a key theme in this study. Being connected to a Black community of creatives was cited as a mechanism to address systemic barriers and combat the negative effects of anti-Black racism.

"All of this, all of the things that we're experiencing, all of the oppression we're experiencing is a distraction for us not to create, for us not to thrive and not to [have] drive and not have joy. So, the importance is for us to keep giving each other spaces to create, to love, to have

joy, and to live still and to thrive. I think [that] community can really do that."

(QUEBEC ARTIST/DESIGNER).

Community was also described as a resource for work opportunities, mental health support, encouragement, funding, mentorship, information, and opportunities to learn skills. Being associated with a community of Black creatives helped to build confidence in one's practice and self-concept, held space for conversations where individuals' voices could be heard, and experiences would be validated. Participants expressed the importance of reciprocity, whereby they had a responsibility to contribute to the Black creative community and many saw this as a call to action to create opportunities for themself and other Black creatives especially in regions like British Columbia where the Black creative community is sparse. The effects of isolation or exploitation have led some to entertain thoughts of giving up a career in the creative field.

"The disjointedness of our community has a direct relationship to the economic precarity as artists."

(BRITISH COLUMBIA PERFORMANCE ARTIST).

Black artists/designers in Ontario and Quebec described what they perceived as impediments to building a collaborative community. Silos between peoples of the African diaspora (Caribbean, Black Nova Scotians, Brazilians, Spanish speaking communities), as well as Anglophones and Francophones, created barriers that, if removed, would foster a "really unified Black artistic community [that] would allow Black creatives' creative practice to flourish in Canada and internationally because we're all in the same boat and we kind of want some of this community where we can all help each other rather than work like fighting against each other." (Ontario Artist/Designer).

4.3 Kujichagulia (Self-determination)

"I feel like I'm the most effective, efficient, creative, powerful being that has ever existed. And I hold that optimism within my spirit, and I do not allow anything to compromise that. But I am aware that others do not see me that way."

(BRITISH COLUMBIA ARTIST/DESIGNER).

Kujichagulia is the second principle of the Nguzo Saba. It is defined as the act of self-determination, self-definition and autonomy. The principle of Kujichagulia encourages individual and community empowerment to tell their story, shape their own destiny and assert their voices in the broader society (International African American Museum, 2023).

Black creatives recounted their experiences with precarious employment, funding and resources to support their creative practices and "seeing things that are blocked and saying I have to create this for myself and create it for others because otherwise it's just not going to happen" (Quebec Performance Artist). The scarcity of opportunities led many of the Black creatives in this study to take a leadership role to advocate for and create

opportunities to showcase Black creative arts in their city. In this study, we found that creating a Black-led support system was connected to leadership, advocacy, community, collaboration, grassroots organizing, unity and empowerment. These characteristics were aligned with the key themes of protective factors, empowerment and creating opportunities for ourselves. In this study, advocacy and activism were shown to be strongly connected to Black leadership. Black creatives advocated for exhibition space, resources, and funding to support their own creative practice and for others. One visual artist from Winnipeg stated that "they have been uplifting other black creatives in the city, including music artists and media artists." One participant shared a story of a Black female DJ in British Columbia who raised money on Instagram to give to artists in need during COVID. The storyteller stated they received $700 in much-needed support. They commented, "Wow, look at this individual who wasn't gonna wait for an organization to do it...took matters into their own hands and just posted on Instagram and helped so many people."

Writing one's own story of success left some participants feeling discouraged and exhausted. They commented that they lacked leadership training and knowledge to create their own artist-run centre.

"I'm just thinking that again, this whole lack of leadership, leadership training, you know, when we talk about the establishing artist-run centers, yeah, how, where do we get the knowledge? So, for me, the iceberg is about knowledge... And so, although I want to start an artist-run center, I just don't have the strength. I don't have the knowledge...So that's a deterrent in a lot of ways."

(PRAIRIES ARTIST/DESIGNER)

Others shared that advocating for oneself and other Black creatives felt like a constant campaign effort. One British Columbia Artist/Designer queried, "Who is the artist with the resources and the time and the energy?" They noted that constant self-advocacy can negatively impact the sustainability of a Black creatives' practice because of the amount of time required.

4.4 Ujima (Collective Work and Responsibility)

Ujima is a Swahili word that means communal work. Within the Nguzo Saba framework, Ujima is interpreted as collective problem-solving to improve conditions and working together to support each other and the Black community. In the context of this study, participants described being supported by Blackfocused, Black-led organizations and support systems. Our analysis showed a relationship between Black-focused organizations and advocacy, Black leadership, cooperation and collaboration, empowerment, and joy. Two key themes emerged from the data related to Ujima. They were protective factors, empowerment and creating opportunities for ourselves.

Black-led organizations and Black arts collectives were described as safe spaces to express oneself without feeling judged or suffering microaggressions. Examples of Black-led organizations that were cited as providing supports, such as connecting emerging creatives with established artist mentors, peer support, networking prospects, and opportunities for Black creatives to showcase their work were: Black Artist Network in Dialog (BAND), Nia Centre for the Arts, and Vibe Arts in Toronto, Afro Van Connect and the Vancouver Black Library (Vancouver), the Black Arts Centre (Surrey), Black Artists Network of Nova Scotia (BANN), and Black Theatre Workshop (Montreal). Riverdale Hub (Toronto), a non-Black led centre was also described as beneficial.

"I'd also say Riverdale Hub is a great organization that provides workshops and the ability to showcase your work as newcomers, marginalized women specifically. I recently started a textile workshop through them, and they provided all the materials for free. There were three instructors ranging from dyeing to embroidery arts and we received free access, like free tickets to the Textile Museum."

(ONTARIO ARTIST/DESIGNER)

Black artist collectives have emerged as hubs to showcase Black art and foster recognition of Black Artists. The emergence of Black arts collectives was described by one Prairie Visual artist as 'beautiful' because "we're able to pull [together] resources and also advocate for each other in particular ways." In the spirit of Ujima, one Ontario Artist/Designer queried, "How do we advocate for abundance? Meaning there is more than enough for you, for you, for you, for me. We don't have to feel like we're grabbing and trying to claim this thing before you can."

4.5 Ujamaa (Cooperative Economics):

Ujamaa is a Swahili word, meaning extended family relationships. It formed the basis for socio-economic policy in Tanzania under President Julius Nyerere. Ujamaa was characterized by cooperative village economics (Swahili-English Dictionary, 2023; Ashly, 2020). In the Nguzo Saba, Ujamaa teaches the importance of shared work, shared wealth and making decisions for community benefit and sustainability (IBW21, 2012). The key themes emerging from the data related to Ujamaa were finding creative solutions, opportunities, successes, and economic sustainability as well as protective factors and empowerment.

This study's Black creatives shared their stories of balancing employment with their creative practice when income earned from their practice was not economically sustainable. They found that building a network of community relationships provided support when resources were limited. A visual artist from the Prairies described working to create a hub for Black artists to showcase their work and increase visibility, like collective art spaces in Nigeria.

“Yeah, so I encouraged this thing when I came here, I noticed that they didn’t have like [a] group of artists together. You know a collector can visit an artist in his studio and see another artist’s pieces or artist’s works. So that could be like marketing for the other artists. So that was this kind of space we had in Universal Studio of Arts in Nigeria where you have sculptors, you have painters, you had people into visual art space that were practicing tirelessly.”

(PRAIRIES ARTIST/DESIGNER)

They also encouraged purchasing services ands needed skills from each other to improve economic viability and wealth. For example, one participant stated their willingness to pay a percentage of a grant’s value in exchange for help writing the grant.

“So, to be able to give them a percentage is keeping that wealth in the Black community and that was very amazing. And through that experience I learned it’s all about unity and working together that’s basically what I got for that.”

(PRAIRIES ARTIST/DESIGNER)

4.6 Nia (Purpose)

The Swahili word ‘Nia’ means to intend, resolve, decide or reflect (Swahili-English Dictionary, 2023). In the Nguzo Saba, Nia is contextualized as having a purpose, and, in this study, ‘purpose’ was identified as empowerment to create independent self-run organizations and support groups when little or no support for their creative practice was found. Black creatives also sought ways to empower themselves by seeking to become members of relevant decision-making organizations. Empowerment refers to the positive attitudes that strengthen an individual’s sense of agency. In this study, key themes related to empowerment were resilience, pride, celebration, community, encouragement, acceptance, selfadvocacy, self-care, self-reliance, peer support, support from allies, family support, as well as generational wealth.

“There is a huge opportunity for the art sector in not only Canada but in Alberta and Edmonton to explode … It’s just gonna be on the sweat and tears of the people who are like me. But it’s fine, as long as there’s a progression along, there’s progress in our communities. I am willing.”

(PRAIRIES ARTIST/DESIGNER).

However, of the few Black creatives who shared their perspectives on having a sense of control over the decisions affecting their creative practice, only the individual that described themself as being mid-stage to established in their career perceived degrees of freedom to choose or opt out of an opportunity to showcase work when the opportunity felt undervalued or exploitive. Emerging creatives felt a need to accept everything offered.

“One big thing, really where we are now is accepting the ‘no’s’ and actually being

okay with saying no to opportunities cause not every opportunity is a good one. And not every money is good money or money that aligns with the value of what we wanna do, with the gifts that we have."

(QUEBEC PERFORMANCE ARTIST)

Those who had found success in sustaining their creative careers still experienced struggles related to undervaluation of their work and not being paid the same remuneration as their white counterparts.

"I've been able to circumvent or balance things out by having an interdisciplinary practice. So, one part of my practice could help in chipping in for another part of my practice. For example, my painting practice could fund my installation practice or whatever, my ceramic practice or my sound practice."

(PRAIRIES VISUAL ARTIST/DESIGNER)

4.7 Kuumba (Creativity)

Kuumba is a Swahili word that means to create, form, shape, make, or fashion. Black creatives found ways to be resourceful when they did not have access to resources. They maximized the use of the community services available. Local libraries played a big role in giving access to software such as professional industry-standard Adobe Creative Suite, film, animation, audio and artwork production software. The library provided access to computers and software that allowed them to compete in their industry and or complete their creative projects. They shared that a library card enabled them to take advantage of online education, masterclasses, and access databases for research. One Ontario Artist/Designer shared, "I know the Public Library downtown on Yonge [Street], also. Once you have a library card, they have the full Adobe suite on their computers. If you do not have any of those, because they are really expensive to try and get yourself, they do. You can have access to it." Another shared, "They also have free access to some master classes through Hoopla. …really cool drawing classes actually…and there are a couple of great movies about artists that I have a list now that I'm gonna watch and that can inspire me." Key themes that emerged from the stories they shared were finding creative solutions, opportunities, successes, and economic sustainability. To increase sustainability, they shared information about environmental practices and where to find inexpensive materials and access sustainable materials in their work.

4.8 Imani (Faith)

Imani means faith in Swahili (Swahili-English Dictionary, 2023). In the context of the Nguzo Saba, Imani means having faith in the community's power to be resilient even during the struggle for justice. Key themes that emerged from the stories participants shared, that were associated with Imani were: protective factors and empowerment, creating opportunities for ourselves, and overcoming institutional barriers. Despite lived experiences of anti-Black racism within the creative

industries in Canada, Black creatives in this study exhibited optimism and hope grounded in a sense of belonging, acceptance, and connection to the community that they saw as a resource to continue moving forward. One participant noted, "It's good to feel uplifted by people who face the same challenges as you but also who can distract you from that. And inspire you to not be distracted by the oppression and the struggle" (Quebec Artist/ Designer). They held faith in the community of Black creatives to guide and support them and sought mentorship opportunities.

"I said [to the Edmonton Arts Council], is there anybody that you can introduce me to so that not only can I have someone that I know that's like me, but that my imagination could be stimulated, and my creativity doesn't have to be stifled? And so, they introduced me to a bunch of artists…a bunch of poets and musicians, which is all I've been looking for. And Black people like when we're in this type of space where we don't have a lot of people, we do gravitate towards each other. So, I found that we give each other opportunities, especially when it's like there's nobody there."

(PRAIRIES ARTIST/DESIGNER)

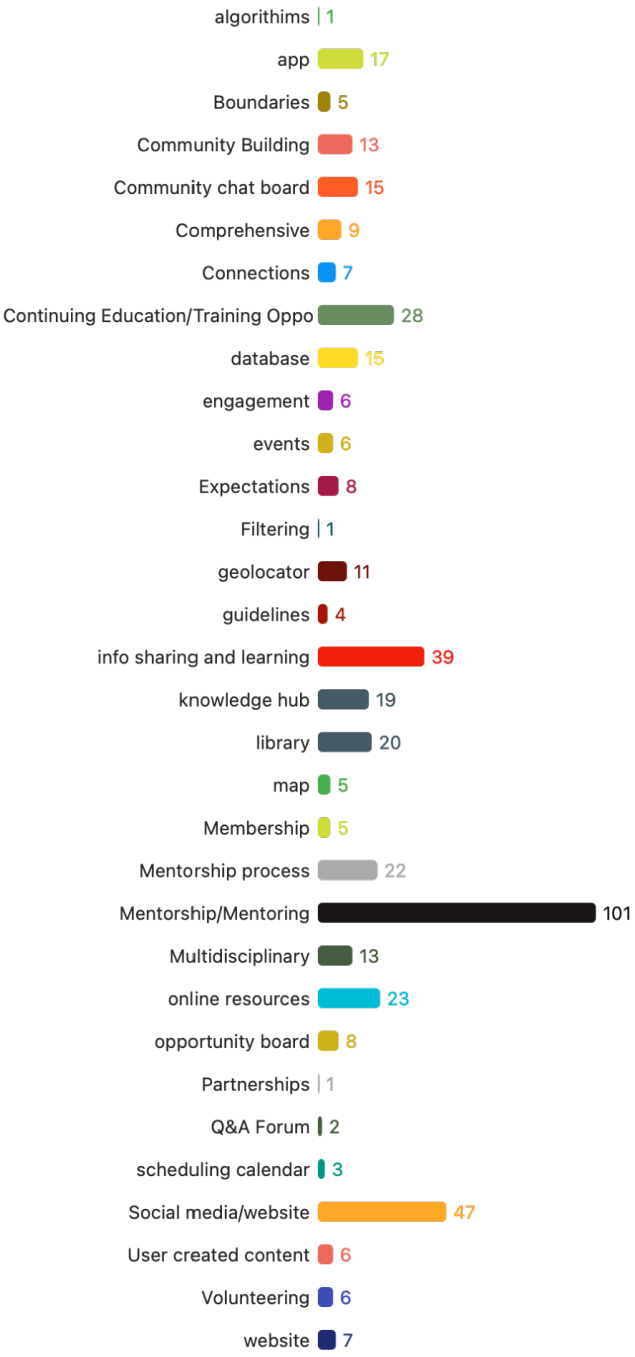
4.9 PHASE 2: CO-DESIGNING SOLUTIONS

Resource needs was a key theme that emerged from the stories Black creatives shared about progressing in their creative practice. They disclosed that they had a significant knowledge gap in key areas they believed could help them progress. The gap could be reduced by creating an accessible centralized knowledge hub.

"A centralized hub, I think it would be more effective in dispersing that information while also serving as a way to connect with each other."

(ONTARIO ARTIST/DESIGNER).

Black creatives participating in the speculative co-design session were invited to use any tool of their choosing (e.g., pencil & paper, Miro, sample wireframes or other options) to ideate on the characteristics and function of the resource tool now and in the future. They shared ideations centered on a tool that would function as a centralized hub. They highlighted the need for an online resource tool with a responsive design whereby participants could connect via a mobile phone or device. Their designs were modeled after the public library, facilitating easy, free access to its resources. The tool would be a knowledge hub for continuing education and training, information sharing, mentorship, a Q&A forum, and other resources. Figure 4



shows the key characteristics identified.

Figure 4. Characteristics of Co-designed Resource Tool

To foster community building, the resource tool would also act as a multidisciplinary community connector for Black creatives to search for partnerships, collaboration, and engage in socializing about their creative practices. To overcome regional isolation, participants speculated on designs that could connect Black creatives across Canada, facilitating collaboration. Ideas were shared for maintaining content currency, who would be authorized to moderate content and how content might be moderated. However, additional research is needed to develop concrete ideas for a crowd-sourced resource tool and test them in the prototype.

5. CONCLUSION

The International Decade of Peoples of African Descent has sought to celebrate the worldwide contributions of people of African descent and "...advance social justice and inclusion policies, eradicate racism and intolerance, promote human rights, and assist in creating better, more prosperous communities" (United Nations 2015). This study increases the understanding of systemic barriers encountered by Black creatives and provides the evidence needed to create an equitable landscape and create funding opportunities and other resources for support.

This study contributes to the discourse on design's role in fostering positive societal change. The study's participatory co-design research methodology recognized the participants as subject matter experts with lived experience and knowledge to inform best practice. This study empowered participants to be agents of change. Our research shows that emancipatory research methods were effective in empowering Black

creatives to actively engage in speculative co-design processes with robust outcomes. The impact may be further enhanced when studies are conducted by researchers who can uniquely understand the lived experience of Black creatives. The Ubuntu philosophy was fundamental to how we designed this research, our work as researchers, and how we connected with those we openly invited to work with us. The Ubuntu approach to the research (i.e., fostering connectedness and humanity), African diasporic frameworks and research methods were purposely selected to foster participation and address general distrust of researchers by the Black community related to negative historical engagement and exploitation (Farmer, Jackson, Camacho, & Hall, 2007).

The research increases awareness of Black creatives' lived experience with racism and exposes anti-Black racism as a barrier to career progression. In exposing the way anti-Black racism is manifested in the creative sector policy makers have evidence to inform policy decisions that will more strongly advocate for resources to support Black creatives. Studies have shown that mere-exposure can affect preferences or aversions; the impact increasing with the amount of exposure (Bornstein & Craver-Lemley, 2017). Exposing the effects of anti-Black institutional racism on creating inequity, can lead to policies that reduce the barriers, advance diversity and inclusivity within cultural and artistic spaces to pave the way for more vibrant, creative cities in Canada (Canada Council for the Arts, 2021).

6. KEY RECOMMENDATIONS

Key policy recommendations emerging from the research and co-design sessions with Black creatives is Canada are shown in Table 2.

Table 2. Key Policy Recommendations

· Increase Black representation in Canadian arts councils
· Provide infrastructure and long-term funding for Black creatives live/work, studio & performing arts spaces.
· Align organizational procedures with equity and inclusion, recognizing the unique needs of Black creatives.
· Incentivize the development of Black-led creative hubs and Black cultural Centres including funding of networks for mentorship.
· Fund the development of Black theatres, galleries, Black arts marketplaces & collectives to showcase the work of Black creatives.
· Develop continuing education/training opportunities to address knowledge gaps in areas such as grant writing and business skills.
· Facilitate trans-regional connections/ partnerships with Black creatives and arts organizations across Canada.

7. LIMITATIONS

The researchers unsuccessful in recruiting Black creatives practicing in the Canadian Territories for this study. Therefore, their lived experience with racism, its impact on their career progression, as well as inputs on the co-design of resource tool remain unknown. More research is needed for user testing of the prototype of the co-designed resource tool.

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EXPERIENCE PROTOTYPING WITH AN EDUCATIONAL ROBOT PLATFORM: DEVELOPMENT AND PEDAGOGICAL REFLECTION FROM AN INTERACTION DESIGN COURSE

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ABSTRACT | Design students in higher education often lack hands-on understanding and tools for designing Human-Robot Interaction (HRI). While many commercially available educational robot platforms require users to have extensive training or prior experience, we developed ADA, an entry-level robot prototyping platform, for design students without any previous background in robotics and programming to better explore and conceptualize HRI design concepts in the early stages of design processes. This paper reports on the design and development of AIDA, along with our pedagogical reflections on its implementation with bodystorming techniques in an interaction design course over the past two years. Our findings show that using AIDA with bodystorming enabled students to rapidly prototype HRI concepts by tinkering with available materials, generate design concepts in situated contexts, and foresee potential unintended HRI consequences from a user's perspective. For platforms with similar goals, our study suggests that hardware and software accessibility is important for designers to easily conduct HRI concept exploration and prototyping. The tinkerability of the platform proves handy particularly when used in bodystorming for designers to identify interaction problems and rapidly prototype and test solutions. The in-situ perspective, where designers "become the robot" and dynamically switch between the roles of user and robot, facilitates a tacit understanding of what robots can and cannot do when interacting with users in their activities.

KEYWORDS | HUMAN-ROBOT INTERACTION, DESIGN EDUCATION, BODYSTORMING, PROTOTYPING, INTERACTION DESIGN

1. Introduction

Robotic applications are gradually permeating all facets of society and affecting people's everyday lives. The growing interest and recent advancements in embedding AI-powered features into robotic applications highlight the importance of future design education in Human-Robot Interaction (HRI). However, existing studies suggest that many higher education institutions are falling short in equipping design students with the necessary learning opportunities needed to develop hands-on skills for future HRI design challenges. When it comes to designing human interaction with robots and other types of smart products in everyday life contexts, designers often struggle to prototype and envision how these products can effectively solve user problems and how the interactions might be experienced by users (Holmquist, 2017; Yildirim et al., 2022; Zamfirescu-Pereira et al., 2021). Therefore, from a pedagogical perspective, design educators need to provide students with a comprehensive set of toolkits, comprising not only hands-on practical tools but also design techniques that can be applied with the tools, to better prepare students for HRI design practices.

In terms of hands-on tools, several commercial robot platforms, such as the Mbot robot, Lego Mindstorm, and NAO Robot, offer educational kits for users to learn to program and implement their robotic applications. However, in higher education contexts, these platforms are often used by dedicated researchers for research purposes or by teachers and students in STEM (Science, Technology, Engineering, and Mathematics) educational programs with a specific focus on developing programming skills and AI literacy (see e.g., Kumar, 2004; Williams et al., 2024). They are not specifically tailored to design education, where students may lack a solid knowledge background in robotics and programming. Moreover, these existing platforms might not fully students in design processes where the emphasis is on exploring the problem space and iterating on various design concepts rather than delivering a final engineering solution.

In terms of design techniques, this paper examines an instance where students prototype experiences using a robot learning platform. Experience prototyping is an

umbrella term for prototyping experiential elements or qualities of design situations (Buchenau & Fulton Suri, 2000). One type of experience prototyping techniques specifically suggested for exploring future technologies and contexts is Bodystorming (Oulasvirta et al., 2003) which is a technique where design questions represent "the phenomenon as a problem in the events, experience, and/or practices of users" (ibid., p. 126). The bodystorming technique was based on enactments and performances described by Burns et al. (1994), where hands-on approaches to problem solving were suggested.

To meet the need for design-oriented prototyping tools and techniques, we developed an entry-level robot prototyping platform called AIDA. The goal of AIDA is to support design students in developing a hands-on understanding of HRI, enabling them to better explore and conceptualize HRI design ideas in combination with bodystorming during the early stages of design processes. This paper reports on the design and development of AIDA and our pedagogical reflection on its use, combined with bodystorming, as an experience prototyping method in an interaction design course over the past two years. A total of 128 graduate students used AIDA to prototype HRI on the topic of autonomous delivery robots (ADRs), resulting in 26 group projects. We reviewed the project reports and analyzed the design processes and outcomes in relation to the use of AIDA.

This paper will briefly describe the development and key characteristics of AIDA. Following that, we will report on how AIDA was implemented in the interaction design course and the results from student projects. The paper concludes with our reflections on the effects of AIDA on students' learnings and practices of HRI, along with recommendations for future similar pedagogical explorations.

2. Related work

Designing HRI poses unique challenges for designers, as it requires a fundamental shift of view from a conventional command-and-response interaction model to an intervention-based interaction model (Schmidt & Herrmann, 2017). Robotic applications, powered by advanced features such as object recognition, object tracking, speech detection, and speech synthesis, are becoming increasingly autonomous. This autonomy spans multiple interaction stages, from acquiring information, analyzing and reacting to changes in the surrounding environment, selecting decisions, to implementing proper actions (Parasuraman & Sheridan, 2000). From an HRI point of view, interaction designers need to consider how to incorporate various interaction modalities, such as visual, verbal, and tactile, to effectively communicate robots' intentions to users during different stages of interaction. Moreover, the integration of AI further introduces another layer of complexity to HRI design. Robots with AI and machine learning capabilities often tend to give the misleading impression of being intelligent agents capable of independently

making decisions and performing actions. This misalignment between user expectations and the actual capabilities of robots thus challenges interaction designers to consider, in the early stage of the design process, how to position the role of robots in the specific users' activities in which they are intended to be used, and how to distribute and balance control between users and robots in various use contexts (Rozendaal, 2016).

Therefore, supporting designers in exploring various design concepts, rapidly prototyping robot behavior, and observing how proposed interactions might unfold from a user perspective is crucial for successful HRI design (Hartikainen et al., 2022; van Allen, 2018). With a broader perspective on the interaction between users and intelligent products, existing studies have pointed out that designers often face challenges in ideating, sketching, and prototyping intelligent system behaviors, particularly in the discovery and definition phases of the design process (Dove et al., 2017; Mccardle, 2002; Yang et al., 2020; Zhou et al., 2020). Translating the insights into HRI design, it is essential to support designers in:

- Articulating what robots can and cannot do to meet specific needs and address specific problems in user activities.
- Envisioning how people may react and respond to robots in various situations.
- Foreseeing potential unintended consequences of HRI.

To address the challenges listed above, we identified three key characteristics that an HRI prototyping platform should offer to enable interaction designers to better explore and rapidly iterate design concepts:

Encouraging tinkerability: According to Resnick and Rosenbaum (2013), tinkerability is a playful, experimental, and iterative process in which makers are encouraged to improvise with available materials during artefact-making. The focus of tinkering is not on producing a final prototype, rather, it is the process of tinkering itself that matters in design. The tinkering process consists of two main elements: 1). using readily available materials to freely craft prototypes, and 2). engaging participants – including both users and designers - in sharing their lived experiences during the prototype crafting process. The value of tinkering has been previously highlighted in interaction design. For instance, in the context of designing AI-powered products, van Allen (2021) stated that tinkering by conducting informal experiments to test different AI features helps designers gain a tacit understanding of the capabilities of AI, which serves as a fundamental step in the design of intelligent products.

Developing in-situ perspectives: Adopting an in-situ perspective can allow designers to directly experience how robots perceive and interact with the human world, which helps designers translate their insights into design concepts that better support users in their activities (Dow et al., 2005; Maulsby et al., 1993). For instance, in a study conducted by

Malsattar et al. (2019), design participants were provided with a prototyping tool to customize a chatbot to respond to different objects in various scenarios (e.g., garbage classification, mindful break reminders, and door-closing alerts). This prototyping tool enabled participants to see how objects were interpreted by the chatbot in real-time, allowing them to prototype interactions by directly setting chatbot messages, subsequently testing out the prototyped interaction on the spot. Similarly, Thellman et al. (2017) developed a VR-based wizard control interface with a motion-tracking system for robot operators/wizards to see what the robot sees. Devendorf & Ryokai (2015) developed a digital-physical hybrid fabrication 3D fabric printer that allows users to become part of the machine and co-produce artistic objects with the machine. These studies all highlighted that adopting an in-situ perspective not only helps designers better understand the specific contexts of user interaction with robotic and intelligent systems, but also enables them to develop an immersive and authentic sense of what it feels like to be a robot interacting with its users.

Accessibility: Many existing HRI prototyping platforms on the market feature advanced hardware and software control systems (see Table 1 for examples of commercially available robot educational and prototyping platforms). However, these platforms often require users to receive extensive training or technical background to be able to use them, making them less suitable for design education, where students usually lack the resources or technical expertise to master the complex operation of robotic systems. Therefore, to support design students in better exploring HRI concepts and developing prototypes, it is crucial that such a robot prototyping platform is both accessible and requires minimal technical skills from the user. One example is the mobile app-based tool *Object Responder* developed by Malsattar et al. (2019), which enables designers to rapidly prototype and test chatbot responses without needing to learn complex software control frameworks. Similarly, the social robot prototyping platform *FLEXI* allows designers to customize robot functions and appearances by using cardboard, 3D-printed accessories, and a set of electronic kits, providing an accessible and hands-on way to prototype the robot. (Alves-Oliveira et al., 2022a, 2020b).

Table 1: A list of examples of the existing commercially available robot educational platforms on the market.

Platform	Manufacturer	Release year	Goal/Targeted implementation case(s)	Technological features e.g., remote control, AI vision, speech synthesis)
Edision Robot V3	Microbric	2024	Learning programing (block and Python)	- Sensors for scanning ground lines and barcodes
Vex IQ (gen 2)	Innovation First	2021	Learning programing (block and Python, C++) Robot building	-Steering with game controller -Optical and proximal sensors
Thymio 2	Mobsya	2012	Learning programing (block and Python) Develop an understanding of AI/ML	-Sensors (proximity, ground line following, temperature) - Programable led lights microphone -Use prebuilt AI features/behaviours -Remote controller (tv-like) -Virtual robot simulator
Makeblock	Makeblock	2015	Learning programing (block	-Obstacle avoidance
mBot			and Python) Learning by playing games Develop an understand of AI /ML	-Pose recognition - Audio & image recognition (AI/ML) -Emojis on screen for display emotions -Remote controller (tv-like)

3. AIDA platform development

3.1 AIDA development and key characteristics

The concept of AIDA originates from a course project where a robot mock-up was built to represent the conceptual design of a receptionist robot. During the project, we learned that students faced challenges in finding suitable platforms for generating, representing, and prototyping their HRI design ideas. Without any access to any existing prototyping platforms, the students decided to build a robot mock-up using materials such as Lego and mobile phone screens to represent and test their design ideas.

Drawing insights from this student project, we recognized the need for a low-entry and hands-on robot educational prototyping platform to meet students' practical needs in their HRI design practices. AIDA was thus created to address the needs. Both the hardware setup and the remotecontrol application of AIDA have undergone three major iterations. The initial version, AIDA 1.0, was completed in May 2022. It comprises an off-the-shelf six-axis mini-industrial robot arm, a tablet attached to the arm, and a Raspberry Pi computer (see Figure 1). AIDA

1.0 is controlled via an Android app installed on the tablet, allowing users to manually operate the robot arm by inputting parameters such as position and angles, which are then transmitted to the Raspberry Pi for execution. In order to enable users to simulate robot behavior and responses, AIDA 1.0 also offers the user three entry-level AI-related functionalities: object recognition, allowing the system to recognize common objects; object tracking, allowing the arm to follow the movement of the designated object once marked; and speech synthesis, allowing users to specify speech input and output.

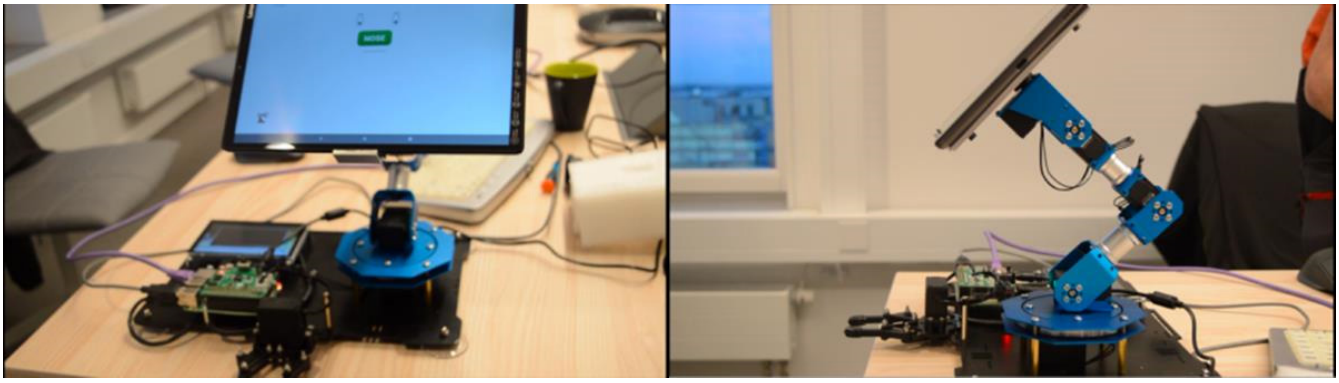

Figure 1: An overview of AIDA 1.0, which was developed in May 2022.

Following the initial development, AIDA underwent two more iterations (AIDA 2.0 and AIDA 3.0) between June 2022 and January 2023. A new base platform was integrated into AIDA 1.0, transferring it from a stationary platform to a mobile and portable platform AIDA 3.0 (see Figure 2). In addition, an off-the-shelf application was introduced to manage the motion control system of the mobile platform, allowing users to control AIDA via a phone or tablet. Another important upgrade in AIDA 3.0 is its modular design feature. With plastic pallets and 3D printed clips on the mobile base, users can easily attach various add-ons, including a mini-industrial robot arm, mobile network modules, multiple cameras, lightweight lidars, speakers, and mini projectors, onto the platform. Furthermore, the remote-control app allows users to access real-time video and lidar feeds from the sensors mounted onto the platform. Figure 2&3 shows an overview of AIDA 3.0 (hereinafter directly referred to as AIDA) with various add-ons and a full list of available input and output devices. In summary, AIDA consists of:

- Detachable mini-industrial robot arms that can be placed on top of the platform.
- A tablet that can be attached to the robot arm, acting as the “head”.
- A mobile base platform serving as the main frame or “body”, featuring a modular structure.
- Various input and output devices/add-ons that can be mounted to the main frame.
- Remote control apps for controlling the behavior of both the mobile base platform and the robot arm.

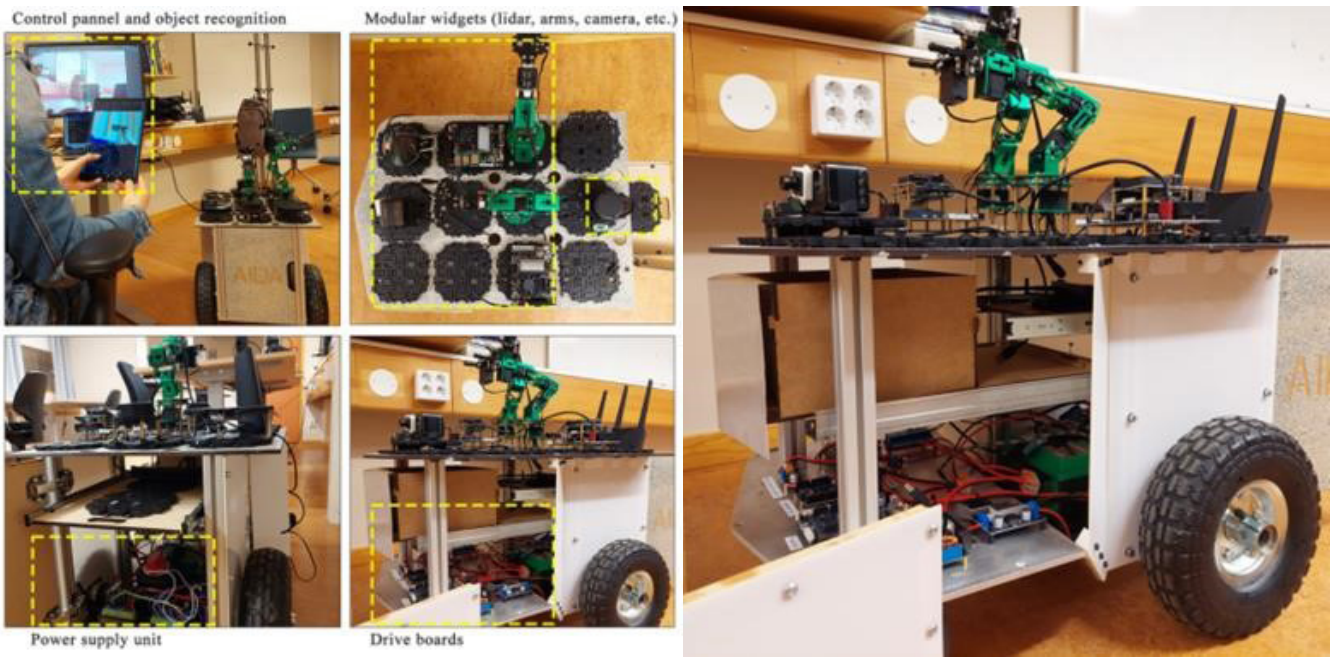

Figure 2: An overview of AIDA 3.0, which was completed in January 2023.

The design and development of AIDA was guided by three key principles: encouraging tinkerability, developing in-situ perspectives, and ensuring accessibility.

· Encouraging tinkerability: AIDA's modular design, both in its hardware and user control system, allows design students to easily add input and output devices, as well as the corresponding remote-control applications of the devices, to adapt to the specific needs of each design case and scenario. For instance, if students want to add a lightweight lidar sensor to AIDA, they can simply clip the lidar onto the plastic pallets atop AIDA and connect it to AIDA's main computing board. This tinkering process is designed to be as simple and intuitive as possible with only a few steps for configuration. Students don't need to have any prior knowledge of mechanical engineering or computer science to modify AIDA's setup.

· Developing in-situ perspectives: Building upon the tinkerability feature, AIDA also

· facilitates the designers to embody the roles of the "robot" and develop more authentic experiences, via visual and auditory means, of how robots perceive the surrounding environment and user actions. This enables students to simulate robotic responses in real-time, creating more immersive and situated environments for students to understand HRI from different perspectives.

· Ensuring accessibility: By incorporating off-the-shelf robotic components into the hardware and software system of AIDA, we aim to lower the technical bar for student designers to quickly and easily deploy the platform. AIDA's remote control app also allows students to employ commonly used HRI design methods such as Wizard-of-Oz (see e.g., Goncalves Freitas et al., 2021;

Green et al., 2004; Zamfirescu-Pereira et al., 2021) and marionette/puppeteering (e.g., Wang et al., 2017) to rapidly prototype and test various design concepts.



Figure 3: Left: AIDA with various detachable sensors. Right: The remote-control apps and station of AIDA.

4. AIDA implementation in a course

AIDA was deployed in an interaction design course given to design graduate students in 2022 and 2023. Most of the students had little to no prior experience of working on HRI. The course aims to help students combine theoretical knowledge on design methods, reflection, and criticism with various practical design activities, including sketching, bodystorming, storyboarding, prototyping, and user testing, to better understand how to work with design problems and develop alternative design solutions.

As part of the course, students were given the group design project and individual design project assignment on designing user interaction with Autonomous Delivery Robots (ADRs). Students were asked to follow the Double Diamond design process in their projects. In the first phase of the project, they collaborated in groups during the discovery and definition stages to identify problems and explore design alternatives. In the second phase, students worked independently during the development and delivery stages to refine their design concepts and evaluate

final prototypes. AIDA was mainly used with bodystorming to facilitate divergent thinking. Specifically, it was used with the goal of supporting students in exploring the problem space during the discovery stage and generating ideas to tackle the identified problem during the development stage.

In the course, bodystorming sessions with AIDA were conducted in two separate teaching sessions. Each teaching session lasted approximately two hours. The first session was held indoors in a classroom and corridor setting, while the second session took place outdoors, simulating real-world environments where human interactions with ADRs may take place. During these bodystorming sessions, each group took turns using AIDA. All AIDA widgets were made available for the students to choose from. Additionally, students were provided with common design ideation props such as postit notes, cardboard, tapes, chenille stems, and plastic foams, which can be used alongside AIDA during their bodystorming sessions.

5. Methods and materials

To gain a better understanding of how AIDA supported and affected both the design processes and outcomes of students' HRI design, we conducted a systematic review and analysis of the groups' project reports.

In terms of the design process, students summarized insights from relevant literature and reflected on their learnings regarding the use of different design techniques, such as sketches, bodystorming, storyboarding, and prototyping, in their projects. Our analysis focused on three main questions concerning the design process: 1). How was AIDA employed in the design process? 2). How did AIDA facilitate the exploration of HRI problem space? and 3). How did AIDA contribute to generating different HRI concepts? In terms of design outcomes, we examined not only the final design proposals but also the problem formulations, statements, and design alternatives students generated throughout different stages of the design process. Our analysis focused on three main questions regarding the design outcomes of each project: 1). What were the overall problem formulations, statements, and design alternatives proposed in the project? 2). How did AIDA contribute to informing or influencing these design outcomes? 3). Were there any limitations or constraints that AIDA may have imposed, and if so, what were they?

We conducted a thematic analysis of the data collected from the reports, following guidelines adapted from Braun and Clarke (2006). First, relevant raw data were extracted from the reports into an Excel document. We then labeled the data with different codes. These codes were subsequently grouped into themes, which were further reviewed, refined, and linked to the aim and research question of this study. It is worth noting that since AIDA was primarily used in bodystorming sessions, we did not intend to separate the effects of AIDA from the effects of bodystorming as a design technique. Instead, we evaluate them collectively as part of the same process.

6. Student project results and pedagogical reflections

128 students have used AIDA (53 in 2022 and 75 in 2023) to design user interactions with ADRs, resulting in 26 group project reports. The students were in their fourth year of design and product engineering studies. The design concepts generated in student projects mainly cover the following topics on users' interaction with ADRs:

- Delivery monitoring: Facilitating the interaction between ADRs and pedestrians, while providing end users with updates on the robot's status and real-time location.
- On-site meet-up: Helping end users locate the robot at the designated delivery site.
- Item retrieval: Assisting end users in retrieving items from the robot's storage
- compartment
- Delivery confirmation: Ensuring users can confirm the successful delivery and retrieval of items before the robot departs.

6.1 Foresee the potential unintended consequences from a user perspective

Nearly all the groups reported that using AIDA during bodystorming sessions supported them in foreseeing scenarios where potential undesired or unexpected outcomes of HRI could take place. By acting out their scenarios with AIDA, students were able to further break down the scenarios into more specific problems that users may encounter when interacting with ADRs in different contexts. For instance, what if the ADR arrives at the delivery destination, but the user struggles to locate it; what if the user accidentally sends the command for the ADR to open its storage compartment while the delivery is still in progress; or what if the ADR initiated its return sequence before the user has retrieved all the items.

These potential undesired HRI scenarios later became central to the design solutions the groups explored. One group of students noted, *"New problems could be identified that the group had not previously considered. The problems discovered were documented to form the basis of potential solutions during idea generation."* A list of "what if" HRI scenarios generated by students is shown in Table 2.

Table 2: A list of "what if" HRI scenarios that may lead to unintended outcomes.

Delivery monitoring	AIDA gets stuck by road obstacles; it is looking for human assistance.
	AIDA is blocked by other pedestrians on the street who are curious about it.
	The end user is worried exactly when and where AIDA would arrive.
Meeting on-site	The end user cannot find AIDA on the delivery site.
	For how long AIDA should wait if no one comes to pick up the parcel.
	AIDA has arrived but is in a place that is hard to spot.
	When there is multiple AIDA presence at the same time, the end user is likely to get confused about which AIDA is carrying their parcels.
Item retrieving	The QR code on AIDA is damaged, preventing users from scanning it to unlock the transport compartment.
	AIDA closed the lid before the package had been picked up.
	AIDA opened the transport compartment without users being there.
Delivery confirmation	The lid of the transport compartment won´t close or the user forgets to close it after retrieving the parcel.
	The end-user walked away from AIDA without fully acknowledging the completion of the delivery process.
	AIDA left before the end user has retrieved all the parcels.

6.2 Articulate what robots can do and cannot do in user activities

During the bodystorming sessions, we provided students with additional design materials for prototyping interactions with AIDA. The materials can be divided into two groups: 1). electronic widgets that can be mounted onto the AIDA platform, such as cameras, speakers, lidars, mini robot arms, and 2). props commonly used in design ideation, such as post-it notes, pens, chenille stems, and cardboard.

In terms of tinkering with electronic widgets on AIDA, we observed that students used various widgets and integrated them into AIDA to generate different HRI design ideas in bodystorming sessions. Examples include mounting a panoramic camera on AIDA which allows end users to view what the ADR is seeing in real-time through an app; adding an external speaker for users to play sound in case they could not spot it at the delivery site; Creating a mock-up of a weight scale that automatically detects whether the delivery item has been taken out from ADR's storage compartment; conceptualizing electronic locking mechanism capable of automatically opening, closing, locking, and unlocking the compartment through motion-detecting sensors.

In terms of tinkering with design props, we found that the tinkerability feature of AIDA allowed students to explore different HRI modalities and expand their design solution space. For instance, in a scenario where users forget to close the storage compartment lid and confirm delivery completion, students

developed concepts of using both auditory and visual feedback for the ADR to remind users of this missing action. As for visual modality, post-it notes with "Close me when done" were placed on the lid of the storage compartment, simulating how a digital screen would display text to users. Other props, such as paper and chenille stems were also applied on AIDA to mimic physical buttons and LED lights that change color in response to user actions. Moreover, one group used cardboard to represent a digital screen with various facial expressions to convey the ADR's emotions and system status to users. As for auditory modality, some groups added external speakers onto AIDA to play confirmation sounds once the delivery has been confirmed by users. Similarly, another group used speakers to simulate speech prompts, such as "waiting to be unlocked" when the robot is waiting for users to unlock the storage compartment, "box open" when the compartment is about to open, "thank you, have a nice day" upon confirmation of the delivery.

Reflecting on the use of the electronic widgets and design props on AIDA, we found that AIDA's tinkerability enabled students to explore and articulate what robots may or may not be capable of in supporting user activities, as one group stated: *"We came to the conclusion that there are many possibilities for creating clear communication for end users, and it can be beneficial to use sound, light, and images."* Similarly, another group noted that *"with the use of props such as cardboard cell phones (showing the actor different steps of the interactive sequence), the actors and people analyzing the interaction could more easily find flaws in the interactive sequence and take note of where flaws may arise."*

6.3 Envisioning how users may respond to robots in situated contexts

Engagement and improvisation were frequently mentioned by students when describing their experiences using AIDA to identify HRI problems and generate design concepts. The process of problem identification and concept generation in bodystorming sessions with AIDA often followed an iterative pattern. Initially, students started identifying HRI problems through bodystorming with AIDA, which led to various early-stage design ideas. Leveraging AIDA's tinkerability feature, the proposed design ideas were quickly turned into low-fidelity prototypes for implementation and user testing. After that, the feedback gathered from these "quick and dirty" tests often informed the discoveries of new HRI problems, which in turn further led to another iteration of concept generation and problem identification.

This rapid problem identification and prototyping that the students demonstrated in their HRI design process was facilitated by the in-situ perspective that AIDA aims to bring to its users. As previously presented, the in-situ perspective, as one of the three core design principles of AIDA, allows designers to operate the platform in a situated context, enabling them to embody the role of the

robot and simulate robotic responses by directly manipulating the robot in the scene. We observed that the dynamic switching of perspective between robots and users in situated contexts helped design students understand, envision, and test interaction sequences from both the end user and the robot viewpoints. The effects of this perspective switching in situated contexts through AIDA, as documented in student's reports, are twofold. Firstly, building upon the "what if" scenarios students previously identified in their bodystorming sessions, prototyping with AIDA enabled students to gather feedback and identify the potential problems that may emerge in their design concepts from a user perspective. One group explicitly stated, *"Bodystorming sessions were held where the group was able to test and get immediate feedback from our design ideas as well discovering new flaws in the systems that the group did not previously think of."* Another group shared similar insights: "*To continue breaking down problems, the process continued with brainstorming and discussion to map out solutions to different scenarios perceived. This resulted in many solutions where additional problems emerged which should be addressed"*. For example, faced with the scenario where a user struggles to locate the ADR's exact location at the delivery site, one group initially proposed using sound as an auditory cue to guide users. However, after testing this idea on AIDA in the actual context, the group quickly realized that this idea might be ineffective in environments with significant background noise. Thus, they expanded their solution to include other interaction modalities, such as allowing users to access the camera view of the ADR and observe the surrounding area, making it easier for users to find the robot.

Secondly, AIDA's tinkerability enabled students to easily engage in "quick and dirty" prototyping on AIDA in situated contexts. One group pointed out that *"the bodystorming session focused on creating physical mock-ups and prototypes which represented AIDA's functionality. By doing this we created a space which allowed the group to play with and interact with the ideas in a more performative way than just merely discussing which functions that AIDA should contain and provide, which allowed the users to use their imagination in a more performative way as well."* For example, with a focus on designing interaction for users to unlock the ADR's storage compartment, one group initially proposed the concept of using a numerical code input panel for users to type in the code they received from their delivery service provider. After the group prototyped AIDA with props to simulate their envisioned user input behavior and subsequently tested the prototypes in the bodystorming sessions, they quickly discovered unexpected problems in the user interaction flow, such as what would happen if the user accidentally entered the wrong code multiple times. This led them to immediately start improvising the solution on the spot with AIDA.

6.4 Limitations imposed by AIDA

We found that students generally appreciated using AIDA in their bodystorming sessions to identify potential HRI problems that may occur and explore corresponding design concepts for solutions. As previously mentioned, this problem identification and solution process is supported by AIDA's tinkerability, in-situ perspectives, and accessibility features. However, the current technological constraints within AIDA's hardware and software set-ups may also impose limitation to the design space and the quality of HRI concepts that students explored. One group of students elaborated on this issue, noting that AIDA may have *"applied an inadvertent psychological limit to the imagination of the designers, further limiting the possible solutions due to some potential ideas never being explored due to this prerequisite."* Although AIDA's current limited technological capabilities meant that students could not explore certain HRI concepts in depth, it still served as a window for design students to peek into what robots can do and cannot do in addressing specific problems in human activities. For instance, several projects explored issues such as verifying users' identities, ensuring the correct delivery of goods, guiding users to correct locations, and considering the impact of external factors including weather and road conditions, which were made possible by combining the use of AIDA and the bodystorming technique.

7. Conclusion and future work

In this study, we developed AIDA as an entry-level robot prototyping platform to help design students better explore and conceptualize HRI design ideas during the early stages of the design process. This paper reports on the design and development of AIDA, along with our pedagogical reflection on the implementation of AIDA with bodystorming technique in an interaction design course over the past two years. Our findings show that using AIDA in combination with bodystorming enabled students to:

- Rapidly prototype HRI design concepts by tinkering with available props and materials,
- Generate design concepts in situated contexts,
- Foresee potential unintended consequences of HRI from a user perspective.

In addition, we found that AIDA allowed design students to embody the role of "robot" by directly simulating and improvising robotic behavioral responses in real-time on the scene. This feature enabled them to dynamically switch between the perspectives of the robot and the user to better understand and design interaction sequences from both viewpoints. However, we also found AIDA may pose limitations to design outcomes as the current technological setup of the platform might restrict students from exploring certain HRI design concepts in depth.

Overall, this study highlights the importance of employing entry-level robot prototyping platforms in combination with experience prototyping techniques to enhance students' hands-on understanding of HRI. Our findings and reflections suggest that, when developing similar HRI prototyping or educational platforms in the future, hardware and software accessibility of the platform is essential for facilitating the exploration and prototyping of HRI design concepts. Tinkerability of the platform is handy for designers to identify interaction problems and rapidly test solutions. Moreover, offering an in-situ perspective allows designers to "be the robot" and dynamically switch between the roles of user and robot, fostering a tacit understanding of what robots can and cannot do when interacting with users in human activities.

In terms of the future development of AIDA, we plan to continuously upgrade the technological capabilities of the hardware and software of the platform to meet the diverse needs of HRI design prototyping. This includes expanding the range of input and output devices connected to AIDA, as well as better leveraging the platform's modularity feature. Besides, we also aim to incorporate more AI-powered features, such as advanced object recognition and speech synthesis, into the software system and the remote-control app of AIDA. Future research projects will involve conducting workshops and gathering insights from professional design practitioners to further explore how AIDA can be used to support HRI design in industry settings.

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ONLIFE. EXHIBIT DESIGN IN THE TIME OF THE MANGROVE SOCIETY.

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ABSTRACT | The paper focuses on onlife exhibit design, a design mode in which digital technologies, Artificial Intelligence and the Internet of Things, are integrated with exhibition design strategies that enable the interconnection of physical and digital spaces, trying to outline new innovative approaches by understanding how Extended Reality (XR) can create new levels of interaction between exhibit and visitor. Designing exhibits with an onlife perspective would create a circularity between the different interaction contexts: generating not only “enriched” paths for the public, but creating temporary exhibitions that thanks to “the introduction and technological advancement related to the diffusion of new technologies make it possible to experiment new levels of interactivity and involvement of visitors in the exhibition spaces” (Del Puglia S. 2022) An exhibition today is a conscious spatial arrangement of a more or less coherent set of objects which, on the basis of more or less succinct selection criteria, will enter into a documentary interrelation for the duration of the event. This interrelation, according to the intentions of the book Narrative Spaces, “will produce a cohesive narrative potential capable of giving the whole its expressive power and clearly addressing the audience. Other perspectives may of course be valid, but since the exhibition is the result of an interdisciplinary effort, we opted for a formula that involves all parties involved in the realisation of exhibitions, regardless of the conventions of the profession or the various backgrounds of the experts in the field. In this way, it is intended to establish a common central position that, for the sake of the medium itself, will push the boundaries and lead to greater collaboration between disciplines’. (H. Kossmann, S. Mulder, F. den

Ousten, 2012) In order to investigate how the technologies is changing our lives, the philosopher Luciano Floridi coined the word Onlife, a neologism that serves to indicate that in most industrialised societies there is a fusion of online and offline, digital and physical. “These are not two distinct worlds but two inextricably intertwined layers that inevitably have strong repercussions on experience design as well.” (Floridi L., 2017)

Since 2004 Dotdotdot has been investigating and implementing strategies to create true experiential exhibitions, refining project after project their digital know-how in the service of storytelling; consolidating an approach to exhibition design and digitalisation by outlining new paradigms and proposing innovative types of storytelling and visitor experience. In Italy there are a multitude of small realities, such as archives, which through digital exhibitions can become an important means and resource to tell their story, their connection with a territory, their research activities and transformations that, without digital technologies and Interaction Design, would remain inaccessible. The ambition is to demonstrate how new technologies and communication methods can showcase any type of subject matter, making it accessible and comprehensible to everyone. By providing a more in-depth and focused contribution to the field, for find a new approach for emphasizes the potential to amplify the value of exhibition content. It confirms that experience and interaction are indispensable elements in the creation and successful engagement of an exhibition.

KEYWORDS | DIGITAL, ONLIFE, TECHNOLOGIES, EXHIBIT, NEW MEDIA

1. Redefining experience: the intersection of real and virtual spaces in post-pandemic design

The need to investigate at a critical and design level aspects of the multiplicity of bodies and spaces and their interactions stems from Maldonado's reflection on the meaning of the word virtual and the relationship between real and virtual space. « He seeks the meaning of illusory reality, in which man produces images that he deludes himself into believing to be real. A practice that goes back to primitive man's ability to depict symbolic worlds rather than a novelty triggered by technological progress »[1]. (Maldonado T., 1992)

The sudden push of the Covid-19 pandemic updates the theme by bringing our physical bodies into virtual spaces for interaction. The field of post-pandemic exhibit design has sought to understand the ongoing change and develop new designs without sacrificing the value of experience. To enable a clear reading of this, philosopher Luciano Floridi coined the word Onlife a neologism that serves to indicate that in most industrialised societies there is a fusion of online and offline, digital and physical. « These are not two distinct worlds but two inextricably intertwined layers that inevitably have strong repercussions on experience design as well ». (Floridi L., 2017). Hsin-Chien Huang, an internationally renowned artist specializing in the creation of immersive content and artworks that combine virtual reality, interactive elements, performing arts, and installation art, to better define his approach to art and new media, during the conferenc[2]e held on November 9th at the MEET Digital Culture Center in Milan, briefly presented the history of digital tools, highlighting how the technological and communication sectors have shifted from a storytelling-focused rhetoric to what he calls « story-living ». Hsin-Chien Huang thus focused

[1] Maldonado, T. (1992). Reale e virtuale. Milano: Feltrinelli.

[2] Floridi, L. (2017). *La quarta rivoluzione: come l'infosfera sta trasformando il mondo*. Milano: Raffaello Cor>na Editore.

on how the distance between viewers and digital content, and hence the screens, has shortened, from 4-5 meters in cinemas, to 15-20 centimeters with smartphones, down to 2-3 centimeters with VR headsets. He emphasized how this change is related to the increasing level of interactivity demanded by users. « People no longer want to be spectators », explains the artist, « they want to be closer to the content they consume, they don't want to just hear a story, they want to be part of it, to participate in it. For this very reason, in my work, I use new media and virtual reality to define an artistic and narrative experience where interaction absorbs the reader's thoughts and memories, as if they were playing a video game, thus making them the protagonist of the story, a part of the Art itself »[3].

2. Bridging worlds: the role of bodily presence in onlife exhibitions

The 'onlife' exhibition mode represents a crucial development direction for the future. Through careful planning and development, an onlife exhibition can contextualize cultural objects, including those impossible to display physically, to communicate through a tailor-made narrative. A key element to consider is the concept of 'sense of presence,' which plays a key role in generating a strong connection between people and the virtual environment. Unlike the traditional physical exhibition space, where exhibitions were predominantly static, the digital environment offers an enhanced experience to the public. Maurice Merleau-Ponty, a phenomenological philosopher, placed significant emphasis on the importance of bodily experience in acquiring knowledge and perceiving the world around us. In his main work, Phenomenology of Perception, Merleau-Ponty argues that « the body is not simply an object in the world, but rather the instrument through which we experience and understand the world itself »[4].

According to the author, our experience of reality is intrinsically linked to our bodily experience, to "gestures," as it is through our senses and bodily perceptions that we come into contact with the surrounding environment. Consequently, the body acts as the bridge between our consciousness and the external world, becoming our « first and last reality » as it is the foundation upon which all our experience and understanding of the world are based.

The concept outlined by Merleau-Ponty is particularly relevant in the context of communication and art as it emphasizes the importance of considering the body as an integral part of the design process and, therefore, of understanding the content.

[3] Rossi D. (2023). *Hsin-Chien Huang, il media guru che coniuga il gaming con la cultura taiwanese*. Retrieved November 13, 2023, from hHps://www.elledecor.com/it/tech/metaverso/a45818890/hsin-chien-huang-storia-opere/

[4] Merleau-Ponty M. (2003). *Fenomenologia della Percezione*, Feltrinelli, Milano, p.120

Nicolas Bourriaud, French art critic and philosopher, argues that « gestures are not only means of individual expression but also tools for creating connections and meaningful relationships between artists, artworks, and the audience »[5]. It is well known that the chosen medium for communication is not simply a vehicle for transmitting content, but profoundly influences the way the content itself is perceived and interpreted, as Marshal McLuhan, a sociologist and author famous for his statement « the medium is the message »[6] asserts. If we apply this theory to the concept of "gesture" in the context of exhibit design, we can consider the human body both as an actor, in the case where the visitor is called to actively participate in an action, and as an audience, when it becomes merely a spectator of an activity that conveys meaning. In both cases, the "gesture" becomes a carefully designed element to foster meaningful interaction with the content of the event.

With the advent of the Internet, not only has the approach to exhibition design changed, but there has also been a questioning of the value of the exhibition venue. In the past, the location was simply a frame for the exhibition, but now it becomes not only a container but also a content that interacts and connects with both the audience and the exhibition and the object itself.

to redefine cultural spaces to adapt them to the social and economic context of the coming years. This challenge can be addressed through the new design approach of Exhibit Design Onlife. The digital environment offers the opportunity to make cultural content accessible in innovative ways, thanks to immersive strategies and immersive technologies such as artificial intelligence (AI), augmented reality (AR), mixed reality (MR), visors, interactive displays, dynamic lighting, eye-tracking, stimulating visitors through entertainment, education and training, taking advantage of new technological resources. In addition, the digital integration of temporary exhibitions enables seamless circular experiences: the experience can start at any point and continue without interruption, offering the public richer experiences. Today, studios such as Dotdotdot, Art+com, and AKQA are recognized as leaders in interactive, immersive, and digital exhibit design. Their work demonstrates how to create truly interactive exhibits and experiences by leveraging new technologies and tools to support storytelling. These studios effectively create synergies between tools, content, and visitors

[5] Bourriaud N. (1998). *EsthéAque relαAonnelle*, Les Presses du Réel, Parigi, p.87 - in Merleau-Ponty M. (2003). Fenomenologia della Percezione, Feltrinelli, Milano, p.168

[6] Cfr. McLuhan M. (2023). *Gli StrumenA del Comunicare*, ilSaggiatore, Milano, [McLuhan M. (1964). Understanding Media: The Extensions of Man, McGraw-Hill, New York]

3. From physical to digital: how technology is shaping the future of cultural exhibitions

The research in this work is essential and the inspirations come from many directions, from the world of art to the world of technology, and of course design and architecture. The advent of technologies and innovations has not erased the physical vision of temporary exhibitions or museums, but rather added to it a digital space that is complementary to them, providing technologies and services to enhance the visitor experience, creating an alternative space in which the various cultural actors can interact with each other (Teece, 2018)[7]. These are exhibitions that put the viewer at the centre, no longer the work of art, focusing on arousing emotions and involving the viewer in all his senses. They are therefore easy to enjoy, and involve a broader segment of viewers. With immersion and interaction tools, in which the visitor is immersed in a new world, in which works of art are projected onto the walls, ceilings and floors of museum rooms, accompanied by audio narratives or matching music. Today, technology is a presence taken for granted when enjoying exhibitions, but if the use does not meet our expectations, we are disappointed. Since 2004, the Italian-based studio Dotdotdot has been investigating and implementing strategies to create true experiential exhibitions, refining their digital know-how project after project in the service of storytelling.

They have consolidated an approach to exhibition design and digitization by outlining new paradigms and proposing innovative types of storytelling and visitor experiences.

Dotdotdot emphasizes, “we design innovative human experiences”. In Italy, there are a multitude of small realities, such as archives, which can become important means and resources through digital exhibitions. These digital platforms enable them to tell their stories, showcase their connection with their territories, and highlight their research activities and transformations, which would remain inaccessible without digital technologies and interaction design. The incorporation of new technologies into the promotion of culture, the on-site experience, and the approach to exhibition design has fundamentally transformed how exhibitions are conceived, presented, and experienced. These advancements have expanded the reach and impact of cultural institutions, making art and culture in general more accessible and engaging for a diverse audience. By embracing digital innovation, exhibition designers can create more interactive, immersive, and memorable experiences that resonate with visitors and foster a deeper appreciation of culture. The application of new technologies has predominantly revolutionized three different areas: the promotion of culture, the on-site experience, and the approach to exhibition design.

[7] Teece D.J. (2018) *ProfiAng from innovaAon in the digital economy: enabling technologies, standards, and licensing models in*

4. Digital transformation in exhibition design: enhancing cultural promotion, on-site experiences, and design approaches

4.1 Promotion of Culture

In the realm of exhibition design, the promotion of culture has been profoundly transformed by digital technologies. Museums and galleries now leverage social media, virtual tours, and interactive websites to attract and engage a global audience. Digital platforms enable institutions to showcase their exhibitions far beyond their physical locations, reaching audiences who might never visit in person. As Alessandro Baricco aptly puts it, « The challenge today is to build experiences, not just to provide information »[8]. This shift underscores the importance of creating engaging and memorable cultural experiences through digital means.

Virtual tours, for instance, can offer a preview of exhibitions, enticing potential visitors to experience them physically. Additionally, social media campaigns can highlight key exhibits, share behind-the-scenes content, and facilitate online discussions, thus generating buzz and fostering a deeper connection with the audience. Matthew Ball, a leading thinker in the digital space, notes that « the virtual world can extend the life and reach of physical exhibitions »[9]. This digital outreach not only amplifies the cultural institution's visibility but also creates a dynamic and interactive platform for cultural promotion, making art and history more accessible and engaging.

"Ore Streams" is an ambitious investigation into the recycling of electronic waste developed by Formafantasma over the course of three years. First as a commission at the NGV2 Triennial in Melbourne in 2017, curated by Ewan Mc Eoin and Simone Le Amon, and then in 2018 for the XXII Triennale 'Broken Nature', curated by Paola Antonelli (senior curator of Architecture and Design at MoMA in NY). It uses a diversity of media (objects, video documentaries, and an animation) to address the topic from multiple perspectives, and reflect on how design could be an important agent for more responsible use of resources[10]. In the case of this study, the theme "sustainability" as the theme of exhibition is represented by the figure of the designer which is evolving, oriented towards the concept of ecological transition.

[8] Baricco A. (2018); *The Game*, Torino, Einaudi Editori.

[9] Ball M. (2022); Metaverso - cosa significa, chi lo controllerà e perché sta rivoluzionando le nostre vite; Milano, Garzan>, 2022 the wireless world, Research Policy, 47(8). DOI: https://www.sciencedirect.com/science/ar>cle/pii/S0048733318300763 (open access).

[10] Valenti A., Trimarchi A., Farresin S. (2023); Design e pensiero Ecologico; in Agathon n.13, pag. 19-30. (hHps://www.agathon.it/agathon/ar>cle/view/342/376)

A dynamic in continuous movement, as Andrea Trimarchi and Simone Farresin argue that the concept of transition is stimulating because it represents a condition of continuous change, which reflects how we should live today (2022). Humans have mined the Earth's surface for millennia in search of metals and minerals to fulfill production demands. In fact, forging metal changed the course of history: bronze empowered humans to weaponize, and gold facilitated local, then global, trade. At this very moment, new cavities are being hollowed out, while existing excavated sites are abandoned or refilled with new Earth – a superficial recompense. By 2080, the most significant metal reserves will not be underground but above the surface, as ingots stored in private buildings or otherwise circulated within products such as building materials, appliances, furniture, and consumer electronics. Imagining the future, what would archaeologists of tomorrow think of our era if they were to explore the sites of our current cities? They would encounter numerous landfills filled with waste, as argued by Marianna van Helvert[11] (2019). The eighteen channel Ore Streams video installation aims to offer global strategies for the design of products that lend themselves to more efficient repair and recycling. It includes a series of interviews the Studio conducted with practitioners in the recycling sector, including European e – waste recyclers, academic researchers, electronics producers, NGOs working in developing countries, and members of Interpol. The installation also includes a video collecting historical and contemporary examples of planned obsolescence in electric and electronic objects at the centre of class – action lawsuits. One video explains recycling systems and technologies for sorting waste, and two videos show a selection of electronic products being carefully disassembled and recomposed. In the animation, Formafantasma uses 3D rendering to visualize possible strategies to improve repairing and recycling[12].

[11] Van Helvert M. (2019). The Responsible Object: A History of Design Ideology for the Future. Berlin, Valiz, pag. 220. 12 Valen> A., Trimarchi A., Farresin S. (2023); Design e pensiero Ecologico; in Agathon n.13, pag. 19-30. (hHps://www.agathon.it/agathon/ar>cle/view/342/376)

[12] Teece D.J. (2018) Profi>ng from innova>on in the digital economy: enabling technologies, standards, and licensing models in the wireless world, Research Policy, 47.

4.2 On-Site Experience

The on-site experience of exhibitions has undergone a significant transformation with the integration of Digital technologies in exhibition design. Interactive displays, augmented reality (AR), and virtual reality (VR) have revolutionized how visitors interact with exhibits. For instance, AR can overlay historical context onto artifacts, providing deeper insights and a richer understanding. According to David Teece, « Technological advancements are not just tools, but enablers of new ways of thinking and experiencing»[12]. This highlights how AR and VR can immerse visitors in historical events or artistic environments, creating an experiential narrative that goes beyond traditional static displays. Interactive touchscreens and multimedia installations allow visitors to engage with content in a hands-on manner, making the learning experience more dynamic and personalized. These technological advancements ensure that the on-site experience is not only informative but also immersive and memorable, enhancing visitor engagement and satisfaction. The ability to tailor experiences to individual preferences and learning styles makes the exhibition more inclusive and appealing to a broader audience.

The ArtScience Museum of Singapore, in 2019, for example, has design an immersive experience and interactive exhibition based on stunning content from “Our Planet”, a new Netflix original documentary series, created in partnership with the World Wide Fund for Nature (WWF). “Our Planet” is an eight-part documentary series from the team behind “Blue Planet” and “Planet Earth”, released on 5 April 2019 on Netflix, filmed over four years in 50 different countries. The exhibition “REWILD Our Planet” then uses cutting edge technology to transport you into the landscapes featured in this ambitious documentary. At the exhibition at ArtScience Museum, people were able to dive into the deepest oceans, visit the most remote forests and take a journey over vast ice caps. Blending stunning IMAX style projections with spatial soundscapes and a soundtrack. This is Singapore’s first Augmented Reality social experience which allows multiple visitors to interact with digitally-created environments, whilst examining how climate change impacts all living creatures[13].

[12] Teece D.J. (2018) Profi>ng from innova>on in the digital economy: enabling technologies, standards, and licensing models in the wireless world, Research Policy, 47.

[13] Cfr. Rewind our planet (2019) Comunicato stampa. URL hHps://www.marinabaysands.com/museum/rewild-our-planet.html 15 Baricco A. (2018); The Game, Torino, Einaudi Editori.

4.3 Approach to Exhibition Design

The approach to exhibition design itself has been revolutionized by new media technologies. Designers now have access to advanced tools and software that allow for greater creativity and flexibility in planning and executing exhibitions. Projection mapping, for instance, can transform ordinary spaces into dynamic, immersive environments that change in response to the narrative being presented. Alessandro Baricco's concept of « narrative intelligence »[15] is highly relevant here, as it emphasizes the need to weave compelling stories that resonate with the audience through innovative use of technology. It plays a crucial role in the modern approach to exhibition design. Baricco posits that narrative intelligence is the ability to understand, create, and use stories to make sense of the world around us. This concept extends beyond traditional storytelling, encompassing the use of narratives in various forms of media and communication to engage and educate audiences. In the context of exhibition design, narrative intelligence involves crafting a cohesive and compelling story that ties together the various elements of an exhibition[14]. This can include the physical artifacts, digital displays, interactive elements, and overall thematic structure. By weaving these components into a unified narrative, designers can create a more immersive and emotionally resonant experience for visitors. Baricco emphasizes the importance of creating narratives that are not only informative but also emotionally engaging, as this connection can significantly enhance the impact of an exhibition. For example, in a historical exhibition, narrative intelligence might involve creating a storyline that follows the journey of a particular individual or community, using artifacts, multimedia, and interactive displays to bring their story to life. This approach helps visitors to connect with the material on a personal level, making the history more relatable and memorable.

Interactive installations and responsive environments engage visitors in new and innovative ways, creating a participatory experience. Furthermore, the use of digital tools in the design process enables detailed simulations and virtual walkthroughs, allowing designers to experiment and refine their concepts before implementation. As Teece suggests, « Digital tools are not just for creation but also for continuous iteration and improvement »[15]. This digital-first approach not only enhances the aesthetic and functional aspects of exhibition design but also allows for continuous improvement based on visitor feedback and interaction data.

[14] Ibidem

[15] Teece D.J. (2018) Profi>ng from innova>on in the digital economy: enabling technologies, standards, and licensing models in the wireless world, Research Policy, 47.

The theme of the next Milan Design Week 2025 it's going to be "Connected Worlds", which it's going to be a participatory and generative design process through the integration of artificial intelligence[16]. This theme encourages reflection on how design connects various aspects of our lives, from the natural environment to advanced technologies and from cultural traditions to future innovations. It emphasizes design's role in fostering unity and global cooperation. This theme explores the connection between physical and digital worlds, enhancing life quality through AI and smart devices. It highlights cultural exchange, ecological design, and sustainable technologies in urban contexts. It underscores the importance of designing public spaces that foster social interaction and installations that promote inclusivity and dialogue. Additionally, it examines urban mobility innovations and the sharing of information across disciplines. Milan Design Week 2025 aims to celebrate relationships and engagement through design, showcasing how hybrid skills and immersive experiences can transform our ways of living, working, and interacting with the world.

5. Adaptive design: the role of intelligence in the built environment

To develop our project, we drew inspiration from the 2025 Venice Biennale project curated by Carlo Ratti. The nineteenth International Architecture Exhibition of Venice, in fact, will be dedicated to the built environment and the numerous disciplines that shape it. Architecture is at the center of these, but not alone: it is part of an extensive ensemble that must integrate art, engineering, biology, data science, social and political sciences, planetary sciences, and other disciplines, connecting each of them to the materiality of urban space.

« The titles of the International Architecture Exhibitions are usually announced in both English and Italian. However, in 2025, the title will be condensed into a single word for both languages, invoking their common Latin origin: Intelligens. From intelligens comes the modern ‹intelligence›; this choice, however, also indicates an expansion of associations in meaning. Translated separately, the final syllable, ‹gens,› means ‹people›: from this emerges an imagined alternative root, suggesting a future of intelligence that is more multiple and inclusive, escaping the excessive limits of today›s focus on AI »[17].

[16] Cfr. Salone del Mobile 2025 (2024) Comunicato stampa. URL: hHps://www.salonemilano.it/en/exhibi>ons/saloneinternazionale-del-mobile

[17] C. Rah (2024) Biennale architeRura 2025: il Atolo è intelligens. naturale. arAficiale. colleXva. hHps://www.labiennale.org/it/news/biennale-architeHura-2025-il->tolo-è-intelligens-naturale-ar>ficiale-collehva

The built environment is among the major contributors to atmospheric emissions. In this sense, architecture can be blamed for much of the environmental degradation of our planet. In the face of the accelerating climate crisis, must we resign ourselves to this role, or are we still able to offer substantial, not cosmetic, solutions that are effective and quick to implement? The Exhibition will attempt to chart new paths for the future, suggesting a range of solutions to the most pressing problems of the present. It will bring together a collection of experimental design proposals, inspired by a definition of "intelligence" as the ability to adapt to the environment starting from a limited set of resources, knowledge, or power. The exhibition, in particular, imagines architects as "mutagenic agents", capable of triggering evolutionary processes and directing them in new directions. Learning from multiple scientific disciplines, and advancing through trial and error, this exhibition aims to accelerate the transformation of the present in the search for better futures. Objects, buildings, and urban plans will be arranged along the axis of a multiple and diffused intelligence, dividing the space into three main thematic areas related to natural intelligence, artificial intelligence, and collective intelligence. Some ideas are destined to fail. But others may point us to promising paths.

5.1 Natural Intelligence

Architecture, whose original function is to shelter humans from natural elements, now relies on nature to re-orient its action. Bringing vegetation back to the heart of our cities is one of the most effective ways to combat extreme temperatures. Organic materials can store carbon while also preventing further emissions through insulation. Biomimicry reminds us that the best designs are the product of millions of years of evolution. Will we one day be able to design a building as intelligent as a tree?

5.2 Artificial Intelligence

Vast networks of connections and sensors link our metropolises, creating a digital infrastructure that spans the entire planet. Despite their energy consumption, these technologies can be used to mitigate the environmental impact of urban development. Thanks to real-time feedback loops, the built environment is beginning to respond like a living organism. At the same time, artificial intelligence could disrupt the traditional role of architects. How will the profession change when generative models can produce construction details from a simple textual input?

5.3 Collective Intelligence

Since prehistoric times, architecture without architects has been able to devise sustainable solutions in response to environmental pressure. From the Machiya of Kyoto to the Dogon rock dwellings on the Bandiagara Plateau, and from the Trulli of Alberobello to the vast array of settlements classified as “informal” that are still the main drivers of urban growth today, collective intelligence speaks to us of adaptation: working with nature, not against it. How can we connect the old and the new to harness the endless possibilities of collective intelligence?

6. Innovative pathways: methodologzy for integrating digital tools in exhibition project

Carlo Ratti, Artistic Director of the Architecture Sector of the Venice Biennale, invites students, graduates, and emerging professionals under 30 (from architecture, urban design, engineering, interior design, landscape architecture, and built environment) to submit projects that utilize natural, artificial, and collective intelligence to combat the climate crisis[18].

From this global pool of applications, the Artistic Director will select up to 16 projects to be developed in the Biennale College Architecture program. Selected candidates will be invited to participate in a 10-day workshop in Venice in September 2024 to further develop their proposed projects, including production plans and budgets. The workshop, led by Carlo Ratti along with a group of curators, architects, tutors, and mentors, will feature both group and individual sessions, as well as meetings with visiting professors and cultural operators.

A final selection of up to 8 projects will be chosen by Carlo Ratti himself. Each selected project will receive a grant of 20,000 euros for production and will be presented out of competition at the 19th International Architecture Exhibition. The goal of this project is, among other things, to expand opportunities for emerging young professionals by sharing their work with a wide audience. The Venice Biennale has long supported the productions of emerging talents in the fields of Art, Cinema, Dance, Music, Theater, and the Historical Archive of Contemporary Arts.

The methodology chosen for the project selection will specifically include four main areas:

- **Transdisciplinarity:** Architectural projects will promote collaborations among different professionals, with the goal of advancing scientific knowledge wherever possible.

[18] Ibidem

· **Living Lab:** In 2025, the Central Pavilion at the Giardini will be under renovation. Consequently, it will be replaced by a series of special projects designed to transform portions of Venice and the external areas of the Biennale exhibition sites into Living Labs, where multiple forms of intelligence can converge.

· **Idea Collection:** Adopting a collaborative approach to design is crucial, especially in times of crisis. On May 7, 2024, the Biennale website will open a space for collecting ideas to expand the diversity of voices, visions, and suggestions.

· **Circularity Protocol:** The Exhibition aims to achieve particularly ambitious circularity goals. Through the development of a Circularity Manifesto, precise guidelines will be established, setting a new standard for future cultural events.

7. Sustainable synergies: exploring through interdisciplinary collaboration

The project draws inspiration from the criteria chosen by Carlo Ratti for the Venice Biennale 2025, focusing on the integration of new technologies and the importance of sustainability in materials and production processes. The exhibit aims to explore how advanced technologies, such as Artificial Intelligence, Augmented Reality (AR), Virtual Reality (VR), and the Internet of Things (IoT), can enhance awareness and understanding of the urgency to develop sustainable materials and processes. The goal is to create an interdisciplinary dialogue between art, engineering, natural sciences, social sciences, and technology, promoting innovative solutions to address the climate crisis and reduce the environmental impact of the production sector.

The chosen methodology thus follows the one developed by Carlo Ratti and is structured around four fundamental criteria:

· **Transdisciplinarity:** The project will promote collaboration among professionals from various disciplines, including architects, designers, engineers, material scientists, biologists, and technology experts. The objective is to develop scientific knowledge and practical solutions that integrate sustainable approaches into design and production processes.

· **Living Lab:** Part of the exhibition will be organized as an interactive "Living Lab," where visitors can experience firsthand the applications of new technologies in sustainable production processes. Dedicated spaces within the exhibit will allow for the observation and participation in practical demonstrations of innovative production techniques, such as 3D printing with recycled materials, biofabrication, and the use of natural and renewable materials.

· **Idea Collection:** A virtual space will be created on the exhibit's website to collect ideas, proposals, and suggestions from professionals, students, and the general public. This space will serve to stimulate an open and collaborative dialogue, broadening the diversity of voices and visions on the topic of sustainability and innovation in materials.

Circularity Protocol: The exhibit will adopt a Circularity Protocol, establishing precise guidelines for waste reduction and the promotion of reuse and recycling of materials used in the setup. This approach will not only minimize the environmental impact of the event itself but also serve as a model for future exhibitions and cultural events.

Similarly, the event will be divided into three thematic sections:

· **Natural Intelligence:** This section will explore the use of natural and biomimetic materials, showing how inspiration from nature can lead to sustainable and innovative solutions. Examples of biodegradable materials, fabrics derived from living organisms, and structures inspired by natural processes will be displayed alongside interactive demonstrations.

· **Artificial Intelligence:** Here, visitors will explore how AI can optimize production processes to reduce waste and improve energy efficiency. Projects using AI to monitor and manage the lifecycle of materials will be presented, as well as examples of generative design that create optimal structures with minimal resource use.

· **Collective Intelligence:** This section will be dedicated to collaboration between communities and professionals to develop shared solutions for sustainability. Examples of community recycling and reuse projects, circular economy initiatives, and knowledge and resource exchange platforms will be showcased. Visitors will be invited to actively participate through workshops and brainstorming sessions

8. From awareness to action: immersive technologies for interdisciplinary design

In conclusion the role of the designer involves shaping and enhancing practices that promote the circularity of actions, materials,products and event.

The project aims to raise public awareness about the importance of sustainability in materials and production processes through an innovative and interactive approach.

Under these circumstances, both designers

and society must be aware of the origins of materials and enhance the use of those that reduce environmental impact and promote awareness and change. To define and increase the application of these materials, fostering processes of valorization, understanding, and implementation, it is essential to examine how to represent the value and significance of materials in relation to the theme of sustainability.

Inspired by the methodology of the Venice Biennale curated by Carlo Ratti, the event will promote interdisciplinary collaboration and the use of new technologies to create educational and engaging experiences. This will encourage visitors to reflect on their choices and the environmental impact of their daily actions. The exhibit will leverage Extended Reality (XR) technologies to create immersive and interactive experiences. Using AR and VR, visitors will be able to explore virtual environments that demonstrate the impact of sustainable materials and innovative processes in various contexts, from industrial design to urban architecture. The integration of IoT sensors will create a responsive environment, where displayed objects and installations react to visitors' movements and interactions, making the experience more engaging and memorable.

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AIGC AND VERNACULAR CREATIVITY: A STUDY OF CHINESE RURAL CHILDREN'S AESTHETIC EDUCATION FROM THE PERSPECTIVE OF CAPABILITY APPROACH

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ABSTRACT | In recent years, AIGC has developed rapidly and has assisted human creative thinking. Since 2023, China's Ministry of Education has recognized AIGC as an important technological tool for empowering education and promoting creativity, encouraging its widespread use throughout the country, including rural areas. However, the application of AIGC in Chinese rural children's aesthetic education presents both opportunities and challenges. On the one hand, AIGC can help children expand the possibilities of creative thinking. On the other hand, the existing AIGC is generally characterized by insufficient data of the Global South or marginal regions, aesthetic homogeneity and difficulties in involving tacit knowledge related to embodied cognition. All of these challenges the endogenous traditions of local culture which are with rural children as the main cultural subject and characterized by vernacular creativity. From the perspective of the Capability Approach proposed by Amartya Sen, this study considers AIGC as a capability sensitive design and explores its impact on vernacular creativity in the aesthetic education of children in rural China. In this study, vernacular creativity represents creative actions that non-experts may engage in every day, as opposed to professional creativity, and is characterized by improvisation, embodiment, situation and materiality. The study was conducted in a remote rural elementary school in Southwest China with an aesthetic education class. The class theme was rural papercutting creation. Through the A-B testing, interviews, observations and expert assessments, the study was conducted on the four phases of the teaching process (discovery-define-develop-deliver) and researching on the paper-cutting works created by the children. The changes in characteristics of vernacular creativity which are associated with the learning of paper-cutting in rural areas under the AIGC are analyzed. Finally, it is proposed that orienting to the Pluriverse what should we do when AIGC intervenes in indigenous culture in the future, ensure rural children have the capability to choose their own future and promote the sustainable development of indigenous culture.

KEYWORDS | CAPABILITY APPROACH, AIGC, VERNACULAR CREATIVITY, CHINESE RURAL CHILDREN'S AESTHETIC EDUCATION, PLURALISTIC 1.

1. Introduction

Rural children grow up in an environment characterized by nature and rural folk culture, supplemented by modern culture. They are highly malleable, energetic and good at learning new things. They are a group characterized by the infinite potential of children and the heterogeneous cultural background of the countryside, and can be regarded as the initial stage of villagers. However, as the modernization process has brought many complex problems such as cultural heritage disruption, environmental damage, economic imbalance and other issues to remote areas in the global South and villages, “Design for a pluralistic world”, “Resilient society”, “Self-governance” and other design perspectives that turn to the ontology of marginalized areas have gained attention, providing new epistemologies and methodologies to help people face an uncertain future.

Among them, many researches argue that transformation and innovation in vulnerable areas should not rely solely on radical external interventions, but should start from the interactions of subjects, relations and processes in daily life to explore endogenous power (Manzini, 2019; Zhang, 2023; Middha Bhavna & Horne Ralph, 2024). Therefore, this paper focuses on the subjectivity and endogenous power of rural children as villagers in the rural context, seeing them as dynamic and creative subjects in the rural network, as well as the subjects of Vernacular Creativity.

Vernacular creativity represents the non-professional, non-exceptional, creative actions embedded in the daily life of the villagers, as opposed to big creativity. It is an ability to help villagers effectively respond to the complex problems that arise in their daily lives (Zhang, Shangguan, 2023). It aims to enable the villagers to achieve a better life and well-being. This well-being is not only to bring economic and material satisfaction at the primary level of demands, but also aims to achieve dynamic and sustainable development in the rural space through the network involved in the process of village practices, which has a renewing effect on the explicit and invisible subjects such as vernacular creativity itself, the subjects of the

villagers, local knowledge, material carriers, and rural places.

Artificial Intelligence (AI) has revolutionized people's lives. Artificial Intelligence Generated Content (AIGC) such as ChatGPT, Dall-E, Midjourney, Stable Diffusion, etc. are widely used in the field of creative exploration, assisting people in their creative activities, but the prospect of its exploitation and impact in many segments is still as unknown as Pandora's Box. Modern children grow up accompanied by AI devices. Applications based on AI technology and AIGC are already common in the supply of educational resources and the front end of products. For example, some artificial intelligence educational robot toys have entered the K-12 educational stage of many children's families in Chinese cities, and primary school art classrooms in first and second-tier cities will use AIGC to generate images to assist in teaching, and so on. AI has taken on the task of dialoguing and interacting with children as well as artistic enlightenment in education. In contrast, rural children only have smartphones and computers as means of smart education.

The Capability Approach theory proposed by Amartya Sen and Martha Nussbaum provides a pluralistic perspective on judgments of individual well-being and social progress, rejecting uniformity and economic supremacy, advocating capability relativism and equity of choice, providing an ideological basis and instrumental framework for empowerment in marginalized regions (Robeyns, 2005).

Therefore, under this theoretical perspective and design practice, this paper considers AIGC as a capability-sensitive design for empowering vernacular creativity. It also employs a case study of rural children's aesthetic education, providing them with equal access to AI tools as urban children. The experimental process and paper-cutting works are qualitatively analyzed through A-B testing, anthropological ethnography and participatory observation and interview methods.

Through the intervention of AIGC in different parts of paper-cutting, the four characteristics of vernacular creativity revealed in the children's creative behaviors and the presentation of the final works are observed to comparatively analyze and explore the impact of AIGC on rural children's creativity. Finally, the interaction between AI technology, design and rural children's creativity is discussed in the context of the "Technology-Human Capability" relationship framework under the Capability Approach. It also discusses the possible paths for AI to enter the education of rural children and the development of vernacular culture in the future.

2. Theoretical Perspective: The Capability Approach and Empowerment Framework for Rural Areas

2.1 Definition of The Capability Approach

The Capability Approach, which provides a multidimensional framework for analyzing human well-being and social development, was first proposed by the socio-economist Amartya Sen in the 1980s in defense of human capability development and freedom. Against the backdrop of a society predominantly shaped by industrial technology and economic globalization as mainstream developmental ideologies, the core proposition of the Capability Approach is that people's well-being and quality of life should not be judged by uniform criteria such as economic income or consumption levels, but rather by what they are able to achieve with their degree of capability (Robeyns I, 2005, 2006). The term "capability" refers to the number of effective opportunities a person can have and the degree of freedom to make choices, not to the level of competence. So the concept of capability defined by Amartya Sen emphasizes more on capability set in a person, while at the same time many social theorists based on Sen's views suggest that capability is a opportunity set that a person has.

The Capability Approach is characterized by a strong interdisciplinary nature (Robeyns I, 2005). In theory, it has been widely applied in development theory, welfare economics, policy design and political philosophy. In practice, it has also addressed a number of issues faced by the "real world". In 2006, Robeyns proposed nine types of applications of the Capability Approach in practice: (1)General Assessments of the Human Development of Countries, (2) assessing smallscale development projects, (3)identifying the poor in developing countries, (4) poverty and wellbeing assessment in advanced economies, (5) deprivation of disabled people, (6) assessing gender inequalities, (7) debating policies, (8) critiquing and assessing social norms, practices, and discourses, and (9) functionings and capabilities as concepts in nonnormative research. The integration of the Capability Approach with various disciplines encompasses nearly all aspects of human well-being, providing an interdisciplinary space to guide research in social domains such as education, social design, poverty eradication, gender equality, and decolonization. It offers practical and effective support for enriching people's lives, empowering them, and enhancing their freedom.

2.2 Opportunities for free choice and value-based decisions

A key characteristic of the capability approach is the focus on human capabilities and functions, that is, what people can do and be effectively. This implies a gradual refinement of the meaning of "competence": from "having the opportunity" to a further focus on " actively realizing a valuable function". That is, the process by which the subject moves from being given equal opportunities to being given the freedom to choose how to realize a given function. This has also enabled the Capability Approach to move from theory to practice, and has led to a clearer approach to empower in practice.

Martha Nussbaum further proposes a value determination approach to competence based on Sen's theory, divided into two parts: internal criticism and external standards, emphasizing the importance of democratic decision-making and participatory methods. This is because Sen's standard of value involves diversity. Different people and groups have reasons to cherish different things (Johnstone, 2007). Value plurality arises from individual (or group's) differences in terms of region, culture, experience, and their own cognition level. For example, for the same achievement of "alleviating hunger" to achieve happiness, many adults with nutritional knowledge perceive the value of being well-fed as being healthy, and choose well-balanced foods to satiate their stomachs. For children, who are not yet cognizant, the value of being full is more about taste, so they choose "fast food or snack". This implies that the judgment of value and the realization of function are related to people's intentionality, and that people have the freedom to choose "what is valuable" and how to realize "valuable".

The Capability Approach with respect to issues of justice, equality and empowerment, on the one hand, gives people freedom, on the other hand, provides a theoretical framework that offers designers a consciousness of normative standards. It emphasizes substantial freedom rather than directing people to live according to a particular model envisioned by the designer (Robeyns, 2006). It requires designers to focus on people's potential with a pluralistic and interconnected perspective, respecting people's freedom and right to make decisions to achieve the lifestyles they value. Instead of viewing people in marginalized areas as vulnerable with preconceived absolute standards and changing their daily lives through paternalistic intervention.

2.3 The Extension of Capabilities and Ethical Considerations- AIGC as a Capability Sensitive Design

The ultimate goal of the Capability Approach is to expand people's capabilities, and we need to focus on how to expand and what comes out of that expansion, both in terms of process and ethics. Johnstone (2007) argued that the expansion of people's capabilities is not only an internal process of natural maturation, but also needs to be supported by external resources and empowering

environments, such as the availability of choices to use the same technology (tools), inclusive and pluralistic values etc. Ilse Oosterlaken (2009) suggests that design, technology, and engineering have an obvious relevance to the expansion of capabilities, as reflected in the values of privacy, security and justice inherent in all three. As well as the impact of the material artifacts produced by their interactions on social progress and the expansion of human capabilities. Thus, if discussed for the purpose of expanding human capabilities, we need to carefully consider the character and relevance of the roles of the three, consider the moral implications of the resulting artifacts in relation to the technical design rethinking involved behind them and ethics and politics elements in design. Design provides innovative perspectives, ideas and layouts. Technology is the means to realize the design. Engineering ensures that design and technology can be implemented in the real world.

The interaction of the three contributes to change and progress in society, and the capability approach provides ethical norms and goals for their interaction, that is design for responding to the population majority of the world, with an inclusive and pluralistic value judgment perspective, and with the enhancement of human capabilities and freedom of choice as the ultimate goal. This enables designers to consciously incorporate ethical elements and the goal of enhancing human capabilities into the design process, giving rise to the emerging field of "Capability Sensitive Design".

A framework under Capability Sensitive Design

The internal logic of capability-sensitive design is the relationship between "technological/engineered artifacts and ethical-design- capability". Johnstone's (2007) proposes four objects about future technologies and human capabilities: (1) specific groups or individuals (2) specific capabilities (3) specific contexts or situations (4) specific interventions (technologies, artifacts). It can be found that these four objects are involved in different relational interactions of "technology, engineering, design - capability". Therefore, based on the four dimensions of participation, a relational framework (Figure 1) between technology and human capability research can be summarized, which can focus on how a specific technological object affects the specific capabilities of a specific group of people through the interactions between technology, engineering and design and human capability research with the material and the ethical two impacts.

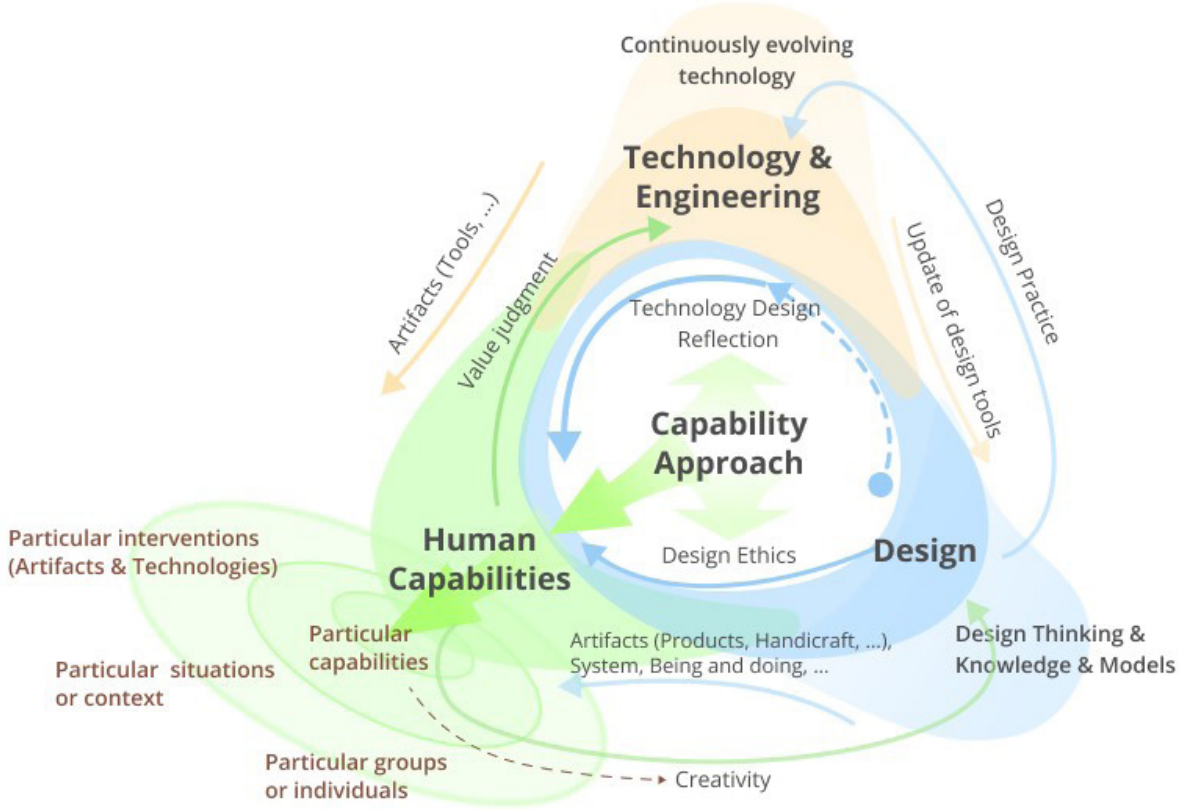

Figure 1. Framework for the Study of the Relationship between Technology and Human Capabilities from the Perspective of Capability Approach.

AIGC as Capability Sensitive Design - Tools, Materiality and Ethical Risks

As artificial intelligence is now in vogue, AIGC is considered as a Capability Sensitive Design. This recognition arises from its functions as a tool and its dual role in digital production that engenders a critical thinking. Artificial Intelligence Generative Content (AIGC) refers to the utilization of machine learning techniques to learn from elements within existing databases (text, images, audio), integrating and creating content that is both similar to and distinct from the original data.

On the one hand, AIGC serves as a content integration and decision-making and intelligent design tool in the creative industry, enhancing work efficiency and assisting creativity. AIGC has made many advances in the generation of graphic content such as paintings and drawings, and is gradually maturing in the creation of 3D content, which has enabled many Chinese folk cultures based on graphic arts to have a new tool for generating content.

In Addition to the creative field, AI has caused educational revolution in China. The big data, large-scale models, robust computational power and integration behind AI subvert the traditional paradigms of knowledge innovation. Knowledge production not only comes from human experience, but also can come from data-based generation by AI. Therefore, AI can break the limitation of marginal knowledge transmission and innovation by the amount of knowledge of the inheritor and the learner, broaden the new knowledge production pathway. Based on cultural databases, empowering education and culture through human-computer collaborative knowledge.

AI's attributes of a tool are also characterized by its materiality. Although AI is a digital tool, its data are generated from solid-state physics, generating content and knowledge need to be presented, disseminated and perceived by human multisensory senses with the help of digital devices and other artifacts, and intervening in human creative behavior and social development.

On the other hand, under the ontological turn in Design, the use of AI has triggered critical thinking about "ways of being", resulting in a lot of ethical risks in terms of values, intellectual property, etc. For example, many design activities now prioritize using AI over the need to solve problems or other better solutions. It needs to be clarified whether AI is a tool to assist people or a design purpose. Amartya Sen distinguishes between means and ends of well-being and development, providing a discursive perspective. Where the ends embody the intrinsic value of functional realization, the means are tools to achieve well-being, justice and development (Robeyns, 2005). This identifies AI as a tool to assist people, rather than a designed end to avoid ethical controversies because of the ambiguity about its identity during development.

In addition, existing AI generation tools also have many contradictions between the context of application and achievable goals, e.g., the database behind AIGC lacks data from the global South or remote regions, the generation content is biased towards Western narratives, the generation style is aesthetically homogeneous, and the generation method is limited to the dismantling of surface symbols and random combinations. In fact, the units and configurations of many Chinese folk motifs have a sequence of meanings, and contain craftsmen's embodied knowledge and improvisation. These make AIGC able to generate similar forms with traditional expressions, but the deeper meanings cannot be scrutinized. Therefore, there's still much space for the application of AIGC in the creation of minority cultures such as folklore, but we don't deny that AIGC has the potential to promote marginalized cultures and expand human capabilities.

3. Vernacular Creativity

3.1 The Definition of Vernacular Creativity

The word “Vernacular” in Vernacular Creativity is widely interpreted as the non-official language used by local people in daily lives. It’s also used to describe folk styles in architecture, art, design, music and other fields. The concept of Vernacular creativity therefore naturally carries connotations of community, folklore, informality, daily life, pluralism and social inclusiveness. It proposes an opposite argument to ‘Extraordinary Creativity’ and ‘Big-Creativity’, i.e. creativity is not for a specific minority, nor should it be viewed restrictively as the ability to produce groundbreaking ideas, programs and works in specialized fields of art, business and science (Amabile, 2014). It should be present in everyday, non-economic, non-productive and valuable creative behavior (Vermeeren, 2022).

Studies of Vernacular Creativity regard everyday life as a space, which belongs to the study of everyday creativity. Thus Vernacular Creativity also represents a typical kind of everyday creativity (Zhang, Shangguan, 2023). Vernacular Creativity is the ability embedded in the creative experiences of people in their daily lives (Amabile, 2017; Silvia, 2014). It encompasses a wide range of creative actions in everyday life, which can involve people’s hobbies, like writing poems or paintings, or ways of coping with everyday tasks (Richards, 2007). Tim Edensor defines Vernacular Creativity as the creative actions presented by ordinary people in specific behaviors. What shows the same essence between the two concepts of creativity. Therefore, we can see the connection between the two in terms of concepts, characteristics, research frameworks and creativity assessment. Differently, Vernacular Creativity emphasizes more on the relationship between specific regions, cultures, people and creative actions (Edensor, 2018). Even it has a trend to explore the world from the perspective of the Other.

Vernacular creativity has the meaning of adaptability, which is recognized as an ability to help people cope with complex situations. Tim Ingold suggests that “design’s creativity is not in a preconceived plan, but in the ability that inhabitants can respond precisely to changing circumstances”. Ezio Manzini also proposes the concept of “Gestaltswitch”, which refers to the process of exploring, and reassembling collected materials to apply them to the environment like a mosaicist. It contains the anthropological process perspective of “the improvisation with their surroundings and materiality” and the Capability Approach of “People have the ability to freely choose to realize the life they desire” are both involved. Design Anthropology proposes social innovation through designing the process, which can engender “newness” not only through the creative nature of design, but also through the Vernacular creativity stimulate improvisational responses. For instance, facing the inevitable domination of technology, Gaskins (2021) develops “Techno-vernacular creativity”, which argues that

marginalized and poorly resourced groups can utilize technology to counteract the forces oppressing them, by mixing technology with local culture, values and practices to develop technology indigenously. Vernacular creativity allows for the adaptation of mainstream technologies, transforming unfavorable situations into endogenous power for favorable development, and provides a guiding direction for the application of AIGC in rural folk culture.

Therefore, combining the Capability Approach and the case study of rural children's aesthetic education in the following section, it is clear that the Vernacular creativity proposed in this paper refers to the ability of the villagers to make immediate, appropriate and innovative responses to the complexity of daily changes. It is also a kind of ability that is influenced by the local traditions, folk customs and upbringing, and is universally existed, constantly generated and emerging in the villagers' daily life.

3.2 Four characteristics of Vernacular Creativity

According to the definition of Vernacular Creativity, we find that it exhibits four characteristics: improvisation, materiality, embodiment, and situation (Zhang, Shangguan, 2023), which interact with each other to influence the creative actions of the villagers.

Improvisation

Vernacular creativity is characterized by improvisation and has two aspects: flexible response and temporality. Flexible response corresponds to the meaning of adaptability in its conception, which refers to improvisation oriented to the complex world. Folk craft is a special kind of improvisation in the everyday rural world, is a kind of artistic creation by "thinking while doing", which reveals the dual temporality of Vernacular Creativity pointing to the immediate and the millennium (Vermeeren, 2022). Vernacular creativity is rooted in the history, folklore and ideology of the vernacular society that has been developed over thousands of years, and is expressed in the moment through immediate behavior, and the results of the creativity will become experience and culture. This reveals the dynamic renewal pattern of existence, generation, emergence, and accumulation under the appearance of improvisation of Vernacular creativity, so as to maintain the continuity of the rural daily life and to cope with the challenges.

Embodiment and Materiality

Vernacular creativity is "immaterial", but it emerges through the interaction between "people and things". The process cannot be separated from the material medium as a carrier, and therefore has a material nature. The first is the human body serving as the carrier of Vernacular creativity, storing knowledge and skills, and that Vernacular creativity emerges through the embodied

creative action of multi-sensorial linkage of human being, and it also has embodied nature. The second is that, Vernacular creativity requires material places and artifacts as carriers to build space, provide materials, tools, and create outcomes (artifacts) for human's creative action. The outcome is the concrete presentation of creativity, depending on the limited material form of the tools and materials. But its transformation of the tacit knowledge in creativity, the embodied knowledge of the human being, is infinite and again manifests itself through the subsequent material creation.

Situation

Creativity arises from the interaction of humans, tasks, and situations (Tromp, & Sternberg, 2022). Vernacular Creativity is more influenced by the term "Vernacular", which emphasizes the contextual influence of the society, place, and culture in which it occurs, with specific territorial and spatial constraints. Creativity is always collective, emerging and connected (Escobar, 2018), it cannot be separated from the social culture and situational contexts in which it is located, so it also affects the value judgment of creativity. The situations are therefore an important basis for judging the value of creativity under the Capability Approach, which represents creativity in a specific geographical area with specificity.

3.3 The relationship between AIGC and Vernacular Creativity

The relationship between AIGC and Vernacular Creativity is intricate, marked by both similarity and interactivity. Initially, both Vernacular creativity and AIGC rely on material carriers to manifest existence and content. Vernacular creativity is expressed through human creative actions and the creation of artifacts, while AIGC serves as a tool that can intervene in the creative process. AIGC's digital representation on physical entities provides visual cognition, concrete imagery, and contextual frameworks, correspondingly influencing the embodied, material, and contextual characteristics of Vernacular creativity, thereby affecting its development. Moreover, the impact of AIGC on Vernacular creativity also lies in its inherent randomness, which, when it generates presentations different from initial imaginings, brings surprises that stimulate curiosity and mobilize tacit knowledge for comparison and exploration, potentially sparking creativity. Based on this interaction, we can discuss the interplay between AIGC technology and the four characteristics of Vernacular Creativity among rural children and their creations, extending the discussion to Vernacular creativity.

4. Case Study: Children's Paper Cutting Aesthetic Education Class in a Rural Village in Southwest China

Based on the Capability Approach, Vernacular creativity, and the framework of technology and human capability interaction, it is worthwhile to explore what impact AIGC, as a Capability Sensitive Design into the countryside, can have on rural children's creative behaviors. Therefore, the study conducted a participatory rural paper-cutting aesthetic education class in a remote rural elementary school in Southwest China. The main intention of this Aesthetic Education Class is to explore the following questions:

1. What is the attitude of rural children exposed to AIGC?
2. Does AIGC promote or inhibit Vernacular Creativity among rural children?
3. What characteristics of vernacular creativity are affected by AIGC? What is the impact?
4. What impact will AI tools have on rural children's paper-cutting creative process, artwork output and their own subjectivity? In what parts of the intervention will it have an impact?
5. Beyond the classroom, what is the impact of AI on rural education and on rural crafts?

4.1 Experimental Background

The study was conducted in an elementary school in an ethnic minority village called "Hua Yao". Located deep in the mountains, the village is rich in natural and cultural resources, and their ethnic patterns are colorful, diverse, and have a unique artistic style. Village children, our experimental subjects, grow up in such an environment, being nurtured by ethnic culture and getting to know the world. Children get inspiration by observing the surroundings, so the pattern of paper-cutting is the carrier of children's creativity, which can show children's daily focus, thinking and aesthetics. Moreover, paper-cutting is a representative Chinese handicraft, with easily accessible tools and materials, easy-to-grasp skills, and flat-based patterns suitable for AI creation, making it a suitable material medium for this study.

Participants

A total of 12 students and three researchers participated in this art class, with two researchers assisting with the experiment and one researcher recording the entire class, which lasted nearly two hours. The participating students were all from the same rural elementary school and ranged in age from 7-12 years old.

Theoretical foundation

Based on the "Double Diamond Model" by the British Design Council, we propose a similar framework for AI participation in the craft

creation process (Figure 2), dividing the paper-cutting creation process into Discover, Define, Develop and Deliver, with the corresponding papercutting processes as follows:

- Discover: Conceptualizing the theme and allegorical content of paper cutting.
- Define: Determine the theme and content of the paper-cutting.
- Develop: Conceptualization of specific paper-cutting patterns, graphical and figurative content.
- Deliver: Do the paper-cutting in person.

Due to the two "diffusion-contraction" features in the model, it was categorized into two stages: abstract creation (Discover and Define) and figurative creation (Develop and Deliver). According to other studies (Sreenivasan, 2024), we believe that the AI's intervention in the Discover and Develop stages has an impact on children's paper-cutting creation behavior.

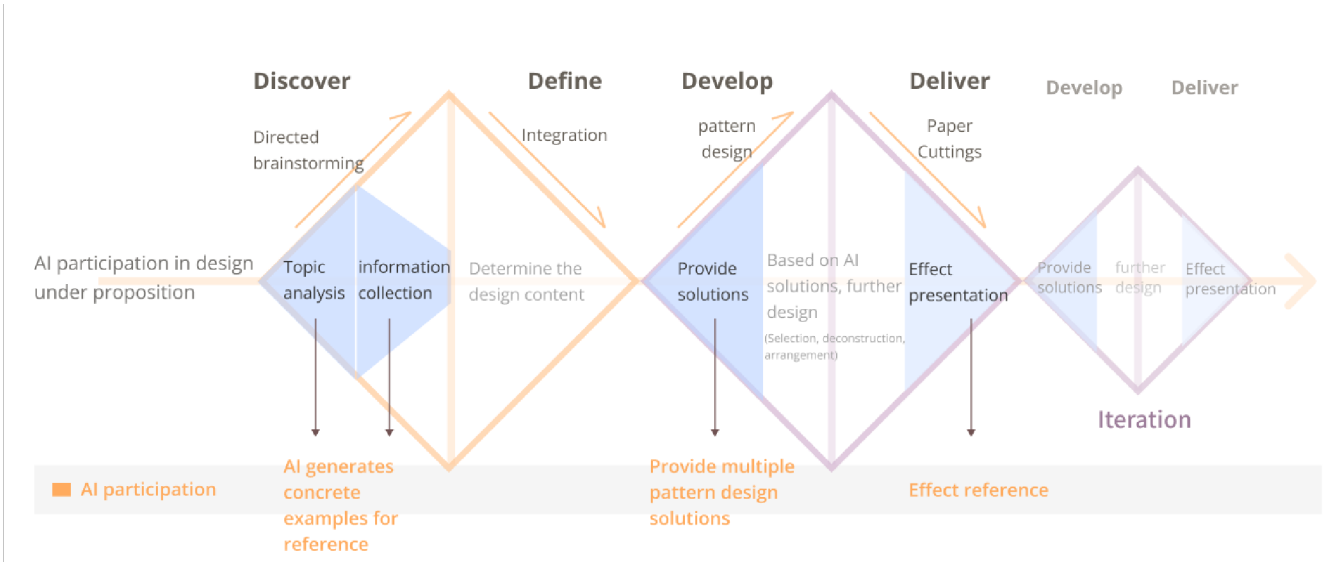

Figure 2. Diagram of AI intervention in handicraft creation process based on double diamond model

Preliminary

The usage of AI: Through previous interviews with art teachers in this school, we learned that digital devices are used for teaching, but only computers and not use AI and AIGC software.

Place: This school has a special traditional culture classroom (handicraft classroom), but due to the curriculum, it is seldom used.

Preparation: The preparations for this class are recruiting students, borrowing the classroom, providing handmade materials such as paper, children's scissors, and display paper, a laptop, Midjourney software, and a Chinese aesthetic AIGC software "QIYU".

4.2 Experimental Process

Warm-up

First, the event is explained to the students participating in the class. The topic of the paper-cutting was “plants”. Afterwards, the students were led to a free discussion where they were asked, “What plants would you choose to create?” to understand their creative intentions and to learn about the students’ cognition of plants and local natural resources.

A-B Testing

The experiment was divided into two rounds of paper-cutting stages. First, in the first round, all participants were given a freehand based on the theme of “plants” as the initial output of Vernacular Creativity. In the second round, the students were divided into two large groups of six students each, with the ages of the two groups averaged out as much as possible. The first group was to create freely in the abstract stage (Discover and Define), and to add Midjourney in the Develop stage of the figurative stage, which was further subdivided into two groups, A and B. Group A was to create freely on the basis of the theme, and to get “My paper-cutting” (this session could be overlapped with the first round). Students will be asked to describe their work, express the meaning and graphic imagery, and use Midjourney’s “text to picture” to generate paper-cutting images for students to view, and then create their paper-cutting works. Group B, based on the propositions to create their own works, and get their “My paper-cutting” works (same as Group A). The researcher will take photos of students’ works and upload them to Midjourney, and input keywords, “picture + text” to generate paper-cutting images, and let students watch to make papercutting creation for the second time. The second group was involved in Midjourney from the beginning of the abstract stage (Discover), and was divided into Groups C and D. In Group C, students were guided to view the “plant” theme paper-cutting images generated by Midjourney that the researcher had prepared in advance, and then carry out the conceptualization and figurative creation of paper-cutting symbols; Group D, based on the process of Group C, added the session of taking pictures of students’ paper-cutting works and uploading them to the Midjourneygenerated pictures, and then carried out the third paper-cutting stage.

Evaluation

The AI-generated paper cut patterns, the students’ free-created drawings (anonymized), and the cocreated drawings with the AI were laid out. Students were organized to have a discussion about” Tell me which of the paper-cutting you think is good, and why?”. The work was then evaluated by design researchers and elementary school art teachers at the end of the class.



Figure 3. Recordings of children's paper-cutting class: top left-warm up briefing, top right-second largest group of students looking at AIGC-generated images, bottom left-groups A&B, bottom right-groups C&D



Figure 4. Left one-A student working on paper cutting, right one- Work evaluation sessions were conducted in classrooms

4.3 Findings

Cognition and situation

First of all, in the communication before paper-cutting, we found that although the countryside has the advantage of natural plant resources, the children are still influenced by external plant knowledge and personal aesthetic judgment. They choose plants such as roses and tulips or abstract flower shapes as the prototypes for their creations. Moreover, according to the communication with the art teacher before the class and the actual observation of the children's performance in the paper-cutting handicraft workshop, we found that the children in the countryside like paper-cutting, this traditional handicraft form. They had a high degree of concentration and immersion in the process of paper-cutting creation.

The attitude of rural children exposed to AIGC

In their engagement with AI technology and the Midjourney application, the rural children showed a bland or neutral attitude, neither actively wanting to use the AI nor rejecting to be guided by the researcher, referring to the pictures generated by Midjourney or QIYU for their creations. This may be a manifestation formed by the imperfect knowledge of the material world and technological tools of the rural children, who are unable to recognize in time the functions that the AI software can achieve for them.

AIGC's materiality affects improvisation of creation

Another example is that, in Groups A and B, before the Development stage, students elaborated on the design of their independent paper-cutting works and were assisted by the researcher in summarizing the keywords and the generated patterns. Comparing the interaction between the children's embodied paper-cutting and AI recreated patterns, it is found that, due to the limitations of children's paper-cutting skills, their patterns were inclined to be simplified and utilize abstract botanical shapes of symmetry. However, the patterns generated by AI would become complex and detailed based on the keyword instruction "plant", and therefore, after referring to the AI creation, although the children showed a more introverted attitude, saying "it is too complicated", "I can't cut it out". The children showed the non-adoptive attitude, but in the second paper-cutting round, almost all of them found that the paper-cutting works were subconsciously influenced by the generated patterns, which made the children's works have less white space and more openwork patterns. This reflects the influence of AIGC on children's improvisation, paper-based material vehicles, and embodied cognition.

	Human	AI	Paper Cuttings
The role of materiality	The carrier of knowledge storage and creation	tool	The carrier of outcome
Interaction that generates creativity	The body stores knowledge and experience	Human use tools	Human create objects
The states of materiality	Non-Materiality	Materiality	Materiality
The Dynamics of Creativity	Existence →	generation, emergence →	emergence

Figure 5. The emergence relationship of creativity

Unexpected gains

There were a few surprises in this experiment. Because the researcher, as a cognitively mature adult, had an inherent understanding of the term “paper-cutting” as a paper craft with an openwork technique such as “Chinese windowpane”. Therefore, the term “paper-cutting” was used directly when explaining to the children, and no examples were given to show them, as there was concern that giving examples would limit the children’s creativity.

However, in the subsequent paper-cutting sessions, it was found that the children presented a variety of paper crafts, including cut-outs, collages, origami, and even 3D construction of paper crafts. Then the researcher adjusted the experiment immediately and standardized the papercutting forms of rural children through demonstrations. But some children still did not care about the fixed forms of paper-cutting and created according to what they wanted and wished to create. Although this had a certain impact on the experiment, the author believes that this is a form of vernacular creativity and a natural development of the experiment, which is characterized by the children’s less stereotyped thinking, strong self-expression, and willingness to do things.

Finally, in a mutual evaluation meeting of the children’s internal works at the end of the class, they selected what they considered to be the best works, but found that the selected works did not share common aesthetic characteristics, apart from neatness of the picture and harmony of the colors, and may have been influenced by the mutual selection of their partners.



Figure 6. The comparison of student cutouts and AIGC work, student secondary cutouts influenced by AIGC images

5. Conclusion

Paper-cutting is a craft characterized by improvisation, materiality, embodiment and situation. First of all, children are given the theme to create in view of the fact that situation helps children to focus their creativity so that they are better to call upon their own accumulation in life and interests for artistic expression. However, pictures are a more accessible form for children than textual expressions. Image Generation AI generates figurative patterns based on prompts, guiding children's creative situations from vague to concrete, giving directional references and influencing their embodied cognition. At the same time, we are concerned that children may be limited by the thinking of the generated pictures, imitating rather than innovating, but this depends on the differences between individual children's psychology and personality.

Further, both AI and paper-cutting have materiality in themselves, and both need to rely on material carriers to realize pattern presentation and creation. Human, AI and paper-cutting respectively undertake the roles of knowledge storage and creation carrier, tool and creative outcome carrier. They form a series of implied creativity existence, generation and emergence process, which revolves around the interaction of the three: human storing knowledge and experience, human using tools, and human making things, and implies embodied behaviors and knowledge transformations. Therefore, AI acts as a tool, the decision-making power based on the big data behind it can indeed facilitate the generation and emergence of creativity, but one needs to be wary of the authenticity of the AI-generated data. Whether it affects

the new tools used for rural cultures, causing culture mutation or extinction between human embodied creations and materiality transformations. That would deprive us of the possibility of receiving the right kind of knowledge and experience, and the existence that we rely on every day would be unknown. Expanding cultural databases and perfecting a few cultural motifs may avoid the risk of such alienation, but it involves the security of cultural information and the ethical controversy of intellectual property rights.

Paper cutting is an improvisational creative activity, forming indeterminate patterns as the scissors improvise and twist on the paper, conceptualizing as they go. The intervention of AI is a pre-conceived limitation to improvisation, hindering the random of the paper cuts, which is the surprise of the random aesthetics of the paper-cutting. It is reflected that AIGC-generated images serve as normative, figurative guidelines for paper-cutting creation. But sometimes the randomized results generated by AI stimulate interest, promote improvisation and tacit knowledge, and inspire creativity.

AIGC has different effects on the four characteristics of vernacular creativity from different aspects. AIGC makes the goal of creativity clear by assisting situational figuration. AIGC and creativity share a common demand for materiality, so that we can start from the overlapping material carriers and better provide design solutions to promote the human-AI collaboration in recreation; AIGC has a direct effect on the "seeing" of embodied behavior, and indirectly affects the "doing" and embodied knowledge cycle from materiality, expanding more possibilities for embodiment. Finally, AIGC has both advantages and disadvantages for improvisation, destroying its immediacy and stimulating its randomness and adaptability. These four features intertwine, Vernacular Creativity emerges, and human dynamic activities are carried out as a result. Although there are still many risks and ethical issues associated with the application of AI, AIGC, overall, has a positive effect on vernacular creativity when considering current practices.

There are differences between the images generated by Midjourney and the Chinese-style AIgenerated software, which is the effect of different algorithms and databases. The viewer can see the difference in image style because of the details, which is often the essence of traditional Chinese graphic arts including paper-cutting, such as the color and graphics that make Chinese cultural characteristics more distinct. Moreover, considering the students' sensitivity and acceptance of AI-generated images, those that align with their cognitive characteristics and scope can bring them a more positive influence on creation. This insight inspires designers to utilize AI technology for design activities targeted at specific groups, under the perspective of AIGC as a capability sensitive design. For instance, exploring small-scale databases of regional characteristics and children's perspectives, and the implication of those for vernacular creativity are pivotal areas for future research.

We should also hold an open attitude to face the possibility of technology in marginal cultures and try localized ways of technology development to empower marginal areas. While giving the same technological opportunities, we should pay attention to the interactions and relationships in the rural dynamic network, to explore the great potentials that heterogeneous cultures have, and to promote the endogenous development of the countryside and the world towards pluralism.

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‘RE-WILDING’ THE CULTURAL LANDSCAPE. BRERAPLUS, AN ETHICAL AND NO BORDERS MUSEUM EXPERIMENT.

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ABSTRACT | Climate change represents a serious threat to humanity, with air travel and tourism significantly contributing to excess carbon dioxide emissions. In response, contemporary museums are adopting ecological concepts such as sustainability, diversity, and ‘re-wilding’ to restore cultural landscapes, foster new community relationships, and offer alternative experiences. Traditionally focused on education, museums have shifted over the past fifty years towards a ‘leisure industry’ model, prioritizing visitor numbers and revenue, which has led to new museum construction, blockbuster exhibitions, and international marketing. While economically advantageous, this model often clashes with the museums’ original missions and environmental stewardship needs. Although museums have implemented measures including LED lighting and recycling to reduce their carbon footprint, addressing emissions from visitor travel remains challenging. The pandemic altered museum practices by drastically reducing international travel and accelerating digital adaptation. Museums quickly expanded their online presence, making content accessible from home. This paper explores the design ethics at the Pinacoteca di Brera over the past eight years, culminating in BreraPlus, an online platform that provides 24/7 access to the museum. This initiative illustrates how museums can achieve greater inclusivity and sustainability, remaining relevant and accessible while promoting empathy and intercultural understanding.

KEYWORDS | MUSEUM; CULTURE; DIGITAL; DIVERSITY; INCLUSIVITY; RE-WILDING; SUSTAINABILITY.

1. REFLEXIVE DISCUSSION. Museum, Leisurely Flânerie, and Emission.

Climate change is the most significant challenge to the continued survival of humankind, as the planet's dominant species. If this fact can be agreed upon, then it stands to reason that the only morally acceptable position for humankind to take now – in the early 21st century – is to address the causes of global warming, the foremost of which is carbon emissions. Air travel, and hence economies based on tourism, are among the largest contributors to excess carbon dioxide. International tourism has a statistically and economically significant detrimental effect on the environment by increasing CO2 emissions (Cevik, 2022). Although these emissions are currently not well quantified, the rapid increase in tourism demand is surpassing the pace of technological advancements aimed at decarbonizing the tourism sector (Lenzen, et al., 2018).

Modern museums, which emerged during the French Revolution, were not primarily intended as venues for leisurely flânerie but for popular education, research, and study. Moving away from their origins as private collections of the aristocracy, these institutions were designed to be accessible and inclusive, rather than simply objects of admiration for an exclusive group. This mission is now being positively reaffirmed in a world where the community to which the museum's holdings belong has become increasingly diverse. Tourism growth remained relatively limited until the introduction of wide-bodied jet airplanes in the 1970's (Gossling & Peeters, 2009) . Before the late 19th century, tourism was a slower-paced activity, largely dependent on trains and ocean liners. It was not until the 1950s, with the simultaneous development of the automobile, the highway system, and increased leisure time, that more people had the opportunity to conveniently visit holiday destinations, both near and far.

Now, for over fifty years, museums have been exhorted by politicians, abetted by journalists and economists, to consider

themselves part of the 'leisure industry' (Foley & McPherson, 2000), measurable in terms of visitor numbers and direct and indirect revenue, which in most European countries pre-COVID-19 contributed a substantial sum to the Gross Domestic Product (GDP). This contribution has become the justification for building new museums, creating 'blockbuster exhibitions', and marketing museums as a destination for international tourism. While this approach may have made economic sense in the short term, it poses a long-term challenge to the original mission of museums and contradicts the pressing need to reduce carbon emissions.

In response, museums have initiated efforts to understand how to reduce their carbon footprint (Müller & Grieshaber, 2023). Measures include replacing old lighting with LEDs, utilizing well water for climate control systems, lowering temperature settings, and promoting recycling. However, these steps are insufficient. Similar to how the carbon footprint of food must account for its production, transport, and preparation, a museum's carbon footprint must also consider the emissions associated with bringing visitors to the museum.

2. ETHICAL QUESTIONS. How to re-wild the cultural landscape?

"I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer. And perhaps with better cause, for while a buck pulled down by wolves can be replaced in two or three years, a range pulled down by too many deer may fail of replacement in as many decades. So also, with cows. The cowman who cleans his range of wolves does not realize that he is taking over the wolf's job of trimming the herd to fit the range. He has not learned to think like a mountain. Hence, we have dustbowls, and rivers washing the future into the sea. [...] We all strive for safety, prosperity, comfort, long life, and dullness. The deer strives with his supple legs, the cowman with trap and poison, the statesman with pen, the most of us with machines, votes, and dollars, but it all comes to the same thing: peace in our time. A measure of success in this is all well enough and perhaps is a requisite to objective thinking, but too much safety seems to yield only danger in the long run. Perhaps this is behind Thoreau's dictum: In wildness is the salvation of the world. Perhaps this is the hidden meaning in the howl of the wolf, long known among mountains, but seldom perceived among men." (Leopold, 1948, p. 132)

Aldo Leopold (1948), Ed Ricketts (1941), were pioneers of what we now call 'ecology' – seeing all life on the planet as a single related whole, where changing one element triggers effects throughout the system. Ecology teaches us that altering a single aspect of a complex whole is extremely risky, and the consequences can be alarming and unforeseeable. These ecological principles offer invaluable insights for contemporary museum thinking, centred around the

concepts of sustainability, diversity, and now, rewilding. Rewilding means working to bring back the natural balance and wildness to an area. It's about protecting the environment and its natural processes. Rewilding focuses on returning a place to its original, wild state, which might require active human intervention and people to get involved and help make it happen.

With the advent of COVID-19, this third concept has emerged forcefully, reshaping how we view museums and their role in society. In a mere three months, the pandemic not only accomplished what environmental activists had struggled to achieve in decades – a significant reduction in international travel – but forced museums to reevaluate their practices, especially as physical visits became restricted or impossible. This situation has demanded swift adaptation and accelerating technological transformation (Dal Pozzolo, 2021; Sacco & Calveri, 2021). Cultural institutions responded to the lockdown by extending their cultural offer beyond their traditional buildings, reaching their audience in their homes by means of the Internet (Bollati et all., 2024)

3. PRACTICE-BASED EXPLORATIONS

3.1 PRACTICE-BASED EXPLORATIONS. Brera, from visit to subscription

The pandemic encouraged museums to reconsider their relationship with visitors, the community, and the environment. In a post-COVID-19 world, museums were challenged to:

1. Shift emphasis from the museum 'visit' – the phenomenon of viewing the objects in person - to the museum experience – the 'valorisation' of the museum's collections, which we realized during the lockdown could occur increasingly online. Both experiences are equally valid and necessary, complementary but fundamentally different. The museum's identity has long been confused with that of its collection, akin to confusing a score with performance;
2. Recognize that the in-person museum visit is now more precious than ever, and the art of slow looking (Reed, 2017; Watts, 2019) – "an approach based on the idea that, if we really want to get to know a work of art, we need to spend time with it" - is fundamental (Han, 2017) to getting the maximum value from seeing the original. Pre-visit preparation is more important than ever and tools such as labelling encourage visitors to look more closely and extract more meaning, which are more fundamental than ever. We must also consider the insights of the American psychologist Abraham Maslow (1908-1970) – the visitor has to feel safe, respected, included, and comfortable, making even the act of having a coffee in the café at the end or start of a visit an important condition of experiencing the collection fully (Abraham, 1943).

COVID-19 taught us that neither the total number of visitors nor the revenue these visits generate are appropriate parameters to measure the value of a cultural institution (Bollati, 2021); "Museums have become victims of the equation, more = better" (Kenneth, 1996, p. 122). More importantly, if the museum's activities are also readily available online, the way to involve and welcome users and the community to a museum by merely letting them enter its spaces or enjoy its contents and collections in situ is no longer characterized by a conventional ticket, which is only the permission to access a physical space. If the enhanced online content is sufficiently rich and representative, the practice of purchasing a ticket to see the permanent collections could be transformed into an annual subscription – in effect, a membership – which includes access to the museum both in person and 24/7 online. In this way, as Kenneth Hudson argued, the museum can be seen like a private club (even more than a disco) with its ambitions remaining modest and its financial health based on its membership base (Kenneth, 1996).

Thus, whereas tickets expire at the end of a visit, a card is all-encompassing and longer-term. It allows visitors to organize their visits according to their desires and needs at different times, inviting them to return by developing a sense of familiarity with the spaces and the collections. Not only does this card gives visitors access to what the museum has, possesses, and preserves but it also allows them to experience the museum's constantly evolving cultural activities and proposals.

In this manner, the online museum experience—which encompasses preparation for the visit as well as post-visit activities and events throughout the year—becomes the comprehensive museum experience, wherein the physical visit to view the original artifacts is a treasured opportunity. Consequently, the revenue from ticket sales becomes inconsequential, rendering the museum effectively free to all, but only through membership in the museum community. By shifting away from using the single visit as a measure of its quality, the museum can now focus on its primary mission: to transform visitors by encouraging them to stay longer and see more of the objects in the museum's permanent collections. The museum's value can be measured not by visitor numbers but by subscribers to its creative output – by what the museum does, not from what it has. The museum becomes a verb, not a noun.



Figure 1. The fifth re-installation of the Pinacoteca di Brera, room 36. The image exemplifies how the museum presents itself during a traditional visit. Ph. Cesare Maiocchi.

The Pinacoteca di Brera exemplifies this approach, having evolved in this direction through various changes in recent years. Over the past eight years, the institution has undergone a comprehensive reorganization, reclaiming its cultural and social roots by enhancing its artistic, human, and historical heritage, following the legacies of its former directors Ettore Modigliani, Fernanda Wittgens, and Franco Russoli. The latest advancement is BreraPlus, a versatile cross-media platform accessible 24/7 from any location, designed to seamlessly enhance and enrich real-life experiences without attempting to duplicate them (Mandarano, Pagliaro, & Mataloni, 2008). This initiative arises from the recognition that, while the authenticity of encountering an original work of art is irreplaceable, a digital visit can serve as a valuable complement to the physical encounter, as underscored by the pandemic. The digital platform allows for the exploration of aspects that a physical visit might not provide but can be fully appreciated in a virtual format. The online experience can act as a catalyst for subsequent in-person visits or provide post-visit insights, fostering a relaxed and curious exploration of the museum's offerings. (Russoli, 2017) (Modigliani, 2019)

Through the BreraPlus annual subscription, the museum has effectively integrated digital and physical experiences to create a holistic museum offering. By acquiring the BreraCard, users gain access to BreraPlus's online content for one year and can visit the museum for three months at their convenience. This model, established in public libraries for decades and recently adopted by digital newspaper subscriptions, illustrates a shift towards more versatile user engagement. BreraPlus serves as a digital extension of the museum's offerings, allowing subscribers to access a range of content including unpublished stories, interactive documentaries, experimental films, and scholarly studies. Additionally, subscribers can participate in concerts, premieres, live-streaming events, and engage with historical narratives, read books in their original language, and interact with other users.

The BreraCard was first introduced in 2020, but it was in 2023 that a second release of BreraPlus was effectuated with all content available in dual languages. Examining the data from the last two years, 2022 and 2023, it is evident that the number of reused BreraCards (indicating individuals who returned at least once within 3 months with the same card) in 2023 increased by 16%, compared to 2022. Additionally, the number of multiple entries rose from 19% to 24%. In 2022, among the 19% of redemptions, some individuals visited the museum up to 8 times in 3 months; in 2023, this increased to 10 visits in 3 months. In both years, most initial returns were by individuals alone or in pairs, with a minimal percentage returning in groups. Subsequent returns were predominantly by individuals, highlighting a personal relationship with the museum. The transition from a single physical ticket to a card or subscription model that encompasses both in situ and online museum activities has transformed the nature of museum engagement. This shift has repositioned the museum from a static entity to a dynamic participant in a continual dialogue. By functioning as a 'verb,' the museum engages actively with its collections through diverse activities and fosters ongoing interaction with its audience. This transformation facilitates a reciprocal exchange between the institution and its visitors, extending cultural experiences beyond physical boundaries and into the digital domain, thereby enhancing the museum's influence both within the city and within individual homes. The museum starts a dialogue with its public made of users, not just with visitors (Author 2, 2001). To clarify, the terms 'visitors' refers to people who visit the collections in person, while the term 'users' signifies a person who can interact with the museum in a wide range of ways.

3.2 PRACTICE-BASED EXPLORATIONS. BreraPlus, A 24/7 Living Museum.

BreraPlus represents a transformative innovation in the realm of museum experiences, operating as a cross-media platform accessible 24 hours a day, 7 days a

week. This platform is meticulously designed to extend the museum experience both spatially and temporally, offering curated content that introduces fresh perspectives and diverse voices. It integrates various media forms, including experimental films, interactive documentaries, concerts, backstage content, storytelling, and readings in their original languages.

The conceptual framework of BreraPlus distinguishes the museum experience from traditional film viewing. Unlike films, which possess a predetermined and finite duration, the length of a museum visit is inherently flexible. Films follow a linear, narrative-driven structure with controlled emotional peaks, whereas museum visits are non-linear, characterized by chance encounters and social interactions. The emotional impact of film is largely personal and individualistic, while the museum experience is profoundly social and communal. This distinction is analogous to contrasting a meticulously planned amusement park ride with a leisurely stroll through a park, replete with unexpected discoveries.

Operating on the premise that museum visits are elastic, ever-changing, and unpredictable in duration (Falk & Dierking, 2012; Black, 2012; Hein, 1998; Hooper-Greenhill, 2006), BreraPlus offers a diverse array of interconnected content designed as an 'open' narrative experience. This platform allows users to navigate through videos, images, texts, audio recordings, digital versions of original books, high-definition paintings, original music, contemporary reinterpretations of classical artworks, and unpublished stories. Such a structure empowers users to explore, revisit, and continue their journey seamlessly, akin to participating in an endless, immersive game. It fosters an innovative approach to storytelling, providing a dynamic environment conducive to browsing, learning, excitement, and sharing. It replicates the characteristics of a living museum (Wittgens, 1956), through its online platform.

The dynamic and flexible nature of the BreraPlus experience is primarily ensured through the inclusion of supplementary content alongside the main videos. These additional features— VideoPlus, SpotPlus, HighDefinition Plus, DeepPlus, and BookPlus—serve to extend and enrich the narrative experience. As users engage with the main content, these extras appear, offering the option to explore further or continue with the primary narrative, based on the user's preference at that moment. This system is analogous to boarding a train, where users have the autonomy to embark

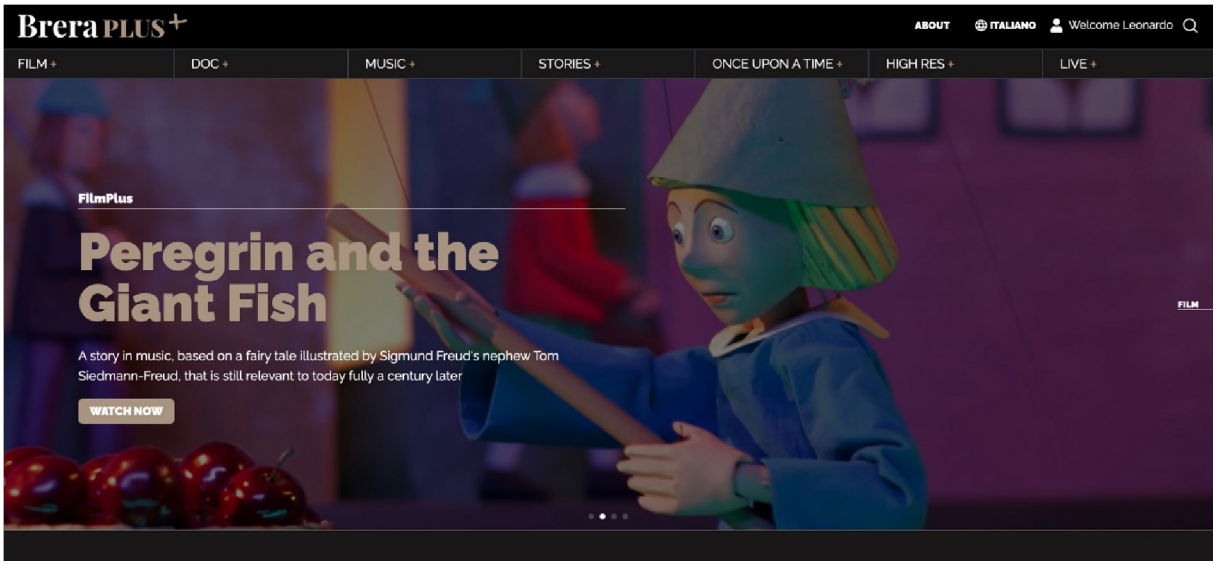

Figure 2. breraplus.org homepage features a preview of Peregrin and the Giant Fish, a musical narrative based on a fairy tale illustrated by Tom Seidmann-Freud, the nephew of Sigmund Freud. This figure exemplifies the platform's second release in 2023.

and disembark, explore intermediate stops, and engage with different segments of the journey. Each piece of content is designed to be consumed in a single session or revisited for deeper exploration and understanding.

Since its inception in 2021, BreraPlus has progressively expanded its content library, now boasting over 100 pieces of content, with new additions introduced monthly. The platform evolves in tandem with its audience, striving to maintain an ethos of openness, dynamism, and inclusivity akin to that of the physical museum. Currently, it encompasses seven distinct sections, acting as a repository of memories, innovations, voices, videos, images, and music:

1. **FilmPlus:** Experimental films produced by the Pinacoteca di Brera, including interactive theatre plays and puppet operas.
2. **DocPlus:** Documentaries that go beyond traditional narratives, incorporating untold stories with additional interactive content.
3. **MusicPlus:** Compositions by renowned musicians, performed by top-tier artists, exploring the interplay between visual arts and music.
4. **StoriesPlus:** Oral histories presented through words, music, and videos, tracing the historical narratives of Brera's connected locales and personalities.
5. **Once Upon a Time Plus:** Narratives presented in their original languages (Italian, English, Russian, Dutch) by prominent figures, blending the pleasures of reading with elements of fantasy and theatricality.

6. **High Resolution Plus:** Masterpieces showcased in ultra-high definition, revealing intricate details and pigment nuances.
7. **ChatPlus:** Interactive discussions and messaging features that allow users to share comments and insights on the artworks.

BreraPlus also includes a LivePlus section, offering live online coverage of special events at the museum, such as concerts, premieres, and conferences. This feature enables remote participation in Brera's initiatives. In June 2023, for the first time, users were invited to participate in a meeting of the museum's Board of Trustees, transforming them from mere visitors into stakeholders. Approximately seventy-five attendees had the opportunity to observe the live presentation of the museum's strategic directions and contribute suggestions via a chat system. This process embodies the social role the Pinacoteca aspires to fulfil, promoting a sense of sharing and belonging, different from mass tourism. A record of the proposals communicated by individual users through chat was drafted, facilitating constructive exchange and dialogue.

BreraPlus exemplifies how digital innovation can enhance and redefine the museum experience. By merging the flexibility of physical visits with structured digital content, BreraPlus creates an engaging, immersive, and inclusive platform, enabling users to interact with art and culture in novel and meaningful ways. It is no coincidence that data from 2023 further indicate that the acquisition of the BreraCard and subsequent activation and use of BreraPlus for accessing online content frequently correlates with physical activities organized by the institution. For instance, the temporary exhibition in the library dedicated to Otto Prutscher, A Golden Thread (1900-1938), linked to a dual documentary on the Viennese architect available on the platform, exemplifies this connection. Additional peaks in first logins to BreraPlus were recorded during the members' assembly in July and the December screening of the film Peregrin and The Giant Fish at the MAXXI in Rome, demonstrated cross-institutional engagement.

4. ETHICAL AWARENESS. Towards A Sustainable Museum.

The concept of rewilding the cultural landscape has emerged as a crucial imperative at the beginning of this paper, while BreraPlus stands as a pioneer project in this endeavour. The Brera approach embodies the shift towards reestablishing the authentic role of museums as integral to their local communities while reducing dependence on unsustainable mass tourism and the leisure industry.

BreraPlus has demonstrated that an ethical design of a museum hybrid, accessible, and sustainable cultural offer is possible. It clarified, by means of a practical example, what rewilding could mean and how it could be translated into real museum actions:

1. **Reasserting the Museum's Links to the Local Community:** BreraPlus emphasizes the importance of connecting with the local community in all its diversity. This includes not only providing access to historic collections but also expanding them to encompass the full range of the community's experiences. This approach necessitates engaging with all stakeholders, involving them in decisions about acquisitions and displays, and incorporating them into the ongoing governance of the institution. It involves rethinking existing museums rather than constructing new ones and focusing exhibitions on contributing to ongoing research or serving the community, rather than merely boosting attendance
2. **Providing Targeted Access to the Museum's Collection:** BreraPlus aims to serve the local community, scholars, and researchers without encouraging mass tourism. Recognizing that casual tourists do not require access to the entirety of a collection, the platform facilitates specialized audiences' access through organized, open storage that is available when needed rather than being displayed continuously. Additionally, it supports innovative projects outside the museum's physical space, such as in community centres, hospitals, elder care homes, and peripheral schools.
3. **Creating Remote Museum Experiences:** The global COVID-19 pandemic underscored the importance of online access to museum resources previously thought to require physical visits. BreraPlus offers access to deposits, interactive experiences, innovative interpretation forms, and new ways to engage with collections, making the museum accessible 24/7. This shift not only enhances access and creates new opportunities but also transitions the business model from ticket-based to subscription-based, allowing stakeholders to participate in ongoing governance, akin to shareholders in a corporation.

Returning to the specific data related to the concept of rewilding the cultural landscape, it is evident that following the second release with dual language support and the international press launch in June 2023, there was a notable increase in foreign BreraCard holders. Initially, foreign users constituted 35% of the total until June 2023, which subsequently rose to 47%. Additionally, among Italian users, the number of BreraPlus subscriptions used outside Milan and Lombardy increased by 7%. This data underscores the fundamental role of online engagement in establishing the first point of contact or maintaining an ongoing



Figure 3. Thirteen renowned artists' masterpieces adorn a 360-square-meter hospital wall, revamping waiting rooms and hallways. High-resolution images from Brera Museum welcome hospital visitors, patients, and staff in the Brera in Humanitas project (2023), strengthening the museum's ties with the diverse local community.

relationship with the museum after the initial visit. It also highlights how such engagement can occur without encouraging mass tourism motivated solely by the desire to check off a famous destination from one's list. This approach exemplifies the social role the Pinacoteca aims to fulfill, fostering a sense of sharing and belonging that is distinct from the dynamics of mass tourism.

In this paper's ethical questions and dilemmas for museums have intersected with design research and practices to create a fully worked example at the level of an internationally recognized Italian state cultural institution. This alone merits the consideration and critical attention of museum professionals around the world.

"No important change in human conduct is ever accomplished without an internal change in our intellectual emphases, our loyalties, our affections, and our convictions". (Leopold, 1948)

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DESIGN-DRIVEN INNOVATION FOR NATURAL CAPITAL: MAPPING CRITICISMS AMONG CONSERVATIONBODIES TO IMPLEMENT ACCESSIBLE TECHNOLOGICAL TOOLS FOR CONSERVATION.

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ABSTRACT | The conservation of Natural Capital is becoming one of the most critical challenges for the upcoming generations in preserving the health of the planet and the human species. Innovative technologies, such as IT sensors, software, and AI, play a significant role in monitoring, managing, and protecting natural ecosystems. However, their integration into environmental sciences to address climate change and ecosystem preservation faces challenges like data accessibility, reliability, and the need for features supporting long-term growth in volatile environments subject to rapid changes. Additionally, the diversity in conservation objectives, cultural backgrounds of practitioners, fragmented nature of information, and lack of coordination contribute to a disorganized data ecosystem and the development of problem-specific solutions that are difficult to transfer to other conservation scenarios. This study employs Human-Centered Design tools to examine the complexities faced by conservation organizations. Through field analysis with six Italian and international organizations and involving 145 operators managing protected areas, the study maps operational criticalities and compares them to identify potential advantages and challenges of using innovative technologies for natural capital management. The research proposes a paradigm shift towards a design philosophy in the environmental sector that prioritizes accessibility and usability, instils confidence in data for decision-making, and strengthens collective conservation efforts. It underscores the need for technological tools to cater to users with diverse abilities, goals, and cultural backgrounds focusing on flexible and tailored solutions. Emphasizing user involvement in design processes, such as personalization and co-design, the study highlights the pivotal role of design techniques in enhancing the effectiveness of digital solutions for environmental conservation.

KEYWORDS | ENVIRONMENTAL CONSERVATION, ACCESSIBILITY, HUMAN-CENTERED DESIGN, USER EXPERIENCE, NATURAL CAPITAL

1. Introduction

1.1 Climate Crisis and Natural Capital

Within the last two decades, extreme natural events connected with climate change are becoming more common. Scientific Academia widely recognises that our planet's climate is drastically changing at an unprecedent speed, and the consequences are affecting the natural equilibrium of ecosystems, biodiversity, and human life (IPCC, 2022). To fully understand how climate change and biodiversity loss affect human life on Earth, it is essential to highlight the interplay between these three elements.

As it is possible to see in the Figure 1 produced by the International Panel for Climate Change within the Summary for Policymakers, there is a strict interdependency between Climate Change, Human Society and Ecosystems, including biodiversity. These three elements are a clear risk for humanity and must be considered in planning and policymaking in the coming years as each change in one area strongly affects the other variables (IPCC, 2022).

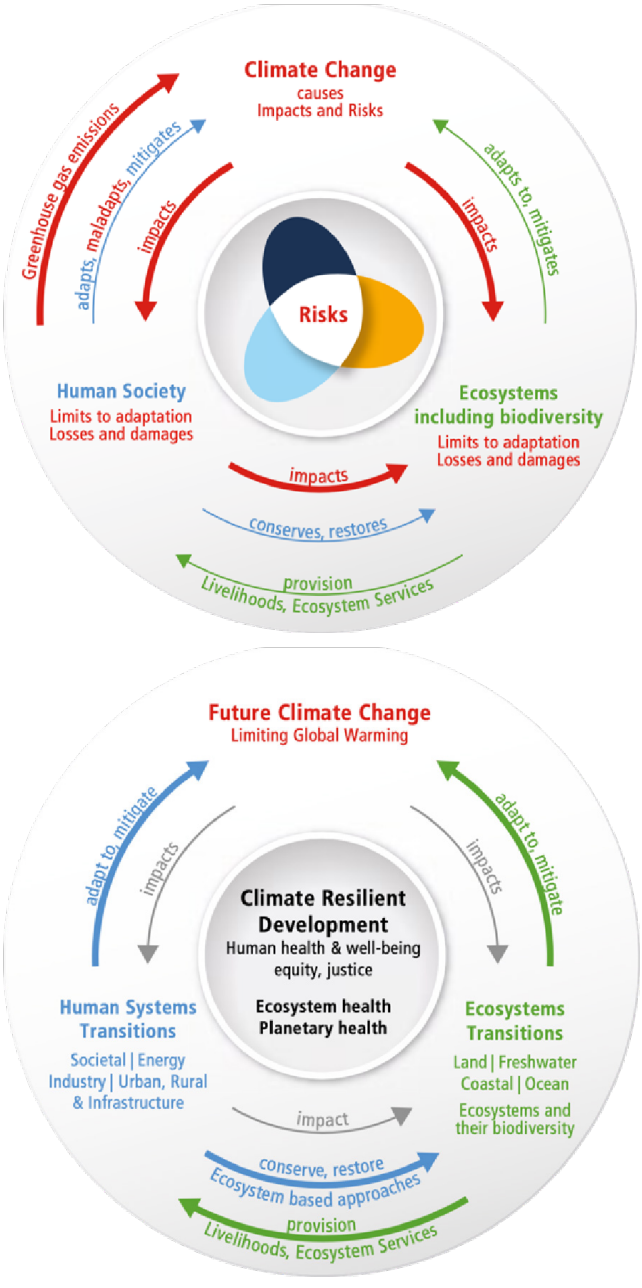

Figure 1. Infographic extracted from 'Summary for policymakers', IPCC, 2022.

As the natural ecosystem and biodiversity play crucial roles in the planet and human well-being, it is essential to develop policies that consider the protection and conservation of Natural Capital. Observing Fig.2., it is possible to see how to stage a Climate Resilient Development, which ensures human health & well-being, equity and justice, it is essential to limit global warming through human and ecosystem transitions (IPCC, 2022). The paper will focus mainly on the latter, as the object of the research is to focus on the management and conservation of natural ecosystems. Indeed, to start an effective ecosystem transition, it is fundamental to focus on the preservation and restoration of the planet's ecosystems and their biodiversity, both on land and water, commonly defined as Natural Capital. However, the equilibrium among these factors is continuously changing, and natural ecosystems, which rely on the delicate balance between organisms, are heavily modified by human activities, sometimes extremely fast and other times slower. For these reasons, it is pivotal to understand how to predict, manage, and mitigate these changes, an area in which technology can play a crucial role.

Defining what Natural Capital is crucial before proceeding with the analysis. The first definition of Natural Capital was given by Schumacher in 1973; he describes the Natural Capital as the exhaustible resources of nature (Schumacher, 1973). Schumacher considers the whole stock of the planet's natural resources, including geology, soil, air, water, vegetation and all living organisms.

Environmental issues affect countries and policymakers worldwide; this paper will focus on areas interested in conservation measures, such as national parks and marine protected areas, home to a wide range of different natural ecosystems. Indeed, the 5° report of Natural Capital in Italy from the Natural Capital Committee states that action is needed to protect this heritage and mitigate threatening events, such as soil erosion or forest fires (Comitato Capitale Naturale, 2022). This phenomenon of an increasing focus on natural capital protection and valorisation interests' policymakers worldwide who are adapting local policies to international guidelines. Indeed, the interest of governments' joint effort to protect the Natural Capital is confirmed by the vast array of national and international conservation strategies, such as SDG goals created by the United Nations. Within this action plan, more than 160 states are working together to follow those guidelines and receive different scores depending on their commitment. More than half of the SDG's goals are related to the health of Natural capital and its conservation (United Nations, 2023).

A valid example of this approach is the PNRR plan in Italy, the most critical environmental policy implementation plan of the next decade. The plan will invest more than 190 billion euros in new policies, with the ecology transition and digital innovation accounting for more than half the budget (Comitato Capitale Naturale, 2022).

1.2 Interplay between Nature and

Technology and the Role of Design

Before starting the critical analysis, it is necessary to highlight the role of technology in this process. Indeed, cutting-edge technologies are being developed within natural resources management to produce more commodities and services with less raw materials.

Indeed, the interplay between nature and technology has become pivotal in monitoring, managing and protecting the natural ecosystem, a phenomenon that has already given excellent results in different fields, such as Agriculture 4.0 (Klerkx, Jakku, & Labarthe, 2019).

These new implementations apply not only to the production and manufacturing sector but also to the observation and data collection related to biodiversity and ecosystems. Indeed, new tools, such as IT sensors, software, and AI, are being implemented in the Environmental Sciences to better understand climate change and how to defend delicate ecosystems (Weersink, et al., 2018) Furthermore, the environmental sector has come to appreciate the pivotal role of credible, objective, and real-time spatial information. This recognition is particularly evident among managers of protected areas, who understand the value and necessity of such scientific information and data. It serves as the foundation for making informed and effective conservation and management decisions, highlighting the significant impact of researchers' work in the field (Fancy & Bennetts, 2012).
Although the development of these new technologies is proceeding at an unprecedented speed, the implementation of these tools in the field of natural capital conservation still needs to reach its full potential and presents many criticisms. This phenomenon contrasts with the thoughts of environmental managers, who recognise the need for reliable data and information on the status and trends of the critical resources they manage as a basis for conservation planning and determining if the management practices have the desired effects (Fancy & Bennetts, 2012).

Over the years, design has evolved from the design of physical and intangible objects to the design of systems to the design of complex adaptive systems. This evolution has shifted the role of designers from central planners to participants in the systems in which they operate (Ito, 2016). In this field, the designer figure is beginning to appear alongside the researchers and developers, with the aim of minimising the gap between two words that seem so different. In highly innovationoriented fields, thanks to their ability to facilitate relationships and an extensive body of knowledge in the project area, they can act as 'connectors' by linking distant situations and people from different subject areas. This ability contributes to stimulating the spark of innovation, frequently determined by novel associations that open up 'lateral thinking', technological, expressive, scientific and cultural transfers (Gladwell, 2000).

A valid example occurs when presenting

data within the environmental area, which carries a more significant challenge because it usually takes into consideration several variables, particularly temporal data and maps. These two variables are critical factors for environmental data visualisation; however, using high-dimensionality, they create unique visual communication challenges (Weersink, et al., 2018). Opportunely, visual design applications within applied environmental research are beginning to emerge, particularly within geological, climate change, sustainability and landscape planning contexts, ecological decision-making and management (Grainger, Mao, & Buytaert, 2016). This application has made it possible to create novel solutions with design by developing more accurate and complex data visualisation means.

This process has introduced another crucial issue where design can be a facilitator: the involvement of the final user. When deciding on visualisation methods, designers should always consider their objectives and audience needs (i.e., overall functionality) (Cairo, 2013). This statement not only highlights the importance of the final user in the design process but emphasises their integral role as well. The user is not just a recipient of the design but a valued contributor to its creation, a fact that will be further analysed later.

Those examples demonstrate that Design can be a powerful instrument for creating new techniques and technologies, as well as a decisive way to boost the innovation processes. Indeed, an effective way to employ Design as a tool to innovate new technologies and environmental conservation is the design-driven innovation approach proposed by Roberto Verganti. This approach could be a gamechanger when developing innovative tools for ecological conservation. According to Verganti (2009), involving key interpreters in the process is crucial when introducing innovation within a sector to create new solutions and meanings. This approach was applied during field research to identify the criticisms and challenges that designers face when developing new tools for environmental management.

2. State of the Art

Before presenting this research's methodology, goals, and innovation, it is important to present to the reader the panorama in which this study positions itself. The innovation processes within the environmental conservation scenario are subject to an unprecedented flow of investments, both in the public and private sectors. However, as it happens for many emerging markets, they are experiencing some criticism.

2.1 Data accessibility and trust

The first issue is data accessibility and trust. As previously mentioned, managers and policymakers strongly believe in the power of objective data to provide support for planning and policymaking, and some pioneering institutions, like the National Park Service in the United States have already started this

innovative process to support management and conservation with new IT tools (Fancy & Bennetts, 2012). However, this is a virtuous example within a sector that lacks many features to support long-term growth in a volatile environment, which is subject to fast and hard-to-predict changes. Indeed, to be trusted, the information needs to be relevant - with clear and defined goals; reliable - supported by scientific information; and committed - part of long-term programs (ibidem). For several reasons, many of the conservation bodies fail to meet these requirements - particularly regarding the relevance as the conservation goals are different among conservation bodies - resulting in information and data that are not trusted and rarely employed to support decisionmaking.

Additionally, the data end-users cultural, institutional and disciplinary backgrounds vary between each conservation body, resulting in the urgent need for easily digestible information. When the information is too complex or outside the user's knowledge area, it can overwhelm the user, leading to a false understanding or lack of trust. Therefore, it is crucial to deeply investigate the end user characteristics and maximise the understanding of the information (Mastrandrea at al, 2010).

2.2. Innovating the Environmental Sector

It is clear that there is a high demand for reliable and consistently collected data from long-term studies to develop quantitative models to inform conservation and action plans for addressing the ecological consequences of rapid climate change (Mastrandrea at al, 2010).

However, within the environmental sector, there is a somewhat disorganised and fractured data ecosystem as government bodies, corporations, and universities are focusing on specific conservation issues (Weersink et al., 2018).

One of the reasons is that the innovation process happens at a local level without coordination, stimulating problem-specific solutions, which are difficult to translate to other conservation goals or transfer into other conservation environments. These issues highlight the urge to start coordinating these innovation efforts, trying to stimulate a sector innovation, rethinking its meaning and features, and avoiding the creation of many independent small innovations. Indeed, there is the urge to start a sector-wide innovation process, stimulating partnerships among key interpreters such as conservation bodies, institutions, companies, researchers and technicians to ensure technological advancement and innovation of meanings. This could lead to exponential changes that could benefit the whole sector by providing tools that are implemented with the knowledge of many users and stakeholders, which could be adaptable to many conservation challenges and individuals with different backgrounds.
Finally, throughout the natural parks and protected areas, there is a low level of digitalisation and innovative tools used for

the management and conservation of natural capital, in addition to a lack of ability to aggregate and interpret data in such a way that it results in inefficient decision-support tools (Weersink et al., 2018).

Defined the most significant issues of this fast-growing sector; the goals of this research will be presented in the next chapter, introducing the methodology undertaken during the field research to focus those criticisms better and explore new possible solutions driven by Design.

3. Goals and Innovation

3.1 Mapping criticism & Innovating through Design

The purpose of this study is to define the significant challenges that developers, scientists, and managers face when developing and implementing new technologies for environmental monitoring and management. However, the environment in which this process takes place is highly diverse and in continuous change, as each protected area has a different ecological balance, biodiversity, conservation goals, natural elements, topography, anthropic pressure, funds, human power and juridical nature. The same technology or tool cannot work for a marine protected area in the middle of the Pacific Ocean or for a highly anthropised national park in the mountains, which gets several million visitors yearly. Besides, it is possible that the same technology could work in two different scenarios if it is flexible enough or with an additional implementation process. A valid example might be the LIDAR mapping tools that drastically changed how remote areas are monitored or mapped.

Conservation bodies have widely used this technology to map the habitats and vegetation cover at Yosemite National Park, California (Kane, et al., 2014). The same technology has been used in Micronesia for cloud analyses, habitat mapping, and mangrove cover analyses in the Republic of Palau's marine protected areas (Cairo, et al., 2020).

Within this context, Design could be a highly effective double-headed solution. On the one hand, the Design could help the process of mapping criticism to define the areas where intervention is needed; on the other hand, it could be a powerful tool for developing practical solutions for those challenges and facilitating the relationship between technicians, such as developers and the final user, such as the biologists.

For the first goal of this paper - mapping the challenges of innovating this emerging sector - design offers a valid solution in terms of methodology and process. Indeed, for this purpose, the design thinking approach proposed by Design Council (2024) has been employed, particularly the discover and define phases, which helped to gather additional information to get to the problem definition. Additionally, the exploration phase could help to better define the state of the art where the data available are disorganised

and fragmented (Weersink et al., 2018). This process of exploration was fundamental during the field research to define the major challenges through 145 semi-structured interviews with stakeholders.

The other objective is to understand how to create solutions through Design to solve those issues and stimulate sector improvements and further research in this field. Once again, Design could offer the right tools for those objectives, particularly in a sector where the cultural and social variety of the end-users is substantial. Design studies, such as co-design, personalisation, and HCD, could help explore and understand the user's point of view better.

This focus on the utiliser can ensure the creation of innovations embraced and accepted by a vast array of final users (Norman, 2013; Papanek, 1971). Additionally, starting a dialogue with the key interpreters of the sector is essential to stage a technological innovation as well as an innovation of meaning (Verganti, 2009).

To summarise, this research's innovative approach is to apply solutions through and with Design to optimise the development of a fast-growing sector where interplay between different disciplines is essential. In this scenario, where developers, biologists, managers and scientists need to work together, the multidisciplinary nature of Design and its role as a facilitator is essential tools to define criticisms, create solutions and ensure effective implementation and improvement (Manzini, 2015). This paper aims to offer the reader an innovative way of thinking about Design as a tool for innovating the environmental sector. On the one hand, it is a problem-finding tool to better define what challenges to tackle; on the other hand, it is a problem-solving tool that tries to offer solutions for managers and scientists. In conclusion, the interplay between nature and technology is possible and can lead to exponential improvements, as has been demonstrated in other fields like agriculture 4.0 and bioengineering. However, it is fundamental that Design acts as a moderator of this relationship to create adaptable solutions that improve management and conservation to ensure a future for our species.

4. Methodology

The preliminary research phase, conducted using Design Thinking tools, involved 145 participants with pivotal roles within protected natural areas in Italy and internationally. These scientific and cultural stakeholders, along with key interpreters, are instrumental in the management, conservation, and monitoring of Natural Capital.

Through the use of multiple tools, a comprehensive analysis of the problems encountered in the management of Natural Capital by the main actors was conducted. This involved understanding the operators who face the issues on a daily basis and collecting specific data concerning a large number of natural parks in the Italian and international context.
The field research used a qualitative approach

based on observation to understand the operators' experiences and viewpoints, as well as a quantitative approach supported by the analysis and comparison of the numerical data obtained during the meetings.

Through closed-ended questions, it was possible to obtain specific and easily quantifiable answers, test hypotheses, and draw statistical conclusions. This allowed objective data to be obtained, answers to be standardised and, above all, easy comparison between groups. The qualitative approach, which involved focus groups and interviews, aimed to collect in-depth opinions from experts and actors in the field to identify hidden issues that had not yet emerged in detail from the state-of-the-art analysis.

In particular, the process was organised in five stages:

1. *Institution selection criteria*: in order to define a sample that could best represent the variety of contexts in Natural Capital management, institutions were selected according to the following criteria: type, level of complexity, and context. Two types of organisations dealing with different aspects of Natural Capital were included: marine protected areas, which deal with the protection of marine ecosystems, and national parks with a focus on terrestrial management. Finally, bodies with different levels of complexity were considered. Various aspects, such as size factors, level of technological development, age of the park, number of workers, anthropic pressure, presence of endemic endangered species, and level of conservation, came into play in defining this parameter. In order to facilitate the comparison of the technological development of environmental management tools and to overcome the scarcity of information, the involvement was extended from an Italian context, where funds dedicated to environmental management are lower, to an international one, through the invitation of protected areas outside national borders.

2. *Contact with directors and stakeholder selection*: The process of contacting and selecting the figures to be involved within the various bodies has been made in collaboration with the directors of the protected areas. The stakeholders interviewed were selected to interact with all the key figures involved in the management of national parks and marine protected areas.

3. *Involvement*: Stakeholders were contacted by telephone or email to agree on a meeting lasting 45 'to 60' for interviews. The contact modality chosen for the interviews was in person, within the protected area's workplaces. This modality aimed to establish a relationship of greater trust with the figures involved and to allow further field investigations with human-centred design tools such as direct observation and contextual observation of the users. In particular, we made use of indirect observation through the use of objective analysis tools.

4. *Interviews*: Interaction with stakeholders took place through face-to-face meetings of varying lengths of approximately one hour, depending on availability and topics covered. During the meeting, a semi-structured interview was conducted, consisting of a first part in which information was gathered on the characteristics of the users (personal details, skills, role); a second part, characterised by fixed questions which were the same for all the operators (22 closed-answer questions and 8 open-answer questions), which offered the possibility of going into specific points of interest in greater depth; a final part in which, starting from the topics addressed in the open-answer questions, the interviewee was freely involved in order to bring out latent and detailed problems, not identified in the interview design.

5. *Analysis of results and restitution*: The results of the interviews and the information from the various meetings were finally analysed and discussed to define and mapping of the main issues. The analysis of the quantitative data collected through the interviews was carried out through the use of descriptive and inferential statistics. Through the combination of the results of the quantitative and qualitative analyses, it was possible to arrive at a comprehensive understanding of the research topic. This helped to confirm the findings or provide multiple perspectives on the topic of the report.

5. Results

Table 1.

		MARINE PROTECTED AREA	TERRESTRIAL NATIONAL PARK
COMPLEXITY	HIGH	Palau International Coral Reef Centre & Palau National Marine Sanctuary	Yosemite National park
	MEDIUM	Nettuno Marine Protected Area	Abruzzo Lazio e Molise National Park
	LOW	Santo Stefano and Ventotene islands Marine Protected Area	Casentinesi, Monte Falterona e Campigna National Park

By applying the criteria defined in Table 1 for the selection of the entities involved, six different organisations interested in natural capital management were approached. For the MPAs, Regno di Nettuno (Ischia and Procida islands, Italy) was selected, which is vast and characterised by solid

anthropic pressure as it is close to several coastal urban centres. The MPA of Santo Stefano and Ventonene islands, located in the Tyrrhenian Sea more than 30 miles from the coast, is small and characterised by the presence of integrated management with a focus on cetaceans and migratory birds. Finally, Palau International Coral Reef Centre and its Palau National Marine Sanctuary are, respectively, one of the centres of excellence for marine research and one of the largest MPAs in the world. They were selected for their relevance on the international scene, substantial scientific and technological development work, and advanced fish stock management.

Concerning protected areas focused on terrestrial management, the following were selected: Foreste Casentinesi, Monte Falterona e Campigna National Park, in Tuscany, a recently formed protected area established in 1993. This body was selected for its young age, focus on forest management, anthropic activities, and medium size. The second entity is the Abruzzo, Lazio e Molise National Park, the oldest national park in Italy, which boasts the presence of several endemic highrisk species, such as the Marsican brown bear. It is an institution with strong anthropic pressure as it hosts around one million visitors a year. Finally, the last conservation authority selected is Yosemite National Park in California, one of the world's most famous parks characterised by mass tourism that reaches 5 million visitors per year. This institution was selected for the high number of workers involved in management and monitoring and for their role as pioneers in scientific research and technological development.

All the protected areas involved responded positively to the invitation, although with varying degrees of involvement. The relationship with the following bodies was developed through direct contact with the figure of the director, thanks to whose involvement it was possible to define in advance the areas of greatest interest and criticism for each park and the most appropriate figures to involve. The possibility of working with the management levels of the protected areas was aimed at establishing clear and rich relations to implement a radical collaboration. This method made it possible to establish a dialogue over the long term and allow for feedback and updates in the subsequent stages of the research, a fundamental process for the innovation process (Verganti, 2009). Through discussion with the directors, the figures involved in the project were identified and selected from each institution. They mainly were technical-scientific figures, researchers, management figures, policymakers, decision-makers, politicians and community representatives, surveillance and control, search and rescue, and technological and cultural developers. Following the discussion with the director, individual stakeholders were contacted in order to gauge their interest in participating in the interview and long-term bilateral dialogue.

The stakeholder engagement strategy yielded a high success rate, with 80.68% (145 out of 173) of the contacted stakeholders

expressing interest and consenting to participate in the project.

The choice was made to meet the operators in the field, in their working environment, to stimulate the sharing of real day-to-day management problems, to carry out analysis and verification of critical issues and to analyse conservation contexts through direct observation and shadowing. The face-toface meetings helped participants to open up more and share their thoughts freely, as well as to conduct an in-depth analysis of the problem and verify the accuracy of the information gathered through the other methods.

5.1 Semi structured interview results

From what emerged from the personal data analysis of the sample investigated, the Italian protected areas are characterised by a higher age and a lower generational turnover. In fact, the age in the national territory is higher, with 27,85% aged between 25 and 40, 43,04% between 40 and 55, and 20,25% between 55 and 70, while internationally, 53,03% are between 25 and 40, 28,79% between 40 and 55, and only 6,06% are over 55.

Table 2.

Age	National	%	International	%	Overall	%
18-25	7	8,86	8	12,12	15	10,34
25-40	22	27,85	35	53,03	57	39,31
40-55	34	43,04	19	28,79	53	36,55
55-70	16	20,25	4	6,06	20	13,79

Concerning the scope of operation of the different operators in the protected areas, 52,41% belong to the scientific-technical area, 19,31% to politics and the local community, 13,73% to surveillance and control, and 14,48% to management. Table 3 summarises the diversity of the organisation's stakeholders and highlights a variety among the operators with a predominance of technical and scientific figures.

Table 3.

Expert Domain	Number	%
Technical and Scientific	76	52,41
Politics and Local Community	28	19,31
Surveillance	20	13,79
Management	21	14,48

5.2 Closed and open questions

Through the use of closed questions, it was possible to validate or disprove the hypotheses arising from the state-of-the-art analysis and to obtain qualitative data to be analysed later.

The first part was aimed at investigating the context of digital innovation for environmental management, the state of the art and the need to integrate processes with technological tools. The results showed that 89.69 % think that climate change is affecting management and monitoring. Contextually, 77,24 % of the operators believe that the number of operators in the protected areas needs to be increased, and 77,93 % think that technological tools could help improve the situation. The second part of the research focused on the willingness to adopt new tools, the user's requirements in terms of functionality, objectives, and accessibility, and potential future scenarios.
Notably, a high percentage of 97.3% expressed their willingness to use new tools, with 91.03% showing interest in being part of the creation and development process of these technologies.

The third part of the research was dedicated to identifying critical issues in the development of new technological tools for environmental monitoring. This was achieved through the use of open-ended questions, which allowed for a comprehensive mapping of these issues. Subsequently, the answers to the open-ended questions were processed using textual analysis techniques to quickly analyse and extrapolate quantifiable data. By analysing the recurrence of certain keywords, Table 4 was constructed, which provides a summary of the critical points found.

Table 4.

CHALLENGE	NATIONAL	%	INTERNAT.	%	OVERALL	%
GENERATIONAL	17	12,50	14	8,48	31	10,33
DIGITAL CULTURE / EDUCATION	34	25,00	20	12,12	54	18,00
COSTS	10	7,35	21	12,73	31	10,33
BUREAUCRACY	14	10,29	9	5,45	23	7,67
FEAR OF CHANGE	0	0,00	8	4,85	8	2,67
IT SKILLS / CAPACITY / TRAINING	28	20,59	46	27,88	74	24,67
SOFTWARES	1	0,74	6	3,64	7	2,33
COMPLEXITY	1	0,74	10	6,06	11	3,67
COORDINATION	11	8,09	3	1,82	14	4,67
CONNECTIVITY	5	3,68	7	4,24	12	4,00
SECURITY & RESTRICTIONS	0	0,00	2	1,21	2	0,67
LACK OF PERSONNEL / DIALOGUE	14	10,29	5	3,03	19	6,33
POLITICS	1	0,74	1	0,61	2	0,67
DATA FRAGMENTATION	0	0,00	5	3,03	5	1,67
FLEXIBILITY	0	0,00	6	3,64	6	2,00
USER ACCESSIBILITY	0	0,00	2	1,21	2	0,67

5.3 Open dialogue part

In this phase of the interviews, opinions and comments were collected, which were not noted in the preparation phases but had a major impact on the continuation of the project. This form of interview allowed us to delve more deeply into specific topics or devote more time to some topics rather than others. This part was crucial in order to gain insight into the behaviour, attitudes, and habits of the operators (and indirectly also of the developers) and assess the potential satisfaction and acceptance of the new approach in the market. This qualitative analysis revealed the following criticisms:

- an excessive number and complexity of specific software for environmental

management;

· a lack of training and development that focuses on the needs of the end user;

· absence of coordination and dialogue between the developers and the end users (biologists, scientists, developers, technicians, and managers).

At a later stage of the research, meetings with technology developers and technical figures will be held to define possible directions for research and development.

6. Discussion

Even if the interviews highlighted a wide array of issues that need to be tackled to preserve Natural Capital, this study aims to focus on the challenges that the end users must face when using technological tools for management and conservation.

Some of the information collected during the interview and the fixed questionnaire helped to understand that it is essential to tackle this issue tempestively. Indeed, 97.24% of the operators think it is necessary to integrate management and monitoring with new technological tools, and more than 42.7% have available funds to invest in employing those technologies.

However, the most interesting outcomes of those interviews relate to the criticism and challenges those operators have been or are facing when undertaking this innovation process. Even if the contexts where the field research took place are so diverse, those protected areas share many common challenges, as well as some specific ones that come from the variety of goals, conditions, and geography of those places.

Among the challenges, those are the ones that have been mentioned more frequently among all the stakeholders involved in the sample: lack of digital culture and education (54 times 18%), generational issues (31 times 10.33%), costs and funding (31 times 10.33%). While the third is strictly related to the financing of the organisation and the policymaking, the first two elements highlight a pivotal element: there is a variety of cultural and educational backgrounds among the stakeholders.

Indeed, this variety is among figures with diverse skills that usually do not require a high level of technical skills or digital culture. Most of the employees in protected areas are managers, conservationists, biologists, researchers, and scientists, and they do not necessarily have a digital mindset. Often, they still use analogical means to carry on their work. The generational issue strengthens this element as more than 50% of the employees are over 40 years of age, and many of them have started working with analogical tools and are less keen to use digital tools than newer generations.

However, as it is possible to observe from Table 4, the most critical challenge among the stakeholders is the low level of IT skills and lack of training (74 times 24.67%). This differs from the digital culture and education

because these are specific IT skills needed to use the software and hardware employed to improve monitoring and management. While the digital culture refers to the propensity of the user to employ digital tools, specific IT skills are needed to use the technological tool employed for management and monitoring effectively. This lack of IT knowledge could make the user feel overwhelmed, resulting in a reluctance to use those new tools and a lack of trust in the information that should support the planning and decision-making processes (Mastrandrea et al, 2010). Additionally, being a novel sector, the software and interfaces are very specific and intricate, and the accessibility has not yet been improved for an audience with different backgrounds and IT skill levels. This element highlights the importance of user research, user experience, and interface design, which are pivotal tools for making the digital ecosystem accessible and useful (Bollini, 2001).

Even if the situation seems similar worldwide, there are a few differences between the national and international contexts. Indeed, in some cases, those criticisms have a different weight in each context; for example, digital culture is a key issue in Italy (mentioned 34 times), while internationally, it is smaller (mentioned 20 times). Also, coordination and lack of dialogue between biologists and developers have different importance. The former is a big issue in Italy as it has been mentioned 11 times against the 3 times of the international protected areas, and the latter has been highlighted 14 times against 5 times abroad.

Those elements allow us to confirm that the situation is different for each scenario and that a flexible and adaptable solution is needed. This statement is confirmed by differences and specific issues among parks. Indeed, the lack of IT skills is a more significant issue among marine parks (mentioned 14 times) than terrestrial parks (only 5). These need for flexibility and personalisation are substantiated by the questionnaire results, as 92.41% of the users would like to be able to customise digital tools, and 98,62% would like to personalise the visualisation of information and data.

An accurate understanding of end-users' behaviours, needs and limitations is essential for effective design (Norman, 2013). Jesse James Garrett (2010) emphasises that the user experience must be at the core of the design, as ensuring a smooth and intuitive interaction with technological tools is crucial for their adoption and continued use. For natural capital management, this implies a detailed analysis of the needs of operators in the field, who must be informed and involved from the earliest design stages. The co-design process argues that actively involving all stakeholders, managers and biologists, including end-users and experts, in designing technological tools is crucial to developing beneficial and accepted solutions and ensuring they are aligned with their needs and goals (Manzini, 2015). In the iteration and testing phases, Buxton (2007) points out that design must be a continuous process of prototyping, gathering feedback and improvements. This approach

is crucial to ensure that tools for natural capital management are refined through real use and direct user observations. In addition, it is necessary to design sustainable and adaptable solutions. Papanek (1971) emphasises that design must consider not only immediate effectiveness but also long-term impact and ability.

Finally, flexibility, user accessibility, and software complexity have been mentioned more often at an international level (14 times in total) and not at a national level again (1 time). These issues have been also mentioned during the open talks as the operator is not able to customise and adapt to their specific goal the tools provided.

This highlights the fact that technological tools and software are more frequently employed within international bodies. Consequently, there is a higher awareness of the issue and a greater urgency to improve user accessibility in those environments.

These elements that emerged from the field research could help to focus on critical challenges that are still blurred in the novel sector of technological tools for environmental monitoring. The findings suggest that there are significant differences between conservation bodies in terms of typology, location, and the unique specificity of conservation issues. However, even if they have significant dissimilarities, those bodies share many common challenges.
This means that to effectively develop accessible technology for natural capital management, it is necessary to focus on accessibility among diverse users, improve flexibility, and adapt those tools to specific needs, goals, and different levels of complexity. Design offers practical solutions for these criticisms tough co-design, personalisation and human-centered design.

7. Conclusion

Among the Natural Capital conservation bodies, there is a variety of end users with different skills, goals and backgrounds. To face these issues, developers and designers need to deeply understand the user's point of view while developing these new tools through co-design and human-centred design. The designer, therefore, must facilitate through his action the co-creation of individual awareness and collective consciousness through the involvement of all actors (Rizzo, 2009) and by directing personal choices towards social responsibility (Leonardi et al, 2023). These tools are an effective solution to establish a long-term dialogue with stakeholders and key interpreters to ensure that the innovation process follows the protected areas' needs and goals. It is crucial to shift the attention to the final user to prevent managers and scientists from losing faith in the data and ensure that they employ the information presented by IT tools - software, hardware, interfaces, IoT - to support decision-making processes for holistic management of Natural Capital. Indeed, creating flexible interfaces and improving personalisation elements among these tools could help to create trust among decision-makers and ensure that they use data

to make informed and strategic decisions.

Moreover, it is fundamental to create a long-term structured dialogue among developers and end users to ensure those criticisms are considered during the development and implementation processes. Indeed, one of the major issues mentioned during the interviews is the lack of dialogue and co-design among technicians and biologists, resulting in tools that are not aligned with conservation goals and user characteristics.

Additionally, as highlighted by different stakeholders, climate change is affecting the way those protected areas are managed and monitored, an element that is enhanced by the ever-changing equilibrium of natural ecosystems. This scenario makes it pivotal to develop tools that are adaptable and resilient to change. Emphasising the need for these tools should reassure the audience of their effectiveness and instil confidence in their potential.

Successfully staging a design driven innovation in this sector is critical as policy-making and major investments are interested in protection and conservation of Natural Capital worldwide. Failing to successfully scale up the management and conservation of protected areas could result in loss of biodiversity and failure to stage Climate Resilient Development for the survival of our species. However, the role of technology in driving this innovation should inspire and motivate the audience and design could be the right tool to ensure effectiveness.

This paper presents a snapshot of the state of the art in creating accessible technologies to manage natural capital, highlighting the challenges and criticisms in staging this development. By providing possible solutions driven by design to the issues that emerged in field research, this study aims to offer a baseline and guidelines for developers, conservationists, and scientists and to stimulate further research in this field.

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PASTRY AS A MEDIUM: DESIGN FOR SOCIAL INNOVATION OF CATERING SERVICE IN A CHINESE NURSING HOME

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ABSTRACT | In China, the focus of elderly catering service has shifted from “eat enough” to “eat healthy” and “eat happily”. The indigenous concept of “dietary health preservation” and lifestyle stimulate the transformation of elderly catering service as a cultural foundation for social innovation. This article introduces the catering service design and social innovation for Outang Nursing Home by a student team. Through observation and interviews with both elderly residents and staff at the nursing home, issues among the elderly, such as monotonous diet services, feelings of loneliness and boredom as well as lack of sense of value were identified. The nursing home has adopted a “three meals plus two snacks” catering service model, aiming to reduce digestive burden on the elderly through smaller meals between main ones. In response, an innovative proposal was made to introduce dining as a means for socializing while incorporating dietary health preservation concepts to promote healthier, happier, and more healing dining experience for older people. The project used pastries, a traditional Chinese healthy delicacy, as a medium and was implemented in three stages: designing a healthy pastry brand; organizing a pastry-making activity; constructing a pastry catering service system. From healthy food products to dietary concepts to dining activities, it completed a comprehensive transformation from product innovation to lifestyle advocacy aimed at enhancing older people’s dining experience and overall quality of life. By tapping into the value of older people while promoting indigenous healthy eating concepts, the project explores a sustainable and replicable nursing home catering service model within the Chinese context.

KEYWORDS | SOCIAL INNOVATION, CATERING SERVICE, NURSING HOME, THE ELDERLY PEOPLE

1. Introduction

In the context of China's aging population, the country promotes "community-embedded elderly care". By integrating elderly care institutions into communities, it combines the advantages of communitybased and institutional elderly care, meeting the desire of the elderly to be cared for in their local area. Consequently, an increasing number of elderly people are choosing to live in community nursing homes. With the improvement of health awareness, dietary health concepts and healthy eating lifestyles are favored. The focus of elderly care catering service has shifted from simply "eat enough" to prioritizing "eat healthy" and "eat happily". The current catering service model in nursing homes is unable to meet multi-level needs and requires innovative changes.

Social innovation leads to a sustainable future by introducing new ways of living and production (Manzini, 2015). To achieve this goal, it is important to not only focus on individual well-being (Zhong, 2024) but also on cultural concepts and social context (Li et al., 2023). China has a rich tradition of dietary health dating back to the ancient medical classic "Yellow Emperor's Canon" from the Qin and Han dynasties. In this book, the concept of "dietary therapy" is introduced, which posits that traditional Chinese medicine is equivalent to natural food and that ingesting food according to the season can maintain good health. The theory of Chinese dietary health holds practical value and can be applied effectively in modern life through cultural and lifestyle innovations (Jin & Li, 2020), offering opportunities for healthy aging and promoting sustainable change (Li et al., 2023).

This article presents a social innovation practice implemented by a student design team at a nursing home in China. It explores how to create a more positive dining environment for elderly residents by incorporating local culture and promoting healthy lifestyles while developing a sustainable catering service model. The OU Pastry Catering Service Project was initiated as part of an elective course for first-year postgraduate students at the School of Design to optimize the existing catering service at Outang Nursing Home.

Outang Nursing Home is the first community-embedded nursing home in Jiangsu Province that integrates medical care and elderly care. It was officially open on December 1, 2022, and mainly admits elderly people with limited mobility and decreased ability to live independently. The nursing home provides professional medical services, including health assessment, daily living assistance, nutritional meals, diagnosis and rehabilitation treatment, long-term care, and chronic disease management. Currently, there are 71 elderly individuals in the nursing home, with the majority requiring high-level care, accounting for 66%. Among them, 33 elderly people need to use wheelchairs for mobility while 29 require long-term bed rest. Within this group, seven individuals are completely disabled. Many of the elderly residents suffer from chronic diseases such as hypertension (56%) and diabetes (27%). The nursing home currently operates a "three meals plus two snacks" catering service model which involves serving two snacks between three main meals. All food is prepared by the nursing home's cafeteria following principles of healthy eating to ensure low sugar, low oil, and low salt content. Elderly individuals with mobility usually go to the dining room for their meals. For bedridden residents, caregivers deliver the meals and assist with feeding if the elderly have difficulty swallowing solid foods.

Before proceeding to our design plan, we posed three goals:

- Propose a customized catering service for Outang Nursing Home to optimize the "three meals and two snacks" mode.
- Shift the elderly from passive recipients of service to active participants in the service system.
- Explore the value of dietary culture to promote sustainable service system construction.

2. Research and Discovery

In order to gain a comprehensive understanding of the service model at Outang Nursing Home and to explore the daily life needs and emotional states of the elderly residents, we conducted three field surveys. We employed semi-structured interviews alongside random interviews with nursing home staff, while also observing birthday celebrations and rehabilitation training activities for the elderly.

In the first survey, the director of the nursing home provided an overview of its organizational structure related to public construction as well as insights into its unique service characteristics that integrate medical care with nursing services. The director also shared information regarding the nutritional standards and meal recipes implemented in the facility.During our second survey, we participated in a birthday celebration for one of the residents, which allowed us to gain

deeper insights into their living conditions and emotional expectations. In our third survey, we observed rehabilitation training sessions and assisted rehabilitators in conducting these activities.

Additionally, we conducted random interviews with nurses and caregiving staff to learn more about the daily routines experienced by elderly residents. Through interviews with elderly residents and staff, observation of dining scenes and rehabilitation activities, we identified areas for improvement as follows:

Dining:

The current dietary arrangement in the nursing home is monotonous and fails to address the personalized nutritional needs of elderly residents. The facility provides a fixed menu consisting of "three meals and two snacks," which includes three meals served in the morning and two snacks offered between meals. This weekly menu is designed according to dietary guidelines to ensure adequate nutritional intake for the elderly; however, it tends to be relatively bland and unvaried. Given the low daily energy expenditure among older adults, stimulating their appetites proves challenging.

Activities:

Limited engagement opportunities contribute to insufficient communication between the elderly and their caregivers, ultimately leading to social isolation.The nursing home adopts a closed management model with strict restrictions on outdoor activities for the elderly. As a result, they have limited options for engagement, often confined to watching television indoors, walking in the corridors or participating in exercise classes after dinner each day. Additionally, there is a weekly rehabilitation training activity led by therapists where residents are assigned tasks without much interaction among themselves.

Emotional well-being:

Lack of social activities and insufficient emotional support significantly impact the mental health and overall well-being of elderly individuals. Many elderly residents have reported feelings of loneliness and expressed a strong desire for increased social interaction. Some even articulated sentiments of 'feeling worthless.'

Figure 1. Rehabilitation training activities in Outang Nursing Home.





Figure 2. Excerpts from interviews with nursing home staff and older people.

To address feelings of loneliness and worthlessness among residents at Outang Nursing Home fundamentally.We analyzed the root causes of these issues. Firstly, upon entering the nursing home, elderly individuals were separated from their children, neighbors, and friends - effectively disconnecting them from their previous social relationships. Furthermore, highly structured schedules within the institution force changes in those individuals' established routines, so the elderly need to rebuild a new way of life. However, due to the focus on physical health rather than mental enrichment within Outang Nursing Home, elderly people lack the opportunity to create value or build new relationships, resulting in negative emotions.

In response to the identified needs, we have resolved to empower the elderly by fostering positive lifestyles through enhanced social connections facilitated by dining activities and identity transformation aimed at creating value. Our approach focuses on generating value by reinforcing social ties and reshaping identities through catering initiatives, thereby promoting a more active lifestyle for older adults and enabling their participation in social engagements that allow them to realize their personal worth. To this end, we propose two key strategies: "diversified diet" and "enriched social activities."

Socializing through dining:

Dining activities contribute significantly towards maintaining good health amongst older adults (Tao, 2024). Specifically in an eldercare setting, enjoyable dining experiences promote individual appetite stimulation and nutritional intake(Dunbar, 2017), enhancing opportunities for making friends and fostering group belongingness (Curch 2004; Wright et al., 2006).

Empowerment through new identities:

Shifting perspectives by viewing older adults as "capable individuals" who actively contribute towards service provision (Manzini, 2015) strengthens their autonomy and agency, thereby elevating proactive well-being levels along with self-esteem (Dong, 2022).

3. Project Proposal Development

We have innovated the catering service at Outang Nursing Home to make it more interactive and dynamic. By incorporating Chinese pastries into the "three meals plus two snacks" model, we enhance the "two snacks" with pastry-making activities as an "afternoon tea" for the elderly. Our approach is rooted in service design and social innovation, placing seniors at the center of our system. This innovation guides lifestyle changes for residents through a reformed catering model. Using service design thinking, we aim to transform nursing home catering services based on principles like "user-centered," "co-design," "tangible and intangible services," "systematic," and "sustainability." To ensure sustainable implementation, we divide the project into three stages: 1.0 Brand Definition, 2.0 Local Construction, and 3.0 Co-creation by Multiple Parties. This corresponds to a gradual transformation of the catering service from establishment to practical promotion. To build an effective service system, we integrate various means of service design and social innovation—such as brand design, event planning, and system innovation—across different dimensions to provide seniors with a positive catering experience. The content progresses layer by layer to meet their physiological needs while fostering social connections and self-realization.

Through these efforts, we aim to connect various stakeholders and establish a healthy pastry living laboratory centered at Outang Nursing Home. This initiative will promote the concept of healthy eating across the community.

3.1 Brand Definition

In phase 1.0 of the project, we aim to build a brand centered on elderly users. This initiative is informed by an analysis of the dietary digestion abilities, habits, taste preferences, health conditions, and special needs of older adults as identified in our survey. We have selected pastries as a medium for promoting dietary health culture.

Specifically, we focus on Chinese pastries due to their embodiment of traditional dietary and health concepts while being commonly consumed in contemporary diets. Renowned for their exquisite appearance and rich nutritional profile, Chinese pastries feature a soft and glutinous texture with moderate sweetness that facilitates ease of chewing and digestion. Their low sugar and oil content renders them particularly suitable for elderly consumers. The selection of ingredients and production processes employed in making Chinese pastries reflects key dietary health principles such as "food therapy" and "eating according to the seasons," which are integral to Chinese culinary traditions. These pastries often incorporate traditional medicinal ingredients like poria cocos, coix seed, and lotus seeds—each serving specific functions aligned with Traditional Chinese Medicine Theory; these include tonifying the spleen and kidney, eliminating dampness while promoting diuresis, as well as nourishing the heart and calming the spirit. Moreover, Chinese pastries adapt well to seasonal ingredients; for instance, individuals in Jiangnan (Southeast China) prepare mung bean cakes during summer using mung beans combined with osmanthus sugar or mint leaves known for their heat-clearing properties. In

terms of production techniques, there is a strong emphasis on preserving both nutrition and flavor through methods such as mixing, grinding, sieving, molding, and steaming.

Based on the nursing and health maintenance characteristics of Outang Nursing Home, medical care is integrated with dietary and nutrition care to provide comprehensive diet therapy. This approach not only meets the taste enjoyment needs and nutrient intake of elderly people but also promotes dietary health concepts and methods while guiding them to cultivate healthy eating habits.

Brand Naming: We have named the brand “OU pastry”.The “O” is derived from the initial letter of Outang Nursing Home, while the “U” symbolizes a smiling curve, representing vitality and healing. In Chinese, “OU” sounds like “We have”, so “OU pastry” conveys the meaning of “We have healthy pastry” (Figure 3).

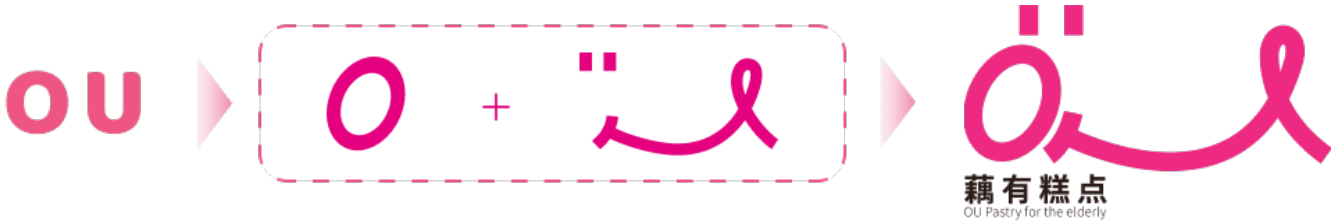

Figure 3. The design process of OU Pastry logo.

Brand Concept: Introducing the 3H concept of “Healthy, Happy, Healable”. Our goal is to establish a living environment at Outang Nursing Home that promotes healthy, happy, and healable for the elderly. Building upon this concept, we developed brand IP and visual materials to foster a welcoming and lively brand image (Figure 4).



Figure 4. OU Pastry brand design.

Pastry research and development: We proposed five standards for age-appropriate pastries, which include “the use of healthy ingredients”, “easy-to-chew”, “delicious taste”, “visual appalling”, and “high-quality control”. We used seasonal healthy ingredients such as yam, red dates, peanuts, etc., in pastry recipes. Additionally, we consulted relevant literature in food science and made a pastry sensory evaluation form. (Figure 5).



Figure 5. Pastry sensory evaluation form and the process of pastry-making.

3.2 Localized Practice

In Phase 2.0, we establish environments and mechanisms that promote collaboration, initiating dietary activities aimed at facilitating lifestyle transformation for the elderly. At this stage, the aim is to enhance elderly participation in activities, strengthen positive social interaction and promote positive emotions. On the afternoon of April 16, 2024, a themed activity called “Pastry Drifting Program” was held at the restaurant activity space on the third floor of Outang Nursing Home. Fourteen senior citizens, four family members (including one child) and five medical staff participated in the activity. During the event, pastries were made by elderly people as an interactive medium, creating an opportunity for communication between senior citizens and comakers. The pastry-making space served as a platform to foster connections and created a warm atmosphere to ensure the smooth development of the event.

Create Spaces to foster relationships

Pastry-making space is crucial. Space provides conditions and atmosphere to make human behavior and interaction possible (Manzini, 2022). Therefore, space design can be seen as a form of “relationship design”. The pastry-making space should aim to cultivate a warm and pleasant atmosphere that encourages communication and interaction among the elderly. In our approach, we put long tables in a row in the activity space to facilitate face-to-face communication among the elderly. Additionally, we decorated the space with brand posters and brand materials to create a sense of ceremony (Figure 6).



Figure 6. Creating a warm and pleasant pastry-making space.

Create new social relationships

In the nursing home, we have established a supportive social network centered around the activity of pastry-making. The elderly residents derive joy from coming together to create pastries, and the interpersonal connections formed during these activities enhance their feelings of support and care. Socializing through pastry-making enables seniors to cultivate new and positive relationships with others. Following the co-design principle of service design, this stage involves collaboration among elderly residents, family members, community workers, and care home staff to foster a supportive social network through interactive pastry-making.

In this context, pastries serve as both a medium for engagement and a pathway for connection. By participating in these activities, elderly individuals transition from being passive beneficiaries to active contributors in the co-creation process, thereby establishing new social networks. This collaborative endeavor encourages older adults to feel valued and supported, further reinforcing their sense of belonging and overall well-being. Notably, some participants spontaneously share the pastries they have made with staff and family members as a means of expressing affection.

Beyond the confines of the nursing home, we developed a recruitment mechanism for pastrymaking activities to attract residents from surrounding communities to participate in pastry activities and build a community collaboration network. We have devised a process involving “registration - participation - credits exchange” along with an associated platform for community members to sign up for and receive rewards for their involvement in these activities (Figure 7).

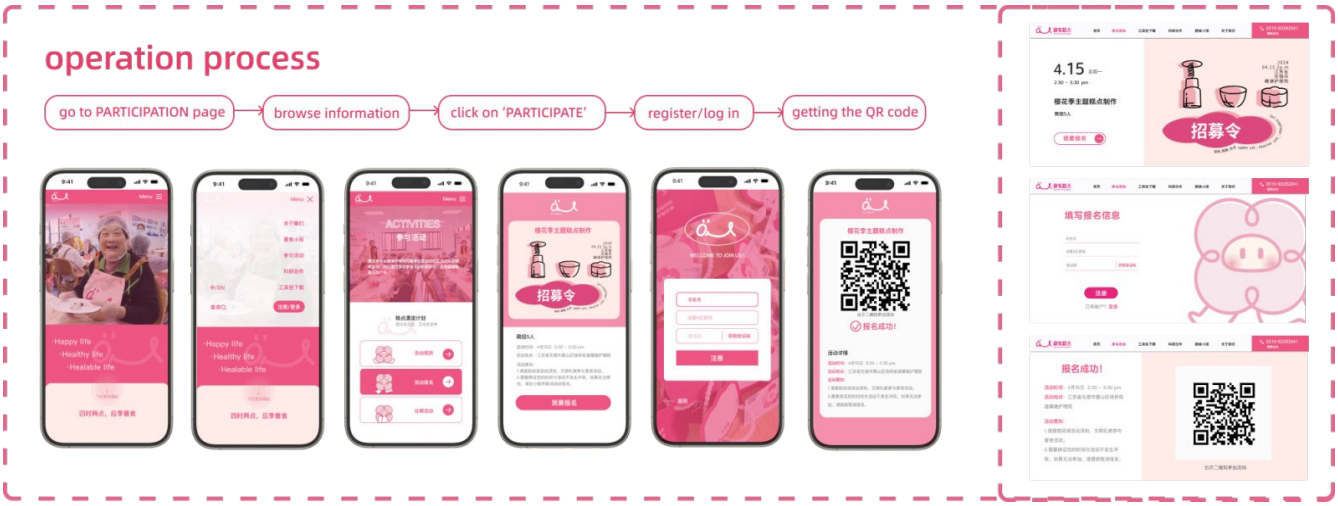

Figure 7. Mobile and PC interfaces for pastry-making activity recruitment.

Positive emotion

The OU pastry initiative integrates both tangible and intangible services designed to cultivate positive emotional experiences for the elderly. To facilitate pastry-making process and alleviate cognitive load, we pre-portioned the crust and filling for each participant. As elderly individuals fill molds with crusts, press them into shape, and remove them from molds, these participants take pride in crafting beautiful pastries by hand. By streamlining the steps involved in pastry making, we empower elderly individuals to successfully complete their pastries, which enhances their self-esteem and sense of achievement.

Furthermore, our approach involves allowing the dough to mature prior to shaping it, enabling participants to taste their creations without extended waiting time. This design enhances happiness through timely feedback; participants can savor the pastries they have made themselves. Such uplifting emotional experiences encourage older adults to spontaneously showcase their work, further reinforcing their positive feelings and social engagement (Figure 8). It is noteworthy that the Pastry Drifting Program serves not only as an on-site construction practice but also as a prototype testing process. We collected tasting scores and feedback from participants who provided encouraging remarks such as “very happy” and “very interesting.”



Figure 8. Photos of the “Pastry Drifting Program”.

3.3 Co-creation by Multiple Parties

In the Project 3.0, to ensure the sustainability of the service model for OU Pastry, we propose the establishment of a service system that integrates multiple resources and stakeholders through a research and development network. The concept of a Living Lab has been introduced, wherein Outang Nursing Home will collaborate with universities and social food research institutions to create a sustainable reasarch and design network. Within the OU Pastry catering service system, Outang Nursing Home serves as the central hub, integrating research and development, new product tasting, activity expansion, and feedback iteration (Figure 9).

In this living laboratory centered around Outang Nursing Home, social volunteers, universities, food research institutions, and other nursing homes form a cross-border collaborative governance model. The role of elderly residents at Outang Nursing Home will transition from caretakers to pastry tasters; their feedback will be invaluable for food research institutions in fostering the sustainable development of elder-friendly pastries. The OU Living Lab facilitates collaboration across various fields, disciplines, and cultures while integrating diverse knowledge bases, resources, and capabilities. This approach not only promotes the dissemination of healthy dietary concepts

but also supports the creation of age-appropriate healthy pastries— providing robust support for the overall sustainability of this service system. Through cooperation that transcends industry boundaries as well as disciplinary and cultural divides, we aim to disseminate healthy diet concepts while cultivating new lifestyles and environments. Our goal is to transform this service system into a vibrant cultural framework with enduring vitality (Lou, 2013).

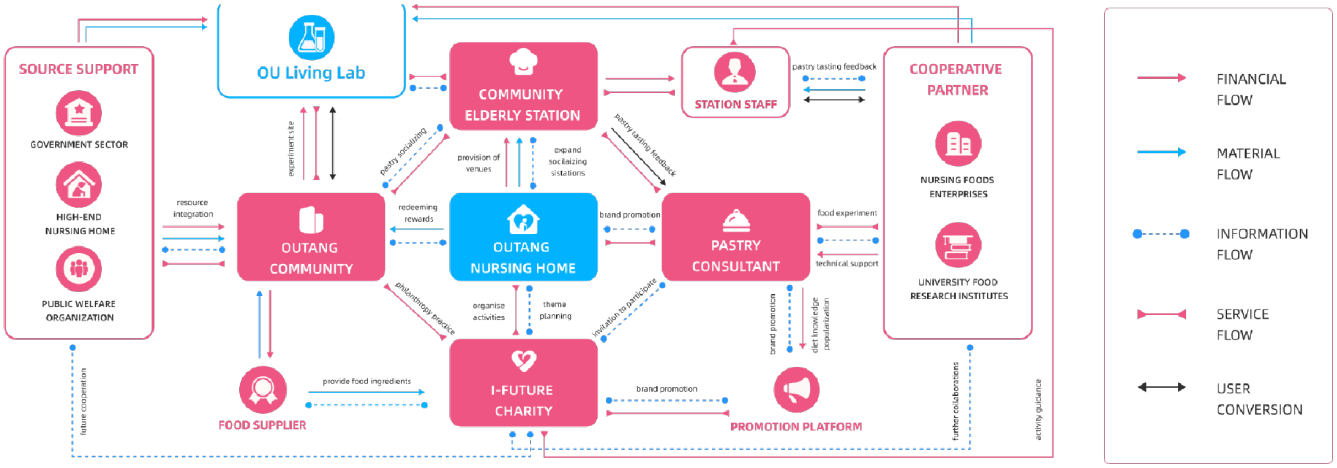

Figure 9. OU Pastry catering service system map.

4. Discussion

Service design thinking and social innovation facilitate systematic and integrated approaches to fostering innovation. The principles of service design facilitate the creative integration of service resources and elements, thereby playing a crucial role in addressing the complex social issue of elderly care. The OU Pastry project adopts a cateing service approach to support older adults, promoting reforms in the service model for nursing homes and evolving into a practice of sustainable social innovation. In three stages of this project, the essence of social innovation lies not only in tackling immediate challenges but also in establishing a sustainable system capable of long-term self-optimization and development. We consistently implement a “user-centered” approach that focuses on the genuine needs and emotional experiences of older adults. Our objective is to enhance the overall quality of elderly care services through systematic design methodologies while emphasizing both effectiveness and sustainability within the service system. Through this project, four key elements of social innvation warrant discussion:

Reorganizing existing resources to create new functions and value.

OU Pastry Catering Service Project integrates multiple resources, including space and service resources in the nursing home, dietary health preservation resources, especially the elderly who were originally served as value

creators. Through active value creation, older people became the key element in maintaining the sustainable operation of the catering service system.

Creating new social connections and encouraging positive interactions.

Positive social relationships build a sustainable society (Li et al., 2023). After socializing by making and eating pastries regularly, older people are able to establish and maintain good social relationships, thereby maintaining positive interactions with others. This not only fundamentally addresses issues of loneliness and worthlessness among the elderly, but also empowers them to some extent.

Replicating and disseminating the service model.

Based on the outcomes of our practice, we have further contemplated the potential for replicating and scaling up the project. To disseminate our concept, we designed promotional websites optimized for both mobile devices and computers. Through social media promotion and targeted publicity efforts, we aim to increase awareness of the OU pastry project among a broader audience. Concurrently, to ensure that this model can be effectively replicated, we have developed a comprehensive toolkit for OU pastry activities to standardize the implementation process.

Cultural innovation for a sustainable future.

As a bottom-up social innovation project, OU Pastry presents a path for design discipline to explore sustainable lifestyles. Culture is rooted in people's consciousness, and excellent traditional culture is the essence of culture, which provides a steady stream of impetus for innovation and development. Combine traditional dietary health preservation culture with the needs of the new era and life scenes, there will be gradual changes in the behaviors, perceptions, and ways of life of individuals and even entire communities through project implementation (Li et al., 2023), ultimately leading to a more humane and sustainable future.

5. Conclusion

This paper proposes a cultural intervention to promote an active lifestyle among the elderly. It outlines a pathway for social innovation within a cultural framework, leveraging Chinese food culture and traditions as starting points. The initiative addresses social issues by gradually shifting perceptions, behaviors, and lifestyles in individuals and communities, ultimately enhancing quality of life while supporting sustainable development. OU Pastery serves as both the design object and guiding system. By integrating food with a social space through services that connect the elderly with participants, it translates values and culture into social norms. Social innovation operates on both local and global levels. Localized projects have an

“acupuncture” effect, initiating change at critical points to influence broader processes and foster sustainable social change (Lou, 2013). Our project is an exploratory pilot of Chinese-style aging but has potential for wider application. Pastries act as a medium to disseminate health concepts and healthy lifestyles across different ages and cultures while inspiring creativity among social innovators. We hope our work will promote further collaboration and lead to more practices for active aging in the future.

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AUGMENTING THE DOUBLE DIAMOND: CRITICALLY INTEGRATING GENERATIVE AI IN THE CREATIVE PROCESS

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ABSTRACT | The introduction of generative Artificial Intelligence is transforming the creative landscape. However, the challenge lies in moving beyond the arbitrary use of numerous generative AI tools towards a structured integration that amplifies human creativity. This paper investigates the potential evolution of the Double Diamond design process and related methods through the lens of AI. We forefront three key insights obtained through case-studies that are central to our approach of developing an AI-augmented double diamond model: friction as a virtue, the AI-efficiency paradox, and (inter)play as a mode of engagement with generative AI technologies. Building on this foundation, we propose an augmented Double Diamond that addresses the benefits and challenges of incorporating generative AI tools in the design approach with varying levels of AI-engagement. The proposed model encourages critical reflection on the design process and embeds ethical and societal considerations throughout the process.

KEYWORDS | DOUBLE DIAMOND, GENERATIVE AI, DESIGN PROCESS, HUMAN-AI SYMBIOSIS, ETHICS

1. Introduction

Building on decades of research into Artificial Intelligence, generative Artificial Intelligence has seen a spectacular rise. Generative Artificial Intelligence encompasses algorithms that generate new content, both textual and visual, and with the widespread adoption of tools such as ChatGPT and Midjourney, it is impacting many industries. Large Language Models, such as ChatGPT by OpenAI and Claude by Anthropic, facilitate tasks like reviewing written texts, autonomously drafting texts with simple prompts, generating concepts, or ideating various copywriting proposals. Text-to-image latent diffusion models, like Stable Diffusion and Midjourney, enable us to generate new images and combine concepts with a simple prompt, and can adapt to existing or newly trained styles.

The creative sector has always been at the forefront of adopting new technologies and methodologies. With the advent of generative AI, capable of generating new images, texts, and concepts (Girotra et al., 2023), there is talk of a potential paradigm shift in how creative professionals will perform their work. These recent developments raise concerns about the possibility of machines replacing human creativity, with the designer becoming subordinate to the machine. At the same time, creatives have explored the potential of generative AI technology, often experimentally. For instance, Kyle McDonald was one of the first artists to experiment with Google DeepDream (McDonald, 2015).

In the last two years, however, generative AI is transitioning away from the experimental domain to becoming a tool for creative professionals, who now engage with as Creative Support Tools (CSTs) – digital tools that facilitate the work of creatives. These tools are increasingly seen as another resource in the creative toolbox, and traditional CSTs are steadily integrating generative AI into their applications. This marks a paradigm shift in the creative field, as we move away from technology that *help* us produce outputs towards technology that can *produce* (generate) output almost independently. Consequently, the relationship between people and their tools is changing,

and calls for an examination of how creative professionals' workflows are evolving. As McLuhan's contemporary, Culkin, stated (Jouhki & Hurme, 2017), *"we shape our tools, and thereafter our tools shape us."* (Culkin, 1967). Therefore, it is important to investigate how these new tools are used, when they are used, and how they alter our interactions with CSTs. In this paper, we dissect three explorative case studies and extrapolate our findings into an augmented Double Diamond model, and examine the implications.

2. Explorative case studies

1. Methodology

In this section, we review three explorative case studies that emerged from our Research-throughDesign approach. Research-through-Design is a methodology that helps researchers *"to investigate the speculative future, probing on what the world could and should be"* (Stappers & Giaccardi, 2017) by employing the *"methods, practices, and processes of design practice with the intention of generating new knowledge."* (Zimmerman & Forlizzi, 2014). Each case-study helped to capture insights in the creative process when engaging in various ways with generative AI technology, and enabled to form the basis of our proposition for a potential new or updated Double Diamond framework.

2. Case studies

The first case-study consisted of a half-day workshop led by a design agency in which approximately 30 first-year design and development students were challenged to tackle a creative brief from a realworld case. This workshop was held twice, each time with a different group of students. The students had almost no prior design knowledge, and very limited knowledge of generative AI. In the preparation of the workshop with the industry partner, we established that the workshop, whilst focusing on generative AI, should not fully be AI-driven. A set schedule was developed with distinct stages to guide the students through the workshop. Students were asked to develop a visual concept for an industrial product in the B2B market, building on a larger, overarching concept, provided by the design agency. The overall goal of the workshop was to explore a hybrid approach between human-led ideation and the utilization of generative AI tools in the process of designing the output. The ideation phase took place in groups and allowed the students to sketch out different ideas on how to communicate their visual concept that highlighted the qualities of the product. As first-year students in their third week of college, it was clear that this was still challenging. However, with some guidance of the tutors, most groups managed to arrive at a concept that could be translated visually. The students were then asked to imagine, and sketch out, the art direction of their concept. This would be the basis for the generation of their concept image in Midjourney. After a short introduction into Midjourney and how to prompt, most of the students quickly iterated on their visual concept. Throughout the workshop, we noticed that students often

treated the generative AI as a slot machine. We speculate that their lack of expertise with editing tools was basis for frustration, as we found many prompts to fix a singular problem in their generated image, while this could have been an easy solve with Adobe Photoshop. We were surprised how close the students adhered to their initial art direction choices – while embracing the unexpected.

The second case-study consisted of a full-day workshop with 23 participants with a relation to the product design field. In this workshop, the participants engaged through a variety of generative AI tools with the creative process – from ideation to final product design. Here, in contrast to the first workshop, all creative endeavors were supported by generative AI powered CSTs, to acquaint the audience with employing AI tools in their creative processes by exploring their limits and possibilities. The participants were tasked with developing a protective gear garment, which could range from ski-helmets to protective shin-padding. With a larger range of generative AI tools, using ChatGPT, Midjourney, and KREA, the participants could execute their 'product design' process fully using generative AI tools, from ideation to creating concept images. Besides the participants getting acquainted with the different tools, it was the connecting of different generative AI tools and use them to their strengths that stood out for participants in the workshop. As stated by one participant, the most beneficial was *"the workflow for integrating AI and using the various tools to complement each other."* This also strengthened our hypothesis that often, generative AI tools are heralded as 'the solution'; but it requires a foundational approach to get the most out the results.

The third case-study consisted of two generative AI focused design projects. The first project was developed by two professors in the digital design and development field, and consisted of developing a projection mapping utilizing generated video. In both of the projects, technical knowledge played a key role in setting up the right environments for the production of the videos. In the first project, ComfyUI was used to create a workflow to generate videos, confirming to the limitations of the mapping, as well as adhering to the art direction that was set out. One part of the challenge was to move away from the 'slot machine' feeling, and developing a workflow that adhered to design choices, while still embracing the hallucinations in latent space. The other challenge was in finding solutions to technical challenges, from noise and quality issues to smooth animations. The second project consisted of a real-time interactive generative AI installation, with a workflow using the StreamDiffusion Touchdesigner (Carrington, 2024) plugin. The goal of the installation was to allow the visitor to control a prompted generation through movement. To accomplish this, a webcam input was taken which tracked the body position. Subsequently, this input was translated to a physics solver which was used to create a water simulation. Finally, the moving image of the water simulation was used as input for the StreamDiffusion. In both projects, we found that the collaboration

between a more technical oriented creative developer and a designer led to the best results. Especially when wanting to move away from closed environments to creating more custom projects, it is essential to have technical knowledge of the domain as the tools get more complicated.

These three case-studies, diverse in their application of generative AI technology in various sections of the creative process, leads us to distill 3 insights that are central to our approach to developing a new way of engaging with generative AI in the creative process.

3. Insights gained from case studies

1. Friction as a virtue

The fear of the blank page – the initial hesitation or creative block when starting a new project—can be alleviated by the utilization of generative AI. Generative AI tools can provide initial concepts, suggestions and imagery, serving as a catalyst for creativity and breaking the inertia that creatives often face. However, there is a risk that this leads to an increased dependency on generative AI, and reduces the human designer's engagement and potentially stifles their creative problem-solving skills. Research by Buçinca et al (2021) already highlighted that the dependency on AI might make people less thoughtful; and especially in the creative process, the latent processing of the challenge is part of the creative process. In the initial conversations with the industry partner from the first case study, they underwrote the importance of ideating concepts with pen and paper. The casestudy further emphasized that this is a learned skill.

Therefore, we argue that this friction should not be entirely removed. Rather, it should be managed to maintain a level of challenge that fosters deeper engagement and innovative thinking. This means that when we are introducing a variety of generative AI tools into the creative process, we also need to account for a mode of engagement with these tools – as it becomes increasingly enticing to 'skip the hard part'.

2. The AI-Efficiency Paradox

Innovations often come with the promise of optimizing and streamline processes – shortening production cycles and therefore cutting down on costs. This is especially the case with generative AI tools, allowing to exponentially reduce the time to form new ideas or produce sketches and highdefinition renders of these ideas. In the context of the design industry landscape, these optimizations are naturally welcomed, yet to stay a leading design or advertising agency, the quality of ideas (and execution) matters, as evidenced by the positive outcomes of obtaining a Cannes Lions (Meléndez-Rodríguez & Roca, 2023), one of the most prestigious prizes in the advertising world. While in specific tasks (such as tedious editing tasks or creating high-definition concept images) generative AI cuts down on the time that is needed, the integration of generative

AI at other stages of the creative process, such as ideation stages, might increase the needed time, which is what we dub the AI-efficiency paradox.

Let's take, for example, the use of Large Language Models (LLMs) in idea generation. Large language models such as OpenAI's GPT or Anthropics' Claude are increasingly used in the idea generation process. These LLMs are capable of generating fluent and coherent texts, and ideate solutions based on given prompts and prior information. As highlighted in *Ideas are Dimes a Dozen: Large Language Models for Idea Generation in Innovation* (Girotra et al., 2023), these tools are capable to generate hundreds of ideas in a fraction of time a human would be able to do so. The paper makes the case that these ideas often are better than human (student) product innovators, rated higher quality measured through purchase-intent surveys. However, Rick et al., (2023) states: *"current generative AI systems by themselves are often not capable of producing uniformly high-quality ideas, a very promising possibility is to let generative AI systems rapidly generate ideas for humans to consider."* While underwriting these conclusions, we argue for an approach wherein the creative (or creative team) autonomously executes an idea generation or brainstorm exercise themselves as well, without it being AI-driven from the start. This allows the creative team to bring out their first observations, building on the (latent) expert knowledge of their organization, product or society. Especially with complex briefs, needing overarching concepts, the limitations of idea generation with LLMs comes to the forefront, often lacking in empathy, originality or applicability to the design brief. By executing the idea generation phase twice, once human-driven and once AI-driven, the most promising ideas can be selected, tweaked, or combined. However, this undeniably means that more time and effort go into these stages, as the conventional approach still must be executed (be it in a more minimal form); but to acquire results that are meaningful, time should also be invested in researching the right models and prompts, pertinent information needs to be briefed or pointed at, as not to generate ideas that are dismissible from the get-go.

3. (Inter)Play

In Play it Again - A Genealogy of Machine Learning, Reigeluth (2023) explores the relationship between humans and machines in contrasting two normative regimes: play and automation. They state: *"Whereas automation pushes us to consider machines as ideally working by themselves and thus replacing humans, play involves a social and affective engagement whose outcome is always partially unpredictable."* (Reigeluth, 2023) Taking the concept of play – or interplay – between human and machine, allows us to understand how we can, as creatives, relate to generative AI in the creative process. This concept highlights the importance of a collaborative process where both human and AI inputs are valued and iteratively refined. (Inter)play involves a continuous exchange of ideas, where AI-generated suggestions inspire

human creativity, and human insights guide the refinement of AI outputs, and vice versa. This symbiotic relationship encourages a fluid and adaptive design process, allowing for the exploration of diverse concepts and solutions. As stated by Liu & Nah (2020*) "In the future, the boundary between humans and computers is bound to become increasingly blurred. The two are interdependent, and indispensable to each other. Man–computer symbiosis is an irreversible trend."* Encouraging play as a mode of engagement can enhance the creativity of the team, ensuring that AI acts as a co-creator rather than just a tool.

4. Augmenting the Double Diamond

1. Creativity and the Double Diamond framework

Creativity, is defined as the ability of generating novel and valuable ideas (Boden, 1998), and as a nonlinear, iterative process. Originally often positioned as 'intuition', this led to the belief that creativity was "unconscious thinking" or "unconscious processing" until the appearance of an idea or insight. These theories "demonstrated the mysterious nature of creativity" (Wu et al., 2021), and lead people to believe that creativity is something to 'have' or 'not have'. However, measurement psychology suggests that every individual can be creative, involving 'divergent' and 'convergent' thinking. In broad strokes, everyone can be creative, and we can encourage creativity through creative actions that open up the process – making creativity less a discussion of 'have' and 'have not'. Wallace was the first to create an overview of the creative process (Interaction Design Foundation, 2024) and identifies four stages of creativity in The Art of Thought (Wallas, 1920). These are:

- **Preparation:** Wallace, quoting Helmholtz, describes this as, *"The stage during which the problem was 'investigated … in all directions'."* Various exercises and methodologies can be part of this preparatory phase to immerse oneself in the problem. It's an active mode of working.

- **Incubation:** This stage involves *"not consciously thinking about the problem."* Actively relaxing your mind – be it by going on a walk or focusing on an unrelated activity allows your brain to digest the information.

- **Illumination:** As Wallace describes the third phase: *"The appearance of the 'happy idea'…".* It's the moment where the active preparation and incubation come together with a potential solution.

- **Verification:** Wallace: *"The validity of the idea was tested, and the idea itself was reduced to exact form."* We see two parts in this verification process - the validity of the idea and the exact form. This comes down to testing each hypothesis – through prototypes and alpha versions, gathering feedback, and iterating until the 'exact form' has been distinguished.

The stages of creativity identified by Wallace can be seen as the intuitive steps creatives

takes. The Double Diamond framework, popularized by the Design Council (British Design Council, 2024), has become ubiquitous to define the four stages further, and is implemented in many design agencies as the proposed methodology to tackle creative wicked problems. The framework is named after how it takes shape, consisting of two distinct spaces: the Problem Space and the Solution Space. Both spaces (diamonds) are represented by a divergent and a convergent phase. The diamond consists of two diverging lines and two converging which represent how to mentally engage each phase in the diamond. Each converging and diverging section is a specific phase.

The *Discover* phase focuses on understanding the problem or challenge. Insights are gathered through primary and secondary research, including stakeholder interviews, market research and data analysis. In the subsequent phase: *Define*, the gathered insights are synthesized, and a core problem or challenge is defined. The third phase is *Develop.* In this phase potential solutions are brainstormed and refined further. Finally, the *Deliver* phase, the most valuable solution or design is created and distributed. With the advent of generative AI, each phase of the design process is impacted by new methodologies and tools. To effectively leverage these advantages and address the associated challenges, it is necessary to reevaluate the design process and the Double Diamond.

2. The augmented Double Diamond framework

Building on the Double Diamond framework, we propose a preliminary model of a modified Double Diamond that incorporates the three concepts derived from the previously reviewed case studies. In the subsequent sections, we deconstruct the newly proposed model. Three distinct changes are introduced to the model. Firstly, the existing diamonds (the Problem Space and the Solution Space) are each compartmentalized in four diamonds: two vertically stacked diamonds in solid lines and two horizontally aligned diamonds in dotted lines. Each of these diamonds introduces specific elements, which will be detailed later in this text. Secondly, specific attention is given to the roles of AI and the designer within the Double Diamond by dividing the diamond along 3 horizontal axes: the human-axis, the AI-axis as well as the human+AI axis. The human+AI axis expands as a gradient towards both the human-axis and the AI-axis. Thirdly, two new phases are introduced at the start and end of both overarching diamonds. These phases are *Prepare* and *Synthetize*.

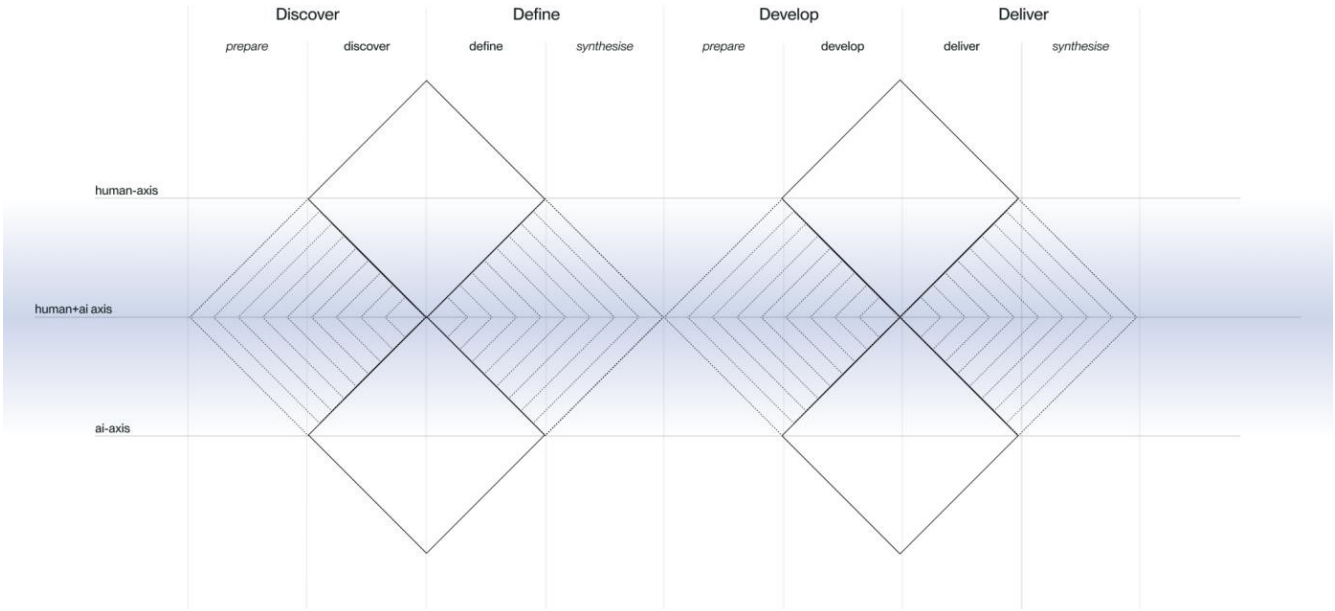

Figure 1. The proposed augmented Double Diamond framework. The three horizontal axes indicate the mode of engagement. The phases are labeled at the top of the image, expanding on the traditional phases of *Discover*, *Define*, *Develop*, and *Deliver*. Each overarching diamond begins with the newly introduced *Prepare* phase and concludes with the added *Synthesize* phase.

First, we examine the first newly created dotted-line diamond that aligns with the human+AI axis. This first dotted-line diamond opens the diverging lines of both overarching diamonds and is situated in the *Prepare*-phase. Here, specific attention is given to the role of generative AI in the creative process, as well as the role of the designer and their team. This approach underscores the importance of critically considering where, how, and when generative AI should be integrated into the creative process. By initially defining the approach in the *Prepare* section, creatives can reflect on their process before starting. This phase touches on all three of the aforementioned concepts that shape this model. The creative team can consider at which moments friction is a virtue – at what point generative AI tools should not be the starting point. The team can appoint moments of high (inter)play between humans and generative AI. By mapping out these considerations, we can take the AI-efficiency paradox into account. By developing the approach from the start, the creative team gains an understanding of which stages will cost more time (e.g. having both a human-led ideation process and an AI-led ideation process) and which aspects will be more efficient (e.g. drafting concept images using a diffusion model).

Additionally, the ethical dimensions of generative AI technologies should be considered at this stage.
As by Benjamin et al., (2024) state, “it is now widely understood that AI technologies can discriminate against particular protected categories (e.g., gender, ethnicity, nationality, sexual orientation)”. Intellectual property

aspects should also be considered, as content scraping strategies often infringe on intellectual property rights. The environmental impact of employing generative AI should be considered as well, from the planetary costs of artificial intelligence (Crawford, 2021) to energy consumption and carbon emissions associated with training and utilizing the technology (Luccioni, Jernite & Strubell, 2024). For example, the shift towards multi-purpose models for discriminative tasks consumes more energy compared to task-specific models for the same tasks (Luccioni, Jernite & Strubell, 2024). Additionally, the unseen human labour of exploited "ghost workers" labelling data (Gray & Suri, 2019) is another aspect to consider before turning to AI. While these are numerous considerations, and the lack of transparency from generative AI technology developers and the black-box nature of the models complicate the process, organizations and governments have been developing ethical guidelines (Balasubramaniam et al. 2023) and policy documents such as the EU Artificial Intelligence Act, which can serve as reference documents.

Concurrently, this preparatory stage should be used to consider the constellation of the design team, identifying skill gaps and determining which profiles should be onboarded. The second dottedline diamond appears at the end of the overarching converging double diamonds, and falls under the phase of Synthesize. We will review this phase after evaluating the horizontally stacked solid-line diamonds.

Within the Discover phase, we encounter the diverging lines of the smaller diamonds located respectively on the human-axis and the AI-axis. By visually representing these diamonds on the human-axis and the AI-axis, we can situate different type of approaches within the Double Diamond framework. The diamond on the human-axis takes a human-led approach. At the top section there is minimal to none AI utilization; this might include primary research through user interviews to discover latent needs of the target audience. As we move towards the human+AI axis in the bottom section, the discovery phase remains human-led but AI-supported, exemplified by tasks such as summarizing interview transcripts. Conversely, the diamond on the AI-axis reverses these roles, adopting an AI-led approach. The top section, closer to the human+AI axis, includes discovery tools and techniques that that are AI-led but require significant human intervention and input. In the lower section of this diamond, we move towards tools and techniques that extend beyond our human capabilities such as AI-driven data gathering and analysis. It is important to note that when discussing an AI-led approach, we advocate for a human-in-the-loop (TELUS International, 2024) mode of engagement. The theoretical background exemplified within the Discover phase applies to each subsequent phase of the traditional Double Diamond framework: Define, Develop, and Deliver.

By having these separated, stacked diamonds, and a gradient towards a symbiotic human+ai

mode of engagement, we can also delve deeper about the concept of (inter)play. As indicated in the second case-study, using various tools to complement each other was found to be beneficial. Building on this, insights, ideas, or sketches gathered from both the human-led and the AI-led approaches can inform each other, bringing the end results further. Finally, the second dotted-line diamonds on the human+AI axis represent the integration of results from both processes. In this Synthetize phase, the creative team takes the lead, reviews the most promising avenues and decides on how to move forward. These phases also serve as moments of reflection on the tools used, the strategies employed, and on the ethical considerations highlighted at the start. Additionally, they provide opportunities to consider how combining the results might give rise to new ethical concerns.

5. Conclusion

Recognizing the varying degrees of AI involvement in creative practice, it is essential that we examine how creative professionals' workflows are evolving, as *"we shape our tools, and thereafter our tools shape us"* (Culkin, 1967). To this end, we applied a research-through-design methodology and conducted three case-studies with diverse participants: digital design and development students, creative professionals from the product design field and professors with background in digital design and creative development. Each case-study provided insights in the creative process through interactions between the creative practitioners and generative AI technology. These insights form the basis of our proposition for an augmented Double Diamond model. This modified model acknowledges the varying degrees of AI involvement, allowing for a flexible and dynamic approach to integrating AI in the design process. By considering the (inter)play between human and AI contributions, the model promotes a more holistic and adaptive methodology, and includes critical reflection on the methodology and tools used. Although our work is informed by three limited, yet diverse case-studies and the proposed model has not been extensively tested in real-world settings, it contributes to developing a critical reflection on the integration of generative AI tools in the creative process. Future work should expand on the proposed Double Diamond model and test it across a diverse range of creative practices and support the approach with qualitative data. However, the proposed model already stimulates critical reflection and can help students, professors, and practitioners in the creative field to ground their approach and thoughtfully consider the implications of utilizing various generative AI tools in their creative practice.

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ECO-DATA INFORMED PROCESSES. NATURE AS A CO-DESIGNER TO FACE ENVIRONMENTAL CHANGE.

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ABSTRACT | Change is a feature of the Earth's evolution, manifesting itself through imperceptible shifts or radical transformations that spread across time and space. However, the climate crisis introduces alterations of unprecedented scale and speed, challenging the natural order. The goal is to address crises by preserving the environment and exploring new paradigms in ecology, society and technology, translating scientific insights into design to address social and environmental challenges. This research embraces the transformative potential of integrating natural processes with design to address pressing global challenges.(Haraway, 2015; Kohn, 2021)

Nature has long been a muse and mentor in design, inspiring innovative and sustainable solutions. This research explores how emerging biodesign and biofabrication technologies can be harnessed to create digital design processes, specifically data visualization, that not only respect ecological balances, but also promote principles of interspecies cooperation. Techniques such as Living Building Materials (LBM) (Alemu et al., 2022), Engineered Living Materials (ELM) (Wang et al., 2022) and others are discussed to explore how they could be implemented in the DIKW (data-knowledge-information-wisdom) process of data visualization.

This approach, part of the transition to the circular economy, defines a post-Anthropocene future (Rognoli et al., 2021), emphasizing co-creation with natural processes. It presents ecologically informed design as a methodology that can integrate digital and biological innovations to promote the embodiment of processes that respect the rhythms of nature in design practice.

Based on these considerations, we investigate the possibilities of incorporating bioinspired strategies in the digital domain, particularly in the field of data visualization. Our goal is to study how these processes can advance the domain, fostering a deeper connection with and for nature. The research aims for a shift in design paradigms to include more holistic, nature-

informed processes that align with environmental sustainability models and promote the use of natural strategies as a key component for innovation. In addition it aims to integrate these practices in the educational field, preparing the next generation of designers to think critically about the environmental impact of their digital work.

The contribution proposes the development of Data-Informed Ecological Processes, which combine digital technologies with biomimicry principles to create innovative and sustainable alternatives to conventional data visualization methods. The research proposes the development of data-driven ecological processes, integrating digital technologies and biomimetic principles to create innovative and sustainable alternatives to traditional data visualization methods. These processes will culminate in the development of an application methodology, leading to the realization of a workshop for design students in the later stages of the research. This scientific contribution will introduce new practices and processes in the fields of design and education. The methodology will act as a catalyst for further applications, including new design courses in which solutions inspired by nature and its strategies will be explored and integrated into data visualization processes.

In conclusion, this contribution advocates for a future design paradigm where nature and technology harmonize, utilizing biofabrication and biomimicry to develop sustainable design solutions. This approach aims to transform data visualization practices, promoting an eco-conscious and integrated design methodology that offers low-energy solutions, thereby advancing conventional data visualization methods.

KEYWORDS | DATA-VISUALIZATION, CLIMATE CHANGE, BIOMIMICRY, NATURE, SUSTAINABILITY

1. Introduction

Humanity is facing a global emergency due to climate change and biodiversity loss, which threaten both the environment and social structures. To address this crisis, technological solutions alone are not enough; a fundamental change in thinking and lifestyle is required.

Design plays a crucial role in this transformation, acting as a catalyst for change. Designers must adopt an interdisciplinary approach to envision a sustainable future, integrating technology with purpose and promoting a renewed relationship between humanity and nature. This new paradigm underscores the importance of innovative design in overcoming challenges and leading us towards a better future for the planet. In this context, there is a need to establish a new shared narrative that encompasses overcoming global crises, a critical reflection on the contribution of new technologies, increased awareness of sustainability challenges, and a rethinking of our current development model. (Lotti, 2021)

Building on these premises, we explore the potential synergies between design and biodesign. Specifically, this contribution investigates the possibility of integrating biodesign strategies into the digital domain, particularly in the field of data visualization. The objective is to examine how these innovative approaches can advance the sector, enhancing our understanding of complex phenomena and leveraging its principles to enrich the visual representation of issues related to the global emergency.

2. Background

2.1 Bio-integrated design strategies, from emulation to integration

Change belongs to our world. In any age of Earth everything is changed sometimes little, sometimes radical, so it's the way of the things that our world is destined to change. Evolution is itself a constant change permuted during the time. The Changing is bound by two factors: time and space. The change brought by the climate crisis is anomalous,

because these two factors are anomalous: a changing too fast and too wide. From the data collected in the IPCC (Special Report on Emissions Scenarios) some experts associated the emission of CO2 with global temperature increase evaluated the rise up about 2.5 C in less than fifty years (IPCC, 2018). This speed of changes is incompatible for the adaptation of living beings, inducing on the living beings that can move, a kind of "forced transhumance", with dangerous consequences on surviving. It was observed that the majority of living beings that can move, are migrating from the protected areas, it's estimated that only 8.02% have residence expectations of 100 years at least in these areas.(Loarie et al. 2009) In conclusion, the changes brought by the climate crisis are happening on multiple levels, this means the scenario we see unfolding is not only worrying and in continuous evolutions, but also chaotic.

Amidst the challenges posed by contemporary crises, the emulation of natural processes emerges as a guiding ethos for shaping design strategies towards greater sustainability, efficacy, and efficiency. Embracing the paradigm of nature as a model, measure, and mentor (Benyus, 1997) has sparked renewed enthusiasm among designers. This has catalyzed the creation of projects that draw inspiration from biological principles, demonstrating an evolving engagement with biomimicry.

Recent growth of interest in biology has prompted designers to create design solutions that increasingly incorporate a hybrid approach (Langella, 2021). Numerous individuals have spoken their views on this issue, particularly in recent years, resulting in a significant increase in contributions. Emerging fields of study include Biomimicry design (Benyus, 1997), Biomimetic design (Vincent, 2006), Biophilic design (Wilson, 1986), Biodesign (Myers & Antonelli, 2012; Ginsberg & Chieza, 2018; Dade-Robertson, 2020), and Bio-integrated Design (Cruz & Parker, 2022).

The concept of biodesign is complex and multifaceted, as demonstrated by the numerous views presented by academics and experts in the discipline. It can be defined as the integration of biology into design processes, with the aim of improving functionality. The growing interest in the principles of biodesign involves the incorporation of biological processes into numerous design disciplines, including architecture, fashion, product design and interface design, highlighting its ability to infiltrate and impact various fields (Myers & Antonelli, 2012; Ginsberg & Chieza, 2018; Dade-Robertson, 2020).

This application of biomimesis at a systemic level has become widespread in recent years, especially within the academic design community and has led to a significant increase in companies and design studios that have an interest in entering this field. See, in this regard, the virtuous case history Officina Corpuscoli from which the brands Mogu, Ephea and, more recently, Sqim were born. These realities show how the topic of

biodesign is growing, especially with regards to biofabrication

In particular, the term “biofabrication, borrowed from medicine (Moroni et al, 2018), refers to a method for fabricating materials using living cells like, for example, microorganisms - fungi, microalgae, bacteria-. Recent biofabrication techniques offer the possibility of developing innovative types of materials such as Living Building Materials (LBM) (Alemu et al., 2022) or Engineered Living Materials (ELM) (Wang et al., 2022). This type of materials allows design to define new concepts co-created with natural processes and is part of the transition from a linear economy to a circular economy and defines a post-Anthropocene future (Rognoli et al., 2021).

The panorama of biofabricated design offers a wide range of examples that demonstrate the increasing use of microorganisms such as fungi, algae and bacteria in the production processes of materials and semi-finished products.

As an example, Mogu and Ephea are leaders in the production of indoor and fashion products based on fungal mycelium, while Solaga and Faber Futures focus on the use of microalgae for filtering solutions and natural pigments.

Biomason, on the other hand, stands out for the production of organic cement, using microorganisms to reduce carbon emissions in the construction industry.

Finally, in the textile sector, Colorifix and Living Color propose biological dyeing processes based on bacteria, offering sustainable alternatives to artificial dyes. These examples illustrate the growing adoption of bio-inspired design approaches, highlighting the crucial role of biotechnology in addressing environmental challenges and promoting sustainability in manufacturing sectors.

As we have carefully explored the impact and application of biofabricated materials in physical design, the natural question that emerges is how these methodologies can be effectively applied in the digital domain, leveraged by the livingness of microorganisms But how can we reinterpret the use of digital technologies, no longer as detached entities from our natural environment, but as integrated tools capable of mimicking, respecting and amplifying natural cycles and strategies?

2.2. Living artefacts as environmental-sensitive interfaces for regenerative ecologies.

The concept of Living artefacts (Karana et al., 2020) stands as a pivotal paradigm in biofabrication and biodesign, promoting prolonged livingness of organisms (e.g., fungi, algae, bacteria, and plants) to use time, enabling novel interactions, functions, and expressions in our daily life.

One of the core principles of Living artefacts concern the way humans experience the livingness of these objects, namely Living Aesthetic (Karana et al., 2020). This occurs by noticing the changes of different type, degree,

and duration occurring in the sensorial qualities (e.g., colour, smell, texture), form, and movement, as interface of their biological phenomenon (e.g., growth, reproduction, and decay) which is affected by environmental inputs (e.g., temperature, moisture, light). Indeed, microorganism offer designers opportunities to endow artefacts with environmental sensing and adapting abilities.

Leveraging computation to mediate these inputs broadens the spectrum of possible inputs to be used, and on the other hand allows digital systems to expand the range of outputs towards more tangible, profound, and critical experiences. Exemplary instances of these hybrid systems have been developed in the field of Bio-Human-Computer Interaction (Bio-HCI).

The concept of Living Bits (Pataranutaporn et al., 2020) is presented as the integration of microorganisms in, with and as computing systems, in the attempt of outlining and inspiring the possibility for integrating organic and regenerative living systems in human-computer interaction. This research analyzes a rich spectrum of example projects within microbial HCI. They characterized and systematically studied the utilization of microbes as biological interfaces in each project across scales and applications. They identified and compared the unique advantages between digital and biological computers, including energy sources (e.g. water, nutrients, and gas, such as oxygen) and the flexibility of microbes. Examples include producing pigments or fluorescent molecules for visual cues or releasing scents as olfactory cues. In addition, they categorize the use cases of microbes through a design rationale and proposition into different application domains of microbial interfaces, e.g. communicate and materialize. Finally, they characterized the design elements of Living Bits according to scale, including interface and interaction scales.

Living Color Interfaces (Groutars et al., 2022) explores specifically the use of Flavobacteria, able to grow in highly organized colonies producing vivid iridescent colorations. The research provides insights on the type, degree, and duration of change in Flavobacteria's expression, i.e., their living aesthetics. The study introduces a capturing tool to characterize these changes concerning form, texture and iridescent color. To support the long-term study of their living aesthetics, they designed Flavorium, a bio-digital artifact sustaining Flavobacteria for a month. Potential applications include a living monitor showing the user's physical activity by connection with their smartwatch or living label indicating a houseplant's wellbeing.

The case of Flavobacterial Displays is further explored as an example of Microbial Displays (Kim et al., 2023), generating three concepts: Flavo in Situ, a Circular canvas left open and exposed to the sea, displaying microbial growth; Flavo's Night Out, a night club dance floor, which accompanies clubbers and music with a magnified and ceiling-projected live footage of swimming Flavobacteria; and Environmental Modification, a living street

display reflecting Earth's lands and oceans shape and colors. Using genetically modified Flavobacteria, which sense air quality changes and trigger dynamic displays to raise awareness about pollution. Ultimately this research proposes a Taxonomy of Surfacing Livingness in Microbial Displays, consisting of six microbe-sensitive, tuneable mechanisms for human noticing of microorganisms: 1) Canvassing, 2) Marking, 3) Magnifying, 4) Translating, 5) Nudging, and 6) Molecular Programming.

Cyano-Chromic Interfaces (Zhou et al., 2023) tackle the issue of temporal dissonance in microbe-embedded artifacts, where the inherent "time lag" in human perception of subtle microbial metabolic changes might impede seamless interactions and timely attention to the living components within these artifacts. In addressing this challenge, they introduce Cyanochromic Interface, in which photosynthetic activity of cyanobacteria (Synechocystis sp. PCC6803) is timely surfaced by an electrochromic (EC) material. They developed different application concepts toy instantiate how the interface can be tuned for diverse functional and experiential outcomes in living artifacts, some of these are a Daylight Log, in which at low light conditions, its EC units fade its color, "requesting" humans to unfold the artifact exposing the cells to more light, and leaving a visible trace for humans to notice and to reflect on their interaction with the artifact over time and a Mushroom Shade, in which its electrochromic unit darkens under excessive sunlight, casting a protective shadow on the fungi body below, allowing users to delicately care for each cluster of fruiting bodies by "planting" the shade.

These examples make evident how biomaterials and living organisms can be used to materialize environmental data, potentially encouraging a connection between user and the environment. In this respect, the following section explores the state of the art on eco-informed perspectives for innovative data visualization processes.

2.3. Nature's Blueprint: eco-informed perspectives for innovative Data Visualization processes

Nature offers a vast array of solutions and strategies for design, promoting sustainability and impact reduction. The plant kingdom's ability to store information and make decisions is a key strength, as is its intricate communication networks (Mancuso, 2019). This collaborative effort ensures resilience even under harsh conditions. Design has been influenced by nature since ancient times, with spider web-inspired fishing nets and plant-fiber artifacts. Digital and biotechnological advances have expanded knowledge exchange beyond traditional production processes, promoting a shift towards design in harmony with nature. This connection has evolved significantly with the advent of digital and biotechnological advances.

The digital field must explore innovative strategies to balance technological advancement with environmental sustainability, particularly in resource-limited

contexts. De-digitalization, which does not mean abandoning digital technology, involves realigning it with sustainability principles inspired by nature. The goal is to achieve a harmonious integration between the technological and natural worlds, enhancing design practice's communicative effectiveness while adhering to environmental principles. This requires an eco-informed methodology for designing materials and products, addressing contemporary environmental and social challenges, and envisioning a future where design aligns with natural cycles. This approach involves employing bio-inspired and bio-based methods to enrich traditional Data Visualization processes, fostering a deeper connection with nonhumans and incorporating nature's strategies into problem framing and solving.

Historical examples illustrate the profound connections between humans, non-humans, and artifacts. The Incan Quipu system, used around 2000 B.C., employed ropes and knots as an early data visualization tool to document community life and culture (Harley et al., 1987). Similarly, Tegan Bristow's examination of Vernacular Algorithms (2021, 2022) reveals that African isizulu beadwork incorporated binary code principles, representing an early form of complex information encoding. These cases highlight the deep ties among societies, artifacts, and the natural world, suggesting that artifacts can play a role in eco-systemic and ethical communication.

Building on these examples supports envisioning a future where design and technology evolve towards sustainable and ethically oriented practices deeply connected to our relationship with nonhumans.

2.3.1. Nature-Inspired Design: Merging Digital and Ecological Systems

The integration of nature-inspired design principles into man-made artifacts is driven by several key motivations. Firstly, it fosters sustainable design by aligning creative processes with natural cycles, thus reducing environmental impact. Secondly, it enhances data visualization by addressing traditional methods' limitations in capturing ecological complexity. By incorporating natural patterns and strategies, new ways of representing data can be discovered, making it more accessible and meaningful. Finally, leveraging nature's advanced information processing systems, such as mycorrhizal networks, can lead to innovative data visualization paradigms, creating a deeper connection with users and promoting a better understanding of complex phenomena.

Previous research (Licaj & Matteucci, 2023) highlights concepts like Data Walking, which involves collecting data through walking in natural environments to foster a collaborative exploration between humans and nature. This method offers a holistic view of complex systems. Sensing Chromatism explores how color variations in nature communicate information, enhancing the relationship between design principles and non-human communication. Sound Datafication inverts traditional data-sonification by transforming

natural sounds into data for design projects. The BioViz approach advocates for Eco-Data Informed Processes, integrating digital technologies with biomimicry principles to offer alternatives to conventional data visualization methods.

Examples include “Atlantic Wonder” (Vezzani et al., 2021) and “Data Meditation”, which promote nonextractive practices and deeper human-environment dialogue. NASA’s use of nature-inspired color palettes enhances public engagement through “semantic association” (Crameri, 2020; Samsel et al., 2018), while Marco Loi’s carpets combine Sardinian sound recordings with AI-generated textile designs, blending auditory experiences with textile art (Sbarbati, 2021). Additionally, The Material Experience Lab’s FlavoMetrics (fig.1) uses microorganisms like Flavobacteria for interactive design experimentation, merging biology with digital technology (Risseeuw et al., 2023).

This synergy between digital and natural worlds has the potential to redefine information design practices, leading to a more eco-aware and integrated approach to data visualization.

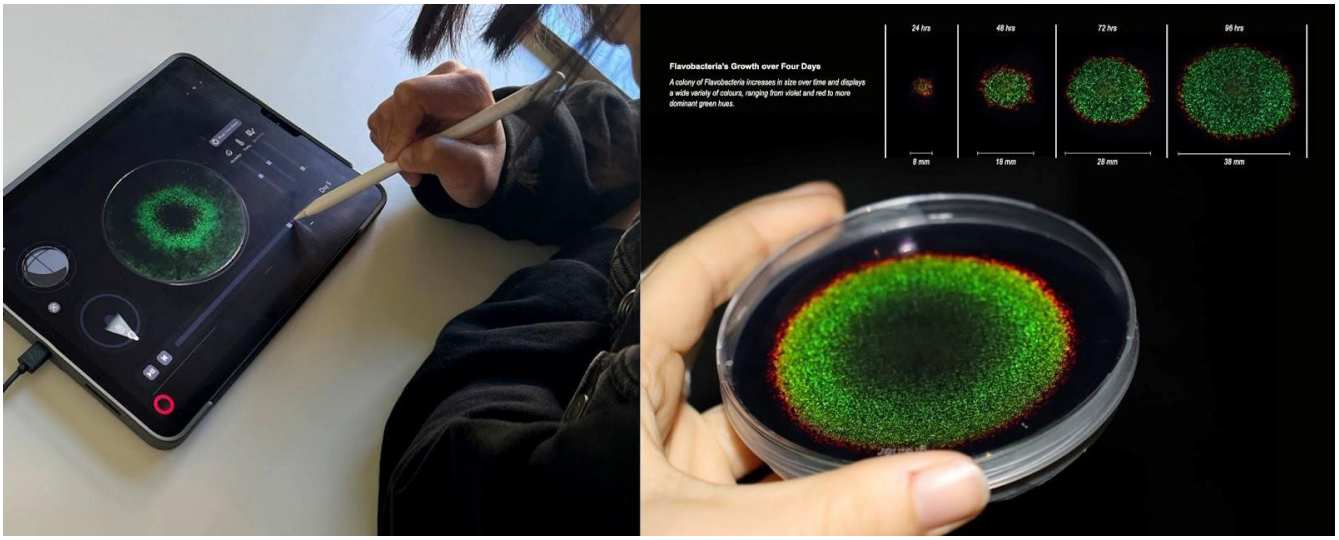


Figure 1. FlavoMetrics. On the left, the interactive digital tool that could support the design process with different living media. On the right, a colony of Flavobacteria increases in size over time and shows a wide variety of colors, ranging from purple and red to the more dominant green tones.

3. Methodology

Building on the opportunities and limitations addressed above, this paper proposes a methodological approach aiming to incorporate the principles deriving from biomimicry, biointegrated design and biofabrication, bio HCI and Living Artifacts, in the different phases of the Data Visualization through “Eco-informed” processes. This methodological proposal is rooted in the structure of the DIKW (Data-Information-Knowledge-Wisdom) model that describes how Data (D) once aggregated turns into Information (I) which then leads to Knowledge (K) of a given phenomenon and consequent Wisdom (W). According to Nathan Shedroff (2000) and Lankow et al. (2012), it is defined as the most suitable model for describing the Data Visualization process.

Through a careful analysis of selected case studies, this research aims to highlight the feasibility and effectiveness of using eco-informed strategies in the practice of Data Visualization, thus demonstrating their potential to enrich and innovate the whole process.

This approach not only emphasizes the importance of inspiration from the living world for sustainable and innovative solutions, but also promotes greater environmental awareness and holistic integration of digital and bio-innovation-inspired strategies in the field of information representation.
After the initial exploration of case studies that establish a relationship between the DIKW process and biodesign, a detailed analysis of data visualization opportunities in biodesign was conducted, focusing primarily on the Knowledge-Wisdom phase. Cases were selected based on specific criteria: the use of living microorganisms and the ability to visualize data in established forms of data visualization. These cases were analyzed by classifying them according to kingdom, species, and visualization method. The result was an initial compilation and articulation of the potential for integrating biodesign and data visualization, advancing towards ecological data visualization.

Finally, the research led to the proposal of a biodesign-inspired educational program aimed at bridging the gap between the fields of data visualization and biodesign. The course structure also included the integration of the already tested tool such as the “Biodesign Agenda” (Marseglia et al., 2024) and the development of a “BioViz Handbook”, which will be further developed in the next steps of the research.

4. Results: From Data to Knowledge Eco-Informed process

Below, the various theoretical and applicative dimensions suggested by the selected examples will be examined in detail following the flow of the DIKW model, defining the following taxonomic classification of the flow of processing, translation and assimilation of the information message.

4.1. Data, the living and non-living world as a spontaneous source of Data.

In the first phase of this process, the non-human domain serves as a broad and spontaneous source of raw data. In this context, the main objective is to observe and record phenomena within ecosystems, biodiversity and biological processes, exploring the inherent patterns, rhythms and structures that regulate the balances of the biosphere. These may include interactions between species, patterns of growth and evolution, and transformation processes in their most basic form. The goal is to recognise the living and non-living world as a vast repository of data that can inform design and inform sustainable innovation.

A representative example is the “Grass Map” project (fig 2). It is an innovative approach at the intersection of urban ecology and data science, with the aim of analyzing urban grass as a natural color palette to understand the environmental characteristics of urban spaces. Treating grass color as a critical interface between humans and nature, the project hypotheses that these shades can reveal insights into the surrounding environment from both cultural and scientific perspectives. Involving the public in the data collection process, participants contribute grass samples from their areas, fostering a personalized and tangible connection to the research. The unique color palette for each zone is linked to environmental data such as the Air Quality Index (AQI), exploring the interaction between air quality and visual aspects of urban greenery. This method deepens the participatory nature of environmental research, highlighting the potential of exploiting environmental features as a source for data collection and fostering a closer relationship between community participants and empirical environmental insights.

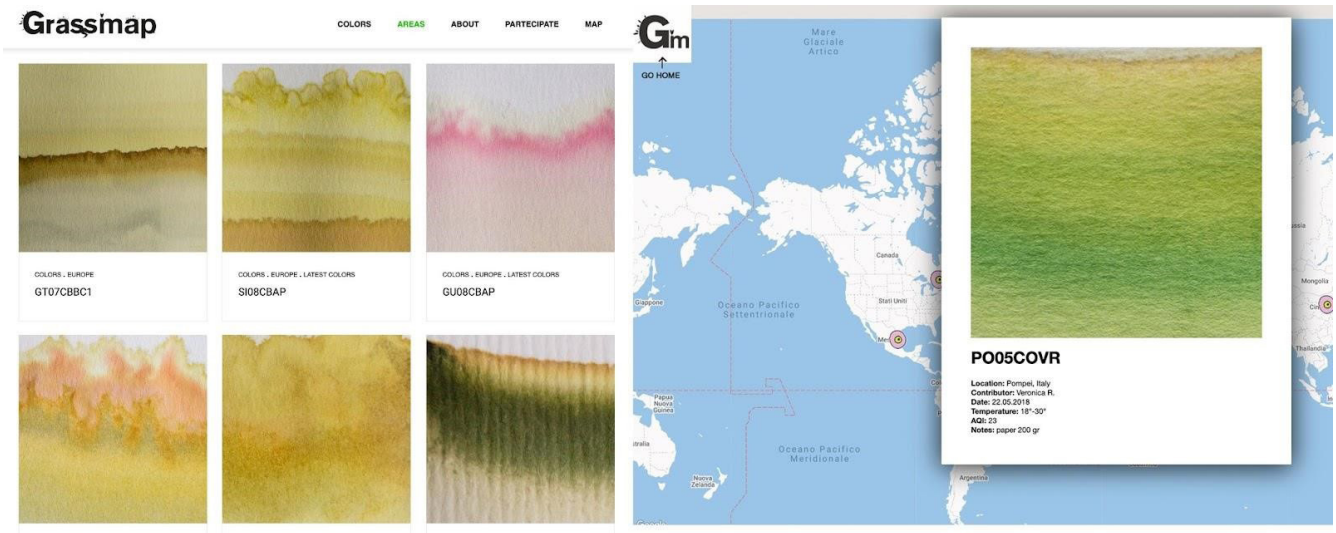


Figure 2. Grass Map project website. Every image is mapped and associated to different data as AQI (air quality index): is a number used by government agencies to communicate to the public how polluted the air currently is or how polluted it is forecast to become.

Two main approaches can be found in this first phase:

- Eco-sourcing of data: Favour data collection from natural sources or use methods that minimize its environmental impact.
- Bio-inspired data collection techniques: Employ biomimicry in data collection tools and techniques, drawing inspiration from the efficiency and adaptability of natural systems.

4.2. Information, aggregations and correlations between data

During the information framing phase, data collected from both the living and non-living realms are consolidated and examined to discern patterns, trends and connections. This phase requires the interpretation of data through the lens of human cognition to create compelling narratives about complex issues, including those related to climate change or societal shifts. A deep understanding of conservation trends and biological dynamics is crucial to devise the most effective methodologies to transform raw data into actionable insights. The ultimate goal is to uncover the symbiotic relationships that pervade the natural world, thereby extracting valuable insights to inform ecoinformed design principles.

An example of this approach is the work of Entangled Others Studio in which ecology, scientific research and generative art are fused through the skillful use of advanced digital technologies, including artificial intelligence. This creative effort focuses on articulating the intricate relationships within ecosystems, resulting in visual narratives that emphasize the concept of biodiversity.

The “Decohering Delineation” project (fig.3) in particular uses neural networks together with oceanographic data to visually represent the interconnectedness of marine ecosystems. While these projects underline the firm’s commitment to fusing digital innovation with ecological issues, they also call for a critical examination of the environmental impact of digital technology. The reliance on massive computational resources and artificial intelligence underlines a tension between the aesthetic and educational ambitions of digital art and its ecological implications, inviting a reassessment of digital practices in favor of more sustainable approaches.

At this stage, the approaches used can be summarized as follows:

- Biointegrated Models: Incorporating biological principles into the design of visualization tools and interfaces, aiming for sustainability and adaptability.
- Nature-inspired Encoding: Design data visualizations that mimic patterns, structures and processes found in the natural world, improving comprehensibility and engagement.

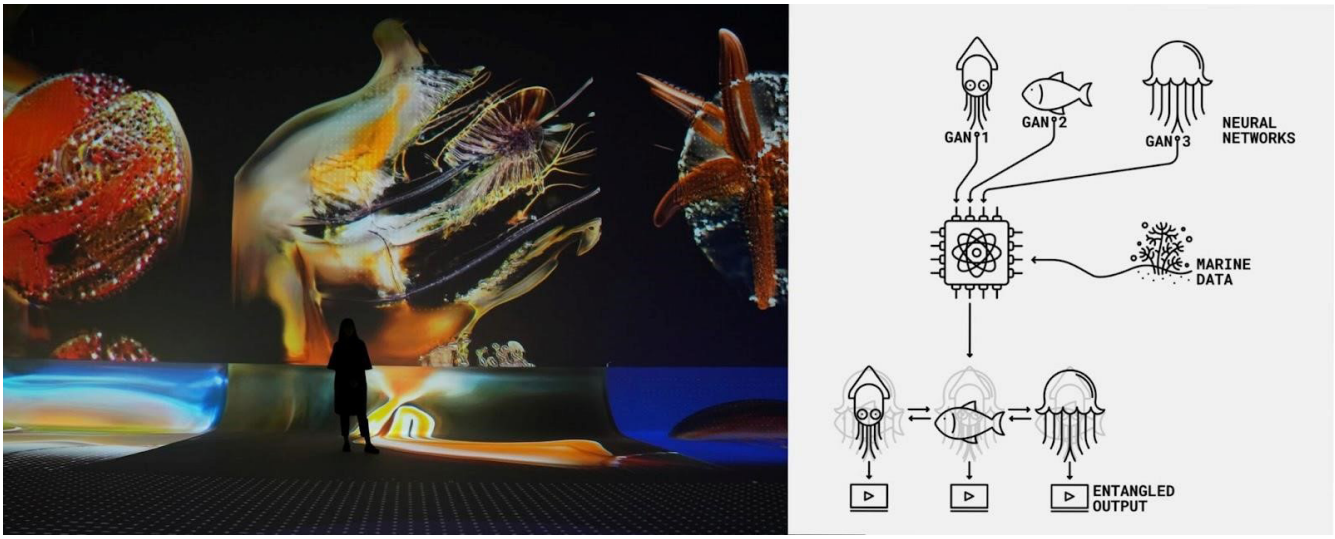


Figure 3. The Decohering Delineation project. On the left, a photo from the exhibition. On the right, a diagram of how using marine data as a driving influence, multiple neural networks are entangled through quantum computing, producing an entangled output.

4.3. Knowledge, the transposition of non-human communication models

The knowledge stage is where the aggregated information is further synthesized to develop deeper insights and frameworks that can address complex contemporary issues. This involves transposing communication models from the non-human world to human contexts, extracting principles of organization, adaptation, and resilience found in nature, and applying these to problem framing and solving. For example, studying the communication networks of fungi or the collective behavior of insects could inspire new ways of managing data, enhancing connectivity, and fostering collaborative problem-solving in human systems. The aim is to interrogate the living and non-living world in order to extrapolate the most suitable strategy to be used for the production of a communicative artifact.

An example of this approach is the experiments by Andrew Adamatzky of the Unconventional Computing Lab at the University of the West of England on Physarum Polycephalum.

Scientists at the lab discovered that the propagation process of this single-celled organism can significantly contribute to seeing and predicting certain phenomena, such as the organization of the railway network (Adamatzky, 2013) or migration routes (Adamatzky, & Martinez, 2013). These results highlight a paradigm shift towards a more organic and less digitally-centered approach to data visualization. In essence, this shift to biodesign and living artifacts represents a significant step away from traditional, purely digital data visualization techniques, embracing a more integrated, designinfluenced process

that capitalizes on innate problem-solving strategies found in nature.
At this stage, the following approaches could be identified:

· Biofabrication for Data Visualization: Using biofabricated materials and processes to create physical models of data, offering a tangible and interactive way to understand complex information.

· Bio HCI techniques: Integrating biological elements and principles into HCI to create more intuitive and natural user interfaces for data exploration.

4.4. Wisdom, sharing knowledge to raise awareness

The climax of the Eco-informed Visualization process, embodied by the Wisdom phase, represents a critical point at which the insights mentioned in previous phases converge, paving the way for innovative approaches to data interpretation and representation.
This phase traces trajectories towards unexplored domains to systematize models that are deeply influenced by both the living and non-living realms.

The aim is to experiment with new communication languages that not only convey information, but are capable of engaging the audience on a deeper and more intuitive level by exploiting the principles that govern the entire ecosystem.

Referring to this the research identifies two pathways for new solutions in the eco-informed data visualization process:

· Living artifacts integration: This approach involves the creation of artifacts for data visualization through collaboration with other living organisms, exploiting their characteristics of growth, adaptation and reaction to changing environmental conditions, thus embodying the dynamic and interconnected nature of the data to be represented. Visualizations employing living artifacts act as a tangible bridge between the abstract world of data and the palpable reality of life, offering the viewer an immersive experience that highlights the symbiotic relationship between human activity and the natural environment. By integrating biological processes into Data Visualization, these artifacts encourage a deeper understanding and appreciation of data, offering the possibility to visualize those issues that are characterized by continuous variation in time and space.

· Combining biological and technological processes: This principle emphasizes the integration between technological progress and natural processes, ensuring that the tools and methods used in data visualization coexist in balance with the principles of sustainability and ecological awareness. This vision challenges us to rethink the role of technology in design practice, proposing a model in which digital and bio-innovative strategies co-exist synergistically to enhance our understanding and translation of data and its wider implications. By taking a holistic view, this approach emphasizes the importance of considering the ethical,

environmental and social impact of our technology choices, guiding us towards more responsible and sustainable practices in data visualization.

Ultimately, the wisdom phase of the eco-informed data visualization process pushes us to look beyond the traditional boundaries of Data Visualization processes to explore new ways of solving problems by incorporating techniques inspired by the non-human world. This phase promotes the adoption of strategies informed by nature, inviting us to re-imagine the way we visualize and communicate complex topics.

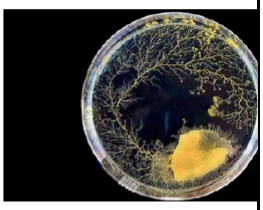
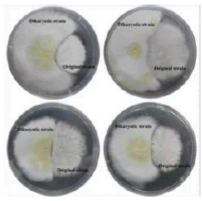
5. Discussion

5.1. Biodesign and Data Visualization. First practical examples of BioViz

The "Visualization through biology" table [Table 1] provides a foundational synthesis of the research's original contributions, offering a practical guide for using living organisms to create innovative and bio-inspired data visualizations. It serves as a reference for students in educational programs to select specific organisms for data visualization, indicating the type of chart each organism can generate. This bio-inspired approach integrates natural elements into the data visualization process, presenting novel solutions for representing datasets.
The table categorizes information into Kingdom (biological kingdom of the organism), Species (specifies the species used), Visualization Method (describes the type of chart that can be generated), and Reference (provides the citation of the scientific article or study). It is designed to assist in identifying which organisms to use for specific datasets and the resulting type of chart or visualization method. For example we can see how, in the kingdom of Protists, the organism Physarum Polycephalum has been studied for its maze-solving abilities, as described by Nakagaki et al. (2000).

Using this organism, the position of the seeds can trace the trajectory of lines in a line chart, and other possible visualization methods include the trend line, transit map, and network chart. In the kingdom of Fungi, Ganoderma Lucidum, described by Tang et al. (2023) for its high spore yield, can be used in a bubble chart, where the weight and position of the seeds determine the size of the bubbles. Other possible visualization methods include the Voronoi chart, packed circle chart, polar chart, and radar diagram, each using seed weight parameters. In the kingdom of Bacteria, Streptomyces Coelicolor, according to Chieza and Ward (2015), can be used to develop a dot density diagram, where the chemical composition of the growth medium determines the population density of the dots. Other possible visualization methods include the Voronoi chart and the convex treemap. Serratia marcescens, discussed by Venil et al. (2021) for pigment extraction, can be visualized with a convex treemap. Escherichia coli can be used to design schemes based on

the position of the agar/seed, as shown in the project by Jelte van Abbema. Paenibacillus vortex can be used for a flow map to represent the architecture of the colony, as well as a radial area chart. In the kingdom of Plantae, Chlamydomonas Reinhardtii can be used to visualize a heat map, where the amount of light is represented by color saturation, as described by Colliaux et al. (2015).

Kingdom	Species	Visualization	Method	Reference	Fig
Protist	*Physarum Polycephalum*	Line chart, Trend Line, Transit map, Network	Seeds position = Line trajectory	Nakagaki, T., Yamada, H., & Tóth, Á. (2000). Maze-solving by an amoeboid organism. *Nature*, *407*(6803), 470-470.	
Fungus	*Ganoderma Lucidum*	Bubble chart	Seed weight+seed position = Bubble size	Tang, C., Tan, Y., Zhang, J., Zhou, S., Honda, Y., & Zhang, H. (2023). A novel strain breeding of Ganoderma lucidum UV119 (Agaricomycetes) with high spores yield and strong resistant	
				ability to other microbes' invasions. *Foods*, *12*(3), 465.	
		Voronoi chart	Seed weight+seed position = Area size		
		packed circle chart	Seed weight+seed position = Circle diameter		

		Polar chart	Seed weight = chart extension		
		Radar diagram	Seed weight = radar extension		
Bacteria	*Streptomyces Coelicolor*	Dot density diagram	Growing medium chemical composition = dot population density	Chieza, N., & Ward, J. (2015, March). Design in the age of living technology. In *Proceedings of the 2nd Biennial Research Through Design Conference* (Vol. 2).	
		Voronoi chart, Convex Treemap	Seed weight+seed position = Area size		
Bacteria	*Serratia marcescens*	Convex treemap	Seed weight+seed position = Area size	Venil, C. K., Dufossé, L., Velmurugan, P., Malathi, M., & Lakshmanaperumalsamy, P. (2021). Extraction and application of pigment from Serratia marcescens SB08, an insect enteric gut bacterium, for textile dyeing. *Textiles*, *1*(1), 21-36.	
Bacteria	*Escherichia coli (Not sure)*	Any	Position of agar/seed = Scheme design	https://www.dutchdesignawards.nl/gallery/jelte-van-abbema/	

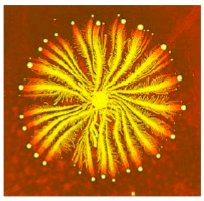
Bacteria	*Paenibacillus vortex*	Flow Map, Radia Area Chart	Position of seed = Architecture of colony	https://www.dezeen.com/2015/09/14/ori-elisar-grows-letterforms-lab-using-bacteria-filled-petri-dishes-hebrew/	
Plantae	*Chlamydomonas Reinhardtii*	Heat map	Amount of light = Color saturation	Colliaux, D., Giraud, L., Yéprémian, C., Bessière, P., & Droulez, J. (2015, July). Probing models of minimal swimming vehicules in vivo with microalgae phototaxis. In *European Conference on Artificial Life 2015*.	

Table 1. Visualizing through biology

5.2. Outlining innovative educational pathways

The contribution proposes a new educational pathway based on the integration of biodesign and biofabrication methodologies and tools with principles of data visualization.
In relation to the bio-informed processes described above, this approach lies between Knowledge and Wisdom. This initial exploration will allow for the development of further experiences at scale in the later stages of the DIKW process.

Through the development of this initial methodological proposal, the aim is to transform the conventional approach to data visualization, replacing digitally constructed processes through classic visualization software with biological strategies and biofabrication processes. The intention is to find a correlation between the function expressed by traditional graphs used in data visualization and the behavior of certain living organisms, seeking to employ this behavior to represent specific types of information or data. By learning the correlations between these conventional visualization tools and the natural processes exhibited by specific organisms, students can understand new techniques for representing information. For example, the growth dynamics of bacterial colonies or the behavioral strategy of organisms like Physarum Polycephalum can serve as graphical analogs for representing complex data sets, providing a highly communicative and biologically inspired visualization method.

This interdisciplinary and systemic approach allows for the creation of projects that represent complex phenomena related to climate and environmental emergencies.
Not only does it demonstrate the potential

of integrating biodesign and biofabrication principles into the data visualization process, but it also promotes interdisciplinary collaboration and the creative resolution of what are known as wicked problems (Rittel & Webber, 1973).

Specifically, the program of the educational pathway could be structured as follows:

1. Basics:

· Introduction to Biodesign and Biofabrication: Overview of key concepts, methodologies, and tools. Introduction to biological materials (e.g., bacterial cultures, physarum polycephalum, agar plates) and biofabrication tools (e.g., incubators, petri dishes, growth mediums)

· Introduction to Data Visualization: Review of traditional data visualization techniques (graphs, histograms, etc.) and conventional visualization softwares (e.g. Flourish, Rawgraph, Tableau, etc.)

2. Integrating Biodesign with Data Visualization:

· Theoretical Framework: Explore the relationship between traditional data visualization functions and the behaviors of living organisms.

· Case Studies: Present examples of successful integration of biological strategies into data visualization.

· Classification and selection of biological materials: Identify and select organisms based on specific characteristics—such as changes in saturation in response to UV light or growth patterns influenced by their medium—to provide innovative alternatives to conventional graphs and histograms.

· Delivery of the "BioViz Methodology Handbook": an open-source guide for integrating biodesign with data visualization. This handbook will include methodologies, best practices, and tools for developing bio-inspired visualizations. It will feature a curated selection of organisms whose unique traits can be used to craft novel alternatives to traditional data representation methods.

3. Hands-on Experimentation:

· Through the "BioViz Methodology Handbook," professors, and experts, participants are guided in the development of a bioinspired visualization process. Participants engage in laboratory work sessions to kick off their projects. Using the methodologies and tools provided, they develop their own biological data visualization projects. Once the projects are developed, each group presents their work to the rest of the students. This is followed by a feedback session, where facilitators and peers offer constructive feedback on the projects, helping to refine and improve the visualizations.

The structure of the program, from basic concepts to practical experimentation, shows a possible comprehensive application of the principles described in the paper. Moreover,

it emerges how this kind of pathway not only improves educational practices, but also promotes sustainability and responsible innovation in design. Moreover, the described pathway can be adapted to various time scales, from a short workshop to a multi-month course or even a Master's program.

For shorter formats, such as workshops, it is critical to consider the reaction times of the microorganisms involved in biofabrication such as the case of those microorganisms whose reactions become visible after perhaps seven days. This requires careful planning and, potentially, prepreparation of some biological materials to ensure that participants can observe significant results within the workshop time frame.

In longer formats, such as a multi-month course or a Master's program, there is more flexibility to delve into processes and observe the full life cycle of biological transformations. This allows for more detailed study and application of bioinspired design principles, giving students a richer and more comprehensive learning experience. By adapting the length of the program to the needs and constraints of the educational context, the educational track can provide designers with methods and tools for more sustainable and innovative design actions.

6. Conclusion

In conclusion, adopting eco-data informed processes marks a significant step towards a sustainable future, where digital and nature merge to address environmental challenges. Through the application of bio-inspired strategies, we aim to tame entropy in our design systems, fostering solutions that honor natural cycles and dynamically adapt to environmental needs. This approach not only strengthens the bond between humanity and nature but lays the groundwork for system design deeply rooted in principles of sustainability and responsible innovation.

The outlined research suggests a path where design and digital collaborate in harmony with the environment, leading us towards more sustainable and aware practices identifying a set of strategies to modify Data Visualization processes in all its key steps which: Eco-sourcing of data, Bio-inspired data collection techniques, Biointegrated Data Models, Nature-inspired Encoding, Biofabrication for Data Visualization, Bio HCI techniques.

By rethinking data visualization through these lenses, we can create more meaningful and impactful representations that resonate with natural processes and cycles. This holistic integration not only enhances our understanding of complex phenomena but also promotes a deeper environmental awareness and ethical approach to innovation.

In conclusion, merging bio-inspired strategies with digital innovation offers a transformative path for data visualization, encouraging sustainable and adaptive practices that honor and reflect the intricate dynamics of our natural world. This integrated approach paves the way for a future where design and technology work in harmony with nature, fostering resilience and sustainable development. The research also includes in its future developments a series of steps such as:

- Collection of large amounts of case studies in order to outline a database of strategies that could be used to design BioVisualizations.
- Making this catalog accessible through a platform in order to provide a useful tool to researchers and designers

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HAUNTOLOGICAL SPECULATION DEVICE: DESIGNING LOST FUTURES WITH DESIGN STUDENTS TO EXPLORE SOCIO-TECHNOLOGICAL SCENARIOS

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ABSTRACT | This paper explores the application of hauntological speculation as an innovative approach to speculative design in undergraduate design education. While speculative design methodologies have gained prominence in design curricula, they often struggle to imagine future scenarios beyond predominant apocalyptic narratives, leading to a form of "imaginative paralysis." To address this challenge, we propose integrating the concept of "hauntology" into design epistemologies. Hauntology expands ontological frameworks by incorporating "the presence of absences" - events that could have occurred but did not materialize - as factors shaping the present. This approach aims to broaden the possibilities for imagining and designing futures beyond the constraints of dominant contemporary logics.

We present two case studies of "hauntological speculation exercises" implemented in design courses. These exercises explore "lost futures" from specific historical bifurcation points, such as the invention of hot air balloons and the origins of Fordism. Students engage in counterfactual thinking to imagine alternative historical trajectories and their implications for present-day design possibilities. The integration of AI-generated imagery in these exercises provokes dialogues about plausibility, probability, and the hegemonic forces shaping our imaginaries.

By examining unrealized past potentialities, this approach enables students to question linear and deterministic understandings of historical processes and to speculate about non-evident potentials in truncated timelines. This paper argues that hauntological speculation offers a valuable tool for design education, fostering critical thinking about the constructed nature of the world and the role of design decisions in shaping historical contexts and future possibilities.

KEYWORDS | HAUNTOLOGICAL SPECULATION IN DESIGN, LOST FUTURES, UNDERGRADUATE DESIGN EDUCATION, ALTERNATIVE POTENTIALITIES, SOCIO-TECHNOLOGICAL SCENARIOS

1. Introduction

At times, it seems that we have more extensive margins of a known past which tractions backwards than possible futures to come. This can be posed as a conundrum or a problem for the future of Design, since it is a project-based discipline oriented towards the transformation of existing situations into preferrable situations (Simon, 2019). In this sense, *the future* projects itself as an elemental operating field for Design. Its eventual disappearance could pose a profound threat to Design's raison d'être as a discipline. However, as Hamlet, the Shakespearean character, reminds us, *time is out of joint*. This observation suggests the need to rethink our relationship to time and the future, considering the status of Design. This reflection is especially relevant for docents and researchers working in this discipline —it acknowledges an academic and a professional drifting. The experience at different stages of a Design education shows how upfront action against planetary crisis has become a fundamental imperative, as well as trying to address some of its implications. In the same vein, the methodologies of speculative design have emerged as a significant formative trend, addressing the task of imagining possible futures. However, a lot of these speculations tend to project predominantly dystopic scenarios, which perhaps reflects a certain "existential and psychocultural condition of the contemporary age" (Danowski & Viveiros de Castro, 2019, p. 4243) —at least in the West—. Yet, this becomes a limitation to imagining possible alternative futures. A clearly eroded world scenario raises the question of what the exertion and presence of Design is.

In this article, the problem about the future or futures that *haunt* Design as an expanding discipline is addressed through exploring the concept of *hauntology*. Hauntology could offer a renovating perspective to tackle the current methodological limitations when imagining alternative futures. Firstly, we scrutinize criticisms of speculative design, as well as its apparent difficulty to transcend the hegemonical possibility frameworks of the present. Later, we examine the concept of hauntology, incipiently developed by Jacques Derrida, as a theoretical tool to rethink Design's underlying ontology and its

relationship to time, history, and possibility. The analysis and use of this perspective —amplified by other authors— could be feasibly applied to a Design education. To this point, we present two concrete pedagogical experiences, which aim to expand the imaginative horizons of students. Finally, we discuss the implications of incorporating Artificial Intelligence (AI) in the processes of hauntological speculation, considering the opportunities and challenges that arise. The text is dotted with reflections about the possibilities that hauntological thinking can contribute to a critical teaching of Design to maintain its project-based and transformative abilities; distancing itself from the restrictions of monolithic ways of thinking that limit the imagination of alternative futures in the context of multiple contemporary issues.

2. On the Haunting Crisis: Modes of Rethinking

During a conference presented at Universidad Autónoma Metropolitana de México, Gui Bonsiepe (2011) referred to how planetary crises "are inevitably reflected in Design, its teaching, its practice, and its discourse", fomenting hopelessness and fatalism, an "attitude that no designer should concede themselves to" (p. 28). Several years later, his words still resonate within the discipline:

"Even though turbulences can cause feelings of danger, threat, insecurity, disorientation, disenchantment, depression, and even the sensation of being irreversible, a crisis allows us to see with greater precision and conscience its antagonisms and its causes, and from there it allows us to draft possible ways to overcome it"
(BONSIEPE, 2012, P. 5).

On a similar note, Adam Nocek & Tony Fry (2021) propose further exploring the construction of practical and theoretical tools for Design and its praxis with ontological alternatives that are more adequate for contemporary challenges. The authors direct their criticism towards modern human behavior that is "responsible for a big part of ecological devastation, colonial violence, and geopolitical instability" (pp. 2-3). This ontology is a byproduct of some Design actions and, at the same time, the foundation of its practice. Thus, it is necessary to rethink new ontologies that allow us to face these conflicts in favor of desirable futures, to avoid forms of impotence that freeze Design practices.

To this point, Design may be understood as something which does not yet exist but that is nonetheless possible, and that projects futures before repairing issues of the present. Despite being a "leading discipline of the future" (Von Borries, 2019, p. 107), Design has a delicate relationship with the present, as it materially replicates the predominant beliefs, identities, and social relationships (Balsamo, 2009). By being present in multiple aspects of our daily lives, it affects practices and makes them possible in diverse fields of human action. It complicates the constructed world, which is a product of project-led actions.

Annie Leonard, in her book *The Story of Stuff* (2011), blames designers and the decision-makers for this ethical dilemma: "While not all execrable initiatives from industry have been intentional and manipulative, a lot of products were designed for infinite markets, where efficiency was the only selective criteria" (p. 223). Therefore, it is a risk to forget the character of the "designed" and thus the designable quality of the world.

Various authors have identified that this sensation of determinist inevitability is one of the multiple ideological deformations that increment the hegemony of a determined system. For Benjamin (2008), hopelessness, anxieties, and prevailing preoccupations under a capitalist regime are attributable to fearing that there is no exit. Mark Fisher (2016) coined the term "capitalist realism" to refer to the contemporary version of this phenomenon: the belief that there is no alternative to capitalism. The famous quote by Fredric Jameson: "it is easier to imagine the end of the world than the end of capitalism" also comes to mind. This ideological torsion or instrumentalization of the concept of *reality* operates in conjunction with what Raymond Williams (1977) called "selective tradition"; that is to say, the emphasis on certain aspects of what has occurred. As the author says, it is "a version of the past that intends to connect with the present and rectify it. In practice, this gives a sensation of predetermined continuity" (p. 116). By this optic, history appears as a sequence of milestones, causes and consequences that are logical and, therefore, inevitable. Thus, it would appear as if the present were the inevitable result of the past, and the future would not be more than the inescapable result of that same present. In doing so, many other histories and those futures that could have seemed possible and even imminent are oppressed and eliminated on the spot (Benjamin, 1969).

However, this perspective can nullify what is ultimately "a succession of selections and bifurcations with different possibilities in conflict" (Berardi, 2019, p. 18), in a landscape of ideological disputes understood as a junction that is susceptible to critical analysis given its historical and social determinism. Going back to Bonsiepe (2011), as a historical moment, "no one will deny the omnipresent and even crushing force of the market, but it is one thing to accept it as reality and another to impose it as the *only* reality" (p. 6).

3. Speculative Design as an Answer to a Future in Crisis

While a crisis "offers the opportunity and imposes the obligation to revise the dominant reference frameworks in which one has operated so far" (Bonsiepe, 2012, p. 28), it seems that crisis, catastrophe, and capitalism are intrinsically linked (Luxemburgo, 2019), or even that capital today was able to extract profit from the planetary crisis (Alizart, 2020). Undoubtedly, we are currently facing a multiplicity of planetary crises, of which the ecological anthropogenic crisis has garnered the most social attention, backed by reports presented to the scientific community as

well as the general population. However, for Déborah Danowski and Eduardo Viveiros de Castro (2019), current discourses about the end of the world as the culmination of the different ongoing crises, constitute a certain mythology for the present times, which affects most areas of contemporary imagination and continue to deeply mobilize academic reflection.

In the face of this, as previously indicated, Speculative Design has gained influence as a current oriented towards imagining other possibilities for the future, inspired by Design's critical explorations prior to its deep commercialization during the years before the 21st century (Dunne & Raby, 2013). These approximations of future scenarios have not stayed exclusively within academic discussions or museographic exhibitions. Rather, they have erupted in the professional world of Design and, more significantly, they have gained ground in the discipline's education curricula. However, one of the most relevant criticisms of speculative design, to our judgement, is related to its trouble questioning the established power structures —especially those of the market—, by omitting the political connotations in which it is located; its spectacularization and aestheticizing of dystopia as well as its difficulty to imagine futures within Western norms and anxieties (DiSalvo, 2012; Tonkinwise, 2014; Prado y Oliveira, 2015; Nooney y Brain, 2019).

Confronting the interrogation about the future in which this current of Design is based, a certain incapacity appears: the inability to imagine an alternative that is different from the dystopia that we are familiar with through neoliberal culture. This strips away its potential premonitory aptitude, while we seem to be drifting in a world that we do not fully comprehend, where we are unsure of what to do. (Danowski & Viveiros de Castro, 2019). In other words, "while crises expand and gain speed, politics wilt away and take steps backward [...] In this paralysis of the political imaginary, the future has extinguished" (Srnicek & Williams, 2015). In the face of this capitalist realism, Mark Fisher (2016) goes a step further by proposing the notion of "reflexive impotence" as a conscious attitude regarding world's state of deterioration, and even further realization of the fact that there is nothing to do about it. Both "imaginative paralysis" proposed by Srnicek & Williams (2015) and Fisher's "reflexive impotence" are, in our opinion, symptoms of the same contemporary affliction of Speculative Design.

4. Hauntology: Absence that Turns into Presence

Creative and project-based disciplines may address these questions of apparent inevitability or lack of alternatives to crisis (which only perpetuates the current state), during their formative process. The concept of "hauntology" may be a novel approach to apply to the process and thinking of Design, in this sense. Theoretically, it constitutes an ontological change that can be illuminating when examining and challenging certain conceptions of the progression of history (understood as lineal and immutable) and offering the possibility of rethinking social change, where Design plays a considerable part. The concept of hauntology, introduced by Jacques Derrida (1995) in his work *Specters of Marx*, can be explained through a linguistic play that works in English and French. It combines the terms "haunt" or "*hanter*" (French), with the suffix "logy" or "*logie*", referring to the study or logic of a phenomenon. However, the most significant aspect of this neologism is its phonetical similarity, especially in French, with the term *ontology*. The French philosopher structures his hauntological proposal around this term. It ultimately suggests that all existence is "based on a series of absences, which precede it, surround it, and allow it to possess consistence and intelligibility" (Fisher, 2018, pp. 43-44). Therefore, a contrast is demarcated between hauntology and traditional ontology: while the latter understands the being as a presence identical to itself, the absences (specters) that Derrida proposes are not beings per se, but rather indicate a relationship to what is no longer, what could have been and was not, or what is yet to be (Hägglund, 2008). Thus, these specters represent an agency of the virtual(ized) that exerts an influence on the present, or the actual(ized), without existing thoroughly, hence resisting ontologization (Balcarce, 2023). In essence, hauntology embodies that paradoxical *presence of absences.*

From an hauntological perspective, what is absent or what disappears is not a particular object, "what has vanished is a trend, a virtual trajectory" (Fisher, 2018, p. 49). They foreshadow future expectations that do not consummate by disappearing since they do not even seem possible: they simply "have evaporated" (Fisher, 2018, p. 48).

On the other hand, it is worth mentioning that these *specters*, absences or truncated events (besides being a part of diverse cultures throughout history) are profusely utilized tropes within a series of disciplines as a critical tool, which is the case for the contrafactual history line of research. Despite the differences that the specter figure may have in these contexts, in general, they coincide with a central aspect: representing a middle ground between presence and absence, making a "different take of the thresholds and taxonomical divisions" (Balcarce, 2023, p. 9) possible. Within these limits and categories that hauntology tensions, there

is one regarding what is possible, a critical dimension for project-based practices and for Design (Franke, 2010). As author Gabi Balcarce (2023) mentions in her book *Posthumanismo espectral*: "the specter interrupts temporal and ontological contiguity and inaugurates a new space in ontology as an experience of the impossible" (p. 8). This notion is "extremely plastic when applying it to the contemporary philosophical register" (Balcarce, 2023, p. 8), which allows for an incursion into other fields of knowledge. In this case, the *spectral incursion* that interests us points to projecting the future. In our opinion, Design has an evident privilege within these tentative explorations. By looking into the field of project-based possibility in the future's uncertainty, Design gives way for a *virtual space of spectrality* (Derrida, 1995) to emerge.

The concept of hauntology rises as a valuable instrument when reconsidering the underlying ontology of Design: its conception of time, its theoretical frameworks, the limits of the possible, and the circumstances that define these possibilities to consider the virtualities, persistences or re-apparitions that affect our present. At the same time, hauntology offers a temporal or historical perspective into multiple possible trajectories in dispute. In other words, history is also based on the exclusion and concealment of other histories, therefore, the past becomes a malleable category that may be explored between its absences in search for lost futures. As Gabi Balcarce (2023) has said:

"Confronting a reading of temporality which takes its metaphors from movement and ties past-present-future in an inexorable way —as is the case with linearistic conceptions of a historicist or positivist type, the discourse of progress—, here, the present is not evident, nor is the past. And their opacity or, to be more precise, their possible readings, do not always meet in the field understood as 'conditions of possibility', but rather as the weaving of the present and the past that the present intends to take for granted —a very modern pretension of certainty—"

(PP. 8-9).

Therefore, an hauntological approach does not only involve the condition of the designed and the designable, but at the same time it postulates a certain degree of agency, persistence, and accessibility to absences. This is to say, the opportunity of activating said virtualities in relation to our present is still latent, as is expanding the repertoire of its possibilities.

By appropriating and adaptating this concept and transferring it to the area of Design, we may explore different ways of learning within undergraduate courses to examine the possibilities that arise from this approach. The following are two concrete cases of the application of the concept through exercises carried out in two design modules (from higher level freshman and junior years).

5. The City of Balloons

The application of the exercise was called "Designing Lost Futures: Hauntological Speculation Workshop". Through exploring lost or unrealized pasts, as well as alternative temporal lines (yet imminently possible if looked at from that past), students will be able to comprehend the influence of logics of power, dominant technologies, trendy imaginaries, and other forces and social energies in certain historical periods of Design. Likewise, understanding how Design conditions back these socio-technical subjectivities.

The preceding operates in an analogical way in relation to the present, functioning as a sort of moral takeaway. By prompting a critical look at how influential the constrictions that did not allow for certain designs or products to emerge are, we may question their agency in current possibility horizons.

This also intended to take on some of the criticism towards Speculative Design to "look beyond given socioeconomical and political structures and look into *how* and *why* our societies have gotten to that point in the first place" (Prado & Oliveira, 2015).

The workshop was divided into three instances: a brief theoretical introduction, a group selection of a historical bifurcation point from which to speculate about possible alternative future expectations (that is to say, a lost future), and finally, a projection and description of the scenario through possible systems/artifacts/services in that lost future. Its objective was to present the theoretical context and the fundamental notions of hauntological thinking, which are necessary to work on the activity (see figure 1).

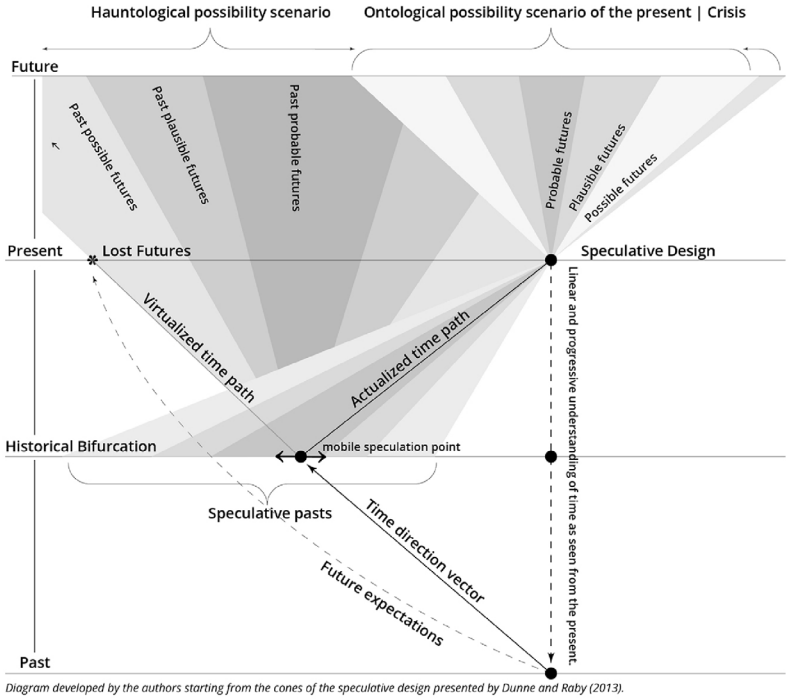

Figure 1. Hauntological Speculation Diagram, developed by the authors from the speculative design cones presented by Dunne & Raby (2013). It represents the contribution of the hauntological perspective to speculative design. It incorporates virtual (unrealised) trajectories, lost futures and the possibilities of speculating about the past.

For a second stage, we used the game cards for the Timeline board game (by Frédéric Henry, Zygomatic). All participants had to collectively define a historical event as a bifurcation point (see figure 1) from which to situate their speculation. The game cards were also a useful element to avoid a potential blank-page paralysis, as well as a bedrock from which to discuss and reach agreements among the group.

One of the interesting observations was how the activity eased the selection of certain technical objects, compared with processes or events. For instance, at the beginning one of the groups had selected the donation of Dolly the Sheep as a milestone. However, since it was not focused on a technical object, students expressed they had greater difficulty in their analysis and further alternative futures projections. When the team decided to opt for another technological moment (the first journey across the English Channel on an air balloon), the discussion was centered on the technical object, which led to a more fluid conversation and hauntological speculation. The group dialogue went toward the means of transportation, arriving at the following speculative question: What would have happened if hot air balloons would have been imposed as a main means of transportation? This set off an interest in establishing a difference with other predominant means of transportation, such as airplanes, cars, and subterrain trains. The hauntological speculation developed by the group to construct the speculative scenario, was guided by a baseline question: How would a city be articulated by hot air balloons as a dominant means of transportation? To address this question, we reflected on transportation services, architecture and infrastructures, social and class logics, acquired habits, energetic costs, among other factors (see figure 2). For students, one of the most useful notions to guide their speculations that derived from hauntological thinking, was that "for everything that exists or could exist, there is always something that seizes or will seize to exist". This is a simple yet considerable reflection at a formative level. A common guideline in the group was to comment on things that would not exist, therefore, speculative questions were oriented towards what would exist in their absence.

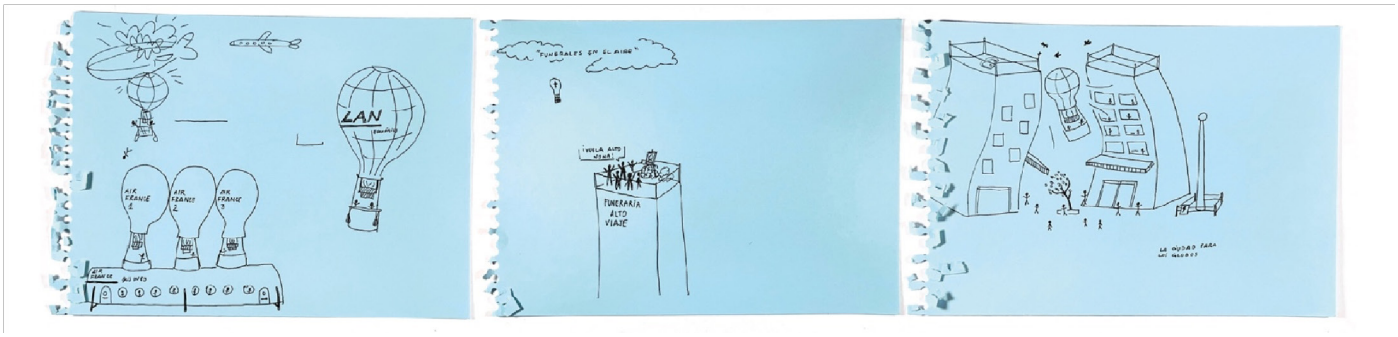

Figure 2. Drawings made by one of the participants in the exercise. It represents part of the group discussions about the socio-technical characteristics of the speculative lost future.



Figure 3. Images generated by OpenAI's artificial intelligence Dall-E. It visualizes some of the representative technical objects of The City of Balloons.

The activity encompassed a series of biases conditioned by the logics of present-day behaviors, which was noted by some of the participants. For instance, market logics or constant acceleration, which are implicitly rooted in our way of thinking. These arose more than once during the construction of the speculative scenario. A specific example comes to mind: one of the speculative technical objects projected by one of the students in the group was the installation of "giant fans" inside buildings to generate wind currents that would rapidly move the hot air balloons, as aerial roads. However, this was quickly questioned by another participant from the team who pointed out that this depended on a paradigm of acceleration which was not necessarily valid (or equally desirable) in a world that prioritizes hot air balloons as a means of transportation. This controversy was followed by a discussion about the relationship to time and technological advancements.

To visualize the results of this exercise, images were generated using artificial intelligence, of the most representative speculations of the scenario (see figure 3), taking as a reference some works that use these technologies to create "inexistent" past speculations (see: *Un archivo queer inexistente* by Felipe Rivas San Martín, 2023; *Unsupervised* by Refik Anadol, 2021; *Terram in Aspectu* by Liliana Farber, 2019). Consequently, employing artificial intelligence offered a series of opportunities (as well as challenges and ethical questions) for the application of this exercise in the context of a massive undergraduate Design module.

6. Lost Futures for Means of Transportation

Another version of the exercise “Designing Lost Futures: A Hauntological Speculation Exercise in Means of Transportation and Locomotion” was applied in another freshman year module of Design History and its Historical Contexts, within the class “Design, Rationalization and Fordist Consumption: Modern and International Design for the Masses”. The objective of this variant of the exercise was to identify the designed and designable quality of the world, through a nonlinear perspective of history that would allow students to conceive of a possibility proposal, beyond the seeming inevitability brought by dominant technologies (Evans, 2018). Situated within a pre-Fordist period (limited between 1875 and 1905), students had to speculate about lost futures as alternatives to Fordism (see figure 4). The group dynamic started with a brief theoretical contextualization of the hauntological perspective, to then present some results from the previous versions of the exercise. To a concurred lecture class, students were given the following coordinates:

Analyzing the political, economic, technological, social, cultural, etc. conditions that allowed Fordism to become a possible future (which ultimately prevailed as a real and dominant production model), you are asked to imagine other futures for means of transportation and locomotion, alternative to Fordism, that, based on the same original conditions, could have been imagined as other possible futures for society at the time. The scenarios imagined by each group must be presented through an image that contains representative elements of the context.
The central piece of the image should be a technical object/artifact related to the means of transportation and locomotion that would characterize the alternative future as clearly as possible.

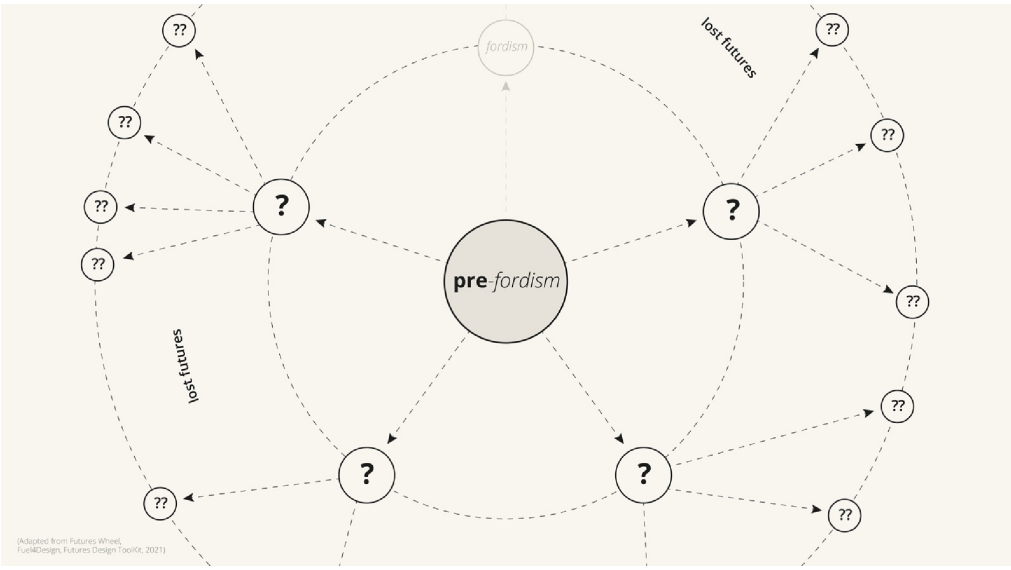

Figure 4. Diagram adapted by the authors from Fuel4Design’s Futures Wheel, Futures Design ToolKit, 2021.
It represents the different possible trajectories that were in dispute in a pre-Fordist period.

For this, we asked each group to describe the scenario of that lost future and to identify a concrete situation that could represent the imagined context. After, they would digitally design the means of transportation and situate the technical object or artifact. The deliverable for this exercise comprised three parts:

1. A brief prompt of about 200 words, written for an image-generating artificial intelligence;
2. A generated image based on the prompt that represents the described scene, and;
3. A reflection text about the technical object and its context, without using artificial intelligence.

To illustrate the results, we present two examples. Firstly, the Hedósfera, which foments hedonism and "making yourself visible" through a translucid spherical means of transportation which is mobilized through rails (see figure 5). Its energetic matrix is electricity-based (no fossil fuels) and its main constructive material is tempered glass, plus metals in a lesser proportion. The artifact promotes sociability and routes that are predetermined by the railway system, which grants a relaxed travel experience and a 360-degree view. Instead of an accelerated and purely functionalist and linear movement, this lost future introduces the possibility of greater wellbeing and a deviation from a univocal concept of progress.



Figure 5. Image created with artificial intelligence by one of the highlighted groups. It visualizes the *Hedósfera*, an alternative means of transport to the automobile from a lost past alternative to Fordism.

Secondly, another proposal was ComuniCicleta (see figure 6), a collective bicycle structure. It is created using rather artisanal or semi-industrial manufacturing, tailor-made to the needs of each community, with varying styles, shapes, and colors.
For this means of transportation not all passengers would have to make a physical exertion, which would benefit senior citizens, children, and people with reduced mobility.

In this lost future the community drives progress. Solidarity is constantly articulated and inclusive, making it not only a means of transportation but also of human connection. Both examples speculate about different global perspectives (other horizons) by making design decisions when ideating means of transportation which reflects certain social expectations in the proposed scenario.



Figure 6. Image created with artificial intelligence by another of the highlighted groups. It visualizes the *ComuniCicleta*, another alternative means of transport to the automobile from a lost past alternative to Fordism.

7. Final Premises: On Hauntology and Artificial Intelligence

When developing this ongoing project, the (we could say spectral) apparitions that artificial intelligence has procured in other works with similar perspectives in the field of the arts (Felipe Rivas San Martín, Refik Anadol or Liliana Farber, previously mentioned), have caught our attention. While the decision of integrating these technologies can seem random, to our judgement, it is an attractive opportunity to explore scenarios and imaginaries with a certain degree of verisimilitude. This has been favorable to generate a feedback dynamic in the speculative use of artificial intelligence with Design students—not only through fast iterations to achieve a Design proposal, but also to discuss the fundamental Design categories of future scenarios: ranges of possibility, plausibility, and probability. However, we are aware that the latter results in more questions and controversies regarding the scope of this investigation.

To close, we identified some crossovers between the present proposal and critical studies on artificial intelligence, to sketch eventual frictions. Nick Couldry & Ulises Mejías (2023) have warned about the colonial-capitalist pre-configuration of future imaginaries. A "snatching" of the future by big corporations of technological irradiation, would have been possible, according to the authors, thanks to the implementation of a historical construction that is assumed as inevitable. In this sense, the increasing datafication and digitalization of the world has transformed practically everything that is social, seizing to be a space of dialogue and democratic debate, to become a "specter of propension and probability" (p. 290).

To our judgement, future investigations with hauntological speculation using artificial intelligence should consider an interrogation of the hegemonic and reproductive tendencies in present conditions, which are inscribed in the models of said artificial intelligence (Sartori & Theodorou, 2022; Suchman, 2023). Beyond forthright rejection, we consider that the application of artificial intelligence in the project-based method interrogates these technologies and emergent narratives (Ferguson, 1999) that explain problems in their origin, diffusion, assimilation, and use. For this reason, this reappropriation of Speculative Design (Prado & Oliveira, 2015), through the hauntological perspective, offers a tool to make the controversies related to these often "frozen" technologies (Dandurand, McKelvey, & Roberge, 2023) visible.

To this point, Fredrich Von Borries (2019) takes the two possibilities that social psychologist Harald Welzer brings up to escape the crisis: by *disaster* or by *design*. The first alludes to waiting until the system collapses before rebuilding over its ruins, while the second intends to "transform the existing into something new up-front, preventatively, through action that is oriented towards goals and planification" (p. 97).

It would then seem that, rather than expecting the world to collapse, for Design, it already has. Therefore, "designing" has to do with "how to live among the rubble" (Latour, 2016, p. 10). However, design also has to do with projecting, hence, with the possible, as well as having our gaze oriented toward the future, to avoid the paralyzing effect of a crisis of the future. This naturalization, partly ideological, needs to be addressed through a critical notion of what we understand for "crisis" (Mesa Moreno, 2011); otherwise, Design's practice and thinking risks being not as much projective than it is submissive (Von Borries, 2019), defuturising (Fry, 2009) or a mere ideological reproducer. Absences, specters or unimagined or interrupted designs reveal not only the designed and redesignable nature of the world, but also serve as a source of inspiration for the future, enlivening the utopic glimmers of pasts that deserve to be recovered (Žižek, 2004). Hauntological thought does not imply a literal return to the past, but rather, as Slavoj Žižek (2004) argues, a return to the field of possibilities that these pasts inaugurated. Therefore, it is not about replicating what has been done, it is about exploring what remained undefined; that is to say, an encounter with lost opportunities, beyond present ideological restrictions: hence Design's relationship with the *new*.

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DEPICTIONS OF SUSTAINABILITY AND UNSUSTAINABILITY: AI-GENERATED IMAGES AS PART OF OUR SEMIOSPHERE

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1. Introduction

Evidence shows that humans have been creating images for more than 50,000 years (Oktaviana et al., 2024), since that period, some of the major technological breakthroughs have been writing on clay, the development of paper, the creation of the printing press, photography, video, televisions, broadcasting, computers, the internet, mobile devices with screens, augmented reality (AR), virtual reality (VR), all up to images and video created by generative AI. Considering the previous statement, it can be argued that humanity has moved on from a spoken culture in which communication among communities relied mainly on verbal language, going through a stage that mainly used written forms for communicating and storing information. In this sense, humanity is now in a state that has been described as an image-saturated society (Jhally, 1990), a stage in which images are one of the main forms for communicating information, creating meaning, and seeking pleasure (Mirzoeff, 1998) thus, we are now part of a visual culture.

As part of our current global visual culture, images can be considered as texts that disseminate the meanings that hold the system together. In this sense, as Peter Torop states: “Lotman´s perspective enables one to combine the treatment of text as culture and the treatment of culture as text, which at the same time means a possibility to consider these simultaneously as wholes at different levels of the same system” (Lotman, 2009, forward by Torop, p. xxix). It can be argued that most of the media through which images are portrayed rely on advertising, for example, social media, news, search engines, and more recently streaming platforms, so many of the images can be considered advertisements. The meanings they convey are related to consumption. Thus, key characteristics of our current global culture are the visual (Mirzoeff, 1998; Mitchell, 2002; Sturken & Cartwright, 2018) and hyperconsumption (Bauman, 2007; Lipovetsky, 2007). In this cultural context, and from a semiotics of culture standpoint, AI-generated images can be considered texts that are now part of the global semiospehere.

It can be argued that the data collected and used to train AI can be considered as part of the nucleus of this global semioesphere and so the texts that it generates reaffirm itself. In the words of Massimo Leone: "The advent of sophisticated algorithms has ushered in an era where visual representations are not just mere reflections of reality but are charged with the power to influence, persuade, and even dictate societal norms and values" (Leone, 2024, p.2). As part of a larger study that takes into account the role of AI-generated images as part of the semiosphere a starting point of six images is considered. Based on the previous, this research uses a visual semiotic method to explore the meanings conveyed by AI-generated images when using prompts related to sustainability and unsustainability.

2. Generative AI and its impact on the biosphere and semiosphere

Intelligence is the ability to learn and put into practice what has been learned, thus Lavista Ferres and Weeks state: "Artificial intelligence is intelligence-the ability to learn and apply knowledge-that is conducted by machines" (Lavista Ferres & Weeks, 2024, p.5), they go on to clarify that the expression artificial intelligence was coined in the 1950s, but that machine learning is the specific term that exemplifies how algorithms are trained on data to create rules that can be put to practical means. Since this intelligence is based on the data with which it was trained, it is important to consider the quality of the information and the biases that it may possess.

Once an algorithm has been trained on data and created its own rules, it is considered a model that can interpret language and also generate it, hence the term, generative AI. The language generative AI can interpret varies from text, image, audio, video, and code, using this input, specifically in the visual domain it can generate video, 3D models, design, and images (Nvidia, 2024). This state of development of AI is possible due to the amount of computing power and data collection, requiring large quantities of energy.

Much has been written on how AI can contribute to achieving a more sustainable future, but it is also important to address the sustainability of AI. For van Wynsberghe, sustainable AI is: "focused on sustainable data sources, power supplies, and infrastructures as a way of measuring and reducing the carbon footprint from training and/or tuning an algorithm" (van Wynsberghe, 2021, p.214). The International Energy Agency (IEA, 2024) estimates that data centers, AI, and cryptocurrency could consume as much energy as the entire country of Japan by 2026. The report states that in 2023 NVIDIA with 95% of the AI server market share consumed an average of 7.3 TWh of electricity annually and could consume 10 times more by 2026. This amount of energy consumption has caused Google to increase its emissions by 48% since 2019 (Brandt & Gomes, 2024) and Microsoft by 29% since 2020 (Microsoft, 2024), so far from reducing their CO2 emissions and meeting their sustainability goals, these bring into question the sustainability of AI technology and its impact on the

environment, and therefore the biosphere. Taking this into account it is clear that AI impacts the environment. Still, to further explore the role that AI images can have in our everyday lives, it is useful to consider Juri Lotman´s theory that represents culture as a series of spheres. Hartley and colleagues identify 6 spheres to describe a complex system at a planetary level, starting with the geosphere, followed by the biosphere, noosphere, semiosphere, technosphere, and finally the futuresphere (Hartley et al., 2021). This work will focus on the semiosphere as the sphere where meaning is created, and culture resides.

For Lotman (1996) the semiotic space or semiosphere is not homogeneous and can have several sub frontiers within itself, mainly the center and its periphery. In the center one can find the dominant structures that give order and coherence to the semiosphere, it is mostly concerned with itself and reaffirming the texts created by its nucleus, putting almost no attention into deciphering external texts. In contrast, the periphery is laxer and more fragmented, thus interpreting the signs with less rigor, and when in contact with other semiospheres it looks forward to interpreting those foreign texts. Lotman goes on to explain that with every translation a new text is created, new information is developed and points out that there can be no exact translations between semiospheres, causing culture to be in a flux of constant change and never static. Without a semiosphere, language would not only not work, but it would not exist, and without language, there can be no culture. In similar terms, (Eco, 1986) goes on to state that the life of signs conforms to a fragile infrastructure that nonetheless influences all of our behavior.

As stated previously, one of the key characteristics of the current global culture is the use of images as a means of communication and the role they play in shaping and maintaining a semiosphere. Sturken and Cartwright (2018) consider photography, drawings, television, and digital media as representation systems that function similarly to language, and for that reason, semiotic and linguistic methods can be used to study them.

3. Method

Taking into account the foundations of the semiotic method, the founding fathers describe it as the life of signs in society in which a sign is divided into signifier, the sign in itself, and signified, the meaning it conveys. Pierce (1931) considers a sign as something used to represent something else, but further divides signs into three categories icon, index, and symbol. An Icon draws its significance by representing the main characteristics of an object, in this sense a road sign of a gas pump indicates that there is a gas pump; in contrast, an index is considered a sign that obtains its meaning in relationship to its proximity to what it represents, for example, a road sign with a fork and knife represents a restaurant. Finally, a symbol conveys its meaning due to cultural relations, for example, a solid yellow

line in the middle of the road indicates that cars on the other side of the line drive in the opposite direction, one must know the meaning attributed to the sign to understand it correctly.

Semiotics has been traditionally implemented in language and discourse analysis but since the use of images to convey information and meanings has become so prevalent, semiotic methods have been developed in order to study them. At the end of the 1960´s Roland Barthes was one of the first authors to create these methods, and since then many have been developed. Visual social semiotics (Kress & van Leeuwen, 2006) explore visual signs to decode the meanings present in the images through three meta-functions. The ideational meta-function allows the description of how the signs relate to each other. The interpersonal meta-function identifies how the sender interacts with the receiver through the images. Finally, the textual meta-function refers to how visual signs obtain their meaning based on their location and dimension within the composition. Next, the three meta-functions will be briefly described.

The ideational meta-function takes into account the represented participants, which can be objects or persons, and establishes if the composition is narrative or conceptual. A narrative composition is one in which a person or object has vectors emerging from it, in order to have contact with another person or object. Arrows, arms or fingers are examples of vectors, and the person or object from which the vectors emerge is considered de actor, and the person or object with whom the vectors have contact is named the goal. Thus, an ideational met-function with a narrative composition analyses the actor's characteristics in contrast to the goal. On the other hand, when a composition has no vectors, and therefore there is no interaction between the represented participants, it is considered a conceptual representation.

The interpersonal meta-function considers how the sender interacts with the viewer through camera shots and angles. The shot used to represent a person or object has a specific meaning and the viewer should decode it similarly. For each shot, Kress and van Leeuwen (2006) establish a personal, social, or public distance. The viewer also interprets an image based on established codes by the use of the camera angle. A high angle positions the viewer in a position of higher power to what is being represented, in contrast to a low angle which positions the viewer in a place of less power. Taking the previous into account, the use of a horizontal angle to portray a person or object establishes an equal level of power between the sender and viewer.

Finally, the textual meta-function explores the location, size and color of the different elements that make up the composition. Generally, the bottom part of the composition is associated with to earth, while the top part of the composition is considered as an ideal state. In a similar way, whatever is placed on the left side is interpreted as given information, and on the right part what can

be considered as new. Size and color are also important visual cues that highlight important aspects of the composition.

These three meta-functions facilitate a structured method for exploring the meanings coded in an image and also take into account common ways in which most people decode them. The images that make up the corpus of study were created with Stable Diffusion and MetaAI using the prompts related to sustainability, and unsustainability. A total of 6 images were generated by using the prompts unsustainable, unsustainable community, unsustainable city, sustainable, sustainable community, and sustainable city. Only the first image generated by each prompt was considered.

4. Results

This section explores the meanings conveyed by the six AI-generated images concerning unsustainability and sustainability, by implementing a visual semiotic analysis that relies on the three meta-functions previously described.

The first (Figure 1) of the six images was generated using Stable Diffusion by typing the prompt Unsustainable. Considering the ideational meta-function, this image can be identified as conceptual since it has no visual elements that look like vectors. The objects portrayed in the image represent decay and look like old car parts in a junkyard. Due to the distance from which the shot is taken, the interpersonal meta-function places the viewer at a far social distance, at a horizontal angle, and what seems a high modality because of the level of detail and texture in the image. This meta-function establishes that the viewer can be part of the image, with an equal level of power in relationship to what is being depicted as real. Finally, the textual met-function establishes no visual hierarchy within the image, there is nothing more important than the rest.



Figure 1. Unsustainability

The second image (Figure 2) was created using Stable Diffusion with the prompt unsustainable community. Using the ideational meta-function, it can be established that this is also a conceptual image in which each house represents poverty and low-income housing. Now, the interpersonal meta-function positions the viewer at a public distance and at a top-down angle, since this image also resembles the quality of a photograph it has high modality. In this case, the viewer is further away and has greater power in relation to what is being represented. The textual meta-function establishes that there is no visual hierarchy, no element is more important than the other.



Figure 2. Unsustainable community

Finally, the third prompt (Figure 3) related to unsustainability was an unsustainable city (Figure 3) it was generated using Meta AI on WhatsApp. Like the previous image, it is also a conceptual image in which each building represents decay. Most of the buildings look old, mostly unpainted, and with little or no maintenance, the plants growing on the roofs of the buildings seem like shrubs and weeds that are mostly unattended. Similar to the previous image, the interpersonal meta-function establishes that the viewer is at a public distance and with greater power over the city. In this case, the image generated with Meta AI has a more 3d feel to it and does not look as real as the images generated with Stable Diffusion. This not-so-real setting is considered a lower-level modality. As in the other two images, the textual meta-function allows to identify that there is no visual hierarchy.

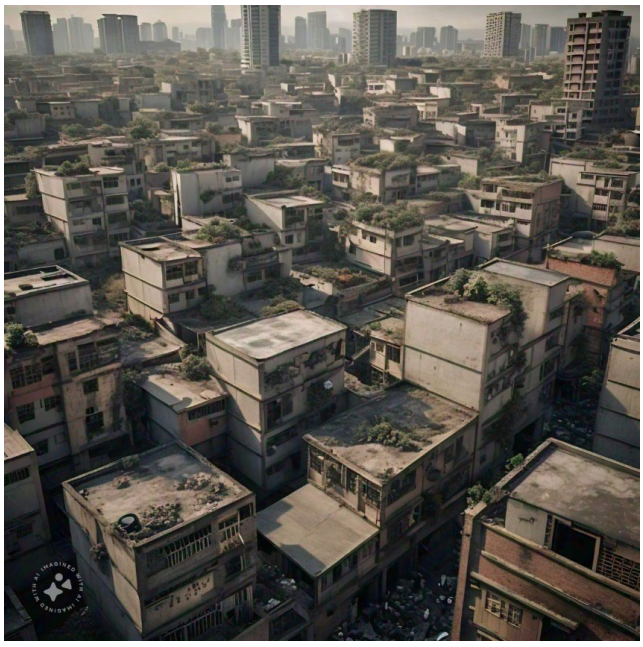

Figure 3. Unsustainable City

Now, using the prompt Sustainable in Stable diffusion (Figure 4), like the other four images already studied, this is a conceptual image, there is no action occurring, so the ideational meta-function considers that a bird is used to represent nature. In contrast with the other images, the interpersonal meta-function identifies that it is a close personal distance, at a horizontal angle with a very high level of modality in which even the texture of the feathers can be appreciated, and a bokeh effect is simulated as if using a wide aperture. Thus, the meaning of this image can be interpreted as one in which the viewer can be very close to nature at an equal level of power. Finally, the textual meta-function establishes a strong visual hierarchy since there is only one element within the composition.



Figure 4. Sustainable

The fifth image (Figure 5) was created in Stable Diffusion using the prompt sustainable community, since this is an image in which there are arms, these are considered vectors and represent a narrative image in which the people are actors and the plants are the goal.

This image can be considered to portray a group of mostly women, working or having a walk among fruits or vegetables that they are growing. It is important to consider that this is the only narrative image that is part of the corpus. The study of the ideational meta-function in this image establishes that the viewer is at a far social distance at an equal power, within the context of a high mode of reality, this can be interpreted that the viewer is part of this community and is taking part in the activity being conducted. Exploring the textual metafunction it is possible to consider the person in blue in the middle as the main focal point, although this is not clear, and in that sense, it is not of great importance.



Figure 5. Sustainable community

The last image (Figure 6) was created in Meta AI using the prompt sustainable city and is very similar to the other image generated with the same app. This is a conceptual image used to represent what can be considered a green and sustainable city. This image also has plants on the rooftops but in this case, they look greener, and they have intentionally been grown there. It is interesting to consider how similar aspects of an image, as in this case plants growing on rooftops can be

interpreted with opposing meanings mainly due to color and other visual cues that make up the composition. Also similar to the image generated with the prompt unsustainable city, the interpersonal meta-function positions the viewer at a public distance with much more power, but a lower level of reality. Since this image was generated with Meta AI it is possible to establish that the default settings of this AI generate images with a lower mode of reality in contrast to Stable Diffusion, they have a more 3d render feel to them, while the images generated with Stable Diffusion emulate as if they are photographs.



Figure 6. Sustainable city

By conducting a visual semiotic analysis using the three meta-functions developed by Gunther Kress and Theo van Leeuwen (2006), it was possible to determine that sustainability is mainly depicted by the prevalence of plants, animals, and nature, while unsustainability is mostly represented by decayed buildings, low-income housing, and a junkyard. The ideational and interpersonal meta-functions provide a more in-depth analysis of what is portrayed in these six images generated with Stable Diffusion and Meta AI.

The study of these six images by using the ideational meta function allowed to identify that five of the six images are identified as conceptual images in which what is portrayed represents unsustainable or sustainable. It is interesting to point out that only Figure 5 is considered an image with a narrative structure in which the people sustainably interact with nature. Figures 1, 2, and 3 can be considered what Pierce (1931) called indexes, they show the consequences of unsustainability but they don´t show what causes it, a more appropriate result would be an iconic image, in which the viewer is presented with a representation of what can be considered to cause unsustainability. Also, Figures 2 and 3, resemble low-income housing, which can be considered social and economic unsustainability, but at the same time, these living conditions do not cause environmental unsustainability, posing further questions concerning the bias that relates poverty to environmental unsustainability.

In general, the interpersonal meta-functions allow to identify that the viewer is placed much closer to the compositions related to sustainability, in contrast to further away from those that represent unsustainable. Specifically, Figures 4 and 5 related to sustainability depict a personal distance and

a far social distance, while Figure 1 represents a far social distance while Figures 2 and 3 position the viewer further away at a public distance. The previous can be interpreted that the viewers are closer to sustainability and further away from unsustainability. The United Nations report (2022) at the Stockholm Summit states that humanity is becoming increasingly unsustainable due to humanity's environmental footprint. Considering this last statement, it would be more accurate if the AI-generated images placed the viewer at a more personal or social distance when using prompts related to unsustainability and further away from those related to sustainability. It would be more accurate for the images that represent unsustainable community and unsustainable city to place the viewer at a personal distance or social distance but not at a public distance as seen in Figures 2 and 3. Overall, the interpersonal meta-function distances the viewer from an unsustainable community and city but is very close to nature and feels like part of a sustainable community.

The textual meta-function is the last studied, it is important to point out that none of the six images that were analyzed used it as a compositional tool to convey specific meanings. It is somewhat common for conceptual images to also use hierarchy, color, and the positioning of visual elements to communicate specific meanings. It would be interesting to further study other AI-generated images to see if the textual meta-function is also lacking meaning and how it is being used.

In conclusion, the images generated by AI can be considered part of ongoing dialogue on the topics of sustainability and unsustainability, in this sense, the visual semiotic analysis has identified that the meanings portrayed in the AI-generated images contribute to keeping unclear the causes of unsustainability and position the viewer further away from an unsustainable community and city.

5. Discussion

This study mainly explores the meanings portrayed by AI-generated images related to sustainability and unsustainability but also has the purpose of further questioning how images generated by AI impact the semiosphere. Considering a complex system in which AI technology, specifically that required to generate images, is already having an impact on the biosphere, studying the impact of these images on the semiosphere would help to understand the role that generative AI is having in the development of culture since the current exposure to AI-generated images is ever-growing and it is even considered that by 2025 most of the internet content will be AI-generated (Constantino, 2024). Since images are the most common and extensive sign system through which meanings are disseminated along what can be considered a global semiosphere and taking into account that algorithms shape not just digital but also social realities (Leone, 2024) it is of vital importance to study the role of images generated by algorithms in the development

of human culture. Further research for a much larger data set by using content analysis from a quantitative studies standpoint should contribute to supporting or opposing the findings obtained by this study.

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REASSEMBLING RESILIENCE IN BREAKDOWN: HOW MEXICO CITY RECOVERED FOOD SECURITY THROUGH MICRO-INNOVATIONS DURING THE COVID-19 PANDEMIC.

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ABSTRACT | Mexico City is Latin America's and North America's most extensive urban system. Feeding this population efficiently and promptly is an enormous and complex challenge. Food supply logistics is one of the least understood aspects of food systems. Mexico City has the most extensive food wholesale market in the Western Hemisphere. The Central de Abasto opened in 1982 when the Mexican government was promoting the values and benefits of modernity across the country. A new infrastructure for food logistics in the capital was a priority, as the long-standing city food market was inadequate. For forty years, the Central de Abasto continued to grow and serve the city and central Mexican region. In 2020, the Covid-19 pandemic wreaked havoc on many labor-intensive facilities like Central. The shock of both the disease and distancing and mitigation measures surfaced patterns of institutional abandonment for 40 years – while the facility faced a simultaneous shock in supply and demand. Many bodegas (shops) closed as many owners died, and those that remained open had to lay off many of their employees to cut costs. This article explores how bodegas (shops) created survival strategies, gradually creating greater economic resilience after the pandemic. The crisis accelerated trends that already existed, but incipiently: from digitalization for sale to generational change to increasing the use of technology to seek to offer merchandise with more value. The Central de Abasto is an ensemble that is adapting to rapid change. The pandemic was just the catalyst, but it remains to be seen what the possible futures will be for Central and Mexico City's food system.

KEYWORDS | MEXICO CITY, COMPLEXITY, ASSEMBLAGES, MODERNITY, COVID-19, RESILIENCY.

1. Introduction

When a new visitor arrives at la Central de Abasto – the vast wholesale food market of Mexico City – they may experience chaos. Constant movement, shouting, fast-moving carts pushed by thousands of men, attending to thousands of customers shopping thousands of food stocks for schools, restaurants, hotels, and supermarkets. However, the perception of chaos is deceiving – the Central is a highly functioning complex system with intelligent, decentralized coordination. The Central de Abasto demonstrates the features of a complex, self-organizing system. It has been operating since 1982 in very challenging situations. Economic crises, earthquakes, and political changes have shocked Mexico's capital, along with the increasing presence of organized crime and different cycles of government corruption. However, nothing has prepared la Central for the 2020 pandemic. We explain how la Central adapted to this impact and how it may endure the ones that come in the future. Modernity has been a worldwide project of the dominance of rationality, moving societies into organized administrative structures and increasing order. It was primarily instigated by Western values of scientific control and progress through economic growth. Transmodernity philosopher Dussel (2008) shows that the "myth" of modernity is based on the idea of a European superiority held over other cultures and ways of being, originating from Spanish Occidentalism 500 years ago. Centralized food markets serving millions of people in a growing megacity can represent an epitome of Western modernism – an industrialized process of thousands of food providers and buyers operating within an enormous dedicated facility. However, the Mexico City market operates successfully as a uniquely Latin system, and our observations suggest that it does not follow the rational controls of modernist managerialism. Dussel's notion of trans modernity lends the insight that authentic cultural practices can build upon the "positive moments of Modernity" (Dussel, 2012, p. 43) toward a pluriversal, noncolonized social structure. These insights support the position that design interventions in such systems must account for the cultural ecosystem and paradoxical effectiveness of chaotic, localized practices.

This study observes whole system resilience facilitated by adaptations and interactions of the agency of its thousands of human parts. By April 2020, the COVID-19 pandemic spread its presence in Mexico City. The contagion seriously affected people in the bodegas (shops) at la Central de Abasto (CEDA), and many could not continue to work. The sales from daily operations declined by around 75 percent, creating a significant risk of collapse (Vela, 2020). A collapse of La Central would be uniquely devastating to the Mexican food supply because of its centrality to the state and its massive scale of operation, providing up to 80% of all food in the central Mexican valley.The design of the Mexican CEDA facility was adapted from the French wholesale system, the Rungis food market (Thiesset & Vlachos, 2022). Rungis, second in size only to CEDA, was also seriously affected by the pandemic. Mexico and France are highly organized around their capitals, so the food supply is centrally controlled from large terminals. Nevertheless, the operation of CEDA is very different from that of Rungis. US and European food supply centers are much more centralized by the administration. However, they then have potentially single points of failure due to the central decision-making, not the web of relations inherent in the CEDA system. The political economy of modern Mexican society changes many expected technological and urban parameters (Gallo, 2005). Mexico City is modern, but its food logistics must be digitized or technocratic. An underlying paradox becomes apparent, with the food logistics of a modern capital being tightly interconnected to Mexican politics (and crime).

1.1. Research motivation and hypothesis

The pandemic inflicted a simultaneous double shock in the food economic ecosystem at la Central – A demand and resource supply shock. The evidence from interviews shows that the pandemic management was weakly coordinated, supporting the rationale for the disappearance of probably hundreds of bodega workers – yet there is no official record of deaths. At the beginning of the pandemic, the CEDA administration decided to order people over 60 years old not to work. This prevention measure likely saved many lives, yet nevertheless, many died, even young men. Walking the aisles of la Central for two years, there was not a single bodega of roughly 2500 where nobody got sick from Covid-19. Many carretilleros (the dolly operators carrying the merchandise) disproportionately suffered, possibly because they circulated throughout all the aisles and had little ventilation.We suggest the hypothesis that the assemblage facilitating la Central management during the pandemic was like a double-edged sword. It was excruciating at the human level but also transforming for business. The story of Central de Abasto's siege and recovery during the pandemic shows the naturalistic social complexity inherent in massively decentralized self-organizing structures driven by social capital. The resilience and recovery

we observed show that people can and will adapt to the most extreme circumstances if they can sustain complex operations despite massive risks without ever observing how well the whole system was operating.

Methodology

Ethnographic field research was conducted from April 2020 through May 2022 at la Central de Abasto, periodically visiting over two years. Over 50 recorded interviews were conducted with different actors, from small bodegas owners to employees of major vendors, informal vendors, and government administrators. Digital ethnography included online and photographic journals. Bodegas were selected for observation for two distinct rationales: a) those with younger operators because it is difficult to interview owners (who fear discussing business with strangers for security reasons), and it was easier to interview sons and employees. This led to opportunistic sampling of others in (CEDA; b) Random, opportunistic availability and personal chemistry helped to facilitate conversations with different people. To conclude the data collection, a follow-up was held with five bodegas of various sizes, also extending the observation period and allowing observation of the changes in business in la Central over the period.

Data was analyzed by transcribing and recording interviews and conversations to examine for thematic analysis and indicative responses pertinent to the emerging study hypothesis. Both etic (responses to direct questions of interest) and emic (emergent and volunteered responses) were coded for the emerging theory. The theoretical perspective of the assemblage (DeLanda, 2006) was adopted as a highly pertinent explanation of the observations consistent with the study's hypothesis. The criteria of relationality, productivity, heterogeneity, desirability demand, and de/territorialization are evidenced across observations. However, the study also covered a period of acknowledged crisis and organized responses to the unexpected, total changes to the work environment and the food industry. Latour's (2007) actor-network theory, consistent with assemblage theory, was helpful in the analysis of both the micro-organizations and relations of the bodegas in the cosmos of la Central, but especially in making sense of the many appropriations of technology, of the changes in products and materials, of prices and configurations as network relationships, and of power and familial networks within the contained work environment. In this paper, the analysis presents the crisis and the multi-network assemblage response to the massive changes imposed on the workplace and industry. These assemblages are always flexible and create different territories that have different temporalities. Distinct practices and languages codify these territories with their own pace or intensities. (DeLanda, 2006)

1. Findings

We present a series of field observations and analyses from the data, starting with ethnographic observations from a first-person narrative from the field study. The observations are followed by sociological analyses that describe resilient responses to the emergency situation, drawing on analysis of social capital (individual unit of analysis) and self-organizing of the whole system (organizational unit). The workers frequently said that la Central de Abasto (CEDA) was a city inside the city. Until I began to walk its aisles, it was impossible to conceive of its monstrous size. Kilometers of bodegas, shops that sell every kind of food commodity, from Mexican chiles to grapes from Chile to cinnamon from Sri Lanka, fill all the aisles. La Central revealed many paradoxes. We observed the crushing (and sometimes painful) weight of materiality, time, speed, order, and bureaucracy, as well as the leaks and escapes of humanity, even joys. In the end, in this sea of uncertainty, people balance daily between the brutal weight of material reality and the human (and non-human) capacities to persist. The distance between business success and tragedy was often very close. Moreover, there is no time for tragedy at CEDA. From an anthropological perspective, the show, the business, must continue (Hoffman et al., 2002).

We analyze two forces intertwined in the CEDA: the temporal and spatial. Time is an actant, vital, and invisible character in the investigation, and it is becoming increasingly present. Matter, space, and time have agency that becomes articulated in the assemblage. Several actors or characters in this research are non-human, including the building and facilities of la Central. The question arises about how we might "talk" with non-human actors. The assemblage methodology follows all the actors, even the non-human. Their actions create territories, which have their communication or language. If these territories persist, they can be observed in the general assemblage but may also be ephemeral. Talking with many bodegueros (shop owners) at la Central, I learned they are flexible with their relationships with the administration appointed by the government of Mexico City and have changed political parties several times in over 40 years. As political alliances change, the allegiance of organized crime also changes, pertinent to the connectivity of governance (Brondizio et al., 2009). Governance is also an assemblage with challenges "caused by the increasing connectivity of resource-use systems and the growing functional interdependencies of ecological and social systems" (2009, p. 253). The pandemic stretched that equation even more. Samuel (September 2021) has had lifelong experience as the son of one of the significant staples dynasties, whose family's staples bodega was at the downtown market of La Merced before arriving at CEDA in 1982. However, he had never seen such a sudden change as what happened.

"Yes, freight is costly. Boarding times are much slower, at least at the outlet. Before, it could take a month from Asia and two by boat. The shipments arrive in Manzanillo, Lázaro Cárdenas, and Veracruz, and the cost is four times higher.... My clients are people who sell to the industry. Some people prepare products for sale in restaurants, supermarkets, etc. Furthermore, they also buy from other supply centers in Mexico. Moreover, with the increase in prices, their purchasing tendencies have changed. There are products that they used to buy, and now they do not buy, and now they buy others that are cheaper, the basics, which are what have sold the most: beans, rice, lentils, chickpeas..."

Their customers buy only the basics because people sought necessities during the pandemic, not luxuries. Uncertainty dominated all decisions. Samuel is young, in his early 30s, and the heir to a generations-old family business, but now carries an enormous responsibility: to sustain that legacy successfully. He thinks carefully about his answers. He speaks slowly, but he is worried. His bodega, although successful with generations of experience, has never experienced anything like a simultaneous halt in supply and demand and only a trickle of activity. Orensanz (2022, p. 128) reported that the pandemic produced food shortages at la Central, but our in situ research never showed a shortage. The real problem was not supply but demand, yet the outcome appears the same. Commodity stocks were ready to be sold, but the buyers disappeared.

We cannot know what could happen if la Central closed because of the pandemic crisis, but Mexico City would certainly not starve. Wal-Mart is the dominant supermarket player in the country and has developed a robust supply chain connected to the US because of NAFTA. In every district of Mexico City, poor or rich, there are distinct types of Wal-Mart stores that could absorb much of the demand (Echeverría, 2024). After the US Civil War, a new economic institution was created to organize commodities trading, the futures market. In Chicago, it began with the wheat trade (CBOT), as Cronon (1994) notes, while in the South, the New Orleans Cotton Exchange (NOCE) was created. This matters today at the beginning of the 21st century for an important reason. The financial and technological infrastructure designed at the end of the 19th century created a lock-in phenomenon that persists, as David Pinzur (2021) describes, and these definitions of infrastructure produced ontological differences typical of the commodity market. Both markets had differences in infrastructure, but both agreed on something that persists to this day: commodities must be homogeneous to be marketed, and that is achieved with quality grading systems. Today, such grading can be seen at CEDA in the same boxes where the products are transported. Generally, the sizes differ in caliber. All this order was to control speculation as much as possible, but this was and continues to be a permanent element of the ontology of commodity markets.

Despite this, the intelligence of the market's assemblage is generally more significant than the speculators' perception. According to three young brothers (garlic sellers, who remain anonymous), an insightful account of the working experience of la Central, with a fragment of the exchange, is as follows.

I said to them that many older bodegueros wanted to refrain from talking. One of them, whom I will call José, told me:

"My brother was going to tell you to fuck off, but when you told him that you were an anthropologist, he changed his mind. However, for many people, even if you show them the university's credentials, they will not give you anything. Why? One, it is for security. The other reason is that many practices they use and will continue to use are illegal. Dumping is prohibited, but it is widely practiced here."

As I learned, the price is such a malleable actant at la Central that it may be considered fiction. The price is never fixed; it can always be negotiable, but it significantly contributes to one's agency in the assemblage. The numbers we see at the bodegas were primarily for government compliance. The price represents a field of power, a trading space to introduce or resolve conflict. The research has shown that in la Central, at least the big players play the price game.

1.1 Social Capital and Resilience

We make the case that the resilience of the succeeding bodegas resulted from the social capital of their owners and workers. Brondizio, Ostrom, and Young (2009) define the connectivity role of social capital as "the value of trust generated by social networks to facilitate individual and group cooperation on shared interests and the organization of social institutions at different scales" (p. 255). The general lack of social capital at la Central is not homogeneous, but it is not surprising either. Some studies have shown that Mexicans have deep trust problems. In 2010, the public opinion research agencies GAUS SC and LEXIA extensively studied Mexicans' aspirations, values, and dreams. In that study, the Mexican persona appeared surprisingly clear as an individualistic character concerned only with himself and his family. In November 2022, the study was repeated, and the results were similar. We see a citizen very poorly connected with other citizens – and even less with institutions.

Cruz-Torres and del Campo Ríos (2021) affirm that social capital moderated between uncertainty and cooperation during the pandemic. Their study analyzed whether Mexicans would tend to reduce their willingness to cooperate with others during the pandemic or not. In a confidential online survey, they evaluated willingness

to cooperate. The results indicated "that higher levels of uncertainty stemming from the COVID-19 sanitary contingency are associated with a greater disposition to harmful community effects, such as a lack of cooperation and a tendency to mistrust neighbors" (2021, p. 1055). Indeed, the concern for contagion, on top of the pre-existing suspicion accompanying high levels of competition, might have affected health and recovery in the vast CEDA facility.

Nevertheless, in a very Mexican paradox, the results support that social capital can protect against systemic distrust, but this "moderation effect" is not general. For instance, people who perceive their communities as high in social capital "suffer less uncertainty in the face of the pandemic." This was not the case at la Central de Abasto. We observed fear to be widespread everywhere during 2020 and 2021, especially in the first months of the crisis. In every bodega, small and big, there were sick people, and some closed because their owners died.

Even in this bleak moment, resiliency endured. Many got sick, but many recovered, and they needed to innovate so their business could survive this crisis. La Central's old business model was once centered on the family. However, the pandemic just accelerated underlying changes that were already beginning. The generational change was difficult because, even being older, the parents wanted to work to feel independent, and as some told me, they loved being in their bodegas more than in their homes. As a family business, the bodega was the center of social cohesion and the source of social capital of la Central for forty years. However, then the pandemic arrived.

A conversation with Israel (July 2021), an employee seller at a medium-size bodega, revealed how things changed with the crisis:

"These last two years, the Central has changed significantly; we have seen a tremendous change due to the digital issue. There are already many people doing home deliveries this way. They buy from us. They are clients who had food service but were diversified, and since they had nothing to do, they started that. Of my sales, food service is about 60-70%. They hardly pay attention to quality; what they want is price. However, if the product is very scarce, they do not care how much it is worth. Little by little, sales are recovering, but it will take time to return to 2019 levels."

Israel explained how the pandemic impacted business.

"We did not close during the pandemic. They have not come to vaccinate us; everyone has gone to get vaccinated on their own. What they have done is free tests, and the delegation sent them. However, in the bodegas, the majority are not vaccinated, not yet, because they are people under 40 years old, and they are just getting started."

It is important to note that the Mexican government did prioritize seniors for the vaccines. Younger people - the average age of people working at la Central at the time – were not selected to have vaccines until months later. That decision may have been consequential for many of the CEDA's workers.

The pandemic created conditions that constricted the flow of social capital to smaller social circles. The re-organization of employment, tasks, and roles in the bodegas, as well as supply arrangements, occurred in response to changes that, while collective, were responded to by small groups of the bodegas and their immediate buyers and suppliers. Nevertheless, while no overall directives shaped the decisions of the bodegas and no general plans were made, in this massively decentralized assemblage of actors, thousands of small organizations, few of them even coordinating with each other, sustained the entire Central operation. Like an ant colony, even if dozens of shops were affected or without products, others were sustaining or adapting their business with customers. The adequate potential capacity of the CEDA system still remained available to customers. However, demand had slowed significantly due to expectations not just of the market but of millions of people in the population, which affected the expectations of buyers and significant vendors.

1.2. Self-organizing as Resilience

We observed collective resilience as well as individual and social capital resilience. The assemblage process we hypothesize from these observations, as expressed in forming solidarities between bodegas and their immediate networks, demonstrates the resilience of large colocated networks. The CEDA facility has no top-down or managerial organization. The responsive recovery of many family bodegas following the rapid collapse of business conditions shows that selforganization of the parts results in restoring function, if not optimal, performance. Each bodega is a purposeful activity system seeking to restore its business in its supplier and sales ecosystem. The relations between bodegas were not coordinated but benefited from the propinquity of onsite communications. However, the effects of internal conditions did not seriously impede the whole operation. The most significant effects were the drop in external demand, creating problems for inventory planning and stocking supply.

One mode of self-organization was adopting technology to improve profits, even if average sales were lower. As with refrigerators provided by individual owners in the earlier era, new tools for production were adopted to restore business performance. The three brothers in garlic sales were one case where innovation was adopted to enhance product sales. The family owner (father) had sold only whole garlic for decades, but the pandemic

decimated demand. To recover the business, they innovated using technology investment to create more value. They bought an airpressure garlic-peeling machine and sold the peeled garlic at a much higher price.

"If we did not do it, we would fall to bankruptcy. We were buying each machine, whether the fridge or the peeling machine, and it was challenging to convince my dad. The purchase, sale, and resale model is already obsolete. It became a penny business. For resale to truly pay off, you must sell a truck daily. The problem is that there is you, and there are thirty others like you. We change the volume for the issue of added value since it becomes unsustainable to sell a very high volume."

The successful bodegas bet on technology. The garlic sellers analyzed the numbers (one of the brothers was an economist), and their risk paid off. Whole garlic sales are now just a fraction of sales. They survived, but not without costs. They fired some employees to buy the refrigerator and the peeling machines. However, in the end, they did not close like many others.

Most bodegas have no website or an online store, but that did not inhibit their adaptation. The ubiquitous smartphone and the apps used by customers and suppliers were the most helpful. As an everyday innovation, the adoption of the WhatsApp text app enabled many to leapfrog beyond their legacy practices. Many first used the WhatsApp smartphone app as an informal withinbusiness messaging intranet. The process quickly caught on to the whole system. Bodegueros, big and small, now use WhatsApp to receive commercial orders, send pictures of new merchandise, and chat with producers and clients everywhere in Mexico and abroad. WhatsApp has become the de facto critical social capital infrastructure at la Central. Moreover, with emoticons and voice mail, even the less literate can adopt its use for everyday work.

Mexico City's government is the de facto management of la Central, which provoked a persistent lack of accountability for its maintenance. When the CEDA opened in 1982, it lacked essential refrigeration, so the bodegas installed their own, especially those selling bananas, apples, garlic, and temperate fruits. Also, operational costs have been increasing due to precarious security from crime. La Central is one of the significant parts of the food value chain in Mexico, and organized crime has taken notice. The bodegueros have suffered continuous kidnapping threats for years. All these different costs compounded and resulted in social and material costs that incentivized change to the organization of la Central itself.

Smaller marginal gains indicated that bodegas had two options: to get bigger and trade higher volumes or increase their product's value, as the garlic brothers did. The family-centered bodegas are adapting, but not

all have, so some have sold their business to more prominent vendors. A market consolidation is happening. The brothers said some bodegas have bad reputations because "they kill the price for the producers, and they keep the product on their fridges and then sell it at the price they want when the season ends…." They say that la Central has five dominant actors for every product category. In groceries, it is clear because that sector is predominantly owned by descendants from Spain, called the Spanish "los españoles," perhaps the only group at la Central known for their ethnic origin. Furthermore, because they are some of the wealthiest bodegueros, trading especially in seeds and grains, they lend money to smaller ones.

As we returned to Samuel, the heir of a large grocery bodega, he complained about the high freight prices. Responding to the question of when the business will return to normal, he said:

"I do not think this business will ever return to what it was. It is cheaper for shipping companies to have fewer ships at sea, have them full, and charge four times more. Operationally, it is cheaper for them."

Do you think the storm will end in a year or two?

"I think it is going to take a while. The level at which it was in the logistics issue is years and years of economic growth, and right now, the growth…"

Two years after the field research, informants share that the CEDA is still recovering, but the demand has not returned to the level before the pandemic. Many restaurants closed, but food prices increased and were passed on to consumers. The open restaurants increased their menu prices, impacting traffic and becoming a circular problem.

2. Discussion

Institutions matter because they are formed with social capital. The one that has survived among all odds is the Mexican family because it is the first circle, the closest one. However, social trust has eroded over the decades. The long-standing hegemonic party, PRI, became authoritarian, commanding obedience by fear, not loyalty.

Thinking about what would have happened to la Central de Abasto in the worst of those pandemic days, we asked different bodegueros several times if Mexico City would suffer from hunger. The answer was a resounding no because of different reasons. The first and most common was the growth of Wal-Mart, especially in the past two decades, which has created its own logistics chain that supplies everything from popular neighborhoods with the Bodega Aurrera brand to higher-class neighborhoods with Wal-Mart Express. The largest CEDA warehouses also supply Wal-Mart since they earn a lot from volume.

In April 2021, I met Antonio Avila (his real name), the regulatory inspector in the "auctions" area, where the trade of vegetables on top of concrete slabs occurs, between the flowers area and the fruit and vegetable warehouses. He was on break due to the pandemic and being over 60 years old. He sadly passed away months after the conversation (it is unknown as to whether it was from complications of Covid-19 or not). Over breakfast, we talked for a long time, and in discussion, we walked through his domain, looking at the products and commodities in everyday work:

"The package of cactus (nopales) with 200 pieces was 60 pesos. Yesterday, it rose to 150 pesos, the first-rate, more than double. It is scarce; there is none due to the drought."

I asked if there is hoarding.

"There is some. Well, it is about 30% of the total trade, but before, there was more; now it is calmer. Most producers have their spaces, but those who do not come and kill their merchandise at a low price. I think 50% make an agreed harvest, half."

He has worked all his career at la Central; so how does he see the changes today?

"For a long time, it was only given minor maintenance. I have been here for 36 years; I saw the Central almost new. When I arrived, it was not even full. They have not paid the ejidatarios [farmers that share an ejido, a prevalent legal form communal land in Mexico] of the original chinampas. In December 2019 we counted 2,100 trailers, 1,600 two-ton trucks, and 59,000 cars and vans that entered daily. There are a total of 8,228 premises, including wineries and commercial premises. There are 981 wineries. There are many mafias here, many. The situation on the night shift is very different. In addition, there is sex work on the eastern road, along the aisles. That is the oldest job in the world."

If institutions fail to provide adequate support and maintenance, not only do the physical components fail, but the social capital, as human infrastructure, also erodes. Institutions are networks of civic participation, and when the civis, citizens feel disenfranchised to act, social inertia prevails. We agree with the study that concludes "there is a neutral quality of social capital because it can lead to both positive and negative outcomes of competing interests… like other forms of capital, social capital opens up some opportunities and closes down others" (Brondizio et al., 2021, p. 262).

Informants told us that some traditions are not upheld anymore, like the annual dinner celebration at the Central's anniversary. Bodegueros may care less, likely because older generations are retiring and new people do not share the history and social capital of the founders who began to work together in

1982. Some young generations are in charge, but some families have sold their rights altogether to newcomers. Moreover, this unraveling of the social fabric gives space now only to good actors.

“Social capital may also have a dark side. Gangs and mafia use social capital as the foundation of their organizational structures”

(BRONDIZIO ET AL., 2021, P. 262).

La Central moves hundreds of millions of dollars a day. It is a massive market, but only some trades are registered because many movements are in cash. Falko Ernst, an analyst for Crisis Group, explains what happens with just one case: the avocado trade. However, as with everything in Mexico, it is connected to the country’s political economy.

“Until 2000, a single authoritarian party governed Mexico for an uninterrupted 71-year stretch. That party might have been a synonym for corruption, but it did manage to impose certain rules onto the narcos and keep violence in check. Then came democracy and former president Felipe Calderón’s attempts to go after the cartels head-on. Regional governments became more autonomous, opening up new avenues for corruption without effective oversight.”

(ERNST, 2020)

This new gray area opened new opportunities for criminal activities, and export products are very valuable and more straightforward to trade. Avocados were an obvious choice because of the high American demand and price spike. In a scenario this complex, we would not expect a rapid solution. Legal reforms of Mexican institutions will take years if there is the will to do so. Just as with the case of the avocado, that is perhaps only the signal of the problem, as repricing and tensions are already occurring with other commodities (Russell, 2022).

Finally, we might address the opportunities for meaningful design interventions in the CEDA system. From a systemic point of view, there is an initial dilemma between the realist and the constructivist formulation of the problem context. We are confronted with the realist perspective of the assemblage, that the CEDA operation is massively decentralized, and there is no management or desire for such over operations and practices. We consider the long history of the CEDA and its socio-historical practices, which are not “scalable” in the way systemic service design would seek to enhance and propagate as a new system.

Even if we could change practices, how would we do so, and how could improvements to business performance be promised? Individual outcomes are what the bodegas would care about most.

From the constructivist perspective, we might solicit interest from more prominent bodega owners who are interested in guiding a long-term vision and creating some form of coalition. Changes to practices and riskier technology experiments could be supported in a prototyping cocreation mode. However, these impacts might be limited to the participating organizations in a traditionalist environment. There are other possible design futures we have yet to explore, and so many structures and infrastructures have yet to be investigated in the ethnography. Such opportunities for intervention may be discovered with the participants themselves. The field research reported here was not an experiment but an inductive ethnomethodological study based on the opportunity to observe social and behavioral adaptations to a once-in-a-lifetime disruptive event. Our insights are drawn from focusing on the responses and recovery from the pandemic effects across multiple worker-participants and by analyzing la Central as an assemblage. Some of these could be managed with government support, such as investment in transportation hubs, docking and trucking improvements, and other infrastructure around the CEDA complex that could improve its sustainment over the longer term.

3. Conclusions

The “creative destruction” process in capitalism initially proposed by Joseph Schumpeter (1942) describes how innovations make obsolete the established practices of their times. The modernist imperative would be to control and monitor such large networks. A design approach might first trust that subsidiarity exists among stakeholders with real skin in the game to make the whole system work to fulfill their commitments. However, during the pandemic, controlling and monitoring the health of the workers at CEDA was impossible for Mexico City authorities and the federal Mexican government. Not because of a lack of resources but, as often found, due to a lack of political will. La Central has suffered from underinvestment for so long that the institution does not even register on the political radar of the Mexican political elite. The end of the PRI political era began in 1997 in the Mexican capital, and then PRI eroded nationally by 2000. The new democratic space was one of experimentation, where old forms died, and the new ones have not fully emerged. La Central has exhibited resilience, not because of management or the government, but despite its neglect. It has adapted even to survive the increasing presence of organized crime and survived the double shock in supply and demand of the pandemic.

Variables like generational change, the rapid use of WhatsApp and smartphones, and the always present soft dealing with the politics of changing Mexico City governments have enabled adaptation, especially in this crisis. Even during times of social capital degradation, CEDA has persisted. Will these practices suffuse the future crisis? Some bodegueros are already adapting to climate

change's impact, adapting to changes in their products' growing seasons - and perhaps technology will come to the rescue again, such as logistics apps for changing providers as they are available. However, there are new social requirements following innovations, like food on demand, where mobile food deliveries and digital commerce are growing. Moreover, while WhatsApp was widely adopted in the first iteration of smartphone use, some are already experimenting with new platforms and formats.

La Central will evolve not into a single future, only decentralizing the central market, as Orensanz (2022) suggests, but very different options, and we can see the signals of change happening now. Some bodegas have closed to the public but provide internal food service hubs. Some are more technology-oriented than pre-Covid, relying more on digital communications to manage smaller/faster inventories. Others are watching climate disruptions, as a worried mango bodegueros noted. He is investing in new suppliers to have more redundancy in supply. The new generations are excited about what is coming but also very anxious. Their parents gave them a legacy, and now they are in charge, with new thinking and new tools.

Assemblages are arranged between human and non-human actors. In the CEDA context, we saw the organic restructuring of work practices that seamlessly appropriated commodities and their logistics, technology and new machinery, forms of payment, and the people and roles they play. These assemblages create territories that can be more or less durable, sustained, sustainable, and interconnected. With all its codifications and intensities, this research has shown that the territory of CEDA continues a rapid transformation process. As Jessica (one of the few women bodega owners in the study) said:

"They (the government) did not just abandon la Central; they stole the money, that is different. From where do you think Morena (the present-in-power political party) got money for the campaigns?... Maybe we are at fault here because we have not demanded accountability, but a bodeguero once said no. What did the administration do? They closed this bodega for two weeks. It is hard, but we need to organize."

The old establishment of la Central is retiring or dying and leaving the reins to a new generation, but many traditions remain and will continue. However, the next generation of workers and owners are already within this assemblage, designing iterations with trials and failures, and shaping the future from their own choices.

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DESIGN-LED CIRCULARITY FOR FURNITURE MANUFACTURING. AN APPLICATION ON MONTESSORI KINDERGARTEN

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ABSTRACT | The increasing demand for sustainable production systems necessitates a reassessment of product design and lifecycle assessment methods, emphasizing socio-technical aspects. This contribution reflects on the results of a laboratory that addressed the needs to widen and identify possible new market areas for circular materials characterised by a marginal diversification of products in the furniture design industry. By collaborating with a local preschool to understand the pedagogical requirements and implications of design, and by creating synergies with recovered material suppliers, the Research investigates the potential of design to function as a mediating force between the inherent limitations of material solutions and their application context. The laboratory leverages technologically innovative recycled materials applied in the kindergarten furniture context, resulting in thought-provoking design proposals for identifying and developing viable design-led furniture production opportunities. Through a combination of design-led material assessment, user-centred approach and iterative experimentation, the Research seeks to provide insights into sustainable design approaches that align with environmental and pedagogical objectives while contributing to the advancement of sustainable design practices. The outcome of this experience is a strategic framework proposal, structured according to the laboratory experimentations, that aims to enhance design methods and process development, focusing on resource-efficient offerings. Ultimately, the Research hopes to contribute to transforming challenges associated with material constraints into opportunities for innovation and sustainable application through design.

KEYWORDS | DESIGN FOR SUSTAINABILITY, LIFE CYCLE DESIGN, MONTESSORI EDUCATION, FURNITURE DESIGN

1. Introduction

The growing demand for sustainable production systems has led to a revaluation of methods and tools for designing and assessing products throughout their lifecycle (Kardung et al., 2021). Sustainable design development becomes an increasingly urgent concern, as stressed by the European Union in its Circular Economy Action Plan (2020), and further reinforced by the new 2024 Ecodesign for Sustainable Products Regulation which calls for a shift towards more environmentally sustainable and circular products and claims the integration of environmental considerations into all stages of product development (EU Commission, 2024).

The evolution towards conscious design has broadened the level of innovation ensuring that products maximise efficiency, optimise resource use, and reduce waste, while being sustainable in terms of long-term satisfaction and usability for users (Bakker et al., 2014). Conversely, a material's sustainability is also perceived for its capability to integrate socio-technical aspects, such as user behaviour, consumption, disposal, maintenance, and recycling (Ceschin & Gaziulusoy, 2016). Exploring new materials and technologies to reduce environmental impact and open up new aesthetic and functional possibilities for designers has been acknowledged throughout the years (Roy, 2010). Controversially, the adoption of recovered material is often limited to specific application, hindering the broader potential these materials could offer (Vezzoli et al., 2015), with producers struggling to open new markets (Castell-Rudenhausen et al., 2022). Ecores et al. (2018) advocates that designing circular furniture products requires research and innovation as well as adopting, mastering, and implementing eco-design skills along with untapped material use. These factors are particularly relevant for the Made in Italy furniture manufacturing sector, which strives to meet rising demands for flexibility and adaptable solutions (Starkey et al., 2021). The goal is to contribute to the expansion of alternative recovered material application, by promoting conscious and sustainable practices, as well as involving stakeholders at various levels, while meeting environmental and societal challenges

(Vezzoli, 2003). In this regard a creation of a relevant value network of suppliers and the use of external expertise is essential to create an effective framework model (Moreno et al., 2016). This is enhanced by the involvement of Montessori kindergartens where the design of furniture will not only prioritise sustainability but also supports the context by promoting educational goals in early childhood education.

By considering the challenges posed to the furniture manufacturing, and the needs to widen and identify possible new market areas for semi-finished and circular materials, this contribution explores the integration of design for sustainability principles, circular economy, and Life Cycle Design (LCD) strategies, applied to a niche setting such as the Montessori educational environment, to bridge the inherent limitations of material solutions and their application context, enabling opportunities for sustainable production. Strategic partnerships and collaborations play a vital role in generating new resource streams, accessing additional skills and competences, and pooling resources to offer integrated solutions (Ecores et al., 2018).

The following sections present critical terms and definitions of the context, subsequently detailing the preliminary Research methodology and descriptive analysis applied in an experimentation lab, introducing the categorization of circular design, and LCD strategies. Section four presents a proposal framework, accrued from outcomes and strategies towards circular-effective production systems, which emphasise the key findings and contributions to both the academic and practical fields, followed by a conclusion and acknowledgment of the limitations and directions for future research.

2. Material sustainability matter

Insights into the circular economy and business transformation in the furniture industry shed light on the economic significance and environmental challenges faced by the European furniture sector (Farahmand & Rahimiaghdas, 2024). Despite a notable degree of knowledge and awareness of circular economy principles, the involvement of furniture companies in circular economy practices remains marginal, particularly concerning reuse and recycle actions, which comes along with a very limited use of process and product certifications.

According to European Federation of Furniture Manufacturers (UEA) statistics, furniture waste in the EU accounts for more than 4% of the total municipal solid waste stream. Of this 80% to 90% is incinerated or sent to landfill, with only ~10% recycled (Arditi, 2017).

While the traditional linear economy is frequently characterised by structural waste where components, products, or materials reach their end-of-use/life, research on the furniture sector has identified, at European level, potential opportunities within a circular economy framework (Pieroni et al., 2019) promising a wider range of efficiency and productivity strategies (Kirchherr & Piscicelli, 2019; Potting et al., 2017). Circular strategies

(i.e. Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover) focus on a design approach that support manufacturing practices aimed to retain resources in use and minimise waste generation and destruction (Murray et al., 2023). This concept is reinforced by the establishment of programs such as the HORIZON *"Innovative circular solutions for furniture"* that specifically address to some extent circular design strategies, including safe and circular material choices, a shift from products to services, extended product life through design, increased material efficiency, and modular design.

2.1 Design as link for circular ecosystems

As awareness of the shift from a materials-focused to a more strategic level grows, waste materials are increasingly perceived as a valuable resource in supporting industrial prosperity, environmental sustainability as well as personal and societal fulfilment (Brown et al., 2019; Pearce & Ensley, 2004). The circular economy aims to enhance the lifetime of products, facilitate the repurpose of items, and divert waste materials from landfill back to production lines (Ellen MacArthur Foundation, 2015). Realising this requires advancement in methods (Bocken et al., 2016), metrics and assessment (Moraga et al., 2019), production systems (Bakker et al., 2014), products and services development tools (Moreno et al., 2016), and the creation of organisational capabilities such as experimentation, value chain innovation, and human factors (Nilsson-Lindén et al., 2019). In this sense, designers play a crucial role in moving through these dimensions (Santolaria et al., 2011) acting as a link between consumer's cultural sphere and the world of production (Mortati & Cruickshank, 2011).

Through a holistic approach and strategic partnerships, designers hold the possibilities to ultimately offer integrated solutions that could promote the birth of new resource streams and competences. Further, by adopting a circular design approach, the design process establishes specific data and informational hierarchies to prioritise waste prevention and production management.

Therefore, aligned with the European Commission's waste management directives (EU Commission, 2020), the Research provides alternative understandings on 'waste' by directly reintroducing it into the life cycle as a valuable 'resource'. By leveraging the recycling strategy, it aims to foster a new ecosystem, made of diverse levels of stakeholders able to create, maintain, and recover the value of resources in innovative ways. The Research identifies opportunities within the kindergarten context and envisions future possibilities for recovered material application, thereby contributing to circularity.

3. Creative educational context

Educators advocate for proactive measures to transform schools into hubs of innovation through interventions in designing educational environments that promote

spatial and didactic innovation (Edwards et al., 2014; Lorenzoni, 2014). Conversely, the design of furniture and the learning environment play a crucial role in supporting pedagogical practices and enhancing the learning experience for children (Antonacci et al., 2019) Child-centred philosophies, such as Montessori pedagogy, the Reggio Emilia Approach, and the Nordic European Model, are closely intertwined with design principles aiming to cultivate environments that foster independent thinking and self-directed learning (Montessori, 1781), and the child's intellectual expression (Fraser, 2011).

They facilitate the free development of children's activities, promoting autonomy, confidence, and the development of practical life skills, motor skills, and sensory training (Keskin, 2016; New, 2007).

Particularly, the Reggio Emilia approach considers the educational environment as a 'third teacher,' being significant as the teacher and peers (Cagliari et al., 2016). The careful selection and the design of furniture and materials in these classrooms serve not only as a functional object, but also a tool to nurture core skills (Murray et al., 2023).

Montessori (1978) emphasises furniture design that is proportionate to children's size, lightweight, and easily accessible to foster independence and practical skills development (Murray et al., 2022). Educational materials and furnishings support holistic learning, covering cognitive, sensory-perceptual, and practical development. Everyday activities like eating, washing, and dressing become learning opportunities, building children's confidence to function independently. Teachers guide students in exploring their environment, nurturing autonomy. Montessori materials are sensory-rich, engaging all senses to stimulate intellectual growth and focus on real-life skills. Tools from real life promote practical skills and fine motor development, with books and materials placed on child-sized trolleys and shelves for easy access. The environment features natural colours and materials to minimise distractions, creating a calming atmosphere for imaginative exploration (Lupi, 2018).

Furthermore, these educational models add values to the concept of 'all places are learning spaces' envisioning learning environments that serve multiple purposes (Stables, 2014). In the restroom, children learn basic life skills like using the toilet, washing hands and personal hygiene. Hallways become spaces for learning to walk, navigate, and greet others. Dining halls are where children enjoy meals, learn table manners, and develop healthy eating habits. Lasty, cultivating a sustainable way of living is one of the philosophies' cornerstones. To achieve this, these educational models include the outdoors as a conceptual learning space. Here, children have a chance to establish a strong relationship with nature and the earth.

Accordingly, research on the impact of furniture design on children's development and learning interest emphasises the role of

furniture in supporting and enhancing the learning experience within sustainability (Cole, 2014). Conversely, in the context of design research, studies on sustainable furniture design provide valuable insights into creating furniture that aligns with ecological needs and promote acceptance (Yang & Vezzoli, 2024).

3.1 Design for student and learning environment

The evolution of school furniture reflects a complex interplay between pedagogy, design, and societal values over time. Originally, school furniture borrowed elements from other institutions, with multi-seat desks resembling church pews and a linear arrangement facing the teacher. This setup emphasised the teacher's role in imparting *"notions, principles, and interpretations of reality in accordance with unquestionable texts"* (Lauria, 2002, p. 66).

Foucault (1975) further emphasised the rigid structure of the school, considering it as a 'machine for learning' and an 'organisation of a serial space' for surveillance, hierarchy, and reward. While pedagogy was still authoritarian, with children considered as passive recipients of knowledge, leading designers and pedagogues, throughout the 20th century, explored how design could enhance and transform teaching and learning experiences.

While pedagogy was still authoritarian, with children considered as passive recipients of knowledge, a paradigm shift emerged in the early 20th century, and leading designers and pedagogues started exploring how design could enhance and transform teaching and learning experiences.

The 1920s and 1930s marked the evolution towards more flexible and collaborative classroom setups. The teacher descended from the podium, and combined table-seat designs broke away from the traditional row, encouraging interaction. Figures like Prouvé introduced functional elements like sliding pencil holders and drawers that enhanced usability, while other designs fostered student engagement and collaboration, with students sharing the same desk.

During the mid-century, school furniture continued to evolve and designs such as the versatile stool by Bill and Gugelot or the Revolt chair by Kramer, exemplified a shift towards a more usercentred approach and student engagement. With the introduction of plastics in early '70s colourful and modular furniture designs appeared, especially for early childhood education, emphasising playfulness and multifunctionality (Harrod et al., 2012). This era marked a departure from traditional, monofunctional furniture towards more interactive and engaging pieces that supported diverse learning experiences and demonstrated a growing understanding of the impact of furniture in educational environments (De Gregori, 2011).

In parallel, research on the relationship between learning environment characteristics, educational quality and student behaviour gained traction, leading to the shift from

factory schools to open school models (Weinstein, 1979).). In response, school furniture continued to evolve nowadays, prioritising student-centred, collaborative, and ergonomic learning environments (Bøjer, 2019; OECD, 2013) and exploring alternatives to improve educational experiences.

4. The laboratory of ABCDesign. Furniture, Childrens and Circularity

To further enrich the discussions, the Research structured an experimental laboratory entitled *"ABCDesign"* in which participants have been invited to design furniture that could efficiently address the dual challenges of environmental sustainability and preschool education. For this purpose, the laboratory has benefited from the involvement of a set of specific key partners:

- (Omitted for blind-review), an international kindergarten management brand offering pedagogical practices grounded in creative and independent educational approach.
- (Omitted for blind-review), a consultancy agency with a strong expertise in supporting producers implementing the most effective and efficient strategy to reduce their environmental impact. They facilitated a network with the following producers:
    - (Omitted for blind-review), a company dedicated to the development of sustainable rubber flooring, that uses advanced technologies and the fundamental addition of specific skills and extensive experience to automatically recover the waste generated during production according to the principles of reduce-reuse-recycle.
    - (Omitted for blind-review), an eco-friendly plastic product producer with a strong asset on sustainability of its plastic products integrating design, research, and development of solutions that preserve integrity, protect the environment, and reduce resource consumption.

The laboratory integrates two lines of investigation: a qualitative field study to understand the context and gain insight into how users behave, interact, and perform activities in a specific setting; a holistic design approach to evaluate and determine the sustainability of predefined recycled materials, their properties, and potential applications. These two lines have been structured in the main 3 phases (Figure 1) of analysis, prototyping and scenario building.

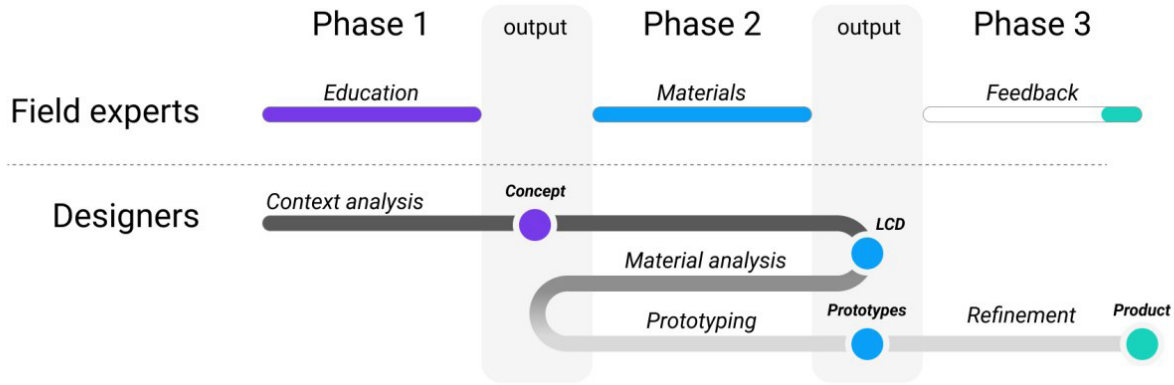

Figure 1. The stages of project development and the figures involved.

4.1 Analysis of spaces, products, users

The first phase encompasses contextual monitoring and analysis to establish a foundational understanding of the research environment and the target audience. The field study, (omitted for blind-review) Kindergarten, was enriched through expert consultation and an on-site observation (Figure 2), which facilitated an examination of pedagogical resources, physical infrastructure, products, and user dynamics.



Figure 2 The visit and observation of the context in the kindergarten.

The school environment is divided into different areas such as reception, play-educational activities, dining, changing and hygiene, sleeping, atelier room, outdoor area as well as being separated into three age sections: small (children 3-12 months), medium (children 13-24 months), and large (children 25-36 months). To enable close observation of the space, each working group, consisting of three designers, was allocated a specific area to focus on throughout the entire investigation and design process.

To facilitate contextual analysis, designers were supplied with a qualitative analysis tool based on the 5W, a method that provides an integral perspective for guiding design practices (Su, 2014) and to consider essential aspects such as stakeholders, product specifications, project timelines, project locations, and project justifications, thereby enhancing the clarity and effectiveness of the design process (Čančer, 2012), that is useful to define from the concept design and investigation stage.

The tool consists of structured tables designed to elicit data collection according to 5 predefined question sets:

- *Who?*
  Refers to anyone who attend the given investigation environment. Associated with this sheet are questions about who is being observed, such as how old they are, what their role is, what characteristics they have, how they relate to the space and how they interact to others. In the results (as in the example in Figure 3), not only types of users were collected but also the various connections between them according to their type of relationship.

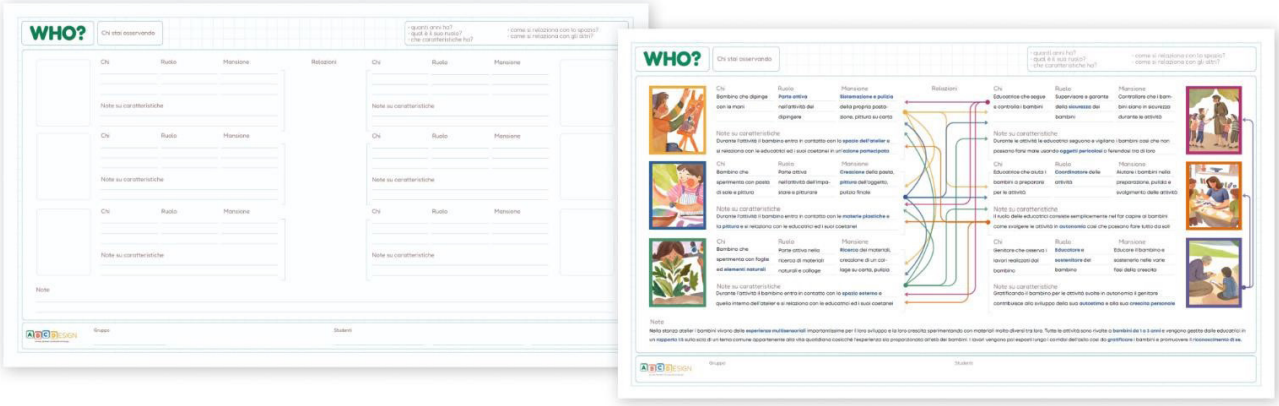

Figure 3 “Who” table, blank and filled by designers (Omitted for blind-review)

· *What?*

The template involves considerations about what activities are being performed, their nature (teaching, recreation, etc.), with what tools they are executed, the interactions they involve with the environment and whether they are individual or in group. The filled template (Figure 4) shows how the activities were undertaken through the analysis of children's interactions with existing products and teachers.

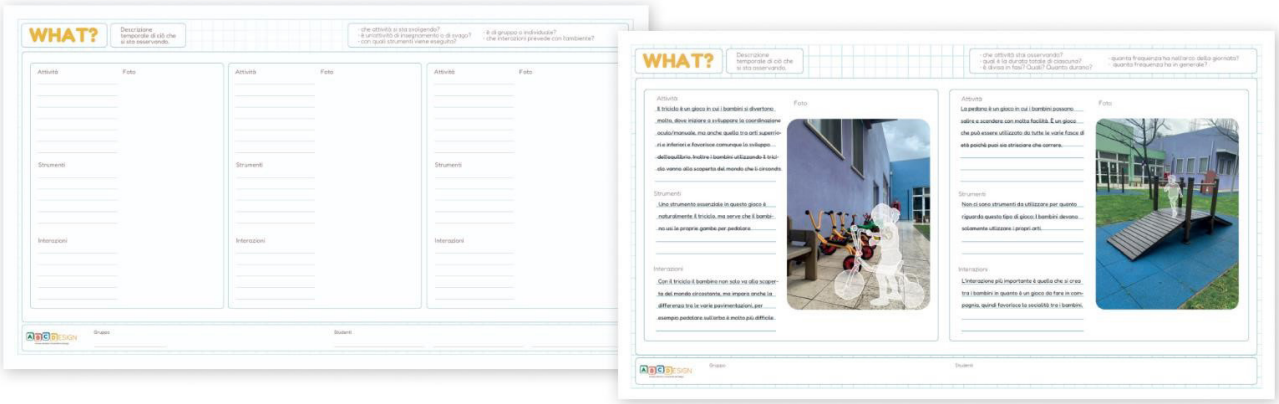

Figure 4 "What" table, blank and filled by designers (Omitted for blind-review)

· *Where?*

Requires the physical description of the place, not only with the mapping of the spaces but also considering how the space itself is characterised, how it is used, what objects define it and how it is exploited (also including the internal movements of people and objects). Here the designers mapped (Figure 5) the internal spaces and the movements patterns of users (parents, children, educators, and staff), identifying the areas of greatest flow and importance.

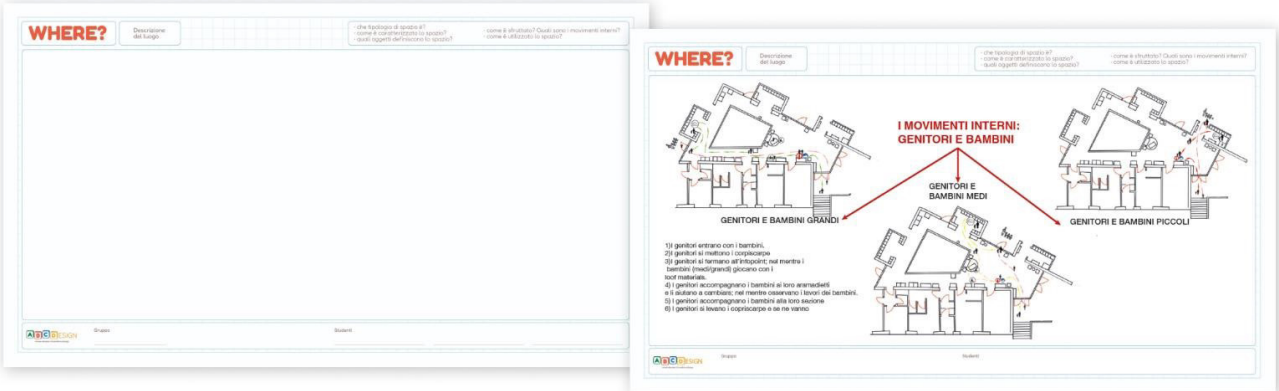

Figure 5 "Where" table, blank and filled by designer (Omitted for blind-review)

· *When?*

Provides a temporal description of what is being observed, defining the activities and their duration of each phase (if any) and total, and whether it is repeated (and if so, how often it occurs). The filled version (Figure 6) demonstrates not only the timing of observed activities, but the division into further temporal subgroups that define each activity overall, in order to understand intervals and internal organisational systems.

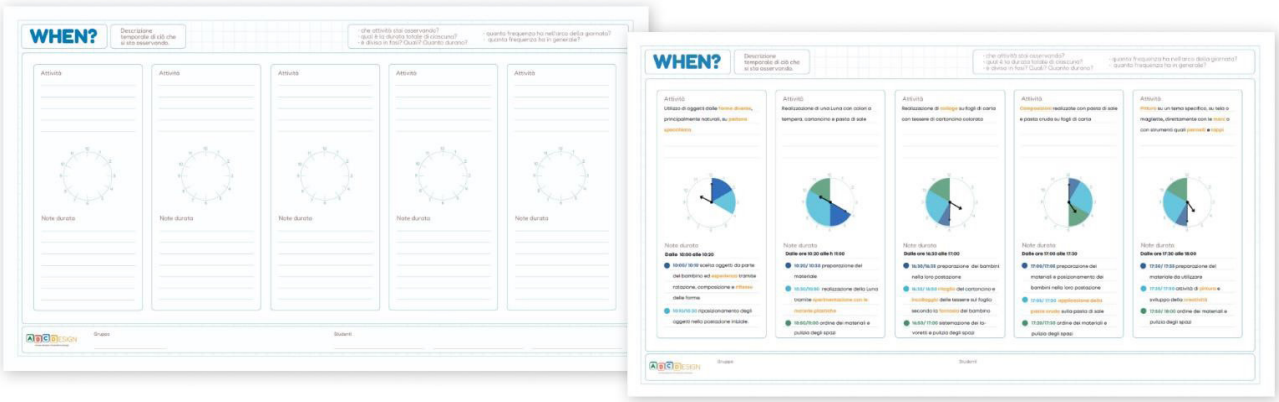

Figure 6 “When” table, blank and filled by designers (Omitted for blind-review)

· *Why?*

Concerns why what is being observed happens, such as the reason why an activity is performed and if it involves specific figures, why specific tools are used and in a specific space and way, and explanations as to why it happens at a specific time. In the finished exercise (Figure 7) not only the motivations for activities were noted down, but the scenes were represented by means of sketches as a way of in-depth observation of each detail.



Figure 7 “Why” table, blank and filled by designer (Omitted for blind-review)

4.2 Prototyping, experimentation, reiteration

As the context and concept clarified, recycled materials analysis shed the light on production and feasibility issues, enabling designers to progress through rough prototyping and deeper analysis to simulate, test and retrieve valuable data from their design proposals. Designers were provided with recycled rubber, supplied by (Omitted for blind-review) and recycled polyethylene sheets, supplied by (omitted for blind-review). This allowed them to deepen their initial ideas and implement new material knowledge to concepts and subsequent prototypes developments.

Following the presentations of the two materials by the supplier companies, participants were given data sheets regarding:

1. **supply:** the quantity of material available per group, and the types available according to colours and finishes;
2. **properties:** applications (whether indoor or outdoor), density, lifespan and toxicity information;
3. **production:** processes (moulding, pressing, etc.), machining (laser cutting, milling, etc.), post-production (painting, coating, etc.), finishes (colour, texture, etc.);
4. **resistance:** to external agents (climatic, electrical, etc.), to chemical agents (cleaning solvents, etc.), to heat (deformation, flammability), and breakage (impact, scratching, flexibility).

Further evaluation, focused on design proposals circularity, was guided through a LCD scheme (Figure 8). The evaluation was divided into 3 value clusters of strategies for optimising the use of resources, defining the consumption of the product and establishing its end-of-life for immediate systematisation of each part. Each cluster is then evaluated with a score from 1 to 3, generating a radar chart for comparing multiple concept proposals at time (in this specific case, there were three proposal each one), and with additional targets on the performance and properties of the given material.

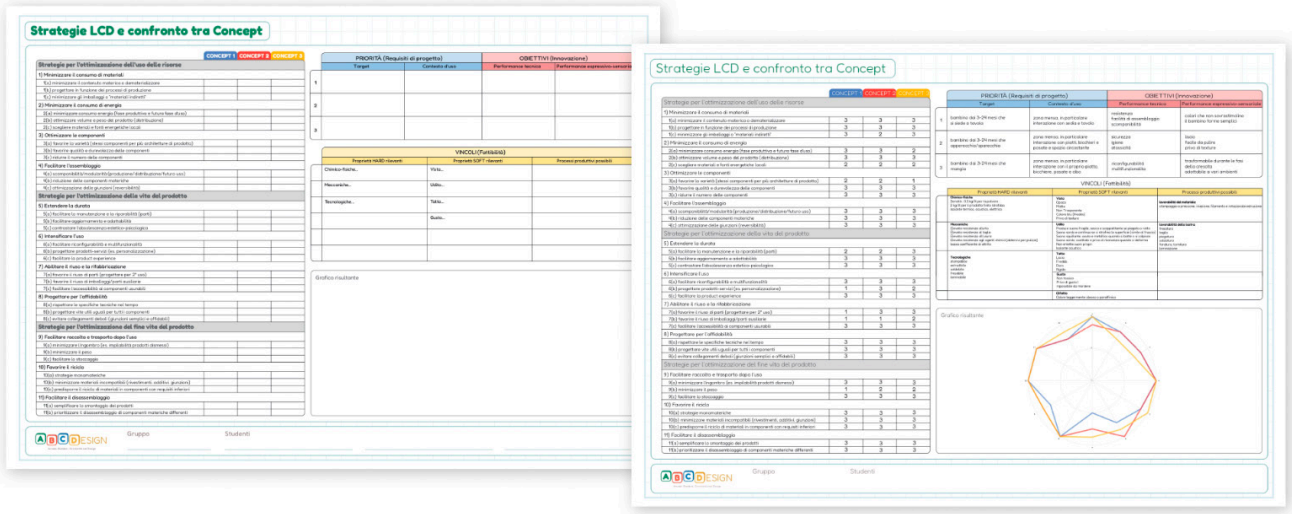

Figure 8 LCD Strategies tool and filled sheet by designers (Omitted for blind-review)

In this case, adopting LCD meant not only to focus on the functions and structures of the product but also on planning the product's life cycle as a whole (Kawada et al., 2009), enabling the evaluation of individual solutions during the conceptual and preliminary design stages, and ensuring that design requirements are met across all stages of the product life cycle (Todić et al., 2017).

Enriched by a series of prototypes and reiteration processes (Figure 9), the selection of the concepts derived from a deeper elaboration of the considerations concerning as much its usability, and the potential new interaction scenarios, as design evolutions oriented towards the realisation of a product. The latter, and resulting concepts, were ideally designed to be made of only a single material or to have elements easily disassembled for disposal matter.

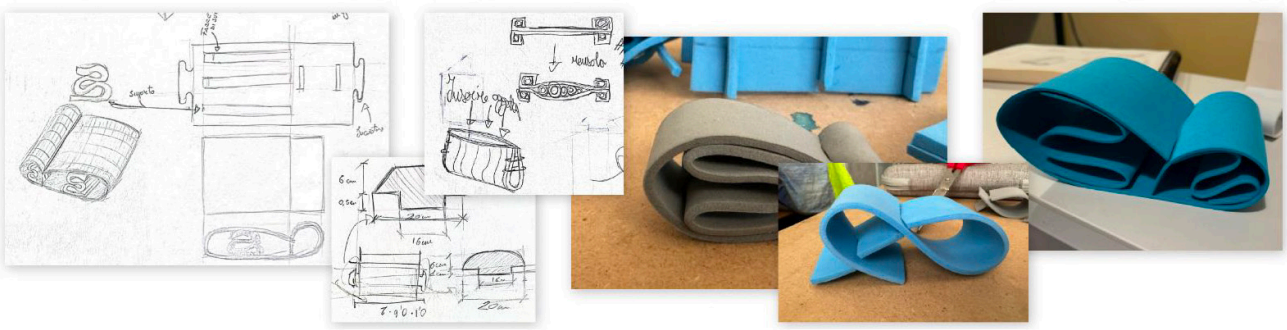

Figure 9 From sketch to rough prototype designed by (Omitted for blind-review)

4.3 Sustainable production and new interactions

The last phase encompasses prototyping and reiteration activities to achieve a final product based on design choices for sustainable production (e.g., design for disassembly and waste reduction from machining) and user interactions (such as use, ergonomics, and transportation). Each group faced challenges in aligning the design concept with the assigned material, both in terms of construction (as allowed by the material), use (comfort, uses, configurations, experiences), and handling (disassembly, shape change, disposal).

At the end of the process, each group successfully completed a furniture product that coherently integrated a series of information and inputs. As the project took shape, the system was able to automatically filter and select the most relevant information. From the analyses conducted, it emerged that each project managed to address two main challenges: the sustainability of the production processes and materials used, and the issue of preschool education, with particular attention to the cognitive processes of young learners and the needs of the adults in the considered ecosystem (operators and parents).

The research process underscored the significance of two interconnected design considerations that shaped the final outcomes:

a. The first focused on product sustainability, emphasising the specific characteristics of a predefined materials and their behaviours;

b. The second prioritised the creation of meaningful products that thrived to accommodate the children's need and their educational development, as well as facilitating the instructor while maintaining environmental responsibility.

Discovery Box (Figure 10) is an interactive and educational playground made of recycled rubber that fosters children's curiosity and discovery process, guiding them through a dynamic maze where each room facilitate motor and cognitive skills development.



Figure 10 *Discovery Box* prototype exhibition, designed by (Omitted for blind-review)

a. From a material perspective, the product is a self-standing structure that leverages on rubber's flexibility. Made from a single sheet of rubber, it underscores the need for an easily foldable solution that features additional and removable elements to facilitate disposal.

b. The playground is a learning environment designed as a dynamic maze in which the children can move through each room to develop different motor and cognitive skills such as concentration, coordination, colour spectrum recognition and tactile experience.

Playspace (Figure 11) is an interactive separator designed to support children's role-playing activities. The product hosts six handy shelves, a bench, and a sliding blackboard.

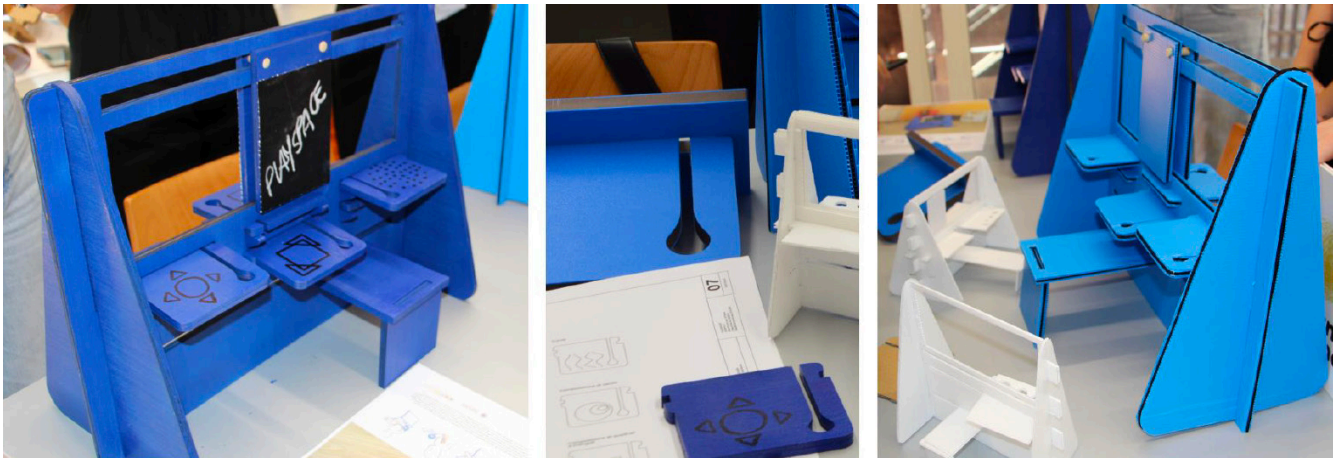

Figure 11 Exhibition of the final prototype and preliminary drafts of Playspace, designed by (Omitted for blindreview)

a. The material's resistance allows this solution to maintain its rigidity despite changing configurations. In addition, the material's degree of flexibility is exploited in the interlocking of the various pieces, which can be inserted, removed and interchanged by means of snap-in joints.

b. From an educational perspective, creating imaginary scenarios and narratives stemmed advanced understanding for the young participant in developing critical thinking on touching points of specific activities. In this sense, "crafting" their own narratives could ultimately help children to effectively communicate their understanding of real world and conveying them clearly to others participants.

Bouncy Bun (Fig.12) is a highchair designed for children aged 0 to 2 years, that accomplishes a double function turning itself into a rocker chair for two children.

a. The peculiarity of this stool are the joints characterised by a strong grip without the need of additional elements. Made entirely



Figure 12 Exhibition of the final prototype and preliminary drafts of *Bouncy Bun*, designed by (Omitted for blindreview)

from the same plastic panel, another feature that characterised this product is its reliability on material resistance and capability to be easily dismantled.

b. The use of this product by the child fosters creative development due to the change of activity defined by the position of the chair (which is done in total autonomy) and encourages sharing. Furthermore, the manipulation actions for changing orientation of the object (vertically for eating, and horizontally for playing) are formative for learning to distinguish the different phases of the day.

Tatami Kid (Fig.13) is a 'sensorial carpet' designed for children aged 03-12 months aimed to stimulate the child's motor skills, and to enhance tactile sensorial experience. This through an embossed surfaces and texturized weaves.

a. The flexibility of the material is fully exploited in this solution, where interlocking pieces are totally secured by passing bands into pre-cut carpet slots. The absence of fixed bands positions

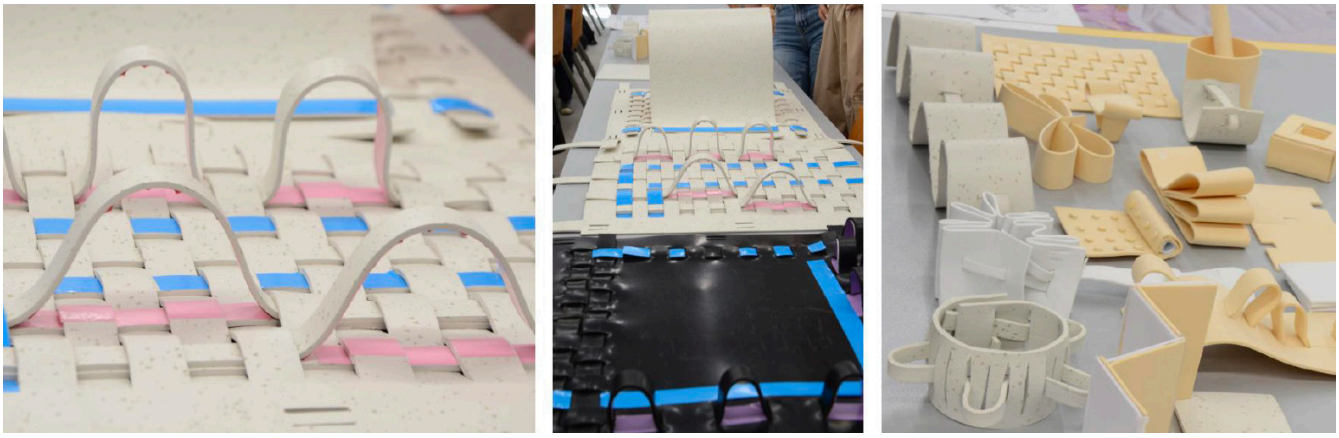

Figure 13 Exhibition of the final prototype and preliminary drafts of Tatami Kid, designed by (omitted for blindreview)

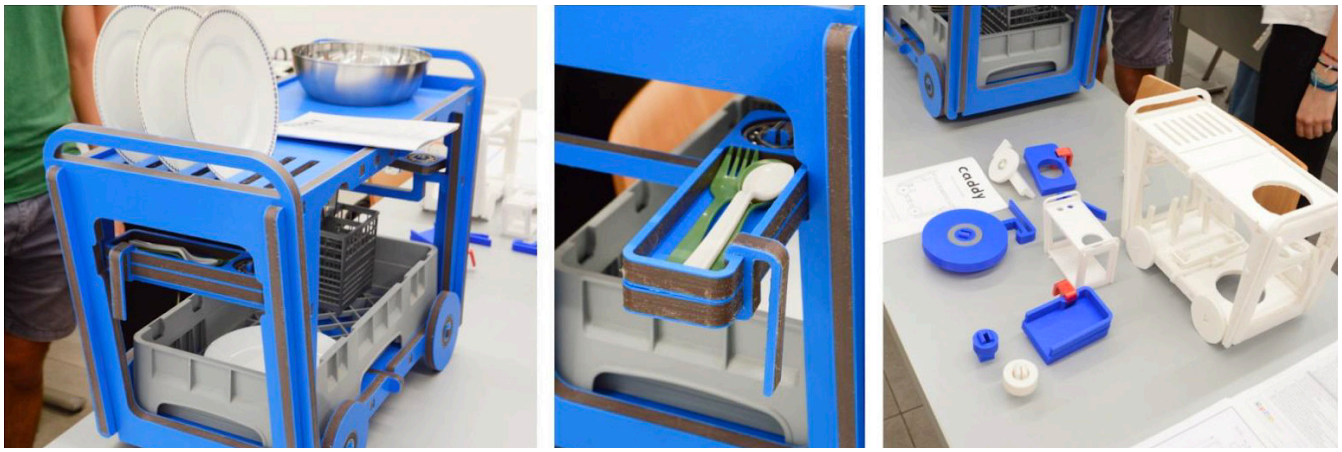

Figure 14 Exhibition of the final prototype and preliminary drafts of Caddy, designed by (Omitted for blindreview)

allows endless configurations and easy components replacement and disassembly.

b. The multiple support points support a child's weight, accompanying and not hindering natural development of fine and gross motor skills. In addition, the presence of different coloured areas encourages visual learning, creating a comprehensive sensory experience.

Caddy (Fig.14) is a multifunctional trolley intended for children from 24 to 36 months and designed according to the Montessori method, which aims at the child carrying out activities independently, in this case during mealtimes and their distribution.

a. This solution is ideated to be obtained from a single square metre of recycled polyethylene sheet. Each joint and mechanism have been designed to work without the need of additional glue or insert. The design is carefully studied to optimise material waste by strategically positioning the elements within the material, allowing for more than 4 trolleys to be placed in the same sheet (on the actual factory size of 150*300 cm).

b. The project aims to stimulate the child's autonomy by helping him or her to intuitively carry out activities related to the moments before and after meals. Moreover, each part of the trolley is designed to host specific elements and tools necessary for the activity (i.e. collecting dirty dishes at the end of meals, serving food, collecting stoves) while promoting the development of practical skills.

Sleepy Loop (Fig.15) is a foldable baby bed that takes full advantage of the flexibility characteristics of the rubber used: the lateral support curves keep the bed suspended, allowing for a peaceful rest in a comfortable position, the integrated cushion is positioned underneath the top band.

a. From a material and processing dimension, the bed structure is made from a single material, without any additional components, featuring a unique shaped hinge that securely locks the bed when place both in horizontally and vertically positions (preventing children to open it).

b. This project operates on a different level, considering both the child's need for safety and comfort during sleep and most importantly, considering the caregiver/ educator's need for flexible space to accommodate various activities according to schedules and guidelines.

Feo (Fig.16) is a folding cot designed to optimise space in nurseries. Each module can hold a standard-sized mattress (120*60*10 cm), allowing it to be used without the need to purchase custom-made mattresses.

a. From a material and processing dimension, the bed structure is made of a single material, without any additional insert, and hinges on a specifically shaped joint that ensure it when place both



Figure 15 Exhibition of the final prototype and preliminary drafts of Sleepy Loop, designed by (Omitted for blind-review)

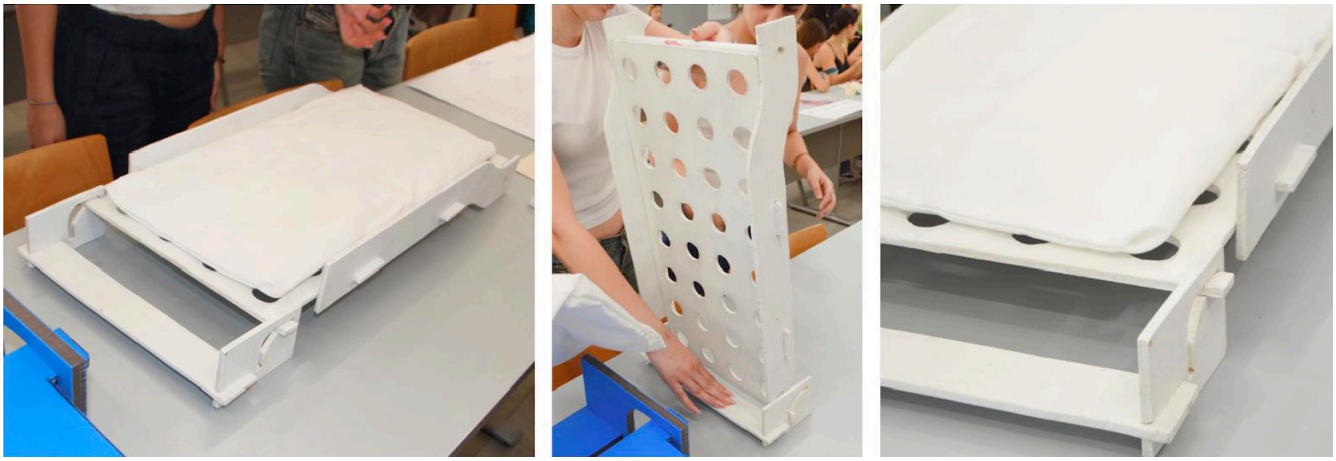

Figure 16 Exhibition of the final Feo prototype, designed by (Omitted for blind-review)

horizontally and vertically (hindering children to open it).

b. This project operates on a different level, considering both the perspective of the child user who sleeps on it and, most importantly, considering the needs of the caregiver/ educator who intervenes to ensure that the rest periods and activities are carried out according to schedule and guidelines.

Librello (Fig.17) is a book stool designed for the reception area of the kindergarten. The lower part serves as a bookcase, providing space for storing picture books, children's books and magazines, while the upper part consists of two seats at different heights to accommodate both child and adult.

a. The entire structure leverages on the material's tangential tension to create a selfsupporting, bended shape held in



Figure 17 Exhibition of the final Librello prototype and construction details, designed by (Omitted for blindreview)

position by a single rope. This design enables dual functionality: a multi-sized stool and a book holder thanks to flexible edge compartments.

b. The dual seating encourages shared reading experience between child and adult, while the shape stimulates the child's imagination and exploration. Through an easy access to books, possible thanks to the playful pick-up system, the visual stimulation and consecutive reasoning and action is further enhanced.

5. Assessing Design capabilities

From the analysis and the consideration stated so far, it is possible to retrieve a first picture of a potential trend of design outcomes when dealing with the two aforementioned dimensions of materiality and education. The insight gained throughout the design process has highlighted different design paths when designers are exposed to specific requirements. The findings suggest that sustainable design interventions can significantly impact sustainability outcomes, guiding designers towards more environmentally friendly solutions. Moreover, the research identifies different design dimensions, including educational and exploratory design for children, behavioural design, productive design, and efficient multi-user design. On the other hand, it is possible also to state that designers more readily identify peculiar insights on the behavioural level than on material one, demonstrating still a difficulty of design to overcome established production processes, if not by pushing it to a sort of limit for efficiency purposes.

These dimensions offer a comprehensive framework for analysing and implementing design solutions that cater diverse user needs and environmental aspects. The results and the process in-depths have revealed key considerations that the designer have embedded in their outcomes, leading to four distinct design approaches (Table 1):

· Design for educational and exploratory purposes, which also led the children to achieve and complete some activities independently (i.e., *Discovery Box, Playspace*)

· Design for behavioural development of user that learn and develop intellectual and sensorial skills (i.e., *Bouncy Bun, Tatami Kid*)

· Design for production that not only streamlines the process but also eliminates components that hinder disposal, like inserts or fittings: (i.e., *Caddy, Sleepy Loop*)

· Design for multi-user design that takes into strict account the different ergonomic scales of users in a context that brings together a diverse community: (i.e., *Feo, Librello*)

Project	RESULT	(a) Material		(b) Education	
Discovery Box	EDUCATION	Space saving	Tension structure	Exploring	Sensory training
Playspace		Tension structure	Easy disposal	Independence	Intellectual training
Bouncy Bun	BEHAVIOUR	Safe assembly	Single material	Sharing	Structured actions
Tatami Kid		Tension structure	Modular	Fine motor skill	Sensory training
Caddy	PRODUCTION	Production	Modular	Confidence	Structured actions
Sleepy Loop		Space saving	Single material	Autonomy	Sensory training
Feo	MULTIUSER	Space saving	Safe assembly	Multi-user	Structured actions
Librello		Tension structure	Easy disposal	Sharing	Structured actions

Table 1. The table shows the systematic analysis of the products resulting from the laboratory: each of them have been analysed by material and educational features. The results have highlighted four different design approaches that influenced their outcomes.

The laboratory structure provides valuable insights into what Design should consider when dealing with diverse stakeholders and the sustainability of a product. Firstly, designers must perceive the environment as a common ground for potential resources. Secondly, in the creative process, they should align the user's aims with the resource's capabilities to support the necessary activities and processes. This approach can reveal possible needs or future roles for users, allowing producers to anticipate applications for their solutions and explore new market opportunities. Additionally, the product should enable users to envision its future life, even when dismantled or repurposed.

These considerations help designers create an integrated set of actions aimed at achieving sustainable design. Throughout each phase of the process, diverse elements introduce valuable data, contributing to the practical application of materials in real-world contexts. To systematize this information, the following framework (Table 2) has been developed:

According to the laboratory results, the final stage of the Research in Design for sustainability involved a deeper analysis of the thematic patterns of the outcomes, as shown above. It has been recognized that the entire process, from the observation phase to the results, consistently reflected the needs and opportunities emerged, not only at first glance but also during subsequent experimentation phases. This approach provided valuable concepts, methods, and avenues for exploration within the study, guiding the initial direction for design experiments. While these insights significantly contribute to the Research, they are not the only factors influencing the design outcomes.

Indeed, the preliminary information obtained from interviews and on-site investigations was enhanced by detailed feedback and data collected during the testing phase. The involvement of the producer and the specific information explored by the design team highlighted potential alternative applications that could align with the concepts, even though the materials were not initially designed for those purposes. This ultimately confirmed the opportunities that Design could

Framework for Design' Sustainability	**ROLES**	**CONTEXT**	**PRODUCT**
ENVIRONMENT	*Objective*	*Need / potential*	*Envision*
RESOURCE	*Process*	*Application*	*Market*
DESIGN	Creative	Opportunity Making	**Integrated sustainability**

Table 2. Framework for Design' Sustainability

create new perspectives for all the main stakeholders involved. By the consideration outlined so far, the Research moved to a consolidation of a pattern of actions that has been structured as follows (Table 3):

Framework for Design' Sustainability	**ROLES**	**CONTEXT**	**PRODUCT**
EDUCATION	*Educational*	*Multi-stakeholder*	*Enhanced experience*
MATERIAL	*Productive*	*Decontextualized*	*New market opportunity*
DESIGN	Creative	Opportunity Making	**Integrated sustainability**

Table 3. Application of the Framework for Design' Sustainability to the results of the laboratory.

The project emphasised the integration of specific circular materials, highlighting tools and methods for sustainable product development. The research challenged designers to intervene in existing realities to benefit end-users, prioritising single material use, efficient production processes, and minimal material use while responding to the educational goals. Notably, a crucial factor was the constraints of the use of a sole provided material, recycled rubber or recycled polyethylene sheets, and embracing a circular design approach throughout the design process. Designers adhered strictly to single materiality, limiting components to those that demonstrably enhance sustainability. Additionally, they prioritised production efficiency and material use reduction, even by repurposing excess material into other product components. The findings highlight the design approach as an invaluable tool for understanding the direct and precise applicability of recycled material. Conversely, they also emphasise the necessity of the active and consistent stakeholders' involvement in the product's lifecycle to enhance sustainability. Users become the critical factor to assess a given material or product.

6. Conclusions

The Research presented in this paper offers a comprehensive exploration of the interplay between materials, education, and design within the context of sustainable product development. Design enables a holistic view of a process that involved stakeholders, service providers, and final users highlighting a pathway to bridge the gap between material limitations and application contexts through design. Through a process that strategically integrated diverse factors, from recycled materials to their application in a kindergarten setting, the study has identified key design dimensions and their impact on product sustainability offering viable integrated solutions.

The results highlight the importance of a holistic approach that considers both material properties and user needs. By aligning these factors, designers can create products that are not only environmentally friendly but also enhance, in this specific context, the learning and development of children.

The framework identified in this study offers a structured approach to integrating sustainability considerations throughout the entire design process. By understanding the complex interplay of roles, context, product, environment, and design, practitioners can make informed decisions to create more sustainable and user-aims products.

Further investigation is needed to explore the long-term impacts of these design approaches on both the environment and users. The framework proposed reveals some advancement in enhanced design methods, process development, and resource-efficient offerings, ultimately transforming material constraints into opportunities for innovation and sustainable design applications. Expanding the study to include a wider range of materials, product categories, and user groups would further enrich our understanding of sustainable design production. Ultimately, this Research contributes to the growing body of knowledge on sustainable product development by demonstrating the potential of design to drive positive change and the invaluable contribution the active involvement of different stakeholders plays in the construction of meaningful designs opportunities.

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TOWARDS A POST-ANTHROPOCENTRIC CREATIVE FRAMEWORK TO SUPPORT DESIGNERS IN ENVISIONING MORE-THAN-HUMAN FUTURES

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ABSTRACT | Climate change and rapid technological advancements are shaping an unstable and uncertain scenario, posing new questions for design (Mortati, 2022). These transformations challenge Western dualisms that separate humans from nature introducing the notion of nonhuman agency which fosters the development of new design frameworks (Forlano, 2017). Acknowledging human-nonhuman interdependencies (Quadflieg, 2021; Tironi et al., 2023) and a broader conception of life (zoe) that reconnects humans to nonhuman species (Braidotti, 2013) is crucial to make design the mediator between humans and nature. Post-anthropocentrism decenters the human subject to focus on ecologies and relationships (Yoo et al., 2023 as cited in Nicenboim et al., 2023), considers more-than-human perspectives to address planetary needs (Talgorn & Ullerup, 2023) and inevitably triggers reflections about designers' creativity. Creativity, a fluctuating concept shaped by the socio-cultural context (Runco, 2017; Bruno & Canina, 2019), is explored through a posthuman lens to identify the abilities that a new postanthropocentric type of creativity would entail (Roudavski & McCormack, 2016). Theoretical notions belonging to posthuman philosophy that intersect creativity research were critically reviewed and synthesized into the Post-anthropocentric Creative (PaC) Framework proposed in the paper. The PaC framework, indeed, systematizes existing knowledge, translating it into an actionable tool to help designers challenge the current anthropocentric paradigm by creating new narratives that promote careful action towards life on the planet. The framework will serve as a foundation for further research to investigate whether and how the employment of the PaC framework might enhance the design futures approach for envisioning preferable and morethan-human futures.

KEYWORDS | POST-ANTHROPOCENTRIC CREATIVITY, POSTHUMAN, MORE-THAN-HUMAN DESIGN, DESIGN FUTURES

1. Introduction

Amidst the ongoing climatic and technological transformations, an increasing degree of complexity and uncertainty is characterizing contemporaneity. On the one hand, digital technologies with their pervasive features have the potential to transform humankind (Schwab, 2017) and radically disrupt the competitive landscape (Zaki, 2019). On the other hand, and simultaneously, the climate crisis is rapidly becoming a global concern that raises important ethical questions regarding human exploitative behavior towards the planet. Anthropogenic transformations are indeed opening the way to dangerous modifications of the biosphere (Steffen et al., 2011) resulting in some of the so-called wicked problems (Rittel & Webber, 1973) namely biodiversity loss, water shortage, depletion of resources and climate change, which are worryingly threatening the ecosystem and endangering irreversibly life on the planet (Schmitz, 2015). Evidence suggests that, even though, throughout history, Earth has already witnessed drastic transformations that impacted the biosphere, human-induced effects are now putting at risk the planet's ability to sustain us and other species (Barnosky et al., 2012).

In this alarming scenario, mitigating measures are not sufficient anymore to deal with the contemporary climatic crisis. It is now evident that a prompt and collective response is necessary to shift from sustainability to regeneration and such a response needs to be supported by (i) new transformative strategies aimed at restoring social and ecological systems (Dolejšová et al., 2021); (ii) a radical shift in mindset to counteract the exploitative anthropocentric dominance (Camrass, 2020); and (iii) new frameworks to acknowledge humanenvironment interdependence (Camrass, 2020).

In this regard, through a design lens, the authors will retrace how Posthuman theories, a branch of contemporary philosophy, offer a valuable theoretical foundation to decenter the human subject in favor of a more ecological and relational understanding of

reality and humannonhuman *entaglements*. Posthuman theories frame a post-anthropocentric paradigm shift as the *conditio sine qua non* for the manifestation of our futures (Ferrando, 2016) highlighting the necessity to go beyond current human-centered perspectives to envision more-than-human futures. Within the design field, practitioners and researchers have been introducing posthuman principles through the emerging more-than-human approaches that account for the agencies of both living and technological nonhuman entities in shaping collective futures (Romani et al., 2022). Ultimately, discourses on post-anthropocentrism and posthuman theories fuel both new debates on creativity, contemplating a wider range of creative subjects and processes, as well as reflections on the abilities that a new post-anthropocentric type of design creative practice would entail (Canina et al., 2021; Roudavski & McCormack, 2016).

Building upon these considerations, the paper explores the key notions belonging to posthuman theories that could influence the design practice and integrates them into a framework to describe the features of a post-anthropocentric creative practice as well as the abilities necessary to envisioning more-than-human futures. The aim of the paper is to set the groundwork for further inquiry into the potential application and efficacy of such a Postanthropocentric Creative framework as a tool to anticipate future scenarios in which humans and nonhumans coexist and thrive.

2. From anthropocentrism to post-anthropocentrism. A posthuman theoretical groundwork

Extractive and destructive human interventions are rooted in anthropocentrism, a philosophical stance that advocates the intrinsic superiority of humans (Ferrando, 2016) with respect to other nonhuman species. Indeed, anthropocentrism considers humans as sole bearers of inherent value (Goralnik & Nelson, 2012) disregarding the nonhumans which can only be instrumentally worth to serve human needs (Ferrante & Sartori, 2016). Often, anthropocentric stances manifest in the ecological debate determining how humans should live in relation to the natural world (Goralnik & Nelson, 2012) in a utilitarian perspective. Anthropocentrism, in fact, emphasizes the “dualistic oppositions” that define what is human by what it is not (Braidotti, 2019b) and detaches nature from culture excluding interest for other species (Hayward, 1997). This binary conception of reality that overlooks the embeddedness of human beings within the ecosystem has now become anachronistic and risky for the sustainment of life on Earth.

Recently, several schools of thought and theories - among others Actor-Network Theory (Latour, 2004) and Object-Oriented Ontology (Morton, 2013) - have developed to criticize anthropocentrism and the deeply-rooted distinction between humans and nonhumans – which can include animals, plants, micro-organisms, climatic systems,

ecosystems, or technologies (Grusin, 2015, p. 7). The critique towards the central role of humans is laying the groundwork for a "post-anthropocentric turn" (Ferrando, 2016, p. 159) essential to modify the traditional humancentered conception of the world and enable humans to acknowledge their inherent entanglement with other nonhuman systems.

Within her Critical Posthumanities, Braidotti (2019a) frames the posthuman predicament at the convergence of posthumanism and post-anthropocentrism stressing that the former criticizes the humanistic ideal of the 'Man', while the latter questions human exceptionalism and species hierarchy (Braidotti, 2019a). Thus, the posthuman concept blurs the symbolic borders that traditionally define the notion of human by challenging dualisms such as human/animal, human/machine that separate humans from nonhumans (Ferrando, 2020).

In Braidotti's view, post-anthropocentrism calls for the redefinition of contemporary subjectivity as an assemblage of both human and nonhuman agents. Critical Posthumanities propose a new notion of the human subject as relationally constructed by many actors and agencies and that thus is inherently "decentered" (Nicenboim et al., 2023). In addition, Braidotti (2013) also introduces a wider conception of *life* (zoe) that she describes as "the transversal force that cuts across and reconnects previously segregated species, categories and domains" (p. 60). In her work, the notion of "zoe-centered egalitarianism" poses the idea that *life* - as a quality equally shared among humans and nonhumans - is the essential foundation for a radical new postanthropocentric meaning of reality. In fact, the nature-culture continuum is to be considered the starting point for a posthuman interpretation of reality (Braidotti, 2013). Furthermore, as Braidotti (2019) highlights, Critical Posthumanities offer a horizon of becoming, they reveal that "we" - as subjects structurally related to the human and non-human world around us – are in the process of becoming posthumanist and post-anthropocentric: we are in a transition moment. In this context, as Bridle (2023) notes, the concept of more-than-human world suggests that we, as humans, are only a small part of something that is vastly bigger that becomes and transforms with everything else that surrounds us.

"All human life and being is inextricably entangled with and suffused by everything else. This broad commonwealth includes every inhabitant of the biosphere: the animals, plants, fungi, bacteria and viruses. It includes the rivers, seas, winds, stones and clouds that support, shake and shadow us. These animate forces, these companions on the great adventure of time and becoming, have much to teach us and have already taught us a great deal. We are who we are because of them, and we cannot live without them."

(BRIDLE, 2023, P. 37)

This transition to become post-anthropocentric requires new ways of being, thus of thinking and doing. It is clear, therefore, that posthuman theories have an impact on the way we design. And since design is about imaginatively shaping the future (Taylor, 2019), these emergent theories might radically reframe the way in which designers employ creativity to envision and give shape possible futures for human-nonhuman thriving.

2.1 Post-anthropocentrism meets design: the question of creativity

Since they disruptively question traditional human-centered norms, posthuman theories and post-anthropocentric stances have a notable influence on the design field in which, indeed, they have been fostering the development of new design frameworks (Forlano, 2017) that account for human-nonhuman interdependencies (Quadflieg, 2021; Tironi et al., 2023). By decentering the subject and shifting the attention from being exclusively on humans to considering also other living species, posthumanism could turn design into the mediator between human and nonhuman worlds through the inclusion of more-than-human perspectives and the consideration of planetary needs (Talgorn & Ullerup, 2023).

As a matter of fact, alternative design approaches are now emerging to move beyond the dominant anthropocentric perspective and promote new forms of engagement with the otherthan-human world. These endeavors highlight a growing interest in understanding the relations between human and nonhuman agencies as well as the new possibilities that arise from human-nonhuman collaboration (Giaccardi & Redström, 2020). The nonhuman element in design can refer to either technology or the natural biological entities. On the one hand, for instance, more-than-human design gained momentum within the Human-Computer Interaction (HCI) field and calls for the involvement of the artificial world and new technologies as design partners (Giaccardi, 2020). On the other hand, other approaches to more-than-human design are focused on engaging the natural world and biological entities. They include - but are not limited to - multispecies design (Metcalfe, 2023; Roudavski, 2020), interspecies design (Parker et al., 2022; Roudavski, 2021) or life-centered design (Borthwick et al., 2022). Further collaborative approaches to design are either becoming popular or developing - such as speculative design and design futures – to explore the potential of future scenarios to enhance human-nonhuman coexistence (Romani et al., 2022). All these approaches are being theorized, studied, and applied in academic and professional settings. Some of them are more structured and have longer history while others have been sprouting as a response to theoretical discourses and gaining relevance in the last few years as experiments to practically apply post-anthropocentric tenets to design. These emerging approaches are surely valuable attempts to evolve design practice and enable it to tackle planetary challenges. Even though they all highlight the

necessity for designers to radically change their mindsets to achieve a post-anthropocentric paradigm turn in their practice, these approaches do not explore what such a new post-anthropocentric mindset might be and *how* it might be developed and nurtured. Today, the notion of human impact on the planet has soaked in discourses on design and designers are increasingly becoming more aware of the negative consequences their practice can generate. So, in this scenario, as Engholm (2023) writes:

"We do not need any more knowledge about the consequences of our actions – what we need is the new mindset that this knowledge ought to produce."

(ENGHOLM, 2023, P. 63)

But what is it that needs to change in the mindset of designers in order to disrupt their humancentered perspective and make them the enablers of preferable futures for both humans and nonhumans?

In this discourse, the question of creativity is relevant because post-anthropocentrism - besides providing a radically new theoretical groundwork to rethink design practice - inevitably triggers reflections about the creativity that designers employ as well as the agents, processes, and receivers that a new post-anthropocentric type of creativity would entail (Roudavski & McCormack, 2016).

To be creative is a necessity in contemporary ever-changing world (Glăveanu & Kaufman, 2019). As a matter of fact, creativity plays a major role not only for people to manage complexity and uncertainty but also for creators to face the multiplicity of futures (Canina et al., 2021). Indeed, humans are capable of exploring the realm of the possible through the act of creatively imagining and anticipating alternative futures and by doing so they become more resilient and prone to adapt to the ever-changing environment surrounding them (Glăveanu, 2018). Creativity itself is acknowledged to be a fluctuating concept that changes and adapts according to the socio-cultural context (Runco, 2017) and, therefore, as noted by Glăveanu and Kaufman (2019), it needs to be investigated historically, considering that the world's continuous process of transformation determines the evolution of its definition too (Bruno & Canina, 2019). However, albeit the latest diffusion of posthuman theories and new understandings of creativity that account for its dynamic, future-oriented (Corazza, 2016) and transformative (Sternberg, 2021) features, nonhuman agencies and multispecies interdependence are still little explored within the debates on creativity which represents a gap to be filled to tackle the contemporary complexities and acknowledge more-than-human ecologies (Rousell et al., 2022).

A post-humanizing creativity would give us the opportunity to creatively navigate current technological and environmental transformations and help us "become" in relation to those changes (Chappell, 2022).

Post-anthropocentrism, indeed, questions the traditional conception of creativity and lays the foundation for a new understanding of creative action. In a posthuman perspective, human and nonhuman entities are connected through a relational creative interdependence and creativity facilitates the understanding of such a relationality (Haraway, 2019 as cited by Harris & Holman Jones, 2022). Therefore, it can be stated that a posthuman conception of creativity would arguably enable radical changes in how humans acknowledge their embeddedness within the ecosystem and their entanglement with the nonhuman natural world. A post-anthropocentric understanding of creativity might provide designers with a new framework to account for human-environment interdependence, something that – as mentioned previously – would be necessary to tackle contemporary climatic emergency (Camrass, 2020).

Elaborating on this, therefore, the authors argue that defining a new post-anthropocentric framework for creative practice represents an essential building block to enable a radical shift in mindset urging designers to think out of traditional binaries separating nature from culture and envision potential trajectories for more-than-human futures.

3. Post-anthropocentric Creative Framework

As argued above, in a contemporary scenario marked by the unstoppable environmental crisis and in which posthuman theories are permeating, a new type of creative practice aimed at envisioning more-than-human futures would be key in leading us through the process of becoming posthumanist and post-anthropocentric. How can posthuman theories be used as a lens to interpret creativity and creative practice?

To date, desk research has been performed to uncover the overlaps between studies on creativity and posthuman theories and start outlining the features of a post-anthropocentric creative framework to empower designers' visioning activities.

In particular, to scrutinize existing research on creativity and post-anthropocentrism, critical literature review - as a method to identify the key concepts that underpin the theme under discussion on a theoretical standpoint (Garrod, 2023) - appeared to be suitable for the purpose. The Elsevier-based database Scopus as well as Mendeley and Web of Science were used to search for relevant articles through title and abstract screening. The search query included a fixed term (*creativity*) preceded by an interchangeable adjective, which could vary among *post-anthropocentric, more-than-human, posthuman* or *post-human*.

Interestingly, in most cases, a keyword or a set of keywords used on different platforms would provide as results the same publications. Eventually, thirteen articles from different disciplinary areas were selected and analyzed. Two Special Issues collect most of the articles, indicating that research on the topic is still little explored and conducted by few scholars but also highlighting its relevance. Ultimately, a book was included in the literature review (Bridle, 2023).

The richest body of literature that investigates posthumanism, post-anthropocentrism and creativity appears to belong to the field of Education. However, inquiry on posthuman creativity has gained momentum in art-based research (Harris & Rousell, 2022) and it is starting to be explored within design research (Canina et al, 2021; Roudavski, 2016; Roudavski & McCormack, 2016).
The grounding set of articles introduced above was essential to get acquainted with already ongoing research on the topic of post-anthropocentric creativity and identify the key notions that underpin the theory behind it as well as those abilities or attitudes that it would require. As a matter of fact, by comparing exemplars included in this initial body of literature, authors were able to extract the recurrent notions that almost every article reiterates as essential and pose them as building blocks for the development of the framework. For instance, most of the articles analyzed highlighted the centrality of nurturing feeling to establish a deeper connection with the nonhuman world.

Therefore, in the framework, the concept of understanding the nonhuman world through feeling to encourage a deep sentiment of care for it occupies a pivotal role for steering post-anthropocentric creative action.
Reflections conducted by the authors starting from the critical review of selected literature led to the synthesis of findings into the first theorization of the **Post-anthropocentric Creative (PaC) Framework** (fig. 1).

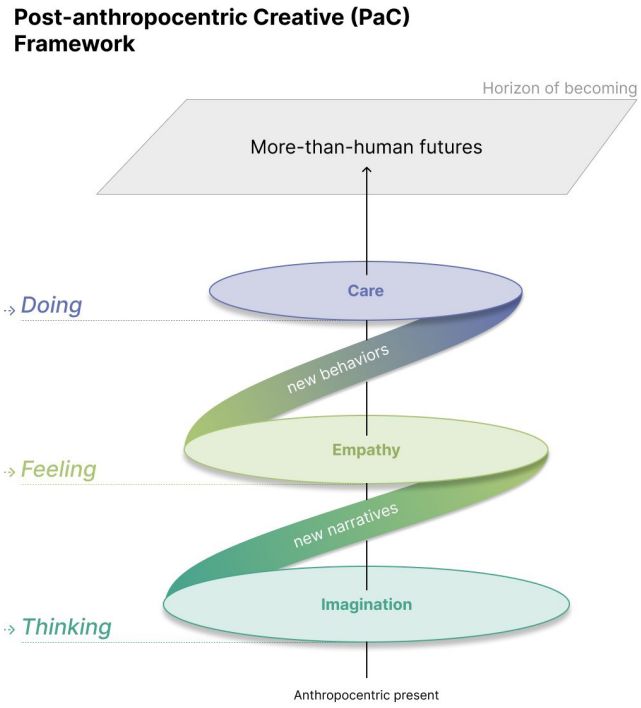

Figure 1. The Post-anthropocentric Creative (PaC) Framework. Visualization developed by the authors.

As anticipated, the framework seeks to systematize the main overlapping notions pertaining to post-anthropocentrism, the posthuman and creativity that emerged from the critical literature review. From the analysis of the literary corpus, indeed, it emerged that practices of thinkingfeeling-living in

relation with the more-than-human plurality might generate a new type of creativity that is posthuman and that has planetary scope (Harris & Rousell, 2022). The PaC framework, therefore, is grounded on a *thinking-feeling-doing continuum* that represents the three stages of a post-anthropocentric creative process. By delineating these stages, the framework traces a potential trajectory for the actualization of a post-anthropocentric paradigm shift, emphasizing the importance of imagination, empathy, and care as essential creative capabilities for envisioning more-than-human futures. Imagination (*thinking*), indeed, can facilitate the creation of new narratives that transcend anthropocentric perspectives, fostering empathy (*feeling*) towards the more-than-human world. Empathy is then consolidated into a deep sentiment of care, which informs responsible future-oriented actions (*doing*). Once the main concepts were uncovered and mapped, an additional literature review based on snowballing (Wohlin, 2014) was then conducted to expand the initial corpus with other resources to especially explore in depth imagination, empathy and care.

As emerged from the critical analysis of the literature, a posthuman perspective on creativity compels research to shift focus from *what* is created to *how* enmeshed actants create (Chappell, 2022) directing attention more towards the creative process rather than on its output. Indeed, to reframe creativity through a posthuman lens it is necessary to move away from the traditional use-value paradigm that privileges productivity over planetary wellbeing (Harris & Holman Jones, 2022; Rousell et al., 2022) and conceive it as a dispersed process that is not centralized on the human subject alone but that includes nonhumans - such as objects and environments - as embodied, agentic and enmeshed actants (Chappell, 2018, p. 14) which, together with humans, constitute creative ecologies (Harris & Holman Jones, 2022).

Therefore, the cognitive acknowledgement of human inherent interdependence with the morethan-human world and of the agency of nonhuman entities can be interpreted as the first stage of a post-anthropocentric creative process: ***thinking***. In this stage of the process, **imagination** is perhaps the most relevant of creative abilities essential to challenge traditional dualisms and mobilize our binary thinking that frames humans as separated from nature. As a matter of fact, imagination allows us to construct mental images of what is not immediately present at our senses (Gotlieb et al., 2019; Milkoreit, 2017). Thus, it can become the connective, bordercrossing capacity to bridge the gap between the human and more-than-human worlds by enabling humans to cognitively perceive perspectives beyond themselves (Jensen, 2016) and reconsider their position with respect to other nonhuman entities.

Hence, in the discourse on reframing creativity through a post-anthropocentric lens, imagination should be seen as a boost for the creative process since it represents an essential ability for humans to mentally

embody the perspective of other beings. "Stepping into the shoes" of others could help us reduce the space that separate us from otherness and feel more connected to the more-than-human world.

As a matter of fact, as humans, we intra-act and relate with the nonhuman world (Chappell, 2018), we are deeply bounded to it. Relational encounters between humans and nonhumans are embodied and empathic felt experiences (Vagg, 2022). The state of being in-relation-with otherness - known as *relationality* (Haraway, 2019 as cited by Harris & Holman-Jones, 2022) - presupposes that we recognize to be affected by and connected to other nonhuman entities. What constitutes our relationality with otherness is, indeed, *affect*, namely our ability to transform and be transformed by what surrounds us (Massumi, 1987 as cited in Shouse, 2005). Therefore, to reconcile ourselves with the more-than-human world, to fully understand it and to feel responsible for its well-being, we need to embrace the notion that we are relationally and affectively interconnected and interdependent to it, we need to perceive our belonging to it and its power to shape us. When we open ourselves to understanding the more-than-human, we breach the established borders of thought and feeling which in turn allows us to perceive reality from another perspective (Bridle, 2023, p. 118). As a matter of fact, thinking and feeling are coconstituting, the former being imbued by affectivity that emerges from relational encounters with the more-than-human world (Rousell et al., 2022). Hence, ***feeling*** our connection to the more-than-human world, sensing our relationality with it, represents the second fundamental stage of a post-anthropocentric creative process. Such an *understanding-through-feeling* of the more-than-human world requires **empathy**, an act of imagination to come to know otherness and an emotive pathway towards a deeper understanding of our connection to it (Jensen, 2016). Empathy is stimulated by the perception, comprehension and attention for the experiences and perspectives of other living beings (Tam, 2013; Young et al., 2018). It is acknowledged to be an essential disposition to restore human-nature entanglement and drive transformation towards more equitable futures (Blythe et al., 2021). A post-anthropocentric conception of creativity, therefore, should leverage empathy as an ability to emotionally reconnect us to the more-thanhuman world helping us *feel* our strong ties to it.

As *thinking* and *feeling* are strongly linked and the boundaries between the two are blurred, so imagination and empathy – namely the main abilities that characterize the two initial stages of the post-anthropocentric creative process - are connected to one another.

Empathy is, indeed, enabled by imagination (Jensen, 2016) which, as mentioned, is the propelling force that initiates the post-anthropocentric creative process. Through imagination we can question current narratives, rooted in the binary worldview of humans-versus-nature, and build emotive pathways to understanding

otherness through stories (Jensen, 2016). As products of imagination, narratives mirror our interpretation of reality and have concrete implications on the world we build (Leitão, 2023). In fact, through stories and creative storytelling we can make and remake worlds (D. Harris & Holman Jones, 2022). With an acquired sensitivity towards the current climatic crisis and awareness regarding the posthuman condition, we could stimulate empathy towards the planet and its nonhuman inhabitants by employing imagination to rewrite anthropocentric narratives and chart a path towards morethan-human futures inspiring action to make them possible. Therefore, *thinking* and *feeling*, with their respective imaginative and empathic abilities, lead to the final stage of the post-anthropocentric creative process: ***doing***. As noted by Milkoreit (2017), imagination – enabled by individual cognitive-emotional processes – allows us, first, to create mental images of the future and experience the emotions of the characters involved, and then, once some emotionally coherent future visions are created and collectively embraced, it has the power to impact the socio-political level, steer action in the present and modify existing norms of behavior (Camrass, 2020).

When new narratives are imagined and empathy for their "characters" is felt, **care** – the conscious sentiment of interest and concern for others – is likely to form. Care is vital for sustainable and flourishing relations with the more-than-human world because it requires us to do something, to act, to make it livable for all (Puig de la Bellacasa, 2017). Once the sentiment of care is consolidated, then designers are fully equipped to start engaging in visioning activities to anticipate more-than-human futures.

4. Conclusions

The paper aims at laying the theoretical foundations for a post-anthropocentric conception of creative practice that might enable designers in envisioning futures where humans and nonhumans coexist prosperously. Such a new type of creative practice is concretized in the making of stories depicting images of possible futures that disrupt the way in which we conceive our relations with the more-than-human world. The Post-anthropocentric Creative framework presented in this paper identifies imagination as the seed of the creative process. Imagination sparks in our flow of thinking when our previous way of relating to reality or others is questioned allowing us to move away from the here and now to explore alternative possible futures (Zittoun & Cerchia, 2013). Indeed, being a transformative capacity, imagination is key in crafting scenes of the future (Moore & Milkoreit, 2020). Leveraging on imagination, a post-anthropocentric creative practice is grounded in the creation of new narratives that could counteract traditional anthropocentric paradigms through the enhancement of feeling for the living nonhuman beings. Indeed, narratives have the power to strengthen our emotional

bond with nonhuman entities by fostering empathy, essential to reconnect humans and nature and promote pro-environmental action (Brown et al., 2019). In the design field, creative storytelling has proven to be key in enhancing our feeling of relatedness with what surrounds us and in stimulating future action (Talgorn & Ullerup, 2023). Hopefully, the alternative visions of future coexistence enabled by the PaC framework would make us feel entangled with the more-than-human world by fostering a feeling of care towards it which would steer our actions into making these futures possible. The framework will serve as a foundation for further research to investigate whether and how the employment of the PaC framework might enhance the design futures approach for envisioning preferable and more-than-human futures.

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A STUDY OF MULTISENSORY STRESS-RELIEVING PRODUCT DESIGN FOR FEMALE OFFICE WORKERS

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ABSTRACT | It analyzes the design of a stress-reducing product for female office workers, who are generally under too much stress. The study analyzes and translates user needs and design elements through questionnaires and user interviews, exploring the multisensory needs of female office workers to relieve stress. Based on the Analytic Hierarchy Process, the study prioritizes the design elements and derives the final design solution for office ladies' stressrelieving products, verifying the scientific feasibility and reference significance of the multisensory design based on AHP in the stress-relieving product design. Analytic Hierarchy Process application avoids the subjectivity and one-sidedness of the design process when considering the priority of the user's multi-sense experience, identifying the core design elements and design objectives of the stress-relieving products. The design of an intelligent stress-reducing luminaire is used as an example to test the applicability of this design method and strategy, and it also provides a reference for similar design studies.

KEYWORDS | ANALYTIC HIERARCHY PROCESS(AHP), STRESS-RELIEVING PRODUCTS, MULTISENSORY DESIGN; FEMALE OFFICE WORKER

1. Introduction

Office workers, as an essential part of the middle class, are the backbone of social development and the driving force behind economic growth. Therefore, their health conditions should receive more social attention. Research has shown that over 50% of office workers are in a state of depression, and 78% are in a sub-optimal health condition. Due to physiological factors, office ladies are more prone to emotional fluctuations when faced with pressure, leading to anxiety, worry, irritability, and other emotional reactions (Dennerstein, Smith & Morse, 1994). The severe stress issues among office ladies have become a significant hidden danger to the development of societal well-being. Assisting office ladies in relieving stress and maintaining physical and mental health is of significant practical value.

2. Research background

2.1 Nature and causes of stress

Stress is the cognitive and behavioral experience resulting from the interaction between stressors and stress responses. During the alert stage, external stressors trigger a series of physiological reactions within the body. Once these stimuli persist and enter the resistance stage, corresponding organs and systems are mobilized to cope with these stressors. If the stimuli continue to persist, the body eventually experiences exhaustion. Adaptation mechanisms that arise during the resistance stage face two possible outcomes: one is returning to the later stage of the alert stage, where other systems or organs are mobilized to cope with the stressors; the other is leading to the failure and exhaustion of the individual's bodily functions, ultimately resulting in death (see Figure 1).

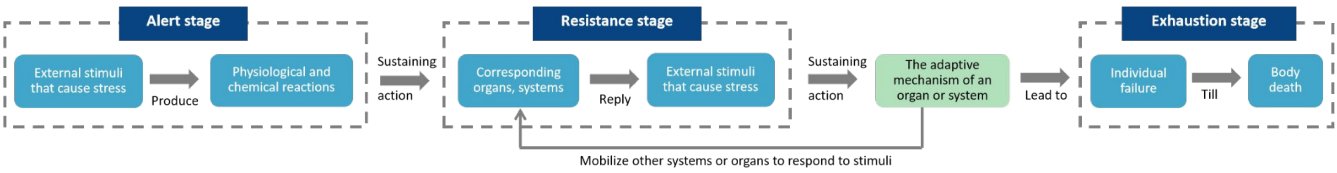

Figure 1.The diagram of the physiological response to stress.

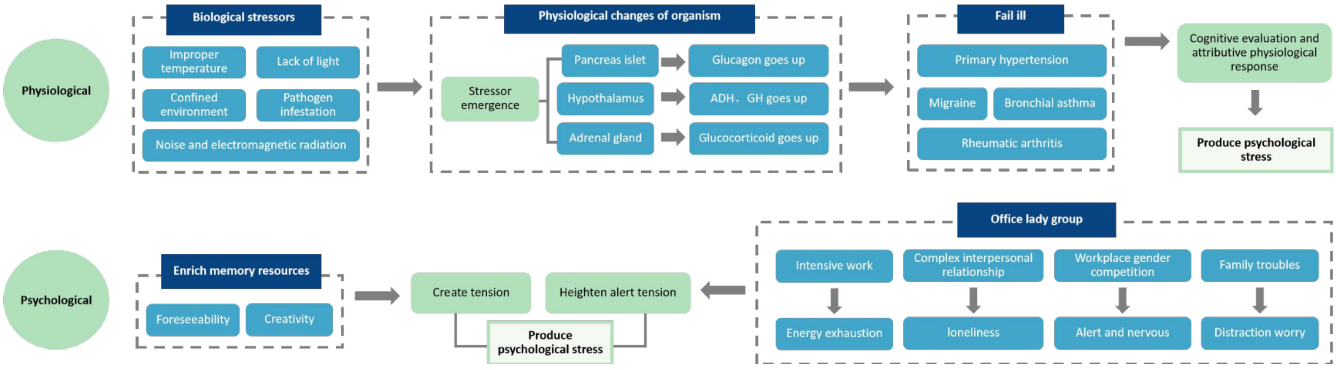

Figure 2. The flow chart of the physical and mental stress generation of female office workers.

2.2 Female office workers' stress and their stress characteristics

Intense stressors put office ladies in a prolonged state of high pressure, resulting in a significantly elevated psychological burden. The manifestations of stress and its effects on office ladies are primarily observed in physiological and psychological aspects (see Figure 2). Physiologically, stress is generated in unsuitable temperatures, enclosed environments, noise, and electromagnetic radiation. Biological stressors interact with the human body, leading to physiological changes. The appearance of stressors triggers an increase in hormones, causing conditions such as hypertension, migraines, arthritis, asthma, and other psychosomatic disorders, thus posing a threat to physical health and creating physiological stress. Simultaneously, individuals cognitively perceive and attribute the previous physiological reactions (Clougherty, Souza, K & Cullen, 2010) , forming psychological stress.

2.3 Current status of stress-relieving products

A comparative study of stress reduction products available on the market shows that there is currently a wide variety of stress reduction products (Jieling & Phungamdee, 2023), mainly categorized into three types: toy and puzzle-based products, training-based products, and impact and venting-based products. Most toy and puzzle-based stress reduction products combine elements such as Rubik's cubes and various hand movements to challenge users' cognitive abilities and achieve a calming effect (Clark , 2017). Examples include wireless fingertip-flipping cubes and puzzle gyro beans. Training-based stress reduction products often involve training specific bodily functions, such as ROM finger trainers and self-starting wrist power balls, which employ simple repetitive movements to reduce stress.

However, these products are generally only suitable for users during their leisure time and have limited long-term stress reduction effects. Impact and venting-based stress reduction products aim to outlet users' anger and frustration through squeezing and kneading actions, exemplified by products like screaming chickens. Although they offer a temporary release of stress through a direct and forceful approach, they do not address the underlying sources of stress. Overall, while stress reduction has gained broad attention in product design, there is still a research gap in the development of stress reduction products specifically tailored to the needs of women. Therefore, this study focuses on developing stress reduction designs specifically targeting office ladies

3. Research method and design process

3.1 Multisensory experiences and stress-relieving products

The 'multi-senses' typically refer to the human perception of the surrounding environment and objects through sight, hearing, smell, taste, and touch, consciously observing, analyzing, processing, and providing behavioral feedback through various senses (Mehraliyev, Kirilenko, & Choi, 2020). Excellent 'five senses' experience design, through information integration and processing, assists users in achieving a higher level of rational information construction in sensory experiences (Spence, C. 2011).

The multisensory experiences forms the foundation of a user-centric design mindset, with sensory experience at its core (AbuKhousa, El-Tahawy & Atif, 2023). It involves the dual perception of physiological and psychological senses, receiving, perceiving, and processing information. In the 1970s, Ayresa proposed the sensory integration theory, which elucidated the inseparable relationship between human sensory perception, brain function, and psychology.

As the fundamental means by which people capture, receive, and process information, applying the multisensory experiences to stress reduction product design can deeply satisfy users' sensory experiential needs and thereby achieve stress reduction effects (see Figure 3).

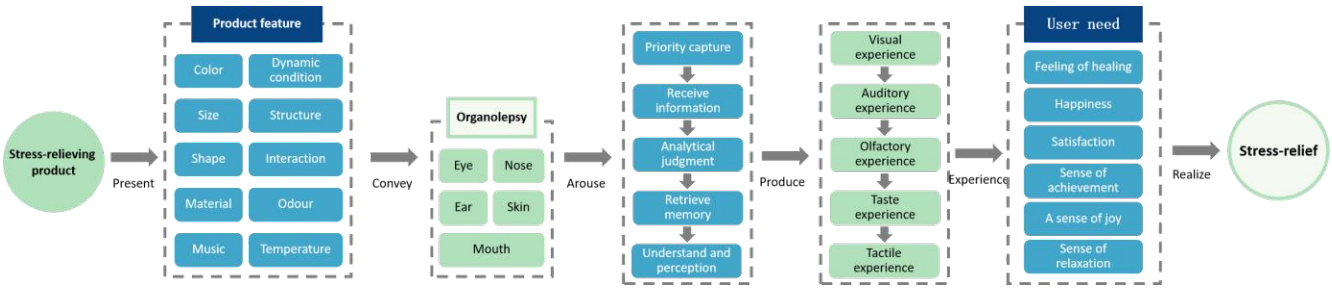

Figure3. The flow chart of multisensory experiences to achieve stress reduction effect.

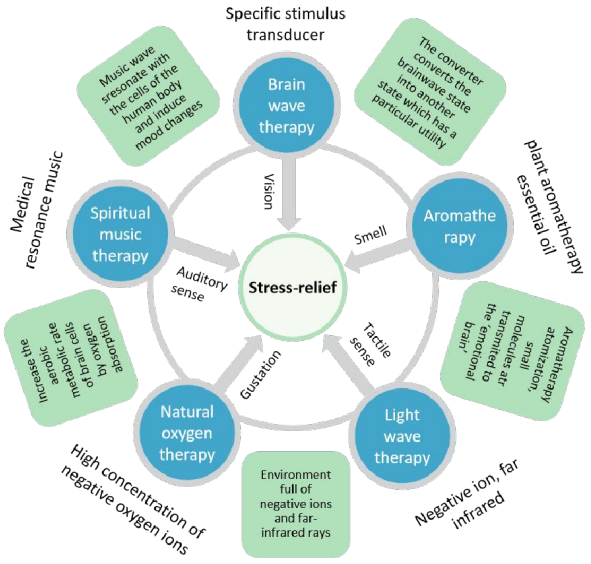

Figure4. The analysis of stress reduction therapy based on multisensory experiences.

By analyzing scientific therapies with stress-reducing effects, a series of scientifically based stress-reducing methods based on the five-sense experiences were compiled (see Figure 4). Key elements were identified, including specific stimulus converters, three-dimensional spatiotemporal dynamic structured medical resonance music, aromatherapy with plant essential oils, highconcentration negative oxygen ions, and far-infrared radiation(Didi & Yanmei, 2021). A critical behavioral analysis was also conducted to understand the realization of stress-reducing effects. These findings provide valuable inspiration and guidance for designing and researching stressreducing products.

3.2 Multisensory experiences and stress-relieving products

The Analytic Hierarchy Process (AHP) is a practical and effective multi-criteria decision-making method that quantifies and processes subjective judgments of individuals. By combining qualitative, subjective descriptions with quantitative objective comparisons, AHP systematically analyzes samples based on mathematical models. When analyzing and making decisions about complex problems, AHP can effectively avoid the subjective bias caused by changing demands.

The factors influencing the five-sense experiences are complex and diverse, making AHP suitable for comparative analysis of multiple factors under complex conditions (Horng & Hsu, 2020). To obtain precise user sensory needs, the five-sense experiences - AHP method (see Figure 5) is employed to qualitatively and quantitatively investigate and analyze the target group. This approach explores the core pain points and sensory needs of office ladies facing stress, analyzes important factors, calculates the weights of influencing factors, and presents scientific results in order of importance.

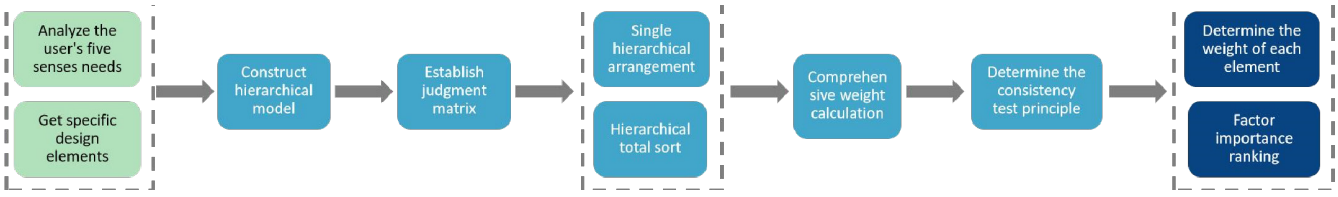

Figure5. The application process of multisensory experiences - AHP.

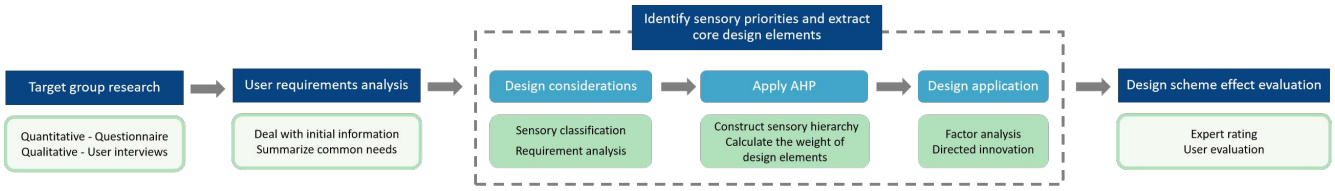

Figure6. The multisensory experiences design flowchart of female office worker' stress reduction products based on AHP.

3.3 Analysis of the design process of efficient and stress-relieving product design for female office workers

The design innovation of stress-reducing products targeting office women is achieved by introducing the Analytic Hierarchy Process (AHP) to determine sensory priorities and extract core design elements, thereby achieving the goal of stress reduction. Firstly, an analysis of the target users is conducted to understand office ladies' overall needs and design elements. This information is then combined with the AHP method to construct a hierarchical model and calculate the target weights of the design elements. Finally, the results are filtered, ranked, and analyzed to enhance design efficiency and user satisfaction. This process ensures that the design of stressreducing products for office ladies is focused on the most essential sensory aspects, providing an effective solution for stress reduction while improving (see Figure 6).

1. Through user interviews and surveys, a quantitative and qualitative investigation of the target group's sensory needs is conducted, summarizing the expected directions and attributes of stress-reducing products for office ladies;

2. In-depth analysis of the research results helps designers accurately capture the target group's implicit needs and underlying motivations, which are then transformed into design requirements;

3. The user needs are further categorized and summarized to perform a qualitative analysis of design requirements, determining the multisensory experience design elements and design directions;

4. Based on the AHP method, the sensory needs of the target group are transformed into a hierarchical structure model, and mathematical methods are used to quantify the design elements based on the established judgment matrix, further clarifying the design objectives;

5. The comprehensive weights of all design elements are ranked and selected, analyzing and understanding each element to derive and determine design solutions;

6. A professional assessment of the final design solutions is conducted. Objective quantitative data is obtained through relevant stress testing to assess the stressrelieving effectiveness of the product. Subjective qualitative evaluations are gathered through expert ratings and user feedback after using the product to validate the scientific effectiveness of the proposed solution;

4. Design process

4.1 User research

To obtain precise user sensory needs using the AHP method, the initial step involves analyzing and researching the target user group, which is achieved by combining quantitative research through questionnaire surveys with qualitative research through user interviews. The research aims to identify the core pain points associated with stress among office women, specifically focusing on the five-sense experiences. A detailed analysis is also conducted to determine the relatively important factors involved (see Figure 7).

To understand the market satisfaction of the target office women group regarding stress-relieving products, Net Promoter Score (NPS) and research questionnaires are used to explore their satisfaction levels with product types, styles, and performance. To ensure a higher level of accuracy, 100 questionnaires are distributed in office buildings, business district cafes, and residential areas. 72, 78, and 66 valid questionnaires were collected from these locations, respectively.

Thirty representative users were selected from the initial research participants, who are office ladies, for in-depth user interviews. The interviews aim to gather preliminary information about the target group's needs by recording the insights shared by the interviewees. This process helps designers identify unknown issues, capture implicit needs, and uncover underlying motivations. Similar or synonymous information is integrated and refined through categorization and stigmatization, leading to the analysis and transformation of these insights into design requirements.

4.2 Analysis of research results

The collected valid questionnaires are organized and analyzed. The Net Promoter Score indicates that the target group's satisfaction with stress-relief products in the market is relatively low. Over threequarters of the respondents have high expectations for stress-relief products, with 91.2% expressing anticipation for incorporating the five-sense experiences into stress-relief products. Through systematic analysis from a design

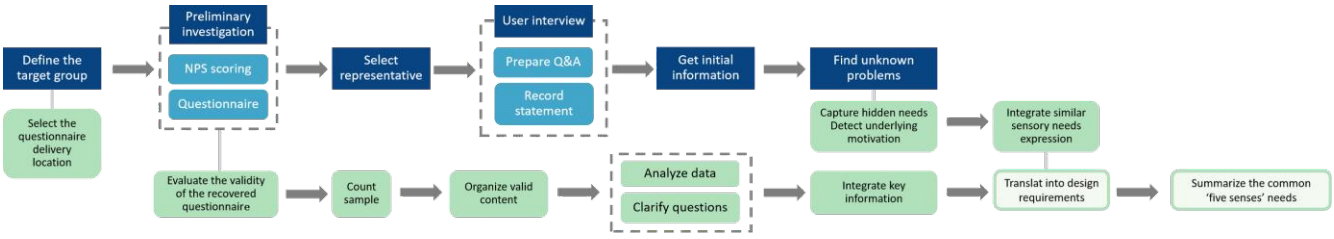

Figure7. The flow chart of the need analysis of user research and multisensory experiences design.

perspective, the valid information conveyed through questionnaire surveys and user interviews is classified, organized, and refined. The analysis identifies users' motivations and ambiguous needs by considering relevant design elements and transforming their language into a concrete overview of user requirements. The sensory factors that influence the stress-relief experience of office ladies are summarized and categorized based on the five-sense experiences. Additionally, the affinity diagram method is used to hierarchically classify the types of five-sense experiences needs and product attributes for office women, completing the qualitative analysis of their requirements.

4.3 Design evaluation grade index weight calculation

Based on the research results above, the leading indicators of the five-sense experiences include visual, auditory, olfactory, gustatory, and tactile experiences. According to the research findings, a set of criteria for ranking the importance of the five-sense experiences design is established, as shown in Table 1.

Table 1. Evaluation grade index of multisensory experiences design.

	Primary index	Secondary index		
The importance of multisensorydesign(U)	U1:Visual experience	U11: Color expression	U12: Dynamic characteristic	U13: Appearance and shape
	U2:Aural experience	U21: Timbre type	U22: Sound intensity	U23: Repetition Period
	U3:Olfactory experience	U31: Odor type	U32: Emotional symbol	U33: Distribution retention period
	U4:Taste experience	U41: Flavor type	U42: Cleanliness health	U43: Synaesthesia effect
	U5:Tactile experience	U51:Material hardness	U52: Windchill	U53: Assembling method

In the study, the weights of the aforementioned secondary indicators were calculated using the expert questionnaire method. Assuming there were L experts involved in the evaluation, a Delphi Technique-based questionnaire survey was conducted. Based on the statistical results, a ranking matrix was obtained and recorded as follows:

$$A = (a_{xi})_{L*M} (x = 1,2,\ldots,L, i = 1,2,\ldots,M)$$

After obtaining the scores from the experts, the entropy value is calculated using entropy theory. Based on the aforementioned theoretical support, the weights of each indicator are calculated to further clarify the weights of the secondary indicators in this study, as shown in Table 2.

Table 2. Secondary index weight.

Secondary index	U11: Color expression	U12: Dynamic characteristic	U13: Appearance and shape	U21: Timbre type	U22: Sound intensity
Weight	0.5	0.3	0.2	0.4	0.3
Secondary index	U23: Repetition Period	U31: Odor type	U32: Emotional symbol	U33: Distribution retention period	U41: Flavor type
Weight	0.3	0.5	0.3	0.2	0.4
Secondary index	U42: Cleanliness health	U43: Synaesthesia effect	U51: Material hardness	U52: Windchill	U53: Assembling method
Weight	0.3	0.3	0.5	0.3	0.2

Based on the weight distribution mentioned above, all secondary indicators are categorized into 'Major Impact', 'Moderate Impact', and 'Minor Impact' based on their importance. Then, the secondary indicators are scored according to their importance level, and the final scores of the primary indicators are calculated based on their respective weights, as shown in Table 3.

Table 3. Secondary index score.

Table Rows	**Secondary index**	Scoring interval	Final score for primary index
p1	U11: Color expression	[90,100]	p
p2	U12: Dynamic characteristic	[80,90]	
p3	U13: Appearance and shape	[0,80]	
w1	U21: Timbre type	[90,100]	W
w2	U22: Sound intensity	[80,90]	
w3	U23: Repetition Period	[0,80]	
c1	U31: Odor type	[90,100]	C
c2	U32: Emotional symbol	[80,90]	
c3	U33: Distribution retention period	[0,80]	
m1	U41: Flavor type	[90,100]	M
m2	U42: Cleanliness health	[80,90]	
m3	U43: Synaesthesia effect	[0,80]	
n1	U51: Material hardness	[90,100]	N
n2	U52: Temperature sensation	[80,90]	
n3	U53: Assembling mode	[0,80]	

4.4 Multisensory experiences elements priority analysis

Based on the calculated results, the design elements for this project are ranked in the following order of importance: Visual > Tactile > Auditory > Olfactory > Gustatory. It is crucial to strike a balance in the distribution of importance among the different senses in the subsequent design plans.

Considering the secondary weights, the following conclusions can be drawn:

1. Visual Experience: Color expression and dynamic features are the most critical factors, while the shape pf product is of secondary importance. Therefore, it is essential to focus on visually appealing effects by utilizing colors and shapes that resonate with the target users' psychology. Incorporating dynamic interactions can enhance both functionality and aesthetics (Cybulski, Keller, Nguyen & Saundage, 2015);

2. Tactile Experience: Material hardness and temperature perception are significant factors. The design plan should consider the varying impact of material softness or hardness and texture on the user experience. By testing the pressure feedback of the human body at different temperatures, the temperature of the contact surface can be optimized. The assembly method should facilitate convenience, amusement, and problem-solving during user interactions, thereby aiding stress relief;

3. Auditory Experience: Sound type and sound intensity are the most important factors. Given the wide range of music genres, the design plan should make the best choice based on the project's theme. Consider the users' common preferences for sound types and the experiential environment of the product. The playback mode should be determined according to the product's functionalities, with a focus on efficiency;

4. Olfactory Experience: Scent type and emotional representation are the most critical factors, considering their alignment with the product's visual theme. The concentration and diffusion period should be intelligently controllable, allowing for flexible and precise adjustments based on user perception;

5. Gustatory Experience: Taste type and cleanliness are important factors. It involves not only stimulating the taste buds but also incorporating green and healthy concepts.

5. Design implement

5.1 The design practice about Multisensory stress-relieving product for female office workers

The design requirements are prioritized based on the 'Multisensory-AHP' method. The final design solution is an intelligent stress-relief lamp called 'BREATH·BLOSSOM' , which utilizes multisensory interaction to reduce stress (see Figure 8).

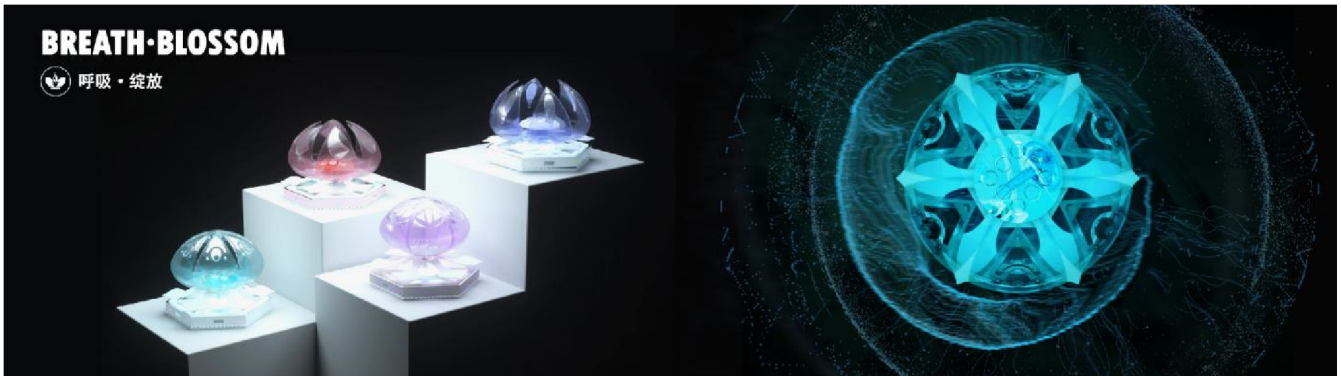

Figure8. The multisensory stress reduction product design for female office workers.

5.2 Visual experience

The color series draws inspiration from the natural world, selecting shades of cherry blossom pink, lilac purple, spring green, and icy blue, creating a dreamy style, as shown in Figure 9(a). Regarding petal shape, it takes cues from flowers in nature and applies digitally enhanced fiber textures (see Figure 9b) to mimic the illumination of light sources on the display screen. Distilling the features, corresponding simple geometric patterns are designed and applied to dynamic screen patterns, petal flat shapes (see Figure 9c), and mobile icons (see Figure 9d). The dynamic patterns displayed on the screen act as light sources regarding dynamic features and stress reduction functionality. Through a unique translucent lens, they form specific light trajectories through an opening and closing structure, serving as a stimulation converter that affects the user's brainwave state and achieves stress reduction, as shown in Figure 9(e). The opening and blooming of flower elements showcase the rhythm of life's breathing, echoing the action of taking a deep breath, helping users experience the magical beauty of life, find inner calmness, and alleviate stress.

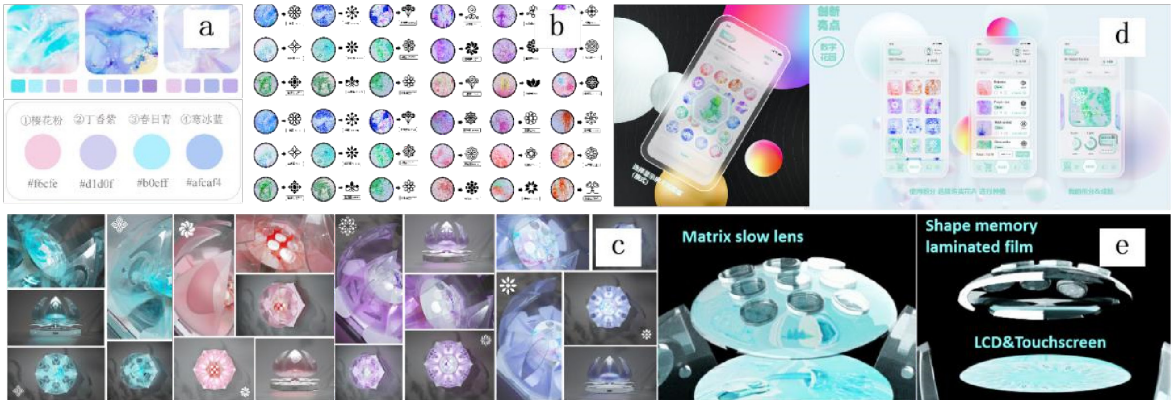

Figure9. The visual experience analysis of the design solution.

5.3 Tactile experience

The external main structure of the product is made of translucent gradient flexible plastics (PE, PP). The surface of this material has low hardness. It offers a soft and comfortable texture, making it easy for users to squeeze and adjust their emotions, providing a means to release and relieve stress. Additionally, it has excellent heat resistance and serves as a stable electrical insulating material, meeting the basic requirements for the primary material of the lamp. The internal functional carrier of the intelligent wall lamp adopts various metal and memory layer composite thin film materials. The bottom of the product contains sensors that automatically detect infrared signals using infrared reflection principles, enabling the lamp to be turned on and off with a swipe of the hand. It also allows for touch-sensitive dimming when the hand is held in place and can adjust the sensing temperature on the product's surface based on the user's mood, as shown in Figure 10(a). The hexagonal product units can be creatively assembled and DIY-ed for added fun and educational value(Cheng, 2019), reducing stress, as shown in Figure 10(b).

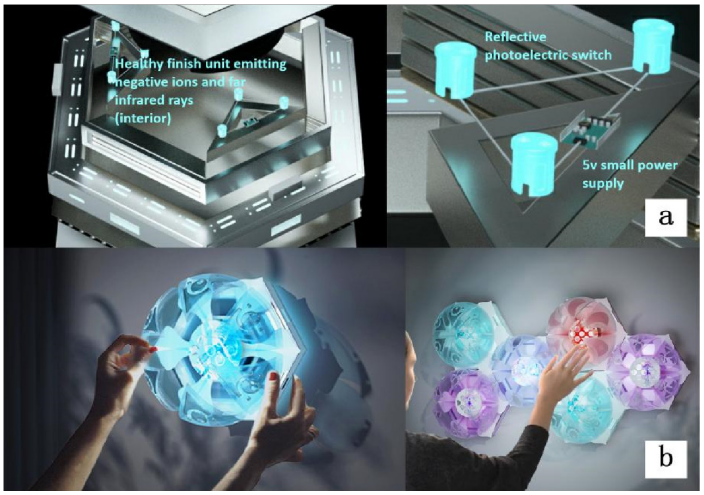

Figure10. The tactile experience analysis of the design solution.

5.4 Auditory experience

The sound profile selected for the product consists of specially designed medical resonance music with a fixed short cycle, accompanied by the rhythmic movement of opening and closing petals. The central axis asymmetric sound structure includes an internal magnetic full-range speaker (see Figure 11). The music vibrations of the medical resonance music harmonize with the body's cells, and the volume can be flexibly adjusted based on the user's experience, influencing emotional changes. The music complements the visual effects of the product, adding a dreamy atmosphere. Users can freely switch between different music tracks within the app interface and control the speakers' volume by dragging the sound axis, as shown in Figure 13(b).

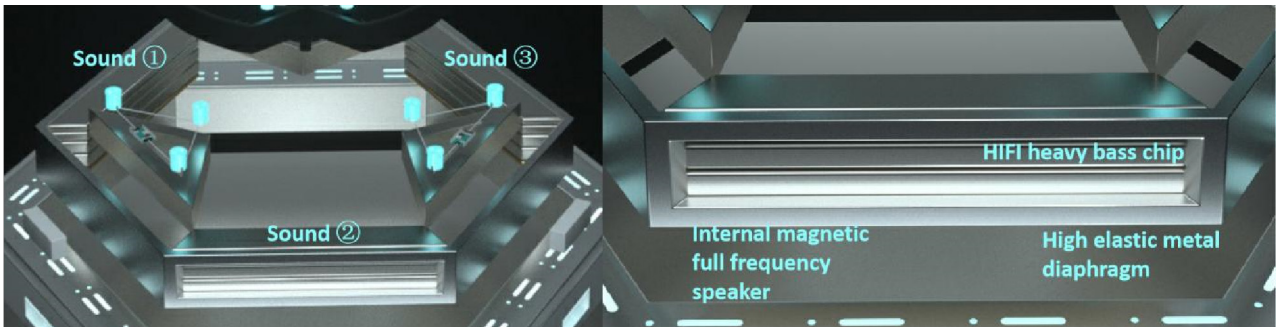

Figure11. The auditory experience analysis of the design solution.

5.5 Olfactory experience

The product features a built-in structure for placing plant essential oil aroma pads, which naturally diffuse through multiple diffusion holes. Different blooming modes correspond to different types of aromas, satisfying emotional symbolism. The base of the unit can be rotated and opened to replace the aroma pads (see Figure 12), and a rotary button can control the intensity of the fragrance. Additionally, the breath-ability film on top of the aroma box can be adjusted via the app to achieve more precise control of the aroma concentration, as shown in Figure 13(b).

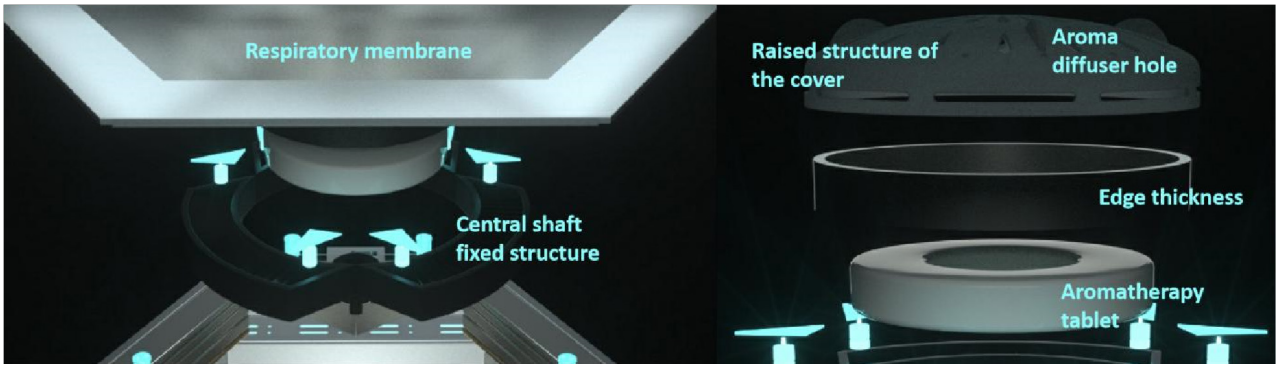

Figure12. The olfactory experience analysis of the design solution.

5.6 Gustatory experience

They were considering the type and cleanliness. The bottom of the product features a magnetic suction structure with an embedded fullerene release terminal that houses a negative ion generator capable of producing 450,000 ions per cubic centimeter per second. This aids in the efficient removal of dust and odor, reducing fatigue and increasing brain cells' aerobic metabolism rate, as shown in Figure 13(a). Users can feel as if they are immersed in nature, experiencing the breath of life and appreciating its rhythm. The app interface allows users to control the concentration of negative ions by dragging the concentration axis, which essentially adjusts the breath-ability film density of the lower gas release section, as shown in Figure 13(b).



Figure13. The gustatory experience analysis of the design solution.

6. Design evaluation

6.1 Expert evaluation

In order to achieve a comprehensive sensory experience design for stress-relieving products, it is necessary to conduct a professional evaluation and user feedback testing to assess the degree of target achievement in meeting the needs and elements of the target group. A group of 20 experts has been invited to evaluate the degree of requirement fulfillment in this research, using a sevenpoint scale as the rating standard. The horizontal axis represents the evaluation indicators, while the vertical axis represents the score points, which show a positive correlation with users' degree of requirement fulfillment (see Figure 14 a).

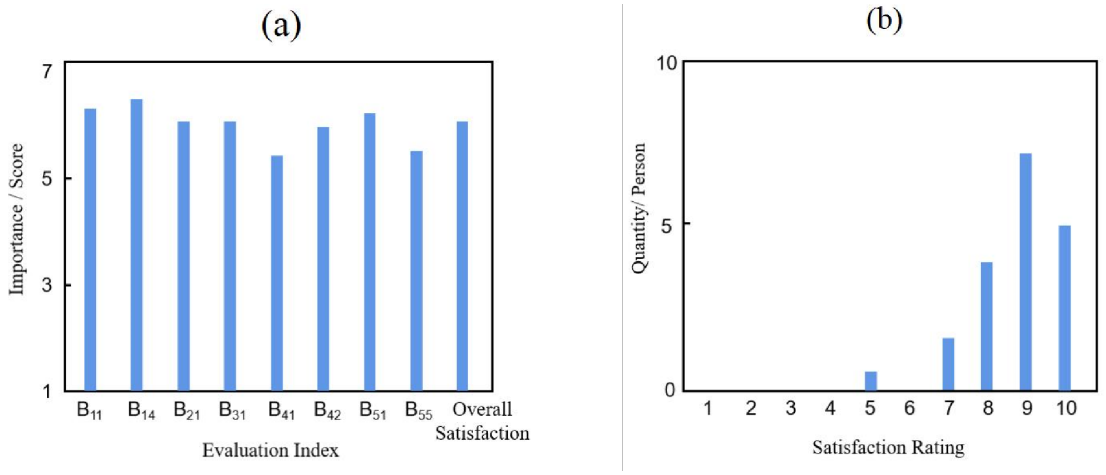

Figure14. The design evaluation results:(a)The evaluation result of the expert panel, (b)User NPS rating results.

6.2 User scoring

To assess the satisfaction level of the proposed product solution, 30 respondents who were interviewed previously were invited to participate in a Net Promoter Score (NPS) test. The NPS is used as the scoring criterion, with the score points represented on the horizontal axis and the number of respondents on the vertical axis. The respondents' recommendation scores are positively correlated with their satisfaction and loyalty towards the product (see Figure 14 b). The overall NPS score for the solution is 48.9, indicating that it meets the target users' requirements and is considered a relatively successful design solution.

7. Conclusion

This paper delves into the specific sensory requirements for stress relief, with a particular focus on office laddies. The Analytic Hierarchy Process is employed to explore these requirements. Through a series of processes including user research, requirement analysis, and weight calculation analysis, the paper effectively extracts, analyzes, transforms, integrates, and applies user requirements and design elements. This systematic approach mitigates subjective decision-making in the design process, culminating in a design that aims to help office laddies alleviate stress through the multiensory experience. The findings of this study provide scientific guidance for related design practices.

By prioritizing the sensory needs of target group, this study conducts a case study on the design of stress-relieving products. The AHP method is utilized to enhance design efficiency and user satisfaction, as well as validate the actual stress relief effects of the products. The research methodology and process are rooted in the issue of stress among female office workers and incorporate the practical application of stress relief through multisensory experiences. As a result, this study offers valuable insights and reference for future research on similar products.

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BRAND STRATEGY EMPOWERS THE REVITALIZATION OF RURAL AREAS AND SOCIAL INNOVATION IN CHINA

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ABSTRACT | Under the vigorous promotion of the rural revitalization strategy, China has witnessed a series of localized design explorations and practical applications deeply rooted in the development of rural areas. These practices usually focus on optimizing specific agricultural products, planning tourist routes, or exploring cultural resources. In order to systematically activate the rural economy, this study focuses on brand strategy as an important means to integrate and further advance rural resources, promote comprehensive and sustainable rural development, and drive social innovation. Taking the regional brand construction practice in Longshan County, Hunan Province, China as a typical case, it illustrates how to propose a vision and strategic model for regional brand construction driven by rural resources through the intervention of brand strategy. It emphasizes the organic integration of strategic analysis and evaluation stage, brand construction and execution stage, and sustainable development stage of rural revitalization. It proposes synergistic effects between small circulation dominated by three major industries and large circulation guided by brand strategy: primary and secondary industries provide raw materials for tertiary industry while tertiary industry promotes optimization and upgrading of primary and secondary industries to form a small circulation; under the guidance of brand strategy, various industries cluster for development which drives comprehensive improvement in regional brand public services to form a large circulation. Ensuring replicability of pathways and adaptability of models is also emphasized while providing a reference for future research on rural revitalization.

KEYWORDS | CHINA'S RURAL REVITALIZATION; BRAND STRATEGY; SOCIAL INNOVATION; SUSTAINABLE DEVELOPMENT

1. Introduction

1.1 Social Background: Current Situation of China's Rural Revitalization Strategy Development

With the process of modernization, the definition of rural areas has expanded beyond settlements primarily inhabited by agricultural populations engaged in farming activities. It has evolved into a comprehensive regional entity that encompasses natural, social, and economic characteristics. The special relationship between rural and urban areas emphasizes the importance of sustainable development in rural areas.

Since the 21st century, China has implemented several policy supplements and adjustments regarding rural issues. In 2012, a new wave of building beautiful countryside swept across the country, marking a new stage in China's rural construction. On October 18th, 2017, the report from the 19th National Congress pointed out that issues related to agriculture, rural areas and farmers are fundamental to national economy and people's livelihoods. It emphasized that solving these issues should always be given top priority by the entire Party and implementing the strategy for revitalizing rural areas (Xiang & Song, 2023).

Thus far, "rural revitalization strategy" has been officially proposed with multidimensional features emphasizing on enhancing the economic, social and cultural development levels of rural areas through leveraging their resources and potentialities to achieve coordinated urbanrural development as well as sustainable development.

1.2 Literature Review: Research Status of China's Rural Revitalization Strategy

The application of sustainable development theory to rural areas initially emphasized the importance of rational utilization of natural resources in achieving the goal of rural sustainable development. As understanding of rural areas deepens, attention and mobilization of resources for rural development gradually expand beyond natural resources to include cultural resources, human talent, tourism resources, and more. Sustainability concerns have

increasingly gained importance among organizations and their stakeholders around the world (Caiado et al., 2017).

However, achieving comprehensive mobilization of resources and collaborative cooperation among stakeholders is relatively challenging within such a complex system that encompasses various types of resources involving multiple stakeholders like those found in rural areas. The design discipline demonstrates unique advantages under these circumstances as it possesses strong interdisciplinary attributes.

The design discipline is undergoing a transition from “material design” to “strategic design”(Lou, 2010). In the past, design often relied on a point-to-point approach within individual disciplines to create added value or address immediate challenges. However, contemporary practice necessitates a consideration of how to confront complex issues through systematic integration (Papanek, 1985). This shift indicates that the manner in which design intervenes in “stuck” scenarios has evolved from early practices of “end-of-pipe solutions” towards more proactive “source interventions” (Liu et al., 2022).

This closely aligns with strategic brand building. As a core concept in enterprise management, brand strategy encompasses foundational theories such as brand positioning, brand value, and brand identity (Kapferer, 2008). It emphasizes the establishment of market position and enhancement of competitive advantage through clear brand positioning and systematic brand management. The introduction of brand strategy offers new perspectives and methodologies for rural revitalization. Chinese researchers have explored the theoretical implications and case analyses related to brand strategy, elucidating its specific application models and outcomes within various contexts of rural revitalization.

Numerous studies have analyzed the successful application of brand strategies in rural revitalization through specific case studies. The implementation of brand strategies in rural economies primarily manifests in the branding of agricultural products. Scholars have explored reasonable suggestions for enhancing the competitiveness and market influence of locally distinctive agricultural product brands from various perspectives, including brand value creation and promotional activities (Xiong et al., 2024). Additionally, some researchers have examined typical marketing cases of local specialty agricultural products to propose branding strategies within the context of rural revitalization (Tao & Tao, 2023). Furthermore, other scholars have approached the exploration of development paths for rural revitalization by focusing on rural culture. For instance, they constructed a model for cultural branding strategy based on design management experience across four dimensions: emotional service, strategic planning, organizational collaboration, and touchpoint experience (Liu & Du, 2024).

These research also address challenges and countermeasures related to the implementation of brand strategies (Deng, 2024). It discusses issues arising from advancements in digital information technology that complicate resource integration during brand strategy planning. These include a lack of diversity in brand communication models and insufficient collaboration among relevant stakeholders; corresponding response strategies are proposed to address these challenges.

In summary, various disciplines within design have made numerous attempts at academic research and project practices for rural development focusing on multiple aspects such as agricultural industry, cultural industry, and tourism industry which reflects scholars considerations for multidimensional needs in revitalizing rural areas. However, research examining the interlinkages between different industries from a macro-strategic perspective at the rural level remains relatively scarce. If rural development focuses solely on the isolated growth of a single industry, it may encounter limitations in economic diversification and potential for growth due to resource singularity. Additionally, this dependence and isolation make it difficult for rural areas to withstand constant external shocks in market competition. Furthermore, excessive exploitation and use of limited resources may cause irreversible damage to the rural ecological environment, affecting its ecological balance and capacity for sustainable development. This contradicts the requirements set forth by the sustainable development model - meeting human needs while ensuring social equity and respecting environmental limits (Holden et al., 2017).

1.3 Critical Path: The Importance of Regional Brand Development in Promoting Sustainable Rural Development

The key to achieving sustainable rural development lies in the implementation of national policies and fostering cooperation across sectors and localities, while also emphasizing citizens' self-reliance and self-organization. (Bock, 2015). In this context, rural resources in rural areas can serve as a stimulus for social innovation, leading to more comprehensive rural awareness, more proactive social innovation and more feasible sustainable development (Artur et al., 2023).

Combining the connotation of brand strategy and the research status of rural revitalization, this study will focus on the construction of rural regional brand. The construction of regional brands contributes to the formation of an industrial brand cluster with a certain regional characteristic of "Distinctive brand + Industry + Region", achieving the sustainable development of rural areas through "self-organization". Different from the previous brand strategy that only focuses on the development of a certain industrial chain when it intervenes in rural areas, regional brand is oftenbased on specific regional

history, culture, geography or industrial background and involve the competition and integration of local advantageous industries and leading industries (Ma, 2023). In the process of constructing rural regional brands, the countryside serves as the foundation, brand strategy serves as the path method, sustainable development concept serves as the guiding principle, and promoting social innovation and sustainable development in rural areas is our goal.

Therefore, Rural regional brand building from the perspective of brand strategy has unique advantages, which goes beyond pursuing single-industry development; instead, it starts from a macro-strategic level to implement specific strategies that emphasize horizontal connections between industries. It aims to construct a unique and comprehensive image for rural areas tailored to local conditions in order to promote comprehensive coordination and sustainable development across economic, social, and cultural aspects in rural areas.

1.4 Research Purpose and Significance

This article integrates brand strategy to consider the issue of "from line to surface" and explores how to effectively build and promote regional brands in the cause of rural revitalization for sustainable development. The aim is to provide a systematic approach for the rural revitalization cause in China, establish a resource-driven model for sustainable development based on the analysis of rural resources and geographical features, and support social innovation and rural sustainable development.

2. Research and Problem Definition

Longshan County is located in the hinterland of Wuling Mountains, Hunan Province, China. Due to its geographical location and the gathering place of Tujia ethnic culture, it has unique advantages in terms of natural resources and cultural resources. Despite being endowed with rich natural and cultural resources, Longshan County still faces significant economic challenges. As of 2022, the per capita GDP in this county reached 23,500 yuan per person. While this number indicates some momentum in economic growth, it only accounts for 27.4% compared to the national average level and 32.7% compared to the overall level in Hunan province, highlighting regional economic imbalances and pervasive poverty issues. In order to address this situation, Longshan County is actively seeking a path towards transformation and upgrading.

The project team first arrived at Longshan County in Hunan Province in November 2023. We visited natural scenic spots, industrial parks, and cultural museums with local government officials as guides to gain a preliminary understanding of existing resources in Longshan County.

Longshan County is rich in resources, with natural resources such as Wulong Mountain and Bamian Mountain, agricultural resources such as lilies, navel orange, cured meat, Tujia brocade, Rebala Tujia settlement, Qin Dynasty culture and other historical and cultural resources. However, under the appearance of rich resources and industries, the industrial development of Longshan County is facing challenges. The acidic soil and selenium content in the territory provide a high-quality soil environment for the growth of high-quality lily□but the lily industry in Longshan County presents a decentralized management model of small farmers and workshops, which reflects the diversity and flexibility of the local area, but also restricts the scale and branding process of the lily industry. In terms of brand development, although the navel orange fruit surface in Longshan County is orange-red, sweet and sour, and has distinct local characteristics, the existing navel orange brand has the problem of low brand recognition and limited market influence. In addition, while Longshan County possesses relatively abundant historical and cultural resources, its development process has been hindered by unclear positioning, a lack of focus, and insufficient resource integration. As a result, the development efforts have become fragmented, leading to suboptimal benefits.

In light of the existing challenges in the industrial development of Longshan County, the project team has gradually defined its design objectives for establishing a regional brand for Longshan County. The core mission of regional brand construction is to effectively balance between regional brands and various product brands within the region in order to stimulate maximum synergistic effects and maximize brand value release. This requires macro-level brand strategy guidance. From a high-level scrutiny perspective on rural revitalization underpinned by brand strategy, it is an integrated system engineering under a single vision spanning across multiple leading industries and auxiliary industries, achieving multi-dimensional and multi-level strategic combinations with characteristics such as locality stage connectivity replicability (Manzini, 2015), holding significant implications for social innovation and rural sustainable development.

3. Design Proposal Development

Therefore, in response to the issues of insufficient industrial scale, low brand recognition, and fragmented cultural resource development in Longshan County, the project team has structured the regional brand building for Longshan County into three stages (Figure 1). This approach is aligned with the principles of brand strategy synergy (Aaker, 1996).

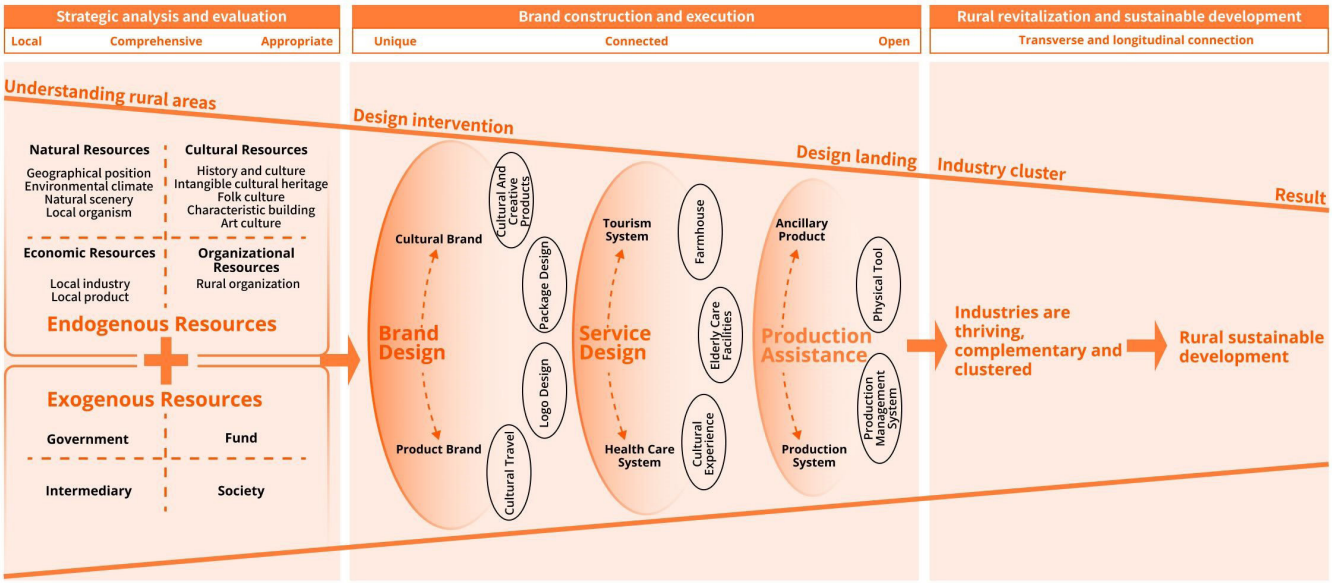

Figure 1. Vision and Strategy Model for the Revitalization of Rural China.

3.1 Strategic Analysis and Evaluation Stage

Strategic analysis and evaluation represent the initial phase of regional brand development, characterized by a local, comprehensive, and contextually appropriate vision. This stage seeks to leverage the synergy inherent in brand strategy to achieve effective complementarity and interconnection among various resources. By integrating both endogenous resources and exogenous resources within the region, it aims to ensure the coordinated advancement of diverse industries and brands under a unified strategic framework. Ultimately, this approach aspires to maximize overall value while fostering long-term sustainable development for regional brands.

Rural resources can be systematically categorized into three major groups: endogenous resources, exogenous resources, and restricted resources (Figure 2). This classification aids in accurately identifying the core competitive advantages and potential development space of rural areas.

Endogenous resources serve as the foundation for rural development, encompassing natural resources, organizational resources, cultural resources, and emerging economic resources. These resources constitute the unique competitive advantage of rural areas. The diversity of natural resources provides favorable conditions for rural development; the stability of organizational resources ensures internal cohesion and consistency in action within rural communities; the uniqueness of cultural resources becomes an important element in building regional brands for rural areas; while the initial accumulation of economic resource lays the groundwork for sustained growth in rural economies. Simultaneously, the introduction of exogenous resource injects new vitality into rural development. The influx of external funds

and advanced technology as well as expansion in market channels accelerates transformation and upgrading within rural industries. However, it is also crucial not to overlook restricted factors such as population age structure, transportation conditions, limited availability of certain resource types, and constraints on cultural dissemination—all these factors may pose challenges to rural development (Figure 2).

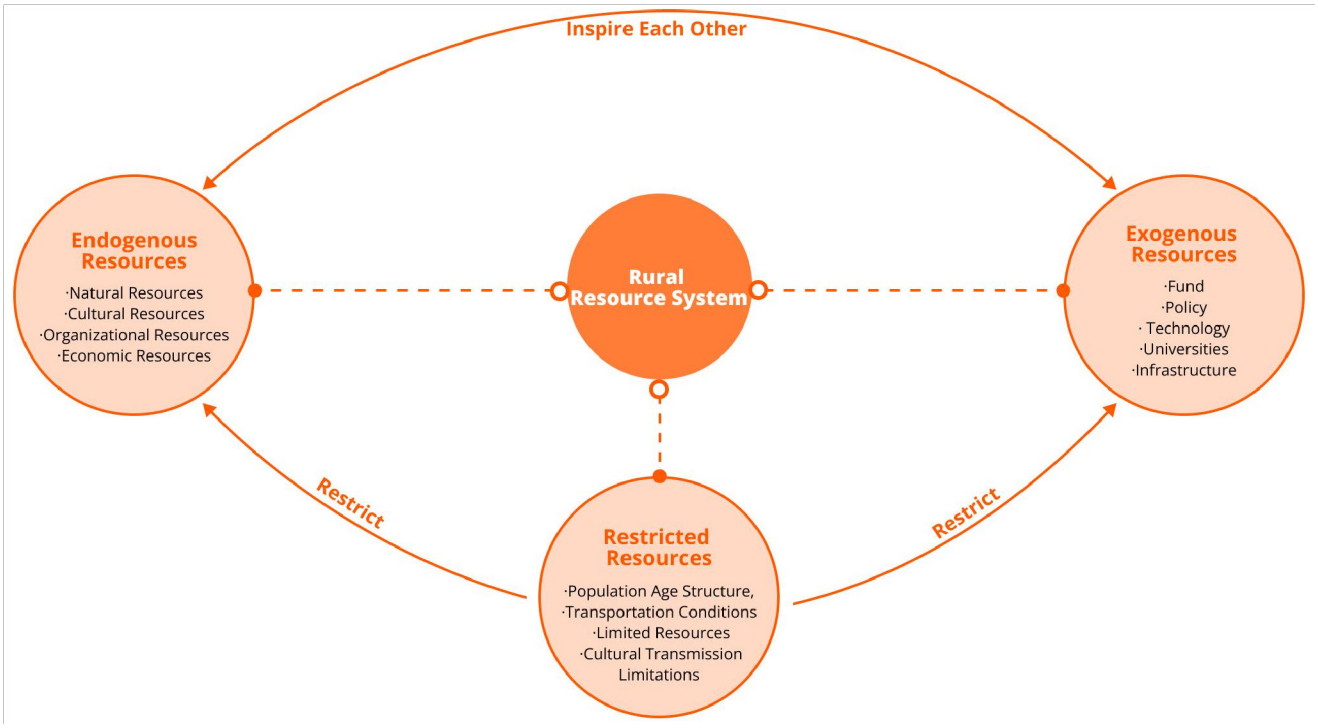

Figure 2. Rural Resource System.

Upon entering Longshan County for the first time, the project team meticulously focused on two key principles: “the uniqueness of resources” and “their potential for sustainable development”, and systematically classified, assessed, and screened both domestic and international resources within Longshan County. This process is a vital component of the development strategy for rural regional branding.

Firstly, the natural resources represented by Wulong Mountain and Bamian Mountain, the economic resources represented by agricultural products like lilies, navel orange and tea leaves, as well as cultural resources represented by Tujia brocade weaving and the settlement of the Rebala Tujia ethnic group are categorized as endogenous resources of Longshan County. Priority development will be accorded to those that demonstrate the greatest potential among them.

Secondly, considering the principles of localization and sustainable development, the project team chose the tea and lily industries as the first development anchor. Product line management was carried out for tea in accordance with varieties and price points, while proposing the integration and joint operation of scattered lily factories within Longshan County to promote their development towards large-scale, branding, and modernization through resource optimization. Additionally, the establishment of a navel orange brand and the enhancement of the brand influence of Longshan County's navel orange will stimulate increased income for farmers. At the same time, other industries represented by cured meat, camellia oil, rice and other products are sold as official gifts.

Simultaneously, the team recognized that cultural resources are a unique advantage for tourism development in Longshan County. Therefore it proposed to construct a comprehensive tourism service system centered on service design to promote effective utilization of Longshan county's resource locally.

At this stage, the team is required to define the advantages, potential, crisis and needs of the target audience of rural resources through comprehensive and accurate resource analysis, and form the core judgment and strategic objectives for the future development of Longshan County. Based on these analyses, a realistic and forward-looking strategic path is developed.

3.2 Brand Construction and Execution Stage

The second stage is a crucial transition from the strategic level to the practical level, which needs to pay attention to the synergy between the regional brand and the product brands in the region, which is embodied in sorting out the internal structure of the regional brand and shaping the regional brand positioning and brand image.

During this stage, the team upheld a unique, interconnected, and open vision to create the regional brand named "Xiangyue Longshan", leading the comprehensive construction of Longshan County's regional brand system. The "Xiang" in "Xiangyue" is derived from the abbreviation of Hunan Province. In Chinese, "Xiangyue" sounds like "meeting with each other", conveying the meaning of "Let's meet in Longshan County, Hunan Province". It is worth mentioning that under this regional brand, three branches were launched by project team: a regional public brand centered around agricultural products, a cultural tourism service brand focused on tourist experiences, and a brand marketing strategy centered around promoting the overall regional brand (Figure 3).

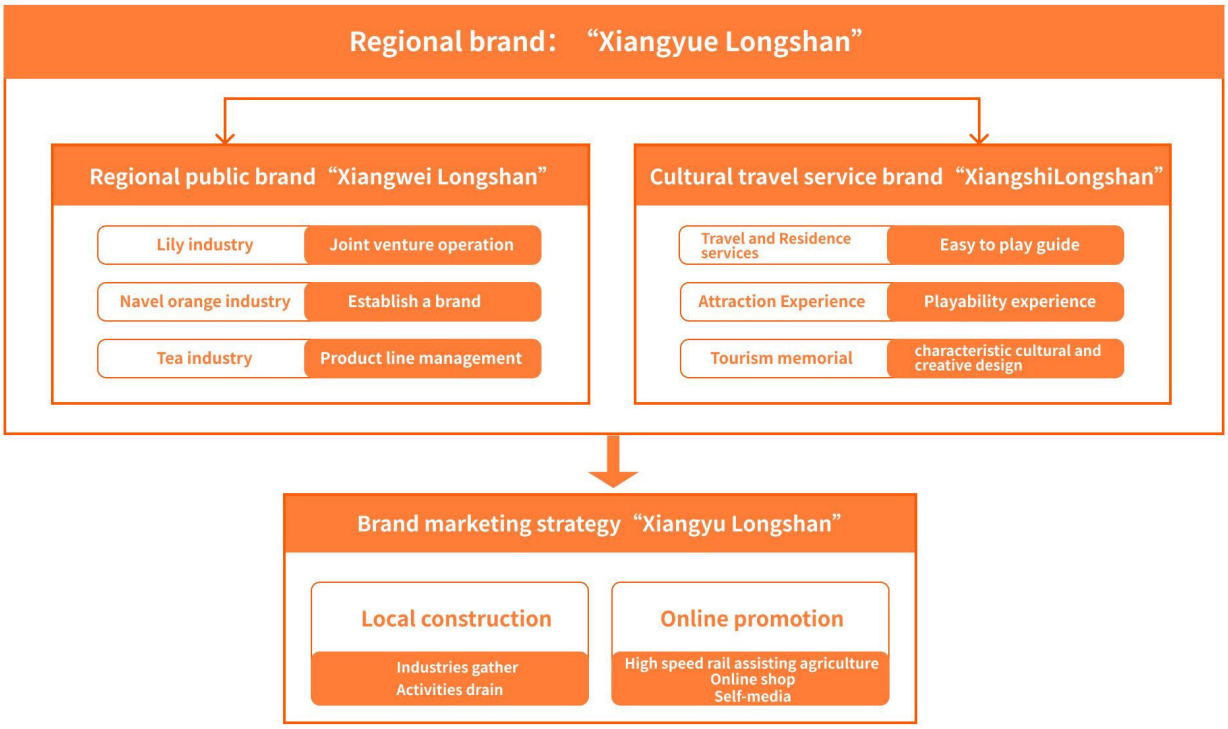

Figure 3. "Xiangyue Longshan" Regional Brand Building Work Plan.

Among them, for the agricultural products industry, the regional public brand "Xiangwei Longshan" is introduced. The term "Xiangwei" represents "Hunan cuisine" in Chinese, thus "Xiangwei Longshan" symbolizes an invitation to savor the delicacies of Longshan County. On the basis of the development strategy proposed in the previous stage, we began to promote the development of the four major agricultural products industries. It is mainly manifested in optimizing tea product line, establishing citrus brand, developing lily agricultural and sideline products, conducting one-to-one brand and product packaging optimization design for representative enterprises, establishing a cross-industry brand unified vision system, and ensuring the consistency and recognition of the region public brand of "Xiangwei Longshan".

In terms of cultural tourism services sector, "Xiangshi Longshan" brand was introduced aiming at addressing homogenization issues in rural tourism. Differentiated strategies including designing tourism service systems, planning distinctive travel routes and providing diverse tourist experiences were formulated to meet growing personalized needs of tourists. Leveraging rich local cultural resources in Longshan County, a series of tourist souvenirs were designed not only enriching shopping choices for tourists but also stimulating consumption growth in cultural creative products.

At the same time, along with the development of “Xiangwei Longshan” and “Xiangshi Longshan”, “Xiangyu Longshan” (In Chinese it means “Let’s have fun in Longshan County”) puts forward marketing strategies for regional brands from two dimensions of online publicity and local construction. Online publicity is carried out by short video publicity, Internet live broadcast and other ways to attract tourists to travel; Local construction collaborates with transportation, accommodation, tour services and cultural and creative product design to increase tourists’ local consumption, so as to achieve regional brand promotion.

To summarize, the focus of the second stage is primarily on the regional brand “Xiangyue Longshan.” Through a coordinated promotion of the regional public brand of agricultural products “Xiangwei Longshan” , the cultural and tourism service brand “Xiangshi Longshan” and the brand marketing strategy “Xiangyulongshan,” this initiative aims to inject new vitality and momentum into the rural revitalization efforts in Longshan County.

3.3 Rural Revitalization and Sustainable Development Stage

The vision of the third stage focuses on building a dual linkage system of horizontal expansion and vertical deepening among industries, promoting the synergy of resources and complementary advantages in various fields, and forming a sustained brand value-added effect. It marks that the development of industrial cluster has entered the core acceleration period.

During this stage, it is essential to strengthen, transform, and deeply develop the primary and secondary industries such as agriculture and manufacturing, while closely integrating with the tertiary industry (service industry), thus establishing a micro-to-macro interactive mechanism(Figure 4). Specifically, agriculture and manufacturing serve as the foundation by providing abundant raw materials and product support for the service industry; meanwhile, the service industry reciprocates and promotes the optimization and upgrading of the primary and secondary industries through its efficient public service functions, forming an internal efficient circulation system. This cycle not only significantly enhances synergies between industries but also lays a solid foundation for comprehensive sustainable development in rural economies.

Simultaneously, relying on brand strategy, various industries construct a closely interconnected network where each node complements each other in an orderly manner to promote regional brand public service development collectively forming a more extensive and far-reaching macro-circulation pattern. This process not only promotes optimal allocation and efficient utilization of resources but also enhances overall competitiveness and influence in rural economies. Enhance the competitiveness and

sustainable development of the overall industrial chain, and ensure that the regional brand of "Xiangyue Longshan" can achieve maximum synergies at various industrial levels.

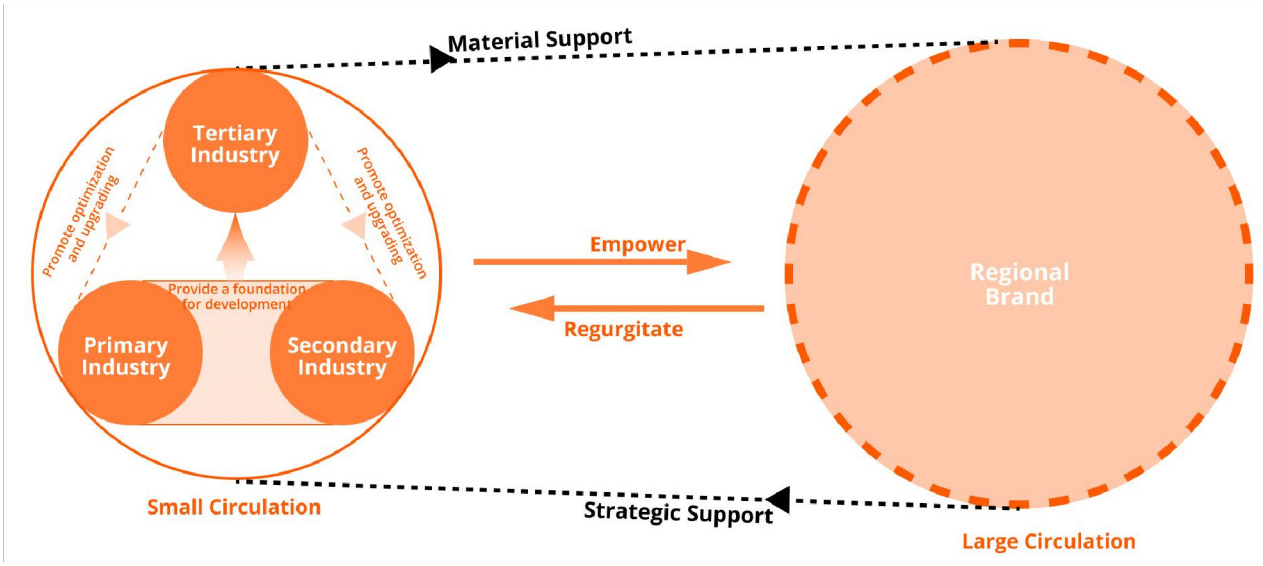

Figure 4. A Micro-to-macro Interactive Mechanism.

Ultimately, an autonomous, closed-loop yet vibrant benign circulation system is formed around rural areas. This system is centered on the interdependence of industries nourishing each other with public services as their support. Not only does this system provide sustainable development momentum for rural revitalization, but it also explores a replicable path for rural revitalization that demonstrates high adaptability and broad application prospects.

4. Project Summary and Conclusions

From the perspective of brand strategy, this study considers rural areas as a whole, emphasizing the importance of exploring and integrating rural resources. It also highlights the establishment of a linkage and circular system among industries in the process of rural revitalization. Through a systematic approach and strategy, the aim is to establish a comprehensive regional brand for rural areas by focusing on macro-level cognition. At the practical level, it has achieved comprehensive progress and sustainable development in terms of economy, society, culture, and ecology in rural areas; at the strategic level, it provides a sustainable, replicable, and scalable development path for rural revitalization in other regions. The innovation points of this study are mainly reflected in several aspects:

Integration of interdisciplinary perspectives: This study combines design disciplines with strategies for rural revitalization to propose an integrated brand construction approach. By incorporating aesthetic, cultural, and creative elements into regional brands from the unique

perspective of design disciplines to enhance their recognition and attractiveness.

Systematic method for resource exploration and integration: It proposes a systematic approach to explore and integrate rural resources that not only focuses on natural resource utilization but also delves into cultural heritage and social resources to form a solid foundation for constructing regional brands.

Development model driven by brand strategy and integration strategy: It proposes strategies that integrate diverse industrial resources through brand strategies to promote organic integration between three major industries within villages while fostering interaction to create synergistic effects at village level.

Exploration of sustainable development paths: The research not only focuses on short-term economic growth but also emphasizes long-term sustainable development in villages. By constructing an autonomous benign circulation system as well as providing new ideas for exploring paths towards village revitalization through sustainable developmental dynamics.

5. Further Research and Discussion

The relationship between design issues and solutions has always been a topic of discussion. In the field of design, the linear logic development of design problems and solutions is no longer seen as such, but rather as a simultaneous and iterative process of discourse exchange, emphasizing the dialogic nature of the design process (Ranulph, 1999). There is an iterative interaction between design problems and solutions. Therefore, seeking solutions to the “sticking” difficulties in the design scenario is not a one-time effort, but will be continuously iterated as people’s understanding of the design scenario and problems deepens.

As rural revitalization is a complex issue rooted in different social backgrounds and involving interdisciplinary cross-cutting, with further understanding of this design scenario and new definitions for rural development issues, it remains necessary to pay attention to the adaptability of this model to other rural environments in the future. To address this issue, further research may include:

Firstly, validating, improving and iterating on the proposed strategic model through more case studies and empirical analysis.

Secondly, establishing a scientific assessment system for sustainable development to regularly evaluate and monitor rural area branding construction and the effectiveness of rural revitalization. Through feedback from evaluation results, timely adjustments to strategic plans can ensure sustainability and effectiveness in rural revitalization efforts.

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ARTIFICIAL INTELLIGENCE AS A CATALYST FOR INDIVIDUAL AND COLLABORATIVE CREATIVITY IN DESIGN CONCEPTUALIZATION

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ABSTRACT | Integration of Artificial Intelligence (AI) in the design process is a growing area of research interest. Less than two years after its public launch, AI has already established itself as the most disruptive tool revolutionizing how designers conceptualize, iterate and innovate. As AI technologies continue to evolve, it is pertinent that design students are acquainted with the potential of the technology and how it can be integrated in their professional practice. The objective of this paper is to explore the role of AI as a conceptualization and research tool in interior design. We aim to examine its effectiveness in enhancing the ideation process and facilitating collaboration and knowledge sharing in intercultural design teams. The case study presented is a collaborative online international learning project (COIL) with the participation of interior design students from Wayne State University (USA) and University of Monterrey (Mexico). Students were involved in experimentation with various AI tools and platforms in the early stage of designing children's spaces in commercial interiors. Through meticulous documentation and evaluation of all design variations generated, were gained valuable insights on the impact of AI on the evolution of the ideas. To collect research data on how students' creativity, idea exchange and decision-making were affected, surveys and reflection writings were distributed. The findings confirmed that students developed a greater understanding of AI as an essential tool in the design process. They acquired skills in utilizing it to aid the decision-making during the conceptualization phase. Furthermore, AI fostered their self-confidence in communicating within culturally diverse teams. The conclusion discusses the challenges encountered and lessons learned from the integration of AI technologies into the learning process.

KEYWORDS | ARTIFICIAL INTELLIGENCE, CREATIVITY IN DESIGN, DESIGN

1. The rise of AI and design education

Integration of Artificial Intelligence (AI) in the design process is a growing area of research interest. Less than two years after its public launch, AI has already established itself as the most disruptive tool revolutionizing how designers conceptualize, iterate and innovate.

The first industry-wide survey on the opinion of architects on AI, carried out by RIBA in November 2023, indicates that 41% of the architectural practices in the UK have adopted AI for occasional projects, while 2% use it for every project (RIBA AI Report, 2024). A more recent research on the use, types of applications and expectations for the future use of AI by Architizer and Chaos revealed that 46% of the respondents are currently using AI tools and 23 % are planning to use AI in the near future (Architizer, 2024). These findings confirm that AI has emerged as an indispensable digital tool in architects' and designers' workflows and that its transformative potential is yet to unfold. Though doubts were expressed that AI poses threats to the architectural and design profession, the majority believe it will play a significant role in the future. Those who have already implemented it in their practice report that it has improved the efficiency of their design process and has enhanced the accuracy of architectural modelling and simulations. Both studies confirm that the most common use, with greatest satisfaction of the quality of the AI-generated renderings is for the early stages of the project development. AI provides greater flexibility by enabling designers to rapidly generate innovative designs, which can later be explored, refined and optimized.

However, the majority of the professionals (60 %) have not received any formal training on how to use AI in their design projects, and 37 % indicate the lack of suitable training resources as a significant challenge faced in adopting AI tools. Consequently, designers mainly rely on self-learning and experimentation (Architizer, 2024). This gap underscores the need for design education to address AI training in its curriculum. As AI

technologies continue to evolve, it is pertinent that design students are acquainted with the potential of the technology and how it can be integrated in their future professional practice. Understanding AI and acquiring the knowledge and skills necessary to adequately assess, interpret and analyze AI-generated visuals according to the needs, context and specifics of use can ensure that students are more competitive and better prepared for the job market. Long and Magerko refer to these competencies required for the future as "AI literacy", which is defined as "a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace" (Long & Magerco, 2020).

Markauskaite et al. (2022) explored what kind of capabilities people need to interact with AI and how learners can develop them. Conceptualized from different perspectives these capabilities are grouped in three interrelated orientations: cognitive, humanistic and social. From a cognitive perspective, in the human-AI system, AI is viewed as a teammate that affects individual cognition, metacognition and behavior. Selfregulated learning and creativity exemplify key individual capabilities within this orientation. The humanistic perspective centers on human values and individual capabilities to use and shape AI to contribute to personal and collective well-being. The social perspective focuses on shared meaning-making and collective practices. In the context of design education, the development of these skills is henceforth to be researched. Vinchon et al. consider that the "human-AI collaboration can be extraordinarily productive" (Vinchon et al., 2023). AI can produce a large number of proposals quickly, thus providing a vast field for exploration of possibilities, but it is the human who plays a central role at the two critical phases of the creative process - at its beginning and end. Designers define the objectives and set the parameters of the AI-generated ideas and make decisions by evaluating, selecting and validating the output.
The objective of this paper is to explore the role of AI as a conceptualization and research tool in interior design. We aim to examine its effectiveness in enhancing the ideation process and facilitating collaboration and knowledge sharing in intercultural design teams.

2. AI-driven children's spaces design

The case study presented is a collaborative online international learning project (COIL) with the participation of interior design students from Wayne State University (USA) and University of Monterrey (Mexico). In this distinct educational approach, students and faculty from the two bordering countries were connected through online collaboration to develop a joint project on the design of a children's space.
Inherent characteristic of the format, "also referred to as globally networked learning and virtual exchange" (Rubin, 2022), is that

when exposed to diverse perspectives, students strengthen their skills to work in multicultural environments, broaden their global understanding, improve their critical thinking and adaptability. The project which was specifically designed to pair COIL with AI-driven design not only offered a memorable learning experience for our students but simulated a real-world, cross-cultural teamwork in a digital environment.

2.1 Participants

Fourteen fifth semester students from the University of Monterrey (UDEM) and fifteen students from Wayne State University participated in a four-week COIL project. The Mexican students were in their fifth semester of the interior design program in the Department of Art and Design at UDEM. The class in which the project was implemented was Institutional Spaces Studio. In this class, students experiment with various design strategies to create innovative and inspiring interiors addressing the physiological, psychological, social, cultural, and environmental needs of contemporary society. They explore the experiential aspects of the space and learn how to create a sense of place and memorable spatial experiences. The partnering students from the USA were junior students in the interior design program at Wayne State University. They were taking their second interior design studio course, which focuses primarily on experience design. In this class students explore the relationships between users and the space to create immersive spaces which are not only functional and aesthetically pleasing but deeply memorable and impactful.

2.2 Research method

The research method selected was grounded theory (Glaser and Strauss, 1967) since it allows the development of theories grounded in the data collected from the experience and interactions of the participants. We aimed to systematically gather and analyze qualitative data in order to identify patterns and gain insights that emerge organically from the research context. Grounded theory ensures that our findings are rooted in the actual experiences and perspectives of the students, which will aid us build a comprehensive framework explaining how the experiment influences the learning outcomes, competences and the collaborative process.

2.3 Project objectives

The “Children’s spaces” project objective was to explore how the utilization of AI in the design of a children’s interior space can enhance the efficiency, creativity and decision-making. The design brief gave students the freedom to select the context in which the project would be implemented - within any type of larger facility, such as a library, office building, community center, educational institution, etc., but delimited the target group - children aged 3 to 10 years and the designated area - 500 sq. m. The design should comply with safety regulations and guidelines for children’s

spaces, and to consider the creation of an inclusive environment for children of diverse backgrounds, abilities and interests.

2.4 AI tools selection

The AI engines used in this collaboration can be categorized into two groups:

1. Conversational AI Models: These models are designed to engage in natural language conversations, answer questions, and provide information. They generate text-based responses in a dialogue format. Conversational AI models, such as OpenAI's ChatGPT, Google's Gemini, and FabriAI, assisted students in their primary and secondary research. These models supported tasks such as gathering information, analyzing data, creating mind maps, and discovering project opportunities.
2. Image AI Models: These models are designed to generate images based on text prompts or input images. They specialize in creating visual content through AI-driven artistic interpretations, translating textual descriptions or visual inputs into detailed and unique images. Image AI models, such as DALL-E 2, PlaygroundAI, and VizcomAI, enabled students to rapidly generate conceptual images of their design ideas. These tools facilitated an iterative process, allowing students to explore various design variations efficiently.

2.5 Cultural dimensions

One of the major benefits of the implementation of the COIL project is that it enriches the students' educational experience by providing opportunities to learn about other cultures, establish cross-border partnerships and exchange knowledge to achieve the project goals in a cross-cultural context. Students become familiar with diverse cultural perspectives, thereby fostering their identity as global citizens who are open-minded and respectful toward differences. This exposure broadens their understanding of the world and enhances their abilities to collaborate effectively in an increasingly interconnected and multicultural environment.

A particularly interesting challenge was addressing the diversity of cultural preferences among students and the inherent biases in AI models. Overcoming these biases and synthesizing new interpretations required careful consideration. AI models generate results based on the data on which they were trained. Students often draw inspiration from their own cultural backgrounds, which can influence their preferences. To address this, student groups were intentionally mixed to maximize the diversity of opinions. Additionally, they were encouraged to use multiple AI engines to explore the differences in the outputs and develop their individual proposals. Similar to human perspectives, AI engines can be directed to generate work based on specific inputs, such as reference images used as style guides. This approach facilitated a richer exploration of diverse interpretations and perspectives.

2.6 Project implementation

The dynamics of the collaboration began with an ice-breaker activity in which teams, composed of students from both universities, shared information about themselves. This is an important step in the formation of a friendly and inclusive environment. Through learning about each other's background, interests and motivations students build mutual trust which can further facilitate teamwork and enhance conflict resolution. To structure the course and foster collaboration, we employed modern presentation and discussion tools, which generated an accessible and productive class experience. We utilized MIRO as an online collaboration whiteboard platform, enabling students to upload their work, engage in discussions, and receive feedback from their peers. It allows users to create and share visual content such as diagrams, mind maps, and sticky notes, enabling teams to work together seamlessly from different locations. Using Discord, we facilitated a space for real-time meetings, chats, and discussions. Through the use of open groups and public discussion rooms, we created an inclusive environment where all students, rather than just individuals, could benefit from collective insights. This platform allowed faculty to address individual group questions and, if deemed valuable, share these responses with all students. Considering the time zone differences, Discord was an instrumental tool in ensuring effective and timely communication across the course. For the synchronous meetings we used Zoom. Zoom offers significant advantages, such as allowing participants to share their screens and granting faculty remote access to interact directly with software on students' computers. Additionally, Zoom enables the creation of online recordings of the meetings, which can be accessed for later review. Zoom was instrumental in enabling students to present their work, facilitate discussions, provide feedback, and receive training on the use of AI engines. Since all AI engines used were accessible online, students were introduced to AI as a research and design tool through live demonstrations during class. This approach allowed faculty to create a workshop-like environment and provided students with the opportunity to experiment with the tools. Based on students' questions communicated via Discord outside of class, additional video tutorials were recorded using Zoom and made available online to ensure students could review the material as needed.

The actual work on the project began with thorough research on the target users, their specific needs, interests and preferences. The analysis encompassed both the functional and emotional aspects of the space to ensure it will be interactive, inclusive and appealing. Key considerations included safety and ergonomic requirements, sustainability, technological integration, etc. To organize and visualize the research findings, students utilized ChatGPT within Fabri to make mind maps, which facilitated the comprehension of the various factors that impact the design of the children's space (figure 1). In the conceptualization phase, students began brainstorming ideas

about the functionality, interactivity and user experience of the space. They were encouraged to experiment with the various AI tools that had been introduced to them earlier to generate concept images. We required that they document meticulously each stage of the design process, including research findings, design iterations, AI tools used, and insights gained. Moreover, we asked students to reflect on the results obtained and note the benefits they observed, as well as the challenges and limitations they encountered in the AI-generated renders.

For the final presentation of the spatial concepts AI engines like VizcomAI were used to produce more accurate representation of the ideas. These AI-generated visualizations were combined with 3d models and other conventional techniques to create a more refined and comprehensive design. As a final deliverable each team submitted a visual diary showcasing all variations of the design developed throughout the process, including all the visual representations of the design concept and its iterations, as well as the prompts and the AI tool used (figure 2). Students provided descriptions explaining the rationale behind each design variation and the evolution of ideas leading to the outcome.

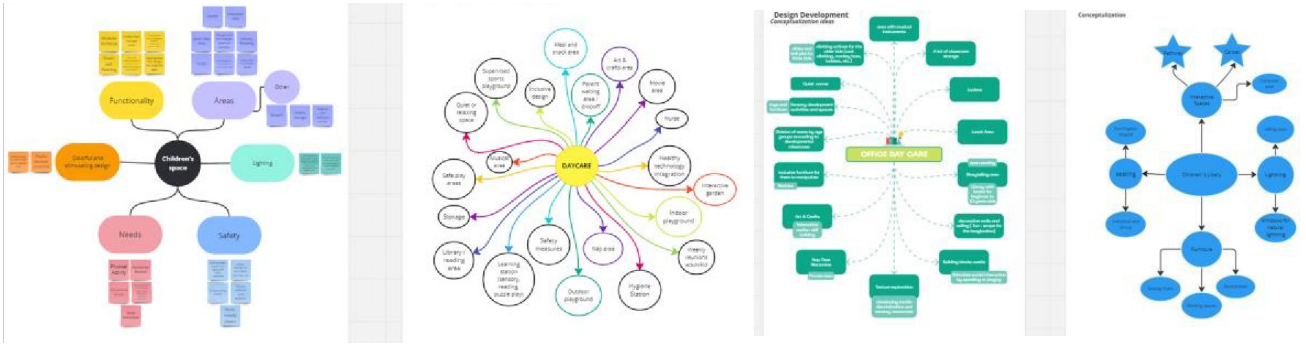

Figure 1. Mind-maps developed by students



Figure 2. Visual diaries documenting the design process

2.7 Results

Research data were collected during the project development using a multi-faceted approach. Through observations, we gained real-time insights into students' interactions, team dynamics

and behavior. The visual diaries prepared by the students offered a narrative record of their design process, while surveys and reflection writings done at the end of the collaboration provided an opportunity to obtain information on students' thoughts and learning outcomes expressed in a more personal and detailed manner.

The first interesting finding was that though the students were familiar with various AI tools, the majority of them have not used these technologies in an integral way for design projects. In that regard, the children's space project contributed significantly to their understanding of AI technologies in design and their potential application. This is evident from the following reflections written by students: "It [the project] helped me completely since I had never used those programs before, I learned from scratch and I think I did a good job," and "[w]e gained a deeper understanding of AI technologies in design. Previously, I was unsure of their practical applications, but now I realize how effortlessly they can be employed. It's remarkably convenient to generate quick, visual representations of projects, facilitating pre-visualization with ease."

In their evaluation of the overall experience of the COIL project, students shared the following opinions: "The AI generator was amazing, I had never done that, and I really enjoyed it," and "I liked it very much. It was a different approach to interior design, and I actually found it very helpful to use AI tools to my advantage to create a space in a more efficient and fast way."

Besides the speed at which AI produces images, among the AI features which students appreciated the most, were the ability to overcome brainstorming fatigue, AI capacity to generate unique images, the use of traditional image montage concepts to produce AI renderings, and its effectiveness as a research tool for data finding and analysis. The excitement with which students approached the project was evident in their enthusiastic participation, willingness to experiment with the different AI tools and their proactive engagement in the collaboration. Some unexpected results emerged such as a proposal for an AI-generated business model of an office daycare. This showcased student's ability to think creatively and their disposition to explore further the application of their design concept with the help of AI. When asked to describe the most engaging and enjoyable aspects of the project students indicated: "I really liked that we got to explore different types of AIs and working on the project with no expectations on the outcome helped me truly explore the different features of the AIs." However, the ability to write prompts to feed the AI engine was observed as a major obstacle in obtaining results relevant to the project specifics. Inappropriately written prompts led to inappropriate AIgenerated renders, so students revised them using ChatGPT to clarify and refine their requests. These iterations helped students learn how to better communicate their design intentions in a written form which subsequently improved

the quality and accuracy of the visualizations. Furthermore, students evaluated positively that we encouraged them to utilize the same prompts with various AI tools and to compare the outcomes: “Seeing the results of the prompts that we made were very interesting, and using that same prompt for other AI pages was very cool and pleasing to see how each of them managed to create different aesthetics and different proposals with the same text.” Another student wrote: “I really liked that we got to explore different types of AIs and working on the project with no expectations on the outcome helped me truly explore the different features of the AIs.”

Despite the overall positive opinion of the use of AI in design, students indicated some shortcomings such as limited options for floor plan generation, isometric drawings, furniture proposals, controlling the lighting of the scene, etc. However, the fact that they realize the constraints of AI tools, demonstrates their awareness of the importance of critical thinking and knowledge on design principles for decision making. “We looked for visual ways to reach the desired results and although the AI pages gave an approach, it could not give an exact representation of what we wanted for this space, but we really enjoyed being able to experiment and find these tools as a basis for brainstorming and moodboards”. Another aspect which students disliked was that each AI engine has a different visual style which can be confusing and requires familiarization with the specific interface to fully utilize their potential.

In regard to their experience of working in intercultural teams, some students reported difficulties related to communication, especially outside class hours, as well as challenges stemming from the differing opinion of their partners. Nevertheless, they acknowledged the necessity of effective communication for the success of the project, as expressed in this student’s reflection: “Collaborating as a team for this project was exciting as it highlighted the importance of communication and taking advantage of the strengths of each team member.” In order to overcome the challenges of the collaboration students were actively engaged in discussions and critical reasoning to reach a consensus, which contributed to the development of communication skills and a deeper understanding of diverse perspectives in the design process.

Lastly, with this project students not only overcame their uneasiness to work remotely with designers from different countries, but also embraced the opportunity to experiment with new technologies. This experience helped them build confidence in integrating AI in their design process: “Before COIL I thought of AI as scary to some level because of how it’s really becoming better and better every day. After COIL I feel at ease and happy to have learned a new area of design and acquired a new work tool.”

3. Discussion

3.1 Project impact

The children's space design COIL project was our first attempt to implement AI in a structured way as a cocreation tool in the development of an educational design project. Motivated by the question whether our students are prepared for the new AI reality of the design profession, we designed a learning experience which encouraged them to experiment with various AI tools and explore their potential in transforming traditional design methods.

The results highlighted a positive impact on the design workflow and acquisition of AI literacy.

1. Impact on the design workflow and efficiency.
The impact of AI on modernizing the design workflow was significant. AI's ability to produce results in seconds enabled students to work more quickly and focus on creative aspects rather than labor-intensive tasks. Additionally, AI tools allowed students with less developed skills in manual sketching or 3D modelling to generate high-quality visual images. This is crucial because, as designers, our primary task is to produce effective solutions rather than art, and high-quality visuals are essential for successful project storytelling. To remain competitive, the field of design must continually innovate and adapt to new processes. Imagegenerating AI engines offer an attractive additional tool for designers, providing a workflow that can be significantly more efficient and effective at times. However, these engines still rely on the data provided. Thus, it is crucial to understand that AI does not replace the need for students to learn manual sketching and 3D modelling. For tasks such as 3D rendering and the development of conceptual images, which are very laborintensive, AI rendering now offers a workflow that is faster, more intuitive, and produces significantly better visual results.

To produce initial conceptual images as part of the initial project exploration, students utilized DALL-E 2 and PlaygroundAI. By using basic text prompts, students were able to contextualize their envisioned topics. The use of various AI models and style descriptions allowed them to explore different artistic interpretations and visual styles. This process was instrumental in understanding AI biases and overcoming inherent user preferences.

VizcomAI played a significant role in modernizing the workflow for developing and exploring specific design solutions. Students were able to combine basic hand sketches, 3D model screenshots, and traditional photo collage techniques to instruct the AI in producing high-quality architectural renderings. By using layers and quick sketches for furniture or human figures, students created realistic representations in seconds. The use of reference images helped maintain desired visual styles and address AI biases. This iterative process facilitated effective exploration of different design solutions. Notably, VizcomAI offered a very low learning

curve for students and significantly enhanced productivity compared to the traditional workflow of manually 3D modelling interior spaces and their assets. While manual 3D modelling remains essential for final project delivery, it is less efficient during the exploratory phase.

2. Acquisition of AI literacy.
Undoubtedly, AI augments the traditional design process by transforming how creativity emerges from text to generate a visual representation of design ideas. In this new AI-human collaboration, the competences of the designer to write prompts and to critically analyze the AI-generated renders are crucial. Our students discovered the importance of breaking down the design brief into distinct components that can be communicated to the AI in a concise, unambiguous and specific way to ensure the outcomes would closely align to their expectations. Through continuous experimentation and iteration, they refined their prompts to improve the quality and relevance of the AI-generated renders. The self-regulated learning process enhanced students' understanding of the capabilities of AI but also aided them in recognizing the value of the human perspective. Students acknowledged that creative criticism plays an important role in evaluating and analyzing whether the image proposed by AI aligns with the design brief and to what extent it corresponds to the designer's vision and the design goal.

Furthermore, in this collaborative endeavor it was important not only for the individual to appropriate knowledge on how to incorporate the use of AI in the design process, but also how the team is engaged with AI and what joint actions can be taken to achieve the desired results. Integrating the views of the others and exploring alternatives to respect the differences are some of the approaches towards enhancing teamwork.

3.2 Limitations, challenges and future work

From a pedagogical perspective, the systematic implementation of AI in the project development helped us analyze both its potential limitations and strengths in the preparation of our students. For example AI aided the exploration of unexpected concepts, color schemes, age-appropriate design elements but failed to optimize the spatial arrangement and comply with codes, ergonomic and safety requirements. In addition to functionality, aspects such as design's emotional impact and sustainability are considerations which rely mainly on human critical judgement and expertise. We obtained valuable insights on the capabilities of the students to interact with AI tools which gave us ideas about areas to focus on in future projects. A strategy to better support students in utilizing AI in their creative process is to include writing exercises to improve the accuracy and clarity of their prompts. This will ensure a more relevant and effective AI-generated output and will equip them with confidence in troubleshooting unexpected results. Additionally, the incorporation of

activities to evaluate AI-renders and compare them against design briefs and project goals, will further enhance students' critical thinking skills. While AI produces excellent renders, it falls short in developing traditionally needed media in interior design, such as plan views, sections and axonometric drawings, which demonstrates that AI cannot replace the work of the trained designer.

One of the challenges we encountered was determining how to evaluate whether the students have achieved AI literacy and the level of mastering the competencies required to work effectively with AI. We used traditional evaluation indicators such as depth and relevance of the research, creativity and originality of the design concept, functionality and aesthetics of the design, detail and accuracy of the design documentation. However, to ensure comprehensive evaluation of the AI-aided design process and outcomes, we consider that the assessment criteria need to be refined and updated. Providing a reliable method for the evaluation of the AI literacy of design students, including prompt formulation, critical evaluation of AI outputs, ethics and responsible use of AI, etc. could be the objective of future research. Though the ethical considerations of the utilisation of AI as a design tool were outside of the scope of the presented study, we recognize their importance. We plan to provide special guidance and recommendations for our students to address these issues in subsequent projects.

4. Conclusion

Contrary to the belief that AI might threaten creativity, with the implementation of the children's space project we demonstrated that it can foster both individual and collaborative creativity and can be successfully used as a research and conceptualization tool in design. AI tools offer numerous advantages that modernize the design process. However, it is important to note its drawbacks and limitations, which highlights the necessity of human criticism. We can conclude that students developed essential skills to interact effectively with AI, which respectfully had a positive impact on their design skills. We exposed them to a new environment where they had to solve problems in a new way which inherently requires a creative approach. Furthermore, student's unique skills and different cultural backgrounds contributed to the creation of a richer project. The overall positive evaluation we received as feedback from the participants emphasized that the project is timely and quite necessary. As one student shared: "AI is the future so it makes sense that we start learning about it in class, it was a good way to learn about actual things, not just a program." We will continue observing how AI technologies mature to explore further the opportunities it offers for design education and the design profession.

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“DESIGN FOR CHRONICITY: THE CASE OF PHARMACEUTICAL PACKAGING IN MEDICAL TREATMENT FOR ELDERLY”.

Mariel Domínguez Molina.

ABSTRACT | As the world’s population ages, people will tend to live longer but also face treatment for a series of chronic conditions for a longer time. In an era distinguished by rapid technological advancements and shifting demographics, the relationship between healthcare, empathy and design takes on a new significance level. In many cases, due to variable social dynamics, the youngest tend to grow further away from the elderly, making many young professionals unaware of the needs of elderly individuals, which reflects less empathy and understanding of the issues around the medical care of this demographic. In diverse contexts, design for the surroundings of the elderly patients is not as curated as the ones for children or younger population, leaving these group excluded from information exchange and participative research processes.

One relevant sector for elderly population is the pharmaceutical packaging design, that does not seem to keep up with the technical development in the field; its concepts have changed at slow pace in the last hundred years with punctual changes mainly around production efficiency and branding; leaving unattended issues such as physical and cognitive changes in elderly population, as well as the relevance of its inclusion on a long-term routine in the emotional states of patients with a chronic disease. In the same way, those few changes have not attended enough the cognitive ergonomics regarding the caregivers, even if an unclear communication could influence the mental effort and human error while handling these products. This stresses the need to reframe medical packaging considering a wider diversity of perspectives, and to boost the role of design as gatherer and intermediary between scientific improvements and the subjective experiences of individuals around the healthcare system for a more empathetic and user-centred approach.

In the present research, an explorative non-experimental transversal study was conducted, taking as case study a group of international design students at a master level to develop concepts of a variety of pharmaceutical packaging followed by the application of a questionnaire to register the possible barriers and opportunities young designers might have when approaching ageing and healthcare subjects, also to compare their insights from users and caregivers, in order to understand differences and common places that could later be useful for transgenerational inclusion.

By opening new research lines around the physical, cognitive, emotional, and social dimensions of users with chronic conditions, with better representation of user groups, we could improve the experience around medical treatment and possibly potentiate compliance. This can only be possible with the collaboration of different professionals in the related disciplines, such as gerontologists, healthcare professionals, users, and caregivers. Each stakeholder's unique perspective and expertise are crucial to ensure that medical packaging design meets the diverse requirements of each stage of the packaging's short life cycle.

KEYWORDS | CHRONICITY, GERONTODESIGN, DESIGN FOR AGEING, DESIGN FOR HEALTH, PHARMACEUTICAL PACKAGING

1. Introduction

This work was born from the observation of many barriers that elderly people need to face to go along with their routines, that younger groups take for granted; sometimes these users develop strategies or purchase a variety of tools to help them overcoming them. When observing the objects and services available for elderly individuals, particularly those who present one or more chronic conditions, it became clear that the options in the market are not thought to suit the diversity of this demographic, as it is for younger groups... many products were difficult to purchase and expensive, but also disruptive of the spaces of the users. Visiting an elderly person with various chronic conditions and facing also disabilities is an emotional demanding experience, not only for the shadow of sickness that all the aid objects bring into the space but because it is present in many moments of the daily routine, one example being all the strategies and devices made to help the user to manage their medical treatment routine. Hence the question of why are these objects like this? Who and how is designing them? Why aren't we as designers taking more steps to address it?

The second reflection came when observing young professional designers while projecting pharmaceutical packaging. It was quite evident that only a few of them were aware of the difficulties patients face when dealing with illness, and the lack of interest to project for elderly patients, even if they were the most common group of users also to their knowledge. Even the ones interested in common conditions present in elderly population, there was a big difficulty to understand their barriers, their expectations and perspectives, which brought the question of how can we learn to better design for this group, was it a matter of technical knowledge or was it a matter of empathy?

This work aims to explore the complexities of pharmaceutical packaging from a design perspective, considering the perspectives of multiple stakeholders, and most of all, boarding the issue of the users from a holistic perspective, considering the 3 mains spheres of the patient: physical, mental and emotional. The objective is to gather contextual knowledge that can inform the design field by incorporating insights from various

stakeholders and disciplines. By addressing issues such as non-adherence and combating ageism through empathetic and usercentric solutions, this research seeks to find what could be useful touchpoints between the various disciplines involved in safeguarding the well-being of seniors, particularly those in vulnerable situations. This holistic approach not only has the potential to reduce healthcare costs but also to significantly improve the quality of life for the elderly.

2. Ageing Population and Healthcare

Global demographic trends indicate a notable and sustained increase in the population aged 60 and older, which signals a significant shift in the worldwide population structure. This demographic shift, driven by advances in medical science and improved living conditions, is expected to result in the elderly constituting a growing percentage of the population in the coming decades.

Such changes have far-reaching implications across various sectors, including healthcare, social services, and consumer industries. There is an escalating demand for products, services, and infrastructure tailored specifically to meet the unique needs and preferences of the elderly. Addressing these challenges is crucial not only for promoting the well-being of seniors but also for economic sustainability related to their healthcare.

However, this increased longevity does not necessarily equate to better health or quality of life. In developed countries, while people live longer, they are not always healthier and may face physical or mental impairments over time. This scenario calls for better coordination across various sectors and the implementation of new systems that can provide an adequate response to the needs of elderly patients, that are not by any means a uniform group of users, only by age groups and situations of chronicity, there can be important differences in their needs and preferences, (eg) according to the ICH E7 guideline on clinical trials in the geriatric population, older people can be divided into three age ranges: 65- 74; 75-84 and 85+ years (EMA, 2010) but the condition of health or frailty will further create important differences between this groups.

By reducing the risks of errors and the progression of chronic conditions, we can help maintain functional abilities, empower individuals. A holistic approach would support healthier and more independent aging, ultimately reducing the burden on healthcare systems. Older patients are a sector particular concern due to some common deficits in physical or mental dexterity and memory, and the problem can be accentuated by a higher number of medications taken simultaneously (Cramer, 1998).

Inclusion of seniors is increasingly recognized as crucial for fostering a more equitable and compassionate community. As populations age, it's essential to value the contributions of older adults, recognizing their wealth of experience and knowledge. Efforts to

include the elderly often focus on improving accessibility in public spaces, and care facilities however, and ensuring that social services are responsive to their needs, but they should also include the representation of this population in research, particularly in the healthcare sector. Furthermore, policy frameworks and inclusive practices that accommodate aging populations can enhance their emotional state and quality of life, while also addressing the economic challenges associated with aging.

2.1 Design & Healthcare for elderly

Design is a dynamic discipline, characterized by a continuous cycle of evaluation and evolution, influenced by the interaction between products and users. The future of "patient centricity" that this industry is beginning to explore, needs a series of coordinated efforts and the progressive alignment of multiple stakeholders – from inside the healthcare system- but also outside of the traditional related fields, and this can only be achieved by collaborations and trans disciplinarity (DuPlessis et al. 2017). Product design must incorporate a synthesis of technical, scientific, and pragmatic knowledge to address various levels of interaction.
In recent years, there has been a growing emphasis on the non-physical dimensions, aiming not only at aesthetic appeal but also at addressing user needs and behaviours in the psychological sphere.

Improving ways to attend to the growing elderly population is a big concern for health systems and governments around the world, where that group is already reaching around 30% of the population in counties as Japan. As market size, seniors were already estimated to represent a global expense of US $1.4 trillion before 2025. (Majerol & Carroll, 2018). The pharmaceutical industry is particularly vital for this objective, since seniors are the principal consumers of medications.

It has been estimated that the majority (78%) of patients older than 65 years are on medications, and that 39% regularly take five or more prescribes drugs (Jörgensen, 2001) while up to 90% patients in this age group are reported to also take over-the-counter drugs. (Hanlon, 2001). Despite that, communication between pharmaceutical companies and elderly users often lacks a two-way exchange. This results in products, devices, and communication features influenced more by technical requirements, regulations, and economic drivers than by user-centric considerations. This gap is evident in pharmaceutical packaging, which should seamlessly integrate elements of graphic, industrial, and communication design but often fails to meet the specific needs of patients with chronic conditions, particularly in elderly age.

2.2 Chronicity

Chronicity is associated with declining aspects of life such as autonomy, mobility, functional capacity, and relationship life, resulting in increased psychological stress, hospitalisations, the use of resources

(healthcare, social, and welfare), and mortality.

Chronicity can be defined as the continuation of disabilities arising from an illness. (Strauss 1980) Many organisations have defined the duration of chronic conditions as at least 6 months, even if it has been contrasted by the opinion that no standard duration can be applied since each condition is unique, as well as the person experiencing it. (Clarke,1994). Generally, the onset of chronic conditions is related to terms such as insidious and gradual, having age as a relevant condition for risk, even if chronicity is not confined to older populations. (Hoffman, 1996).

It is estimated that approximately 70-80% of global healthcare economic resources are currently spent on managing chronic diseases; this becomes even more concerning the most recent epidemiological projections, according to which, by 2020, they will represent 80% of all diseases worldwide.

The care objectives for patients with chronic conditions, as they cannot be directed towards cure, are aimed at improving the clinical picture and functional status, minimising symptoms, preventing disability, and most of all, enhancing the quality of life, therefore design can contribute by paying attention to the factors that will improve different areas of their daily routine and contributing to a user-friendly and non-stressful environment.

2.3 Medicine intake as a daily ritual

Making an analogy between medicine intake -in which pharmaceutical packaging takes part- to other kind of holistic ritual would help considering other aspects of its significance. Just as rituals engage all the senses and affirm our connection to our surroundings and ourselves, so too does medication adherence engage a patient's trust and even faith -we could call it- in the prescribed medicines and the medical devices. Historically, sacred art and rituals served multiple purposes: for patrons, they displayed power; for priests, they symbolized authority; for the church, they educated the populace; and for the public, they provided means to understand and approach the divine, something they could not see. Similarly, the experience of taking medication is not just about the physical act but involves a kind of deeper, emotive engagement that influences body responses, hence the placebo effect. Chronic patients adhere to their medication regimens with a form of ritualistic devotion, hoping for positive outcomes despite uncertainties and any times without informed knowledge of the physical and chemical processes and reactions related to their treatments.

2.4 The Role of Cognitive Ergonomics, Information Design, and Neuroaesthetics

To address these dimensions, it would be important to incorporate principles from cognitive ergonomics, information design, and Neuroaesthetics into pharmaceutical packaging design. Cognitive ergonomics focuses on understanding human cognitive

processes and how they interact with the environment, which is crucial for designing packaging that is easy to use, especially for individuals with cognitive impairments common in the elderly. Information design plays a role in organizing and presenting information clearly and accessibly, which is vital for ensuring that medication instructions are easily understood and followed.

Neuroaesthetics, the study of the neural basis of aesthetic experience, suggests that design elements that are visually pleasing can enhance user engagement and satisfaction. This is particularly relevant for pharmaceutical packaging, where attractive design can improve the user experience, potentially enhancing medication adherence.

When considering the physical, mental, and spiritual dimensions in the context of handling medical packaging and taking medical treatment, each dimension offers a distinct perspective on the experience.

Physical Dimension:
Physically, this involves the practical aspects of managing medication, such as opening packaging, measuring dosages, and administering the treatment. It requires manual dexterity and may be influenced by the individual's physical condition, such as age, disability, or illness.

The physical effects of the treatment, such as its efficacy, side effects, and interactions with other medications, are key considerations. Maintaining a routine, managing symptoms, and adhering to prescribed doses are critical for physical health and recovery.

Mental Dimension:
The mental or cognitive dimension involves understanding instructions, remembering to take medication on time, and staying informed about the treatment regimen. It includes abilities like memory, comprehension, and decision-making skills. It overlaps with the emotional state that include coping with the stress, anxiety, or depression that may accompany illness or treatment. It also involves the mental discipline to adhere to treatment plans, understanding the significance of compliance, and being aware of potential side effects.

Emotional / Spiritual Dimension:
Handling medication can be linked to beliefs about health, healing, and well-being. It might involve rituals, prayers, or other practices that a person associates with their treatment. This dimension involves a person's sense of hope, faith, or purpose in facing health challenges. It might involve reflecting on the meaning of illness in their life, seeking comfort from spiritual beliefs, or engaging in practices that support emotional and spiritual well-being.

These dimensions are interconnected, influencing each other in complex ways. For instance, a positive mental attitude can improve adherence to treatment and potentially enhance physical recovery. Similarly, spiritual beliefs can provide comfort and reduce stress, impacting both mental and physical health. Understanding these

dimensions helps in providing holistic care that addresses not just the physical aspects of treatment but also the mental and spiritual well-being of the individual

3. Materials And Methods

This study was conducted in three distinct stages to explore pharmaceutical packaging design with a focus on elderly users. The stages were: (1) Qualitative Semi-Structured Interviews, (2) Observational Case Study, and (3) Quantitative Questionnaire. Each stage was designed to gather comprehensive insights from a range of stakeholders, including professionals, users, and designers.

Stage 1: Interviews

Qualitative Semi-Structured interviews with 10 open questions, that took place involving a total of 16 participants with the objective of obtain: first the perspectives of the users and their experience and to identify barriers and needs detected by them and their caregivers aimed to understand their experiences with pharmaceutical packaging, including challenges, barriers, and suggestions for improvement. Second, to understand the perspective of diverse actors involved in the pharmaceutical industry to gather insights on the current state of pharmaceutical packaging, focusing on their perspectives regarding design, functionality, and user needs. The participants were:

a. Professionals of the sector: 2 nurses, 2 doctors, 3 pharmaceutical industry professionals and 1 inclusivity expert.

b. Users and Caregivers: 5 elderly individuals over 60 years old with chronic conditions requiring daily medication, and 3 non-professional (familiar) caregivers assisting elderly individuals in home settings.

The interviews were conducted with both professionals and users by separate, in the case of group a, the by electronic means; the questions were sent one day in advance (by request of many of the professionals that wanted to prepare and read the questions in advance) and then, according to the schedule availability of the interviewees, the answers would be communicated by WhatsApp or Google Meet calls.

The interviews with users and caregivers took place mainly in person, since it was more comfortable for the users, and this environment allowed further observations or dialogue aimed to understand their experiences with pharmaceutical packaging, including challenges, barriers, and suggestions for improvement.

Stage 2: Observational Case Study

The study involved 60 international master's programs for postgraduate students with bachelor's degree on various fields of design. The participants, aged between 22 and 42 years old (with 90% between 22 and 30 years old), coming from 20 different countries. A mixed-methods approach was used to

observe the students' design processes and perspectives during one semester in order to gain insights into students' views, interests regarding packaging and the healthcare field.

a. Traditional Packaging. Students presented traditional packaging from their cultural backgrounds to provide insights into cultural values and perceptions to observe their familiarity with the packaging field and their take on local traditions and aesthetics.

b. User Research Approach: Students' methodologies for user research were observed to evaluate their interest and empathy levels towards different groups of users, as well as their research skills concerning the field of healthcare, users with brief or chronic conditions. Students' final design proposals were assessed for relevance to the target users and the technical depth of research into healthcare and production processes.

Stage 3: Quantitative Questionnaire

A 10-question questionnaire was distributed in both digital (Google Forms) and printed formats. This approach ensured accessibility for participants with varying technical capabilities. The questions addressed respondent demographics, perceptions about the elderly, and perceptions about pharmaceutical packaging. The questionnaire was first administered to the population involved in stage 2 (design students), with participation being voluntary. Subsequently, it was distributed to a similarly sized randomized sample to compare response trends across different professional fields and age groups. It was not applied to the same group of users of the interviews to not influence their point of view. A total of 120 individuals responded the survey.

Selection of Survey and Questionnaire Method

Since surveys are standardized tools for efficiently gathering large-scale data, they can offer insights into sample or population characteristics (Meneses & Rodríguez-Gómez, 2011). The questionnaire used in this study was designed to collect structured quantitative data, facilitating statistical comparisons of relevant variables, in this case, the Likert scale, a widely used instrument for measuring attitudes, was employed as inspiration. The scale involves presenting statements to which respondents indicate their level of agreement or disagreement, helping to assess beliefs, behaviours, values, and ideals. Reliability of the Likert scale improves with more response options, typically peaking around seven alternatives (Dillman, 2007).

- Design students
- Design professionals
- Healthcare professionals
- A randomized control group comprising individuals from various occupations and age groups

Methodology:

· Development of statements and response options

· Application of the scale

· Scoring and data entry

· Generation of a database

· Calculation of scores and frequencies

· Preparation of graphical representations

· Response alternatives were translated into numerical values for processing by software.

Data Analysis Process
Data entry, processing, and analysis were performed using Google Forms, Microsoft Excel, Google Sheets, and SPSS (version 10.0). These tools enabled systematic organization, analysis, and interpretation of the data, providing a comprehensive understanding of the research findings. The methodology integrated qualitative and quantitative approaches to comprehensively address the complexities of pharmaceutical packaging design for elderly users. By engaging with professionals, users, and design students, the study aimed to identify key areas for improvement and innovation, ultimately contributing to enhanced user experience and medication adherence.

4. RESULTS AND DISCUSSION

S1. INTERVIEWS

Pharmaceutical Industry Professionals

Not all pharmaceutical companies invest sufficiently in research and development focused on patient experience, particularly in packaging. Effective packaging design requires interdisciplinary collaboration, including engineering, physics, chemistry, and design. These disciplines ensure that the packaging protects the product and withstands external factors such as climate, humidity, and transportation conditions, ensuring the medication reaches patients safely and effectively.

Design has the potential to significantly enhance the patient experience. However, there are few designers specializing in the pharmaceutical industry. According to these experts, many designers lack knowledge of the technical processes in the Pharmaceutical Industry, but also sometimes of printing processes on specialised materials, which can result in impractical designs. Integrating design with other disciplines can create a cohesive and effective user experience, aligning aesthetic appeal with functionality and regulatory compliance. Some of them agreed in the fact that the patient profile is a critical factor in packaging design, but not all of them.

Patented medications, which are often more expensive, typically feature higher quality packaging materials and sophisticated designs aimed at wealthier consumers. In contrast,

generic medications tend to have simpler, less expensive packaging.

Children's medications were a critical factor for all of them, since everyone in the industry seems to have this factor imprinted on their policies, especially for OTC drugs, that often feature colourful and appealing designs to make the experience less daunting. According to these experts, designers should consider several key factors when creating pharmaceutical packaging, including ease of printing, simplicity, target user demographics, company branding, legibility of important information, and adherence to regulatory standards.

Users

Talking in an interview with older adults is complicated because, although they have no problem in sharing their opinions on various topics, they often provide little information about their own lives and view situations from a less fatalistic perspective than younger people, and they also will try not to speak ill of their family, possibly because previous generations were more protective of their privacy.

Therefore, most of what is learned comes more through observation and interaction than from questions expecting specific answers. Generally, the cognitive abilities of all the interviewees were optimal, with the only difference being noticeable after age 75. At this point, they tended to confirm details once or twice or felt overstimulated or pressured by their surroundings when they couldn't respond as quickly to demands that younger people handle more fluidly.

Regarding objects in their environment, older adults show a greater attachment to items than younger people. For instance, they might care for and "treasure" a stuffed animal that reminds them of their grandchildren, or a photo frame that holds a picture of a significant life event. Most of them steer away from minimalism, preferring to keep many objects organized and "in sight. Interestingly, professions do not seem to correlate with reported levels of empathy. Listening to their life stories or observing their actions, they did not appear particularly empathetic. It seems that in this survey, self-reported empathy is more about one's self-concept rather than age, gender, or occupation.

It is also noteworthy that those over 60 do not prefer to work for or with people their age. All mentioned the importance of being in a good mood, being calm and happy, and avoiding conflicts or thinking about things that make them sad. They seek to make their lives more pleasant with small things that do not involve much cost or effort. They find satisfaction in having an environment composed of pleasant things, either for their aesthetic qualities or the memories they evoke. An interesting position not shared by other age groups is that they believe their age group is essential due to their experience and wisdom. However, they think that economic status is more important than age regarding relevance. Most of them share issues with

understanding instructions and, secondly, with possible ergonomic problems because they find it harder to make some fine motor movements, sometimes due to less sensitive hands, large fingers, or arthritis issues (none had severe arthritis, but some atrophy in the distal phalanges was noticeable in those over 70). In other cases, it's a vision problem, making it difficult to handle objects requiring precision. Some of them believed that packaging was designed in some way due to the recommendations of doctors and physicians, making them suppose that "it has it's reasons to be as it is right now".
Contrary to what might be expected, they rarely mention memory problems with medications at this stage. This is because, in many cases, the symptom or disease becomes part of a "new lifestyle" a term we use to describe the adjustments and coping mechanisms older adults develop to manage their health conditions, even if some of them even mentioned "a new identity" related to the diagnose. This 'new lifestyle' often involves incorporating medication routines into their daily planning and organization, making it a central part of their daily lives. They do not forget to take their medications, thanks to specific compensation strategies, but they do need to check several times if they are taking the correct medication and dosage.

Fig 1 y 2. Users and photographs of medication management they shared after the interviews



S2. Design Students Case Observation

In several instances, students who identified real user problems revealed that they had a family member who occasionally lived with them. This personal connection provided valuable insights, allowing them to focus on specific issues or needs. However, many other students conducted their searches randomly, selecting a medicinal product without familiarity with its primary users. some students aimed to raise awareness and destigmatize mental health conditions. However, their user research often oversimplified the patients' conditions and unintentionally reinforced the very stigmas they sought to eliminate. For instance, they portrayed depression patients as solely sitting or lying down, carrying antidepressants throughout the day while feeling ashamed to display the bottle. In other cases, teams struggled to deeply understand the user's condition. For example, they proposed a bracelet with small pills for Parkinson's patients to take orally, overlooking that this fine motor skill could be very challenging for these patients. Despite these challenges, some teams eventually developed better approaches for their final proposals. In contrast, projects that effectively addressed patients' needs, particularly in terms of ergonomics, showed more success. These solutions often focused on problems related to lack of sensitivity or dexterity, as well as visual decline. Such projects demonstrated a more straightforward and linear development process from start to finish. Overall, it was evident that most groups found it challenging to conduct interviews and maintain dialogues with much older individuals or those with health conditions. This difficulty suggests a need for new ways of learning how to approach more thorough research around healthcare issues and of transgenerational exchange and inclusion for creating effective and sensitive design solutions.



Figure 3. Collage of student works suitable for elderly patients with common chronic conditions. (Credits will be added after paper revision)

S3. Survey

Self-reported traits

Regarding empathy levels, we observe that non-student designers show the lowest empathy scores. However, this group does not show a significant deviation from the average empathy levels across different age groups. Specifically, individuals aged 18 to 24 exhibit lower empathy, whereas designers aged 25 to 30 demonstrate higher empathy, with some

of them being students as well suggesting a generational change on their perception. Notably, healthcare professionals rank highest in empathy, sensitivity, and empowerment, indicating their strong conviction on their capability to make a difference on their surroundings. Sensitivity scores vary less significantly, with design students showing the lowest sensitivity, contrary to expectations based on age or field. The findings suggest that healthcare professionals inherently possess more empathy, sensitivity, and a greater sense of empowerment compared to other professions.

Healthcare professionals or students demonstrated the highest empathy score (4.2058), reflecting the nature of their work. Design students and other fields reported similar levels of empathy (4.1969 and 4.1875 respectively). Design non-students had the lowest empathy score (3.9259) among the listed groups.

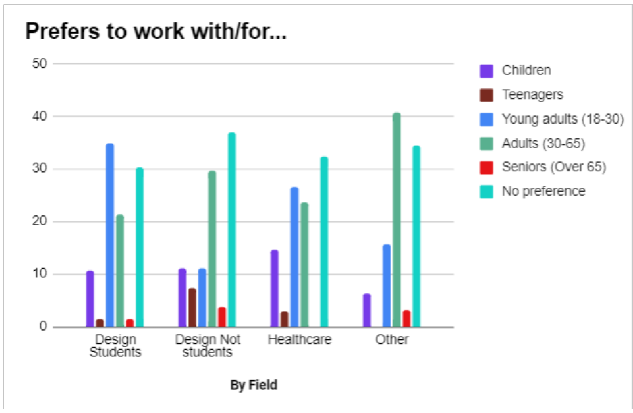
Perception towards elderly users

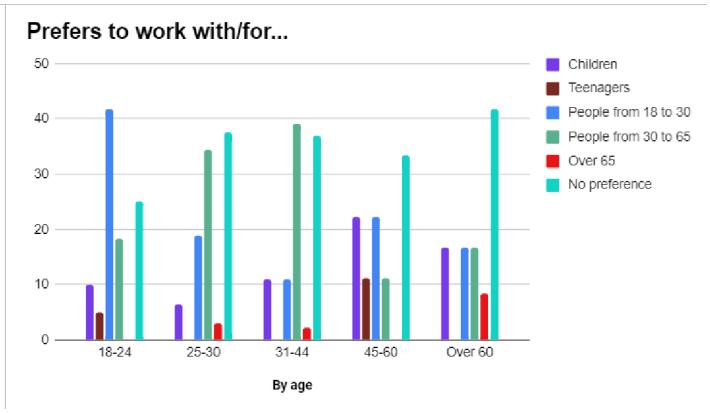
When assessing the perception of vulnerability in different age groups, designers believe that children are the most vulnerable. In contrast, healthcare professionals and others consider the elderly to be more vulnerable. Data segmented by age shows that the youngest individuals and those over 45 years old perceive children as the most vulnerable, while other age groups either see both as equally vulnerable and lean towards the elderly being more vulnerable.

Regarding cohabitation with elderly individuals, design students and people in their 30s are the least likely to have lived with an elderly person, correlating with their younger ages. There is no significant difference by profession in this aspect. Perceptions of when old age begins varying by field: design students typically believe old age starts between 60 and 70 years, whereas other groups, especially those aged 18 to 24, think it begins after 70 years.

In terms of attitudes towards working with different age groups, science students and younger individuals show a preference for working with young adults (18-30 years old). Adults aged 30-44 prefer working with their peers, but this preference diminishes for those aged 45 and older. Teenagers are the least favored group to work with across all ages, followed by individuals over 65, who also received low preference scores. Notably, a significant number of respondents expressed no preference, although their overall responses indicate a bias against working with people over 65. The importance of elderly individuals in society is perceived differently across groups. Non-students and healthcare professionals, along with people over 30, view the elderly as very important, while the youngest and design students tend to rate their importance lower. This discrepancy highlights differing perceptions based on age and professional background.

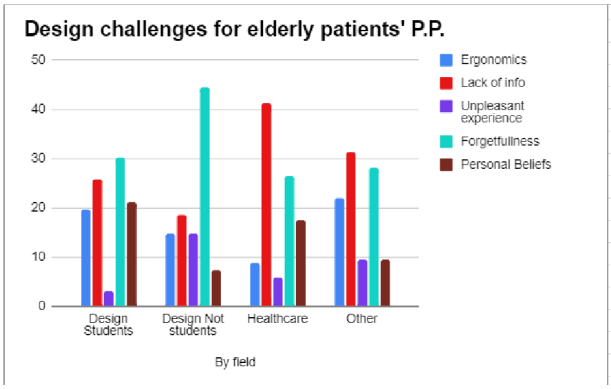
Perceptions on pharmaceutical packaging

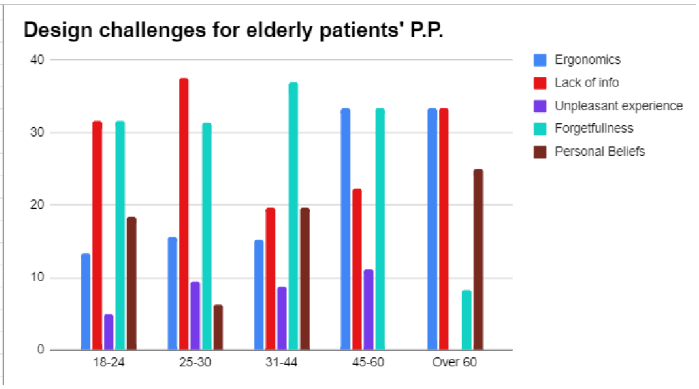


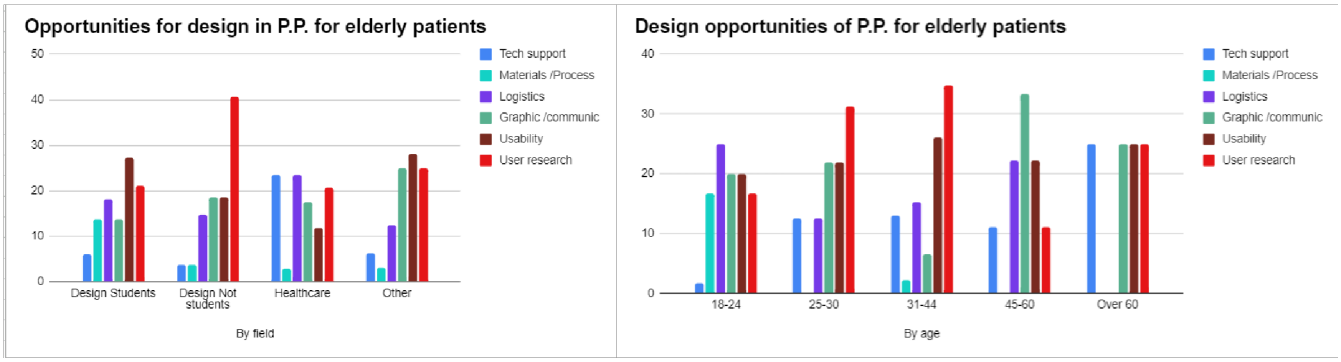


When addressing design challenges for elderly patients in pharmaceutical packaging, design students and non-student designers identify forgetfulness as the primary issue. This view is shared across almost all age groups. Conversely, healthcare professionals and elderly users emphasize the lack of information as the most critical issue, with ergonomics also being a significant concern for those aged 45 to 65. This divergence suggests that healthcare professionals and elderly users, who interact directly with medications, provide more accurate insights into these challenges compared to younger individuals and non-specialist professionals. In terms of opportunities for designing pharmaceutical packaging for the elderly, younger individuals and those aged 25-30 view logistics as a critical factor, while those aged 25-45, along with nonstudent designers, prioritize user research due to the insufficient understanding of this demographic's needs. Healthcare professionals and people over 60 show similar attitudes across all options, except for materials and processes, which they deem less important. This is likely due to the advanced state of the pharmaceutical industry in these areas. Technological support is also seen as a valuable opportunity by elderly users and healthcare professionals.

Notably, non-student designers and individuals aged 25-45 place significant importance on user research, while people aged 45-60 give higher importance to graphic communication, aligning it equally with other factors for elderly individuals.







Overall, these insights highlight the need for targeted user research and a focus on practical usability issues such as information clarity and ergonomic design to improve pharmaceutical packaging for the elderly.

5. Conclusions

Pharmaceutical packaging, though often perceived as a mundane element, takes on varied significance depending on the perspective of the stakeholder involved. For policymakers, it functions as a regulatory tool to ensure that the pharmaceutical industry adheres to standards and protects consumers. Pharmaceutical companies view it primarily as a protective casing that must meet regulatory requirements. For doctors, it serves as a reference for guiding patient care, while medical staff and nurses use it as an essential tool in their daily work. Caregivers see pharmaceutical packaging as a symbol of their dedication and attentiveness to their loved ones. For patients, it impacts their routines and environments and is integral to their self-care regimen. Despite its often-uninspiring appearance to designers, pharmaceutical packaging plays a crucial role that demands a deeper understanding and empathy towards medical personnel and patients. Medical professionals confront human fragility and health complexities daily, and even minor design flaws can have serious implications for patient health. This underscores the importance of studying how people interact with and perceive pharmaceutical packaging to improve its effectiveness.

The study highlights the multifaceted roles of pharmaceutical packaging, which vary significantly based on the stakeholder's perspective. For policymakers, it serves as a regulatory tool; for pharmaceutical companies, a protective casing; for healthcare professionals and medical staff, a daily work tool; for caregivers, a symbol of care; and for patients, a crucial aspect of self-care. This diversity underscores the necessity for designers to empathize with all stakeholders, particularly medical personnel who deal with the human aspects of healthcare.

Designers need to engage deeper on the research of the human and emotional dimensions of healthcare, collaborating with fields such as neuroscience to improve decision-making processes and simplify

visual communication. The analogy of pharmaceutical packaging to a "holistic ritual" akin to religious practices underscores its significance in patients' lives, suggesting that a more empathetic and multi-sensory design approach could enhance user experience and adherence. This research emphasizes the need for targeted user research and practical usability improvements, such as clearer information and better ergonomic design, to enhance pharmaceutical packaging for the elderly. It also calls for a more integrated, empathetic approach in design, acknowledging the diverse needs and perceptions of all stakeholders involved in the healthcare system. Packaging should be projected for two main fields of users boarding the three dimensions of their human experience, fostering decision-making, organisation and modularity for caregivers and the ritualistic experience on users. In order to do this, a wide range of experimentation is needed, to better settle the way in which packaging might unite ergonomics, cognitive ergonomics and Neuroaesthetics; focusing the experimentation in elderly, according to the physical and cognitive changes, that might have an effect on their perception of what "a good design of medical packaging is".

Limitations and Future Research

The study's limitations include the small sample size of international users and caregivers, which may not represent all cultural contexts; and constraints in resources and time affecting the comprehensiveness of the research. Another limitation on the research is the lack of possibilities to do longer-term research with users inside the same context and environmental conditions, and the explorative character of the research implies that for further research the methodologies should be developed in a more controlled environment, and with the participation of professional facilitators and co-researchers to follow a more restricted and replicable framework.

Future research should address these limitations and explore more diverse and extensive samples to validate and enhance the findings of this study according to methods developed by a multidisciplinary team.

By drawing on insights from neuroscience and incorporating more empathetic and user-centred design principles, we can enhance decision-making processes and develop pharmaceutical packaging that better resonates with its users. This approach can help move beyond a purely functional view of packaging, addressing both its practical and emotional dimensions, and ultimately improving patient experience and outcomes.

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ENHANCING PRO-SOCIAL EXPERIENCES THROUGH CROSS-CULTURAL INTERACTIONS FOR THE CAMPUS OF THE FUTURE.

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ABSTRACT | This study aims to present the design concepts and development of proposals for the "Campus of the Future," focusing on enhancing pro-social experiences through cross-cultural interactions. Highlighting the significance of cross-cultural communication and navigation in shaping future educational environments, this research integrates inclusive approaches and proposals with Crossed Reality (XR), Virtual Reality (VR), and Artificial Intelligence (AI) applications. It establishes possibilities for designing new types of experience-led services aimed at promoting pro-social interactions and inclusivity on campuses. Six different short projects were designed over the past two years through intensive workshops from the Post Urban Living Innovation Education and Research Program (PULI), each addressing various aspects of cross-cultural collaboration and communication. These projects were generated by students under the guidance of faculty members and researchers both Chiba University in Japan and Universidad de Monterrey in Mexico. They were assessed for their effectiveness in fostering understanding, empathy, and cooperation among students from diverse cultural backgrounds. The "Campus of the Future" projects explored challenges associated with implementing such services on university campuses, including technological barriers, cultural resistance, and the need for comprehensive training programs. By comparing and contrasting the outcomes of these six projects, the study provides insights into best practices for integrating technology into educational settings. In conclusion, this study offers a comprehensive overview of enhancing cross-cultural interactions through innovative technological applications in the "Campus of the Future." Addressing challenges and leveraging XR, VR, and AI technologies can create more inclusive and pro-social environments. Suggesting that careful application and continuous evaluation of these technologies can significantly shape the future of education, fostering greater understanding and collaboration.

KEYWORDS | EDUCATIONAL INNOVATION, INTERDISCIPLINARITY, GLOBAL COLLABORATIONS, DIGITAL TRANSFORMATION

1. Introduction

In recent years, the concept of the "Campus of the Future" has gained significant attention, emphasizing the need to enhance pro-social experiences through cross-cultural interactions that lead to next-generation experiences for students, faculty, and staff. This paper showcases a diverse exploration of design concepts and development proposals aimed at creating a responsive campus. These cross-cultural workshops and iterations focus on communication and the integration of inclusive approaches facilitated by advanced technologies such as Crossed Reality (XR), Virtual Reality (VR), and Artificial Intelligence (AI).

By sharing six short projects developed through the Post Urban Living Innovation Education and Research Program (PULI) at Chiba University and Universidad de Monterrey with undergraduate and graduate students, this research assesses the effectiveness of these projects in fostering understanding, empathy, and cooperation among students from diverse cultural backgrounds through cross-cultural experiences. Through a comprehensive analysis of these projects, the paper highlights the challenges and opportunities in implementing pro-social, technology-driven initiatives in educational environments. Additionally, it contrasts and considers which projects can be implemented in the short term and which will require a longer timeline.

2.Literature Review

2.1 Campus of the future

In our modern smart campus infrastructure, it's remarkable how students take charge of the conceptualization and design phases of smart campus ideas and projects from multi and interdisciplinary approaches directly to academic environments. This approach not only empowers students, it also provides a platform to participate in creating educational tools and making meaningful contributions to the academic community. Wang and Adil (2023) describe the "campus of the future" as a multifaceted concept that merges advanced technologies, innovative educational paradigms, and sustainable practices to meet the evolving needs of higher education. This

blend of elements highlights a vision for a highly adaptable, flexible, hybrid, sustainable, and technologically advanced learning environment, and deployment of AI-driven technologies (Kamalov et al., 2023), thoughtfully designed to meet the diverse academic needs and aspirations of all stakeholders.

One of the primary grand challenges is utilizing educational technology as the mechanism for fostering institutional development (Li, 2022), the vision of the "Campus of the Future" focuses on seamlessly integrating advanced technologies like the Internet of Things (IoT), Artificial Intelligence (AI), and Digital Twin into university settings as some of the tech trends. This integration enhances operational efficiency, user experience, and environmental sustainability (Pexyean et al., 2022). The integration of Augmented Reality (AR) and Virtual Reality (VR) in educational environment increases creativity and problem-solving skills, highlighting their possibility to transform education within learners from diverse cultural backgrounds. This leads to a better understanding of design processes and encourages collaboration through immersion and interaction (Pexyean et al., 2022, Dembe, 2022).

Thompson et al (2021) describe that despite the rapid emergence of new technologies, the methodological and pedagogical approaches in teaching practices remain relatively stable. This stability is viewed as a strength, enabling the educational technology community to reflect on and adapt its practices in response to new developments.

Yamao and Lescano (2020) explain that the smart campus concept also draws parallels with smart cities, on a smaller scale, with fewer devices and simpler networking complexities. Universities can enforce homogeneous technology use across the campus, turning it into easier management and deployment of IT infrastructures like IoT, cloud computing, and long-distance communication. Moreover, the smart campus serves as a learning platform for Industry 4.0, preparing students to develop and support IoT-based systems through project-based courses that encourage creative solutions to real-world scenarios in multidisciplinary contexts.

Culture and contexts play a crucial role in discovering a sense of unity and belonging among students, and the digitization of campus heritage through internet and virtual heritage which provides more accessible and engaging ways for students to connect with their university's history and culture. This digital cultural heritage augments the interaction between users and heritage, enhancing students' bonding with their universities and strengthening their individual identities (Gao et al., 2018). In summary, the Campus of the Future is efficient, advanced in technology and a culturally enriched environment that not only improves the quality of education and campus life but also prepares students for the demands of modern industries.

2.2 Cross-cultural experiences and pro-social interactions

A framework for designing cross-cultural education integrates multilingualism with interdisciplinary methods to establish inclusive educational settings which are tailored to students from varied cultural and linguistic backgrounds. Yassine (2006) characterizes intercultural competency as the achievement of understanding and appreciation for one's own cultural heritage along with the customs of diverse societies. The idea is to promote mutual respect and understanding among individuals on a global scale. Erlandson (2012) emphasizes the importance of considering cultural standards and core concepts like collectivism, power dynamics, and high-low context societies in developing intercultural awareness.

- Understanding cultural differences between cultures: Cross-cultural interactions enhance design education by exposing students to diverse perspectives. This leads to a richer learning experience, especially in a globalized world.
- Creating comfortable environments: Establishing inclusive and supportive settings, as open communication is crucial for fostering effective learning experiences for students from diverse backgrounds.
- Social barriers: Identifying and overcoming social obstacles that affect cross-cultural understanding and collaboration is essential for promoting an inclusive and respectful educational environment (Ma et al ,2024).

Zheng and Zhao (2012) describe that cross-cultural environments within the education context share detailed and multi-dimensional impact on the processes of learning and creativity, highligthing having cultural awareness and adaptability skills. The concept of cross-cultural experiences is outlined as engagements between people that encompass the comparison and contrast of diverse cultural components, which possess the capacity to a marked influence on belief systems, and patterns of conduct.

In the same investigation, according to scholarly investigations, the influence of cross-cultural highlights on the cultivation of creativity is dependent of an an individual's receptiveness towards unfamiliar cultural environments. Although it is considered that a certain degree of education might have a purpose and that such relations have the potential to augment levels of creativity, upon the open mindnessnes, (Zheng and Zhao, 2012).

Saulnier et al. (2014) demonstrate that in educational settings, successful cross-cultural learning environments are characterized by support systems that handle basic human needs, which makes the structure of the domain visible, prepares participants on this professional-level practice, and provides direct feedback.

Additionally, work on cultural studies in foreign language education emphasize the necessity of integrating language learning, language awareness, cultural awareness, and cultural experience to raise intercultural communication awareness. The use of network technology in cross-cultural education further supports these goals by providing innovative opportunities for cultural exchange and learning, which are essential in today's globalized world, (Shu & Xue, 2013).

Understanding cultural differences between cultures includes the cross-cultural interactions which might enhance design education by exposing students to diverse perspectives. This leads to a richer learning experience, especially in a globalized world. Creating comfortable environments, through the establishment of inclusive and supportive settings is crucial for assuring effective learning experiences for students from diverse backgrounds. And identifying and overcoming social barriers or tabus that might interfere between cross-cultural understanding and collaboration is essential for promoting an inclusive and respectful educational environment.

2.3 Technology at campus, trends and barriers

The decision to incorporate technological advancements in the field of education is difficult and influenced by a variety of environmental and individual elements. Significant obstacles include technological absence of integrated, precise, and timely data or information, predictive analytics, and bias. Additionally, tere might be a lack of incentives and support systems for the adoption of new technologies (Klein et al., 2019).

Despite these difficulties, the advancement of technology has brought a range of alternatives in the educational sector, such as big data, artificial intelligence (AI), cloud computing, and virtual reality (VR). These emerging technologies offer innovative tools for new pedagogical strategies (Jiugen et al., 2020; Klein et al., 2019). Information and communication technology (ICT) has revolutionized the learning process for students, enabling them to transition from conventional classrooms to virtual settings using internet-based technologies. Educational platforms now assist institutions in creating online courses and effectively monitoring student advancement (Jiugen et al, 2020).

Jiugen et al (2020) suggest that professionals engaging with these technologies, must have a profound comprehension and skills in the operational principles of virtual instruments are mandatory. This involves familiarizing themselves with the characteristics and functions of these tools to ensure the optimal utilization in virtual experiments. Through strategical planning of each stage of the design and execution, the procedure evolves into a methodical and well-organized effort. This method not only boosts the efficiency of the virtual experiences but also helps guarantee that the end product is both transcending and useful.

Well know technological innovations are also reshaping the educational landscape, Thompson et al (2021) from their research share that instructional design, learning engineering, and user experience (UX) design are becoming increasingly significant, along with extended reality (XR) technologies such as augmented reality (AR), virtual reality (VR), and mixed reality (MR). Combining these insights, it becomes clear that the thoughtful implementation of technology in education, supported by practices and collaborative efforts, can significantly improve the learning environment and outcomes for both students and faculty.

Project focus and objectives

Design initiatives for the Future Campus are purposed towards the empowerment of all users, which includes students and faculty members, who engage in a collaboration to develop innovative interactions that cultivate a forward-thinking perspectives and models that have an impact on learning outcomes and academic experiences that are characterized by excellence. The primary goal is to enhance the educational environment through the implementation of these initiatives.

The following table provides details on the six brief projects undertaken during the workshop sessions, including information on the iteration, location, year, and keywords associated with each project. This information serves as a comprehensive overview of the projects carried out within the workshop setting.

The projects were executed within interdisciplinary and collaborative settings at Chiba University in Japan and Universidad de Monterrey in Mexico. The workshops brought together groups of 3 to 7 undergraduate and graduate students from both institutions, fostering a rich exchange of ideas and perspectives among participants.

These intensive workshop sessions spanned a duration of approximately 5 to 10 days, during which the participants engaged in rigorous work and interactive sessions. Additionally, cultural visits were organized to facilitate the sharing of diverse cultural perspectives and ideas among the participants, further enriching the general experience of the workshops.

Table 1. Projects for the Future Campus

Project Title	Keywords	Year	Workshop Iteration and location
Neutral Network	Gender discrimination, Diversity	2022	1st iteration at Chiba University
Socioeconomic Integration Project	Integration, Collaboration	2022	1st iteration at Chiba University
Disability Equipment: Manjiro's Device	Community, Physical aid	2022	1st iteration at Chiba University
Tomomigos: Mental Health, Professional Development	Mental Health, Professional development	2022	1st iteration at Chiba University
Design Systems for next gen faculty and students	Design for the future, tech systems	2023	2nd iteration at Universidad de Monterrey
Empowering Cross-Cultural Collaboration	Project-Based Learning, Constructivism Theory	2023	3rd iteration at Chiba University

The primary focus of the project are the various challenges faced in different scenarios, especially within educational settings at campuses. The following bullets are the primary areas of focus from the past six mentioned projects:

1. Addressing gender bias: This initiative aims to mitigate gender bias within the university environment by developing a platform where users can create personalized avatars. By designing interactive virtual environments for social activities, the project seeks successful interaction between users.
2. Promoting empathy and collaboration: This project seeks to promote empathy,
3. collaboration, and economic growth for lower-class students. By implementing a program university students and conducting VR-based activities to enhance communication and teamwork, the project aspires to improve interactions and social dynamics free form socioeconomic status or bias.
4. Accessibility and inclusion: Challenges faced by individuals with motor or physical disabilities in various professional collaborations outside of campus and within educational institutions. It specifically focuses on schools where academic pursuits and practical research activities pose significant obstacles for these individuals.
5. Supporting mental health and professional growth: Development and support of diverse

conditions and needs of students, faculty and staff by creating virtual and physical activities designed to foster mental well-being and professional skills.

6. Innovating educational design systems: Innovate design systems for future technology use in education. It involves using advanced design tools and methodologies to implement educational programs that focus on future tech systems throughout the entire student journey, starting from early years.
7. Fostering cross-cultural collaboration: This initiative facilitates effective collaboration among learners from diverse cultural backgrounds by integrating AR and VR technologies into educational programs and encouraging cross-cultural interaction through collaborative projects.

The project is guided by a set of clearly defined and concise objectives that have been tailored with the intention of improving the overall well-being at universities implementing technology through design strategies and solutions. These objectives are comprehensive in nature, aiming to achieve the following:

- Creating Interactive and Adaptable Campuses: The primary objective is to develop campus environments that are not only interactive but also adaptable in order to effectively prevent and address mental health issues that may arise among students.
- Innovating Assistive Technologies: Another key goal of the project is to innovate and introduce new technologies that are designed to assist and promote interaction.
- Reducing Gender Bias: Furthermore, the project also has a significant focus on reducing gender bias within university settings, with the ultimate aim of cultivating a more inclusive and equitable environment that caters to the needs and rights of all students.
- Promoting Diversity and Inclusivity: The overarching vision of the project is to promote diversity and inclusivity by establishing strong connections among individuals from diverse backgrounds. This includes fostering a sense of community and collaboration within the campus and workplace.
- Expanding Program Accessibility: Lastly, there are strategic plans in place to expand the reach of the program to communities that may have limited access to the internet or smart devices. This expansion aims to ensure that individuals from all walks of life have the opportunity to benefit from the program, thereby promoting equal access to resources and opportunities for personal and professional growth.

Through these targeted efforts, the project aspires to cultivate a more inclusive, supportive, and engaging environment for individuals, fostering personal and professional development within university settings.

3.Methodology and tools

The project employs a diverse range of design methodologies, such as Design Thinking and Human-Centered Design strategies to tackle the diverse issues present within university environments, encompassing classism, gender bias, mental health concerns, and the integration of disabled individuals. These methodologies play a huge role in augmenting social cohesion among students from different backgrounds and ensuring an academic experience that is inclusive.

Some of the strategies implemented where:

In the process of survey construction was one of the primary objective of this approach was to gather first-hand data directly from the students for the purpose of the projects at hand. The acquisition of such data plays a pivotal role in fully considering the real areas of opportunity. The data obtained served as a foundation for deep analysis and the development of necessary interventions.

A considerable emphasis was placed on the identification of contributing factors and stakeholders creating archetypes and user journey maps, with a focus on the key elements that contribute to the specific project under consideration. Additionally, efforts were made to identify the strategies that were put in place to address, mitigate, or resolve the identified problem effectively.

An innovative approach involved the utilization of Artificial Intelligence (AI) for the generation of images and perspectives derived directly from the students themselves. This method aimed to find patterns and relationships within the project and gather information of the specific aspects that required attention and resolution.

Furthermore, benchmarking exercises were conducted, to understand similar project implementation processes. This analysis aimed to glean insights on how design solutions were executed in those projects and how similar approaches could be adapted for the current project.

Lastly, the utilization of software tools pertaining to graphic and video game design were integrated into the process. This was done to the effective design strategies for the utilization of the Oculus Quest platform, as well as for the use of diverse Artificial Intelligence (AI) training webpages.

Specifically for each project:

- Platform for Avatars: An integral component of the project involves the creation of a specialized platform tailored for avatars in software Blender, complete with predefined pronouns, alongside the curation of interactive virtual and AI assistance. This strategic initiative is to ensure seamless and successful interactions among users, thereby fostering an environment that is equitable and devoid of prejudices.

- Virtual and Physical Activities: At the core of the initiative lies the development of a comprehensive array of both virtual and physical activities designed to boost mental well-being and foster professional advancement among students. These interactive activities such ass piano lessons, chess and other, were thoughtfully curated with a specific emphasis placed on cultivating connections.
- Assistive Technology Development: A dedicated aspect of the project revolves around the innovation and deployment of sensor-based technologies that empower disabled individuals to perceive through sense as a multisensorial solution and engage with spaces that were inaccessible to them through the live streaming. This effort permits the mitigation accessibility challenges, generating tailored solutions aimed at improving solutions for the mobility and independence of individuals with disabilities.
- Creative Networks: By applying the power of creative networks, the project pursuits to enrich the diversity and authenticity of virtual representations by leveraging generative networks to generate outcomes that are distinct from real images. This deliberate strategy serves to enhance the overall user experience and promote active engagement.

In addition, these varied methods collectively strive the issues of classism, gender bias, mental health challenges, and accessibility barriers. These different approaches intend to tackle classism, gender bias, mental health issues, and accessibility problems in universities, creating a fair, friendly, and enriching experience for all students, faculty and staff.

4. Creative process and conceptualization

Crucial aspects in the development of innovative ideas and projects were explored by each group of students as they immersed in the journey of this workshop. Each team worked in a final presentation where all the details of the process, design ideas, conceptual framework were shown. Through the next summarized informative tables, serve as a comprehensive tool to summarize the essence of each project, providing a clear overall roadmap.

Table 2. Neural Network Project

Project Title	Objective	Key Activities	Outcomes	Future Plans
Neutral Network	Mitigate the gender bias in the university environment.	Creating a platform for avatars with specified pronouns. Designing interactive virtual environments for social activities.	Successful interaction among users. Positive reception from participants.	Further development of the platform. Implementation of "identical twins" for continuous activity.

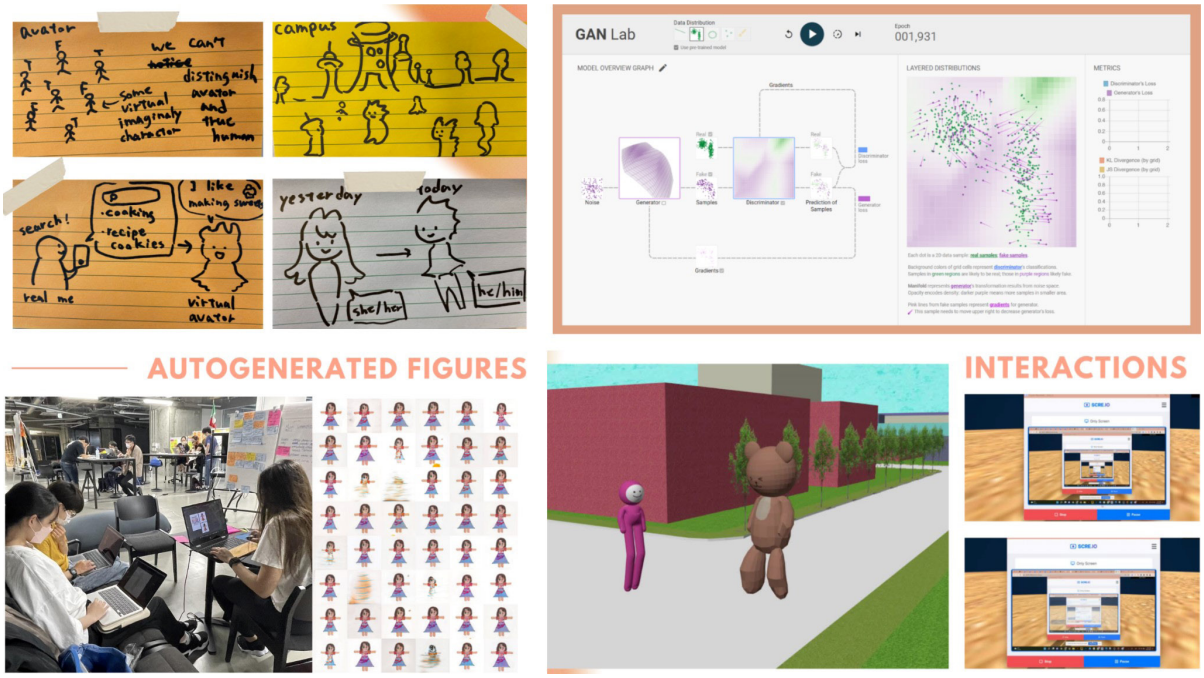

Figure 1. Neural Network project

Table 3. Socioeconomic Integration Project

Project Title	Objective	Key Activities	Outcomes	Future Plans
Socioeconomic Integration Project	Promote empathy, collaboration, and economic growth for lower-class citizens in their workplace.	Implementing a week-long program for freshman university students. Conducting VR-based activities to promote communication and teamwork.	Improved communication among students. Positive impact on student social interactions.	Development of both virtual and physical activities. Continued research to foster diverse workplace environments.

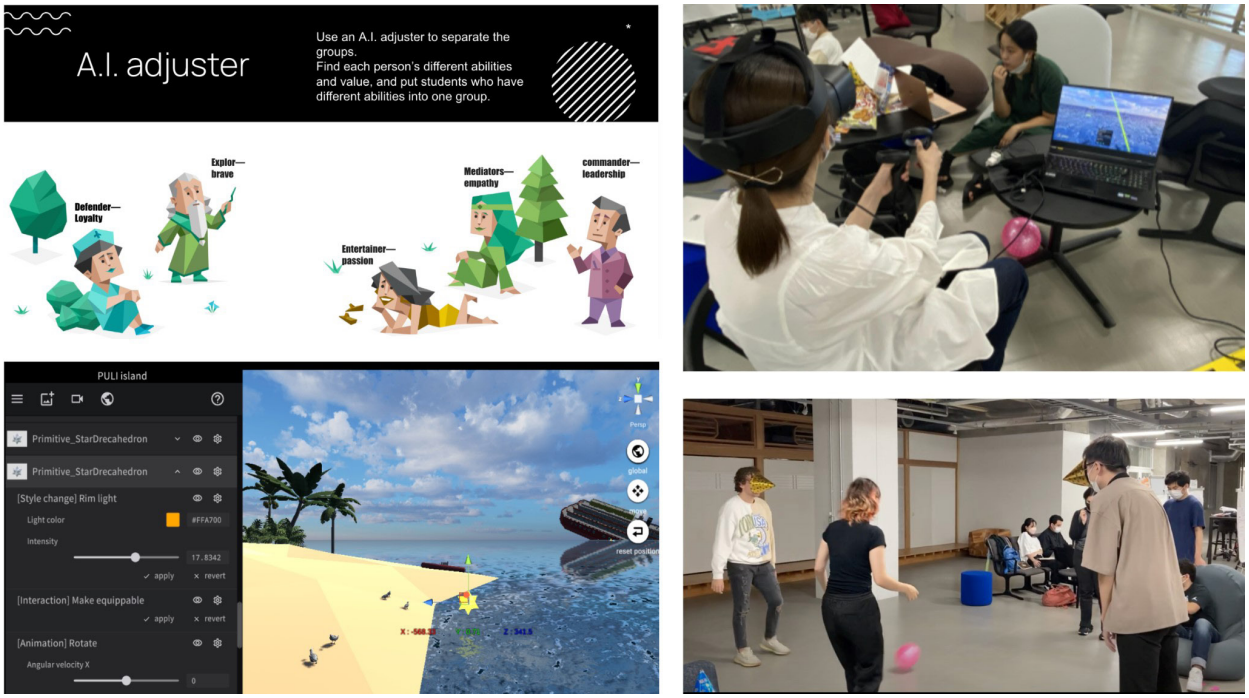

Figure 2. Socioeconomic Integration Project

Table 4. Disability Equipment: Manjiro's Device

Project Title	Objective	Key Activities	Outcomes	Future Plans
Disability Equipment: Manjiro's Device	Develop a device to help disabled individuals see and feel areas they cannot access.	Conducting field research to identify accessibility issues. Developing sensor-based technology to provide remote access experiences.	Identification of accessibility challenges. Successful development and testing of the device.	Enhanced integration of disabled students in university communities. Further development of the project in Mexico and Japan.



Figure 3. Disability Equipment: Manjiro's Device

Table 5. Tomomigos: Mental Health, Professional Development

Project Title	Objective	Key Activities	Outcomes	Future Plans
Tomomigos: Mental Health, Professional Development	Address mental health and professional development among students.	Developing virtual and physical activities to promote mental health and professional growth.	High interest and positive reception from participants. Significant personal and learning growth.	Further development of virtual activities. Implementation of physical activities on campus. Exploration of ways to create strong bonds in diverse workplaces.

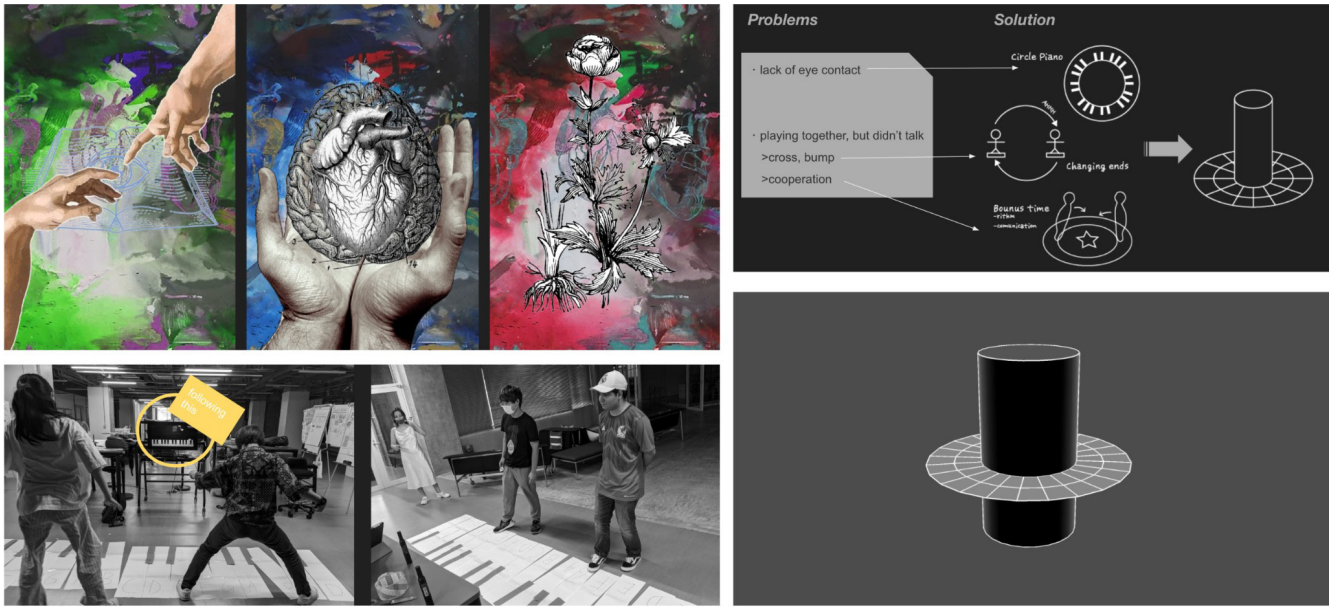

Figure 4. Tomomigos Mental Health, Professional Development

Table 6. Design Systems for Next Gen Faculty and Students

Project Title	Objective	Key Activities	Outcomes	Future Plans
Design Systems for Next Gen Faculty and Students	Innovate design systems for future technology use in education.	Utilizing advanced design tools and methodologies. Implementing educational programs focused on future tech systems.	Enhanced learning experiences. Improved integration of technology in education.	Continued innovation in educational design systems. Expansion to other educational institutions.

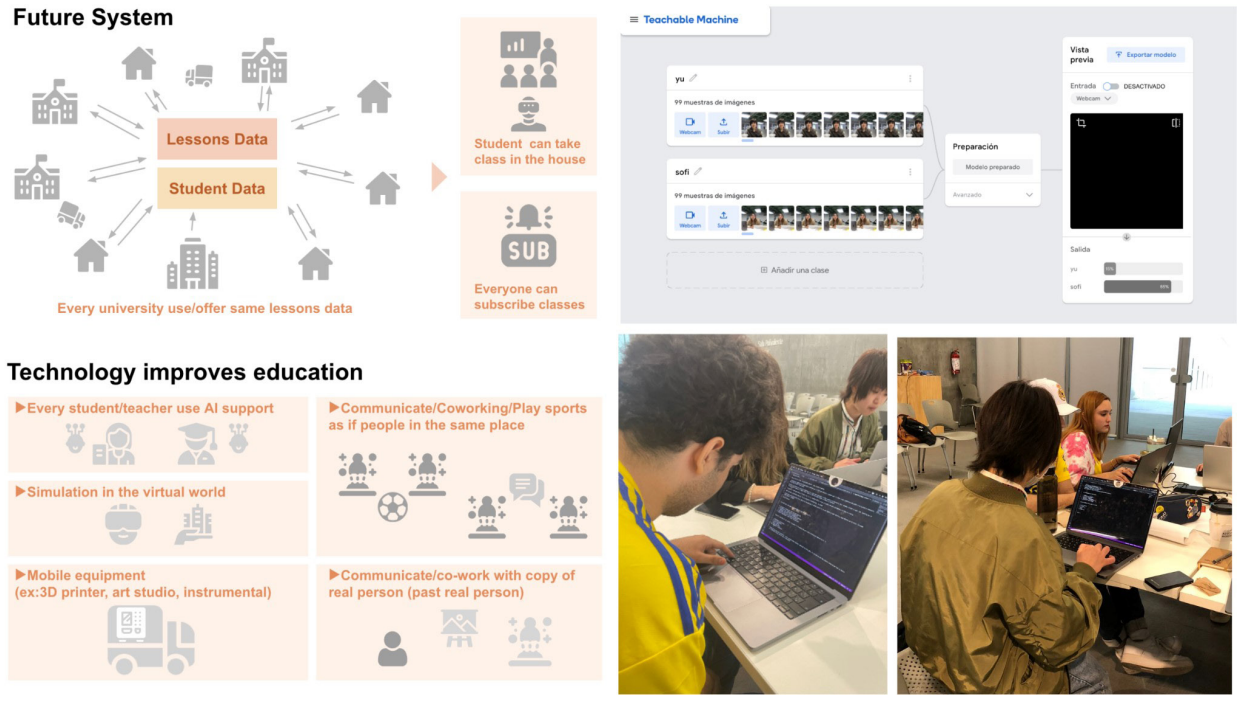

Figure 5. Design Systems for Next Gen Faculty and Students

Table 7. Empowering Cross-Cultural Collaboration

Project Title	Objective	Key Activities	Outcomes	Future Plans
Empowering Cross-Cultural Collaboration	Facilitate effective collaboration among learners from diverse cultural backgrounds.	Implementing AR and VR technologies in educational programs. Encouraging cross-cultural interaction through collaborative projects.	Improved cross-cultural communication. Enhanced creativity and problem-solving skills.	Further integration of AR and VR in education. Expansion of the program to include more diverse cultural backgrounds.



Figure 6. Empowering Cross-Cultural Collaboration

5.Integration and Transcendence

The integration and impact of the six projects focus on creating a strong and lasting effect on social dynamics and community bonding within a university setting. These projects aim to transform the university environment into a place where everyone feels included and valued. The main goal is to build a comprehensive support network that not only connects people but also helps form meaningful relationships across different age groups. This network is designed to encourage interactions that go beyond generational and social boundaries, promoting understanding and collaboration among students, faculty, and staff.

One key approach is fostering a deep sense of belonging and inclusivity within the community. This involves encouraging everyone to join in conversations without bias or prejudice, ensuring that all voices are heard and respected. By highlighting the importance of diversity, the project aims to create a welcoming space where physical attributes like appearance and age aren't the main focus, but rather the unique perspectives and experiences each person brings.

Using the latest technology, and thoughtful design, the project seek to build lasting connections that enrich everyone's lives. These cutting-edge tools help bridge gaps and make it easier for people to engage with each other in meaningful ways. The combination of these technologies and a strong community focus aims to create an environment where people feel supported, understood, and connected on a deeper level. In summary, these projects are all about making the university a better place for everyone. They strive to enhance social cohesion, break down barriers, and foster an inclusive atmosphere where everyone can thrive. By bringing people together and leveraging technology, the projects aim to leave a positive impact on the university community, making it a more harmonious and enriching place for all.

6. Conclusion and next steps

In conclusion, the design interactions have enhanced the knowledge and understanding of students and faculty by leveraging available opportunities without technologica or economic constraints. These constraints, however, do limit project implementation.

This approach ensures the educational experience transcends academic learning, fostering cross-cultural collaborations that develop both personal and professional skills. This transformative journey for Mexican students progresses through iterative processes, preparing them for a design-led educational experience that not only enhances conceptual capabilities but also transitions to practical, efficient methodologies. The evolving projects highlight the collaborative efforts of students, faculty, and staff from both academic institutions.

To conclude the following projects are considered as:

Implementable Now:

- Neutral Network: Quick to implement due to its reliance on existing digital technology.
- Tomomigos Mental Health, Professional Development : Virtual activities can be swiftly launched, with physical activities following shortly after.

Long-Term Projects:

- Socioeconomic Integration Project: Requires extensive planning and resource allocation.
- Disability Equipment: Manjiro's Device: Technological development and field research make this a long-term project.
- Design Systems for Next Gen Faculty and Students: Continuous innovation and technology integration necessitate a longer timeline.
- Removing the Limitations of Current Cross-Cultural Communication & Cooperation Course: Developing and maintaining AR and VR technologies requires a phased, long-term approach.

Limitations:

- Neutral Network: Needs continuous updates to maintain engagement.
- Tomomigos: Requires ongoing adaptation of interactive games or activities to remain effective.
- Socioeconomic Integration Project: High resource and time demands.
- Manjiro's Device: Cost and complexity of technology refinement and
- implementation.
- Design Systems: Continuous investment in new technologies and training.
- Cross-Cultural Communication Course: Extensive resources for AR/VR development and cultural adaptation.

In summary, while the Neutral Network and Tomomigos projects are ready for short-term implementation, the other four projects face significant technological and economical limitations that extend their timelines into the long term. Each project, however, holds the potential for substantial impact within its target area, given the necessary resources and time for development and integration. The next steps will involve team building and budget agreements to initiate the first stages of the selected project. Implementation will begin with minimum viable projects to validate impact and make the required changes. This is an iterative process, given the rapidly changing nature of technology.

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ACROSS BORDERS: A PILOT PHD PROGRAMME IN DESIGN, ART AND TECHNOLOGIES. OPEN QUESTIONS FOR A POST-DISCIPLINARY EDUCATION & RESEARCH MODEL.

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ABSTRACT | The multiple social, cultural, political and environmental challenges posed by the complexities and transformations of the contemporary world require a post-disciplinary education. In this complex scenario, design culture and artistic practice can provide an alternative model for thinking, planning and creating possible and desirable futures, and outline new models for research and education. The pioneering PhD programme in Experimental Research through Design, Art and Technologies, starting in the 2024-25 academic year at the [name of the university], Italy, proposes to shape new research profiles capable of integrating design and artistic, humanistic and social methods, knowledge and skills hybridised with scientific-technological ones. However, this raises a number of structural challenges.

The paper presents and critically discusses the open questions raised by the postdisciplinarity approach of the research doctorate. It aims to highlight the challenges and potentials of hybrid education in design and art at the convergence of technologies, humanities and socio-economic issues.

KEYWORDS | EDUCATION IN DESIGN AND ART, POST-DISCIPLINARY EDUCATION, HYBRID EDUCATION, POST-DISCIPLINARY PHD PROGRAMME, INNOVATION IN DESIGN AND ART EDUCATION

1. Introduction

The multiple social, cultural, political and environmental challenges posed by the complexities and transformations of the contemporary world require a multidimensional, cross- and transdisciplinary (Bernstein, 2015), or rather post-disciplinary (Pernecky, 2019), education (Morin, 2001). In this complex scenario, design culture and artistic practice can provide an alternative model for thinking, planning and creating possible and desirable futures and outline new transdisciplinary models for research and education. This concept is similar to what is currently called the Research through Design, one of three possible forms identified by Alain Findeli (2004). Zimmerman (2007) refers to RTD as "process of iteratively designing artefacts as a creative way of investigating what a potential future might be" emphasising the methodological possibilities of practice-based research and implicitly referring to the concept of the reflective practitioner, without which there could be no theoretical and conceptual reflection during or after practice, as Schön (2002) points out.

The pioneering PhD programme in Experimental Research through Design, Art and Technologies starting in 2024-25 academic year / XL cycle, according to Italian regulation, at the Frre University of Bozen-Bolzano, Italy proposes to shape new research profiles capable of integrating design and artistic, humanistic and social methods, knowledge and skills hybridised with scientific-technological ones. However, this programme, which addresses aspects of inter- and trans-disciplinarity, questions the very concept of discipline and opens a series of structural issues. The programme was initiated by the leadership of the Faculty of Design and Art, in collaboration with the Faculty of Engineering (and Computer Science), and with the participation of colleagues from the Faculties of Education, Economics and Management, as well as colleagues from other national universities and experts and fellow professors from foreign European universities. "The programme provides a space for speculative, critical and pragmatic reflection on problems, potential solutions and new conceptual perspectives inspired by design culture and artistic production. It integrates complex

design, scientific and social knowledge and requires the establishment of collaborative relationships with human, non-human and more than human actors through intercultural methods, learning from others, embracing cultural relativism and experimenting with new research tools and practices." as stated in the official description.

On the one hand it implies a pots-disciplinary reconfiguration of design identity, between practice-oriented research in which design choices are themselves strategic and theoretical moves (Anceschi, 1998) and a practice without theory (Bonsiepe, 2021), a science (Cross, 2001) or even a social skill facilitated by trained profiles (Manzini, 2015). On the other hand, it calls for a convergence of methods, perspectives and languages in a transdisciplinary effort (Rose, 2022), i.e. in the dialogue and cross-pollination of models and approaches from different research traditions and fields, focusing less on the process than on the project. And finally, it challenges the practices and paradigms of scientific dissemination, which often pit the most experimental and innovative modes against formalised processes, but which are sometimes too limited in terms of alternative formats and modes, especially when communication is not only aimed at researchers, but also at more public audiences, and becomes a transfer of knowledge, for stakeholders, policymakers and citizens.

The PhD programme in Experimental Research through Design, Art and Technologies is opening up a postdisciplinary vision, inaugurates a new approach that sees design and art as the driver of cultural innovation while at the same time shaping new models in design and art education through confluence with other research areas.

The paper presents and critically discusses the open questions raised from the post-disciplinarity approach of the research PhD programme. It aims to highlighting the challenges and the potentialities of hybrid education in Design and Art at the convergence of technologies, humanities and socio-economic topics.

2. Challenges for a post disciplinary education and research

1. The disciplinary dilemma (Challenge 1)

In the context of an evolving academic environment, the conventional boundaries between academic fields and research methodologies are undergoing a significant transformation. This reflects the broader societal shifts, challenges and crises that are occurring concurrently.

The initial challenge confronting the contemporary world of research and education, particularly within the domain of

design, is the fundamental redefinition of the concept of discipline and its interrelationship with other research environments, including endo- and exo-disciplines (Anceschi, Botta & Garito, 2006). In the first case, the other fields of knowledge share with it part of the theoretical, methodological and cultural macro-domain (see fig.1 the Map of the graphics field drawn by Giovanni Lussu in 1994). In the second, the contiguous areas of other areas of knowledge share elements to the point of blurring and overlapping the very boundaries between the various macro-domains.

In an increasingly complex academic ecosystem, the traditional and institutional boundaries between fields and modes of research are, however, undergoing profound transformation, reflecting the In the context of an evolving academic landscape, the conventional boundaries between academic fields and research methodologies are undergoing a significant transformation. This reflects the broader societal shifts, challenges and crises that are occurring concurrently. changes, challenges and crises that the world is also facing. The traditional model of education, which is highly specialised and vertical with respect to a particular knowledge domain, has been the subject of significant challenge in recent decades. This model, which has been described as an 'academic silo', is increasingly being questioned by a number of factors. On the one hand, the increasing complexity of research problems necessitates the consideration of diverse perspectives and competencies. On the other hand, the value of transversal and soft skills, such as collaborative capacity, has emerged as a key factor in bringing together differences in a synergistic manner, rather than viewing them as antithetical elements. Nevertheless, even the so-called T-shaped model now appears to be obsolete. This is an educational and knowledge system that assumes a transversal/horizontal competence encompassing several disciplines, followed by a vertical specialisation in a specific subject area (Barile et Al., 2012).

The disciplinary dimension of education is the primary focus of scrutiny, as articulated by Bourriaud in his *Altermodern Manifesto*. In this text, he delineates the

"The work of "artists (that) translate and transcode information from one format to another, and wander in geography as well as in history" (Bourriaud, 2009). Craig Bremner and Paul Rodgers take on Bourriaud's discourse and by questioning "the rupturing ad blurring of the design Disciplines" (Bremner & Rodgers, 2013) they argue for an "Alterplinarity" (Rodgers & Bremner, 2011) or "Alterdisciplinarity" (Bremner & Rodgers, 2013), which in a globalized context requires "an ability to make connections that generate new methods to identify 'other' dimensions of design activity and thought" (Bremner & Rodgers, 2013, p. 12). They further pick up Marshall and Bleecker's

concept of “Undisciplinarity” (Marshall & Bleecker, 2010; Bremner & Rodgers, 2013) where according to learning expert Stephen Heppell “design practice shifts from being ‘discipline-based’ to ‘issue- or project-based’ (Heppell, 2006).” (Eckert, 2017, p. 139).

It is Eckert himself, from whom this discussion is taken, who proposes as an alternative the Y-shaped model as a form of focusing and deepening those competences that are concentrated in that intersection between the transversality and verticality of the knowledge required or prefigured by the T-shaped model:

“Whether BA and MA programs represent complementary or consecutive studies, the missing link, which would facilitate a seamless transition from the depth of skill into the collaborative mode is a repertory of connective competences—competences enabling graduates to embed into an undisciplinary and collaborative working-context. For design education, we therefore “zoomed” into the junction between the vertical and the horizontal stroke (Figure 3) of the Tshape in order to define, what sort of skills might be needed for the transition from disciplinary towards cross-disciplinary working modes. Based upon this reflection, we propose a Y-shaped skill model (Figure 3), which focuses the junction between a disciplinary root and the collaboration across disciplines by shifting the attention towards the perceived role of the designer within the collaborative context (e.g., entrepreneur vs. consultant) as well as towards multimodal literacy (Kress et al., 2001; Kress, 2003; Jewitt, 2006, 2008) as key to transfer the depth of skill to processes of cross-media meaning-making. The Y-shaped skill model does not intend to replace the model of T-shaped personas. For design education, it rather works as a complementary and more detailed view on what sort of competences students need to acquire to embed their depth of skill into a collaborative and cross-disciplinary context.” (Eckert, 2017, p. 140).



Figure 1. Giovanni Lussu, Mappa del campo della grafica / Map of the graphics field, 1994, published in The new Aiap configuration. Documents, interventions, a new statute, and regulations included in a supplement to issue no. 2 of Notizie Aiap published by Aiap Edizioni (p. 3) in1994. It was later re-proposed with a comment by Lussu himself in the Guida agli onorari in 2007, in support of a redefinition of the fields and meaning of graphic design.

The second aspect addressed by the issue of an education and research still based on a disciplinary perspective is the relationship between collaboration and interplay between the disciplines themselves and the adopted models of interaction. The paradigms of exchange and dialogue that have been consolidated over time ideally range from a situation of intra-disciplinarity, that is to say, cooperation of knowledge and methods within the same endo-disciplinary constellation to the concept of pluri-, cross-, multi-, inter-, and trans-disciplinarity (Stember, 1991; Jensenius, 2012; Rose, 2022).

In particular, the original definition proposed by Piaget places emphasis on the necessity for a holistic and collaborative approach. In particular, the original definition proposed by Piaget places emphasis on the necessity for a holistic and collaborative approach, as reported in Bernstein's review article (2015, p. 2): "The conclusion of Piaget's (1972) essay on various kinds of interaction between the disciplines mentions transdisciplinarity offhand, as a kind of an aside, as a "higher stage succeeding interdisciplinary relationships [...] which would not only cover interactions or reciprocities between specialised research projects, but would place these relationships within a total system without any firm boundaries between disciplines" (Piaget, 1972, p. 138)."

This original and primordial definition already contains the root of a further evolution of the relations between disciplines, their relationships and, above all, their boundaries, leading to a perspective that is no longer whatever-disciplinary, but rather post-disciplinary, in which the very concept of disciplines is questioned and gradually replaced. Paradoxically, many disciplines are beginning to move towards postdisciplinary approaches that involve their cross-fertilisation with other research methodologies and practices, embracing other intellectual traditions in order to better understand their own domain of knowledge and respond to the categorical crises they face. This reflection is well outlined in the conclusions of the article by Jessop and Sum, who, by comparing aspects of pre- and post-disciplinarity, focus on three main critical issues - in their case related to the field of political economy, but conceptually extendable to other fields of knowledge:

"First, the most exciting developments in the study of contemporary political economy involve the revival of pre-disciplinary approaches [...] and the rise of post-disciplinary approaches such as 'cultural studies', which, when applied to political economy, opens a space for 'cultural political economy'. Second, the study of political economy became a disciplinary venture in the course of the consolidation of the institutional separation of the market economy, the national state based on the rule of law, and the emergence of civil society and the public sphere. The limitations of

these fetishised distinctions always made the most provocative work in political economy interdisciplinary in the sense of drawing on the best work from different disciplines [...]. But we are now witnessing the emergence of a post-disciplinary approach that respects the crisis in the received categories of analysis and the disciplines that correspond to them. Third, the intellectual tradition [...] can be made even more fruitful through its creative synthesis with other pre- or post-disciplinary traditions such as political ecology and feminism (or 'queer theory')" (Jessop & Sum, 2001; p. 90)

As Pernecky notes in the liminal book Postdisciplinary knowledge (2019), the concept of post-disciplinarity emerges from the convergence and participation of diverse cultural backgrounds and contexts, as well as from a commitment to openness and freedom of inquiry that prioritizes the object of research over its disciplinary affiliation. This trajectory can be observed in various forms of cognitive practice, including "painting, sculpture, poetry, performance and literary works", which often precede the establishment of disciplinary structures.

"A story of postdisciplinarity can be aligned with different figures, movements and problems, and it can also be told through a technical, philosophical, methodological, political or artistic narrative. Where it begins depends on whether we trace postdisciplinarity to the word itself; to articulations of what it ought to do or not do; to concepts such as 'freedom' and 'openness'; to ideals about learning; or, more broadly, to the creative and imaginative capacity of the human being. [...] The story of postdisciplinarity thus becomes many, with each adding a layer of richness and complexity." (Pernecky 2019, p. 64).

Postdisciplinarity represents the conceptual and epistemological framework within which novel, open and hybrid models of research and education in the field of art, design and technology find their natural dimension, potential and expression.

2. Design practice as theoretical speculation (Challenge 2)

One of the most challenging issues in design research and education is the question of methodologies that are proper to the field or borrowed from other fields. This is particularly the case with regard to the more speculative dimension of research typical of the theoretical component of a field of knowledge. As Gui Bonsiepe has observed, design has long suffered from this one-dimensionality of being a practice without theory:

"Judging from design publications and media representations, it can be argued that design is currently being carried by a long wave. [...]. However, at the same time, a contradiction emerges between the widespread use of the term design and the limitations in the theorisation of the phenomenon. Design is today a theoretically unexplored phenomenon, despite its

widespread presence in everyday life and the economy. How can this lack of theory be explained? Avoiding a simplistic answer, it can be argued that there is a trade-off between the fragility of design discourse and the lack of a convincing design theory. Design is so far a baseless domain. In order to open up a new perspective, a reinterpretation of design outside the frame of reference of gute Forme or good design with its associated sociopedagogical aspirations may be useful. This reinterpretation is formulated here in the form of seven characteristics or theses on design: 1) it is a domain that can be manifested in all spheres of human practice; 2) it is future-oriented; 3) it refers to innovation. The act of design brings something new into the world; 4) it refers to the body and space, especially to the retinal space; 5) it aims at effective action; 6) linguistically it is anchored in the domain of judgements; 7) it addresses the interaction between user and artefact. The domain of design is the domain of the interface." (Bonsiepe, 1995, p.24)

In this debate, which commenced prior to the 1990s but achieved significant dissemination and discussion during this period, Anceschi (1993) coined the concept of theoretical move, whereby he referred to the conceptual contribution that some projects introduce through professional practice. Similarly, Anceschi identifies a field of knowledge and experience that designers draw upon to contribute to design research. This is not limited to a pure formalism, but rather encompasses theoretical, semiotic and perceptive issues that are explored and confirmed by design practice.

This position can be likened to what is currently referred to as Research through Design, which is one of the three possible forms identified and formalised by Alain Findeli (2004).

- The objective of research for design is to facilitate the advancement of design practice by meticulously documenting the processes and concerns of practitioners, with the designers and their practice regarded as the primary subjects of study.
- Research into design is primarily conducted in universities and research centres that contribute to the scientific discipline of design studies. This involves the documentation of objects, phenomena and design history.
- Research through design (RTD) is the most closely aligned with actual practice, which serves as a research tool. Designers and researchers who utilise this approach are able to create new products through experimentation with novel materials and processes.

While the first two can be considered analogous to traditional research fields and approaches, the third raises a series of questions regarding the potential contributions of designers to the design, research, and knowledge fields. In this regard, Zimmerman et al. (2007) make reference to HCI in order to define RTD as a "process of iteratively

designing artefacts as a creative way of investigating what a potential future might be". This contribution serves to further identify possibilities and methodologies of research through practice. Indeed, it is a vision that can be likened to the scientific process, based on experiments and iterations, with the aim of progressively improving the design. It is also important to note that RTD implicitly builds on the concept of the reflective practitioner, without which there could be no reflection during or after practice, as Schön (2002) indicates. While definitions of RTD vary, the question that remains open is how, at the end of the research process, the knowledge acquired through the project and reflection can be evaluated, criticised, and transmitted so that a wider field of researchers and designers can draw on and build upon the results.

The intrinsic nature of research conducted within the domain of design introduces a distinctive quality, particularly when situated within the conceptual framework of postdisciplinarity. On the one hand, it is characterised by a distinctive practice- and action-oriented dimension, encompassing practice-based research and action-based research. In these approaches, the design is not merely a meta-product employed as a stimulus in the experimental process of verifying recurrences and correlations. Instead, it is the primary objective, enabling the abstraction and inference of conceptual models, theoretical speculations, and the systematisation of frameworks. Conversely, his own methodological and conceptual approach and contribution become a model for enquiry and speculation in other fields. The Design Thinking approach, which involves adopting design as a 'platform' for exploration, conceptualisation and understanding of complex phenomena, is a key example of how design can offer a valuable contribution to other traditions of investigation.

3. Design/er identity in education and research (Challenge 3)

However, the pooling of practices and the borrowing of methods, theories and practices from other fields raises an important question about the identity of design itself and the role of the designer within the cultural and professional landscape in relation to other fields of knowledge.

The design is primarily configured as a generative and effective practice and is still in the process of developing a theoretical framework or an organic definition that would allow for the organisation of a cultural overall vision (Bollini, 2011; 2016a; 2016b). The definition of a disciplinary context and practice serves to define the professional and, as a result, the tools and training practices. If, as Potter (2002) asserts, every human being is a designer, defined as the capacity to conceptualise and create ideas and objects, what is the specific role of the professional designer?

A designer may be defined as a Gestalter, a professional whose role and purpose is to give form, order, pleasure and comfort (to products, places and circumstances). In

the context of visual design, the object to be shaped according to the triad of things, places and messages is the message itself.

Conversely, the designer is a technically proficient individual with functional expertise, operating within a range of functional objects that can be identified, and which may be situated in contexts of free and ephemeral design, or in highly specific and concrete circumstances.

In the field of visual design, two antithetical approaches and paradigms can be identified in Italian culture, represented by two charismatic figures: A. G. Fronzoni and Bruno Munari.

The initial case study exhibited a notably personal poetic expression and composition, suggesting that the subject may still embody the figure of the teacher, who communicates and teaches using a personalised language. However, Munari eschews any consideration of his personal design thinking and creativity, attempting instead to describe and generalise his experience into a methodology, as a series of operations that are necessary and arranged in logical order (Munari, 1981).

The duality of approach, which encompasses a range of nuances and intermediate positions, is founded upon the concept of visual design culture. This concept is currently viewed as both an artistic creation and a pursuit of objective values. Consequently, the manner in which teaching and the transmission of values are conducted, whether aesthetic, functional, formal, or objective, varies. However, despite this variability, certain issues remain constant in the transmission of design ideas. The focus then shifted to the modelling and narration of a project, that is, the methods of communication employed. The code of representation selected, the use of three-dimensional modelling systems, the description of projective planes, or the expression of theoretical assumptions, are examples of ways to display and, simultaneously, to design the project. Consequently, these methods are inextricably linked to the teaching process.

However, in more recent times, the concept of the designer, their role and the formation of a designer has been subject to significant scrutiny. This is particularly evident in light of the increasing prevalence of design practices, the accessibility of technical production tools and the dissemination of cultural knowledge. This has led to the emergence of alternative models that challenge the traditional boundaries of the designer's role and profile.

In many instances, it is possible to identify nascent models that view design as a pervasive and crossdisciplinary competence, approaching the status of a soft skill. On the one hand, there are positions such as Manzini's (2015) with respect to a facilitating role in which the designer makes their knowledge and expertise available to a community, facilitating design processes. This is the position, above all, of participatory design processes and co-designing bottom-up construction, which finds its contiguity

especially in the world of human-centred design, user experience research and design practices. This contiguity thus interfaces and dialogues with the realms of cognitive and human sciences, as well as digital technologies, encompassing a continuum of approaches, methods, and core values.

This is the design of when everyone designs, which represents a radical transformation in the role of the designer. The other, even more radical position is represented by Mike Monteiro, who, in his pamphlet Ruined by Design (2019), takes the issue even further, arguing that a designer is not someone who is trained in the culture and practice of design. Rather, the designer is someone who makes political, social, and ethical decisions, thereby assuming a significant role that has repercussions and impacts in the real world, in people's lives, and in the transformation of the world. The training of the designer has evolved beyond a focus on creativity, portfolio development, and an immersion in artistic culture. Contemporary designers must possess a range of skills that extend beyond these traditional domains. These include an understanding of business models, the capacity to conduct research, the ability to measure and analyse data, the capability to write professional emails, contracts, and invoices, and the capacity to present and discuss one's work. These skills are not adequately addressed in current training programmes, yet they are essential for effective professional practice.

"Creativity can't be the cornerstone a design foundation anymore. We need to teach students responsibilities of their craft, and it needs to be done at the foundational level. We need to value the consequences of our actions more than the cleverness of our ideas. Design is not about expressing yourself. Design is not about following your dream. Design is not about becoming creative. Design is about keeping people from doing terrible things to other people. [Monteiro, 2019; pp. 61, 63]

For Potter, the role of the designer is an intrinsic aspect of humanity, as each individual possesses an inherent creativity and capacity for ideation that naturally leads them to approach the world in design terms. Conversely, for Monteiro, the role of the design dimension is that of ethical and social responsibility, which is a shared responsibility among all individuals, given their capacity to impact the world and others.

4. Diversity in academic dissemination (Challenge 4)

In the academic context, design research often finds itself in a complex and ambivalent position. It is often located within the human and social sciences, or the humanities more broadly, while being aligned with more 'scientific' disciplines that seek to match the processes and methods of design with those of the hard sciences or engineering.

The homologation of design to science in academia has very definite implications. This affiliation implies the adoption of experimental and verifiable research methods, the replicability of the experiments themselves, and a reduction in the role of design to the sole dimension of problem solving in a sort of procedurality that implicitly suggests a mechanicity of the act and practice of design in the broadest sense. In light of the aforementioned assumptions and hypotheses, the outcome of the process is a result, a successful project insofar as it is consistent with the initial assumptions and the process itself. The temptation to adopt a 'mechanical' and functionalist view of design, which continues to elude reduction despite the liberation from total artistic practices, is often misplaced. This is despite the fact that the design process is not solely driven by 'creativity', which has often perceived as the main driver of design, on the other hand. If, as Cross (2001) points out, the assimilation of design to science in terms of both design research and theoretical culture has seen this relationship change, re-emerge and transform itself at certain critical junctures in the history of design itself, this relationship when the inauguration of master's and bachelor's degree courses introduced design into university education brings with it further food for thought.

"These concerns [with respect to the relationship between design and science] emerged strongly at two important periods in the modern history of design: in the 1920s, with a search for scientific design products, and in the 1960s, with a concern for scientific design process. The 40-year cycle in these concerns appears to be coming around again, and we might expect to see the reemergence of design-science concerns in the 2000s." (Cross, 2001; p. 49)

The issue at hand is of vital and critical importance, particularly when design is required to adopt processes of scientific production and dissemination that challenge the conventional wisdom of academia and, moreover, of the hard sciences, among possible models.

If the dissemination models are indeed those of the paper-based text, which is characterised by an extremely rigid organisational structure (IMRaD: Introduction, Methods, Results, and Discussion), reflecting research practices, there is a risk of losing part of the specificity and richness of the project culture. This is particularly pertinent when one considers that a significant proportion of research in/on/through design incorporates visual, spatial and multimodal communication tools (Bollini, 2012; 2022), which are not fully utilised in the verbal component of the textual format alone, i.e. literacy and numeracy.

It is therefore evident that a postdisciplinary discourse requires the implementation of innovative dissemination models (Bollini & Moretti, 2024) that are capable of including, integrating, and enhancing existing modes of dissemination and project narratives, while simultaneously incorporating diverse methodological approaches to research. The

debate on this specific topic is becoming increasingly pervasive, particularly in an environment such as Italy, where the dissemination and scientific publications have a significant impact on academic career progression and evaluation and assessment systems. These issues are being discussed in a number of contexts, including the CRUI (Conference of Italian University Rectors), the SID, the Scientific Society of Design, as well as individual research and opinion groups (Lupo, 2022) with the objective of identifying new methods, formats and platforms for sharing the knowledge produced within Italian universities, both among peers and in a way that is accessible to a wider audience. Such possibilities include the production and evaluation of visual essays, where the graphicacy element assumes greater prominence than the other communicative assets, as well as the use of interactive and multimedia tools. Additionally, the research may result in a range of outputs, including exhibitions, systems, services, products and artefacts of various kinds.

5. Cross-pollination and social responsibility (Challenge 5)

The opening up of dissemination practices to a wider audience than the scientific community of reference, now made up of personalities from different backgrounds converging on design and its practices, transcending niches, rituals and jargon, represents the moment of synthesis between the many possibilities offered by a post-disciplinary approach to design research and education. This change strongly emphasises the increasingly strategic and important role that design practices also play in other fields, in terms of sharing and transferring knowledge, not only to internal stakeholders, but above all to external stakeholders, decision-makers, policy-makers and citizens, stimulating their participation and forming conceptual and methodological tools, as well as data and results, to build informed participation and decision-making processes. The mix and convergence of different contributions, as in the case of the proposed new doctoral programme, ranging from design to art, from human sciences to technologies, can therefore contribute to the formation of a new generation of hybrid, “contaminated” researchers, open to dialogue, capable of generating new models of research and education, as well as conscious, meaningful, ethical and sustainable innovation and transformation in the world and in the complexity of its systemic challenges, crises and opportunities.

3. Conclusions

The implications of this challenge for both research models and educational practice can only be drawn from the experience of at least the first cohort of researchers over the next three years and the subsequent development of this pioneering proposal. For the moment, however, the five challenges outlined and discussed are a first result, at least speculative, of the introduction of the new doctoral programme

in Experimental research through Design, Art and Technologies and the involvement of different faculties, universities and international experts who have taken up the challenge of a hybrid, open and postdisciplinary proposal.

Among the concrete challenges facing the first year of the XL cycle, which also seem to suggest criteria for evaluating and reflecting on the proposal itself, is the ability to transform the potential frictions between different cultural, disciplinary and methodological systems into opportunities for innovation and growth in a post-disciplinary perspective that goes beyond specific definitions and converges on common ground with different perspectives. A second aspect will be the ability of lecturers and doctoral students, scholars and researchers to dialogue, collaborate and cooperate on individual topics in an integrated, interconnected and transversal way, enhancing and multiplying individual research with synergetic effects. Finally, the ability to negotiate, agree and inhabit shared epistemologies, terminologies that create a common ground for conversation and growth.

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DESIGN IN THE MULTIDISCIPLINARY ERA: COLLABORATIVE APPROACHES TO CULTURAL AND TERRITORIAL REACTIVATION.

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ABSTRACT | The new methodological approaches that have developed over the past decades have led to an ever-increasing rapprochement with communities as they can reactivate processes of re-appropriation of territorial identity. The use of similar terms referring to inclusive practices, often used as synonyms, such as co-design, co-creation, participatory design, and open design, immediately highlights some points to ponder.
This paper aims to shed light on how design can build relationships by analyzing these contemporary methodologies, and through the comparison of three Italian cases of community involvement in the cultural and territorial reactivation processes. The best practices are selected based on the impact generated on the territory and communities, the size of the intervention - small, medium, and large - and the "competitive advantage" (Cangiano, 2019) that they created on the social substructure - an approach that ensures social resilience and is not built around profit. The comparison involved Torino City Lab, a Living Lab in northern Italy, and two cases from the south, namely Farm Cultural Park in Favara, Sicily, and Noi Ortadini in Matera, Basilicata.
The purpose of the analysis is to synthesize territorial examples and models supporting regenerative visions in socio-cultural terms, comparing the various collaborative approaches in support of site-specific expressions of design.

KEYWORDS | MULTIDISCIPLINARITY, DESIGN METHODOLOGIES, CO-DESIGN, TERRITORIAL REACTIVATION, SOCIO-CULTURAL REGENERATION

1. Introduction

In recent decades, there has been a progressive rapprochement between design and community thanks to collaborative methodologies. An ever-increasing sense of responsibility, whether ethical, cultural or political, has led designers to imagine broader and multifaceted methodological visions, capable of giving rise to practices of re-appropriation of territorial identity. As a result, notions such as co-design, open-design, participatory design, and cocreation practices were born.

In Lévy (2002) and De Kerckhove's (1998) theories on collective and connective intelligence, multidisciplinary approaches combine different areas of expertise to tackle complex problems. According to Lévy, Collective Intelligence would be the product of memory and collective imagination, capable of bringing out the skills; Connective Intelligence, according to De Kerckhove, is located in connections and networks and characterizes the way we reflect and process knowledge. Connective intelligence represents the most dynamic and practical part. In this scenario, where more and more actors interact and contribute by exchanging experiences, interests and needs, the concept of community emerges: inclusive, able to experiment with open forms of action and widespread creativity (Manzini, 2018). Paraphrasing Ferreri's concept of 'consciousness of place' (2018), we can delineate community as a manifestation of widespread awareness, imbued with values, visions, and representations, which reacts more or less openly to the development conditions set by society. Using collaborative methodologies makes it possible to reinforce the sense of belonging and responsibility towards one's territory, facilitating the assumption of initiatives by citizens and their active participation. Focusing on communities means analyzing the capacity of local actors to operate as a territorial collective actor (Dematteis et al., 2003). Collaboration practices can reactivate places and foster a shared identity of belonging beyond geographic boundaries. As Ferreri (2018) noted, Italy's small towns and villages are repositories of cultural heritage essential to national identity.

In response to the lack of systematic understanding of collaborative methodologies and the ambiguity of methods for assessing quality, effectiveness and value (Wang et al., 2022), this study proposes a comparative approach to analyzing contemporary practices and addresses the following research questions:

RQ1: How can design build relationships through collaborative methodologies to reactivate territory and community?

RQ2: How do methodologies of participatory design, co-design, open design and co-creation differ?

RQ3: What is the impact of these methodologies on cultural and territorial reactivation?

RQ4: Can we identify methodologies that are inherently more effective?

The study shows that different collaborative methodologies produce different results in terms of community involvement and territorial reactivation. The comparison across three scales of intervention - small, medium, and large - allows the identification of key factors common to the different cases. Moreover, they use different degrees of participation and different actors: large scale - involvement of institutions and authorities (top-down approach); medium scale - bottom-up process starting from citizenship and territories; small scale - prevalent involvement of associations and specific groups. All methodologies emerge as effective tools for territorial reactivation and building more openness and resilient communities. Design, thanks to its disruptive capacity to trigger development and design transformation (Ferretti et al., 2022) plays a crucial role in this process, facilitating dialogue and the creation of trusting relationships.

The structure of this document is as follows. Section 2 gives an overview of the different approaches mentioned. Section 3 and 4 analyses methodologies used within these collaborative networks. Section 5 presents and examines three different Italian case studies and Section 6 presents some final considerations about the comparison and concludes the study.

2. Different approaches

In order to adequately understand the topics discussed, this article proposes a summary and definition of the following terms, highlighting their facets and the difficulties in reaching a universal definition; however, it does not aim to define a state of the art. To achieve this, the most reputable definitions from literature reviews and studies by experts in the field were collected and summarized.

2.1 Participatory Design

This term, introduced from Scandinavia around the 1970s (Cross, 1972), describes an approach that actively involves end users in the design process. It focuses on using tools to facilitate communication between

stakeholders with different backgrounds. Simple tools that invite nonexperts to participate actively in the process.

Participatory design is characterized by its commitment to a democratic approach, aiming to simplify and make the design process accessible by enabling end users to understand and tailor it to their needs. Thus, this practice fosters empowerment and mutual learning by using tools and methods that promote transparency and understandability in the design process.

The strength of the collaboration between the roles of the designer and the end user in this participation is well expressed in the words of Simonsen and Robertson (2012): "The participants typically undertake the two principal roles of users and designers where the designers strive to learn the realities of the users' situation while the users strive to articulate their desired aims and learn appropriate technological means to obtain them".

In recent years, participatory design has evolved to include different variations, which change the definition based on the hierarchy and intensity of the interaction between the designer and other participants.

2.2 Co-design

The authors Sanders and Stappers (2008), explain how the designer and "people not trained in design" collaborate, just as suggested by the prefix "co" indicating cooperation or collaboration. Moreover, in their definition of this term, they admit that the user who participates in design is not only involved in some steps but also collaborates in the design itself, depending on his experience, skills, and sensibility to play an equal role to that of the designer.

In the co-design process, all actors are involved and play a fundamental role by contributing their everyday experiences, participating as "diffuse designers" (Manzini, 2015). In fact co-design is starting to be defined as "collaboration between stakeholders in designing solutions to a prespecified problem" (Vargas et al, 2022).

Contrary to Sanders and Stappers' definition, Simon (1988) explains that in co-design, design professionals work alongside individuals without specific training, emphasizing the designer's role as a process facilitator. In this sense, the designer interrogates users by exploiting and enhancing the input received in the final design but without making them participants in the design itself.

In this view, the designer has the opportunity to leverage his design skills based on problems identified not by the individual but by the experience of a multitude, allowing him to expand and embrace a broader spectrum of problems to be solved.

A recent study by Avila-Garzon and Bacca-Acosta (2024) notes how this term is associated with fields such as machine learning, optimization, hardware/software co-design, and health issues.

2.3 Open Design

The concept of open design appeared in the scientific literature around the 2000s (Vallance, Kiani and Nayfeh, 2001). The most common interpretation refers to a project that follows the open-source model by sharing all information under a Creative Commons license (Balka, Raasch and Herstatt, 2010; Ciuccarelli, 2008; Van Abel et al, 2011). Through these agreements, all design information can be used, modified, and produced by anyone (Menichinelli, 2014). Therefore, open design is based on the concepts of openness and transparency in the design process. It must be accessible and reusable by anyone and for any purpose (Van Abel et al, 2011), and promotes the sharing of knowledge, tools and results within broad communities. This approach allows anyone to contribute to the design, regardless of specific expertise, facilitating large-scale collaboration because its focus is not on the final product but on "its recipe" that is, the sources and method of creation. Open-design can thus be clearly defined as "the state of a design project where both the process and the sources of its output are accessible and (re)usable, by anyone and for any purpose" (Boisseau et al, 2017).

From state of the art by Boisseau, Omhover, and Carole Bouchard (2017), it is also evident that the main areas of use of this term are: the do-it-yourself, which involves end-users capable of creating and modifying designs on their own, using publicly available resources and guides; the meta-design, which includes projects where end-users are integrated and actively contribute in the design process; the industrial ecosystem, which concerns the exchange of knowledge and resources between companies in the context of technological development aiming to shorten development cycles and leverage open innovation.

2.4 Co-creation

This term is often used in a generic and all-encompassing way of collaborative approaches (De Koning et al., 2016; Sanders & Stappers, 2008), and as such has many variations related to different fields of study that have adopted it.

In the business field, introduced by Prahalad and Ramaswamy (2004), the term is associated with the word "value" because it refers to the creation of new value that is generated by the collaboration between user and consumer through interaction with the service, allowing value to be not "delivered" but "co-created."

In the design field, this term identifies design processes where various figures actively participate, from stakeholders to end users, as well as representatives of other disciplines. With this meaning, Ind and Coates (2013) suggest co-creation is understood as creating collaboratively but without outlining specific methodologies or practices.

Looking at more recent theories of more-than-human, the meaning of this term expands to emphasize the coexistence and co-creation of all life forms to address complex ecological challenges, creating bonds and building symbiotic relationships not only among humans (Haraway, 2016). Therefore, in recent years the term has begun to shift to “design-with” (Wakkary, 2021), an approach which recognizes humans as not the only actors in the design process. Instead, they must collaborate and coexist with non-human elements, thus rethinking design as a shared and co-constructed activity by all actors involved, requiring collaboration and interdisciplinarity.

Moreover, the study by Avila-Garzon and Bacca-Acosta (2024) reveals how this term is associated with areas such as product/service/brand co-creation, social media, customers, innovation, value co-creation, knowledge generation, artificial intelligence, living labs, and virtual reality.

2.5 The different roles of the designer

Participatory design, co-design, open design, and co-creation are approaches that actively involve users in the design process. They present more or less significant differences, especially the role of the designer and the way collaboration is structured.

Participatory design focuses on a democratic process in which the designer facilitates the understanding and expressing user needs, ensuring an output that can be considered predictable and controllable.

Co-design extends this collaboration by involving users as co-designers along the process. In this case, the designer acts as project manager, coordinating the interaction between practitioners and users for an equally predictable and controllable outcome.

Open design adopts an open-source model, sharing information under Creative Commons licenses. This approach promotes transparency and large-scale collaboration, making the designer one of many actors in a horizontal process that produces a predictable but not completely controllable result.

Finally, co-creation places all stakeholders, including users and designers, on an equal footing. In this case, the designer integrates as an equal among the other participants, contributing to a predictable but co-created outcome.

3. Methodologies

Getting into the specifics of the methods, participatory design, co-design, open design, and cocreation develop in similar phases but differ in structure and key participants. As for the definitions discussed in the previous section, literature presents many interpretations also in the methodological field. Given the consistent heterogeneity

of design projects, a corresponding variety of methods has been observed depending on the application fields (Jones, 2018), and, often, varying according to the subjective interpretation of the researcher. Since the analysis in this contribution aims to understand the structures of the processes for interpreting three collaborative project cases, it was decided to provide an example of the methodologies selected from extensive literature reviews and based on their relevance to the contextualization of our case studies.

The case of co-creation has not been addressed from a methodological perspective; its definition, in most of the analyzed cases, encompasses many other approaches. Furthermore, according to Avila-Garzon & Bacca-Acosta (2024), many contributions do not clearly define the methodology, and those that do present no specific consensus, even if there are some touchpoints and common frameworks. Messiha et al. (2023) state that "scholars have not consistently and efficiently contributed to the construction of co-creation theory," attributing this to inconsistencies and confusion in the way these terms are used, and possibly a potential fragmentation of knowledge due to the multidisciplinary approach.

Moreover, according to the study by Peter Jones (2018), co-creation methodologies are not formally documented or developed and frequently are branded or proprietary craft practices, making them difficult to validate or compare. These aspects, according to the scholar, contribute to a multifaceted scenario in which we find minimal peer critique of methods.

3.1 Participatory Design

The procedure of participatory design involves the collaboration of end-users with the designer in all phases of the design process. In the Scandinavian approach, active user participation is required, whereas in the U.S. there is a tendency to adopt less intrusive methods such as observation and artifact analysis (Spinuzzi, 2005). According to an in-depth literature analysis by Clay Spinuzzi, there are typically three phases: Initial exploration of work, Discovery processes, and Prototyping.

The first phase involves familiarization between users and designers and the introduction of work tools. The second phase consists of the initial dialogue about the product or system to be designed, leading to the definition of specific objectives. The third phase involves the creation of the prototype. All phases can be repeated multiple times until the process is fully concluded.

3.2 Co-design

In the co-design process, besides designers and users, various other professionals from different fields are also involved, allowing for potentially more functional results from

multiple perspectives. Within this approach, numerous methodologies exist, often with significant differences. Following, we will report the version from Mulvale et al. (2016) developed in the field of health system, which shows a particular adaptability when abstracted from the specific area for which it is conceived.

The system consists of four phases: diagnostic, intervention, implementation and evaluation.

Designers, various professionals and users are always all involved in every phase. The first phase, *Diagnostic*, is aimed at elicit experiencing data; the authors propose some methods as individual interviews, use of visual representation media, focus groups and ethnographic observation. The second, Intervention, is the proper design phase, in which to highlight the problems to solve through the design, or the issues in the system they are evaluating or testing. Following, Implementation develops the considerations done so far in smaller co-design groups, and finally, Evaluation is aimed to make improvements to the hypothesized solutions.

3.3 Open Design

As represented by Silvia Gasparotto in her literature review (2019), the methodological structure can be exemplified in a three-phase scheme, not dissimilar to that of Participatory Design. The three phases are: Conceptualization, Refinement, and Production.

In the first phase, a person or group, which does not necessarily include a designer, structures the "source project," to which other people, not necessarily part of this initial group, will contribute in the subsequent phases. The peculiarity of the method is its horizontal peer-topeer structure, which does not allow any degree of control over subsequent versions of the project.

Indeed, after the launch of the source file released as open source, the subsequent phases involve the interaction of other users for the reworking of the content, which reaches its prototyping through the phase of "open manufacturing," whether manual or digital.

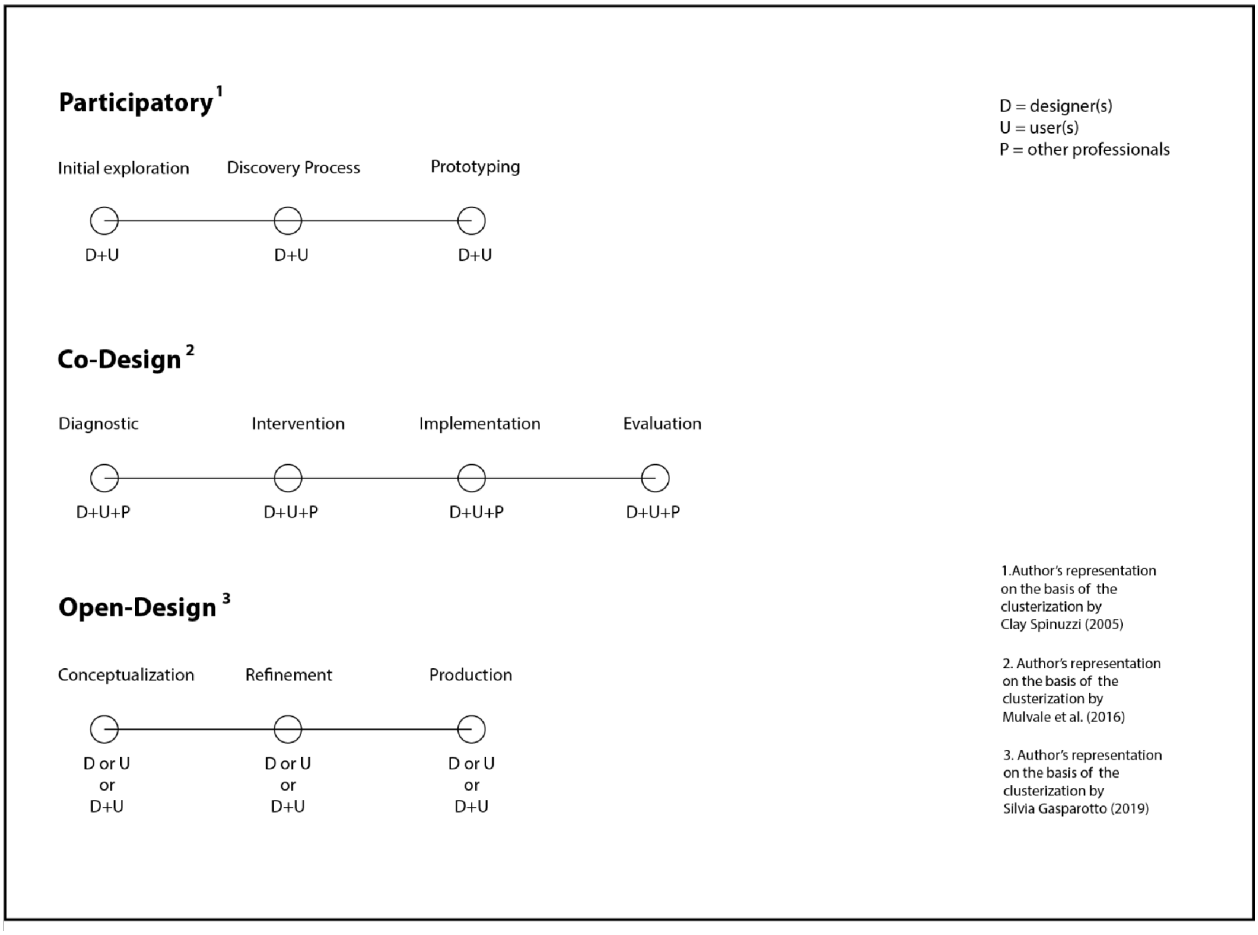

Figure 1. Participatory, Co-Design and Open Design methodology representation.

4. Case studies' methodologies

4.1 Torino City Lab - Living Lab

The first of the three chosen case studies is a Living Lab (LL) situated in Turin. According to the definition of ENoLL (European Network of Living Labs), LLs "are real-life test and experimentation environments that foster co-creation and open innovation among the main actors of the Quadruple Helix Model, namely: Citizens, Government, Industry, and Academia" (What is ENoLL?, s.d.).

Trying to insert LLs to one of the collaborative categories explained above, we immediately encounter some difficulties. Based on our analysis, they could correspond to the co-design definition, which involves designers, users and other professionals; also Scott, Quist and Bakker (2009), among others, attribute LLs to co-design, whereas Dell'Era & Landoni (2014) locates them between user-centered design and participatory design.

Schuurman et al. (2015) point out an interesting gap in methodology in the literature: "[the literature] positions Living Labs too much as an "everything is possible" concept that resembles an empty box, in the sense that you can put whatever methodology or research approach inside."

Nevertheless, some authors, such as Vicini et al. (2012), Esashika et al. (2023), tried to exemplify specific methodological processes that could be applied to different Living Labs. That proposed by Vicini et al. is particularly clear and develops in four phases: Co-Creation - which includes analysis of the scenario, ideation and co-design, - Exploration - consisting in the set up of the testing platforms, the execution of the tests and the exploration of the results, - Experimentation - therefore, more tests and data collections, - and finally Evaluation - which consists in data analysis and conclusions. Analyzing this method, it is possible to find a general coherence and some specific touch-points with the method by Mulvale et al. explained before in the co-design section.

In the specific case of Torino City Lab, it is interesting to highlight the process of creation of the networks: after the first contacts of the Utilizers with the LL net, the Utilizers prepare a testing proposal and send the application via the official website (Torino City Lab Website, s.d.). This open process allows anyone to propose its collaboration, and highlights a bottom-up approach to the creation of the final network, in a pre-set top-down methodology.

4.2 Farm Cultural Park - Urban Regeneration

Farm Cultural Park is situated in the south of Italy, in Sicily, in the municipality of Favara. This urban regeneration project started from a couple living in Favara and willing to trigger a recovery process of the historic center (Faraci, 2017).

Since the literature on this case study deepens mostly the architectural interventions, but does not focus on collaborative approaches to the project, we interviewed one of the two founders, Florinda Saieva, who gave us the following information.

At first the project did not involve the community, as the opening was scheduled for two years later, therefore there would have been more time to co-design. Though, after the collapse of two buildings in the historical center of Favara, the Municipality had decided to demolish the neighborhood and the project had to be pushed to immediate execution in order to avoid the procedure and save the area from obliteration.

Community involvement occurred later; the method adopted was to create distinct projects with different objectives. These were conducted through the involvement of entities, such as schools, and communities using surveys, focus groups, and workshops. The work ultimately culminates in the actual co-design of the space in question. This methodology was repeated with different targets and for designing different

specific areas. Also interviews were used to collect other design stimuli from other targets; the local community is encouraged to provide feedback and suggestions on future exhibitions, events and projects. Public institutions were also involved in the processes of discussion of the projects; specifically neighboring municipalities and mostly local Universities (F. Saieva, personal communication, July 24, 2024). Even though this project does not start from designers per se, the emerging methodology is aligned with shared co-design methodologies and evaluation methods reported by scholars (Want et al., 2022). It is relevant to notice that the approach adopted in this case is significantly more flexible and less structured than the Living Lab.

4.3 Noi Ortadini - Social Regeneration

Noi Ortadini (translatable as "Us Gardeners") (Jones & Pappas, 2023), is the smallest among the compared cases; it consists of a project started from a single person and developed because of the creation of a community of friends with similar passions and values.

Also in this case, we collected the following information by speaking directly with members of the organization (S. Simeone, personal communication, July 15, 2024). The project took place in Matera, a south-Italian city, where a group of friends, professionals in different fields and not coming from design, created a regenerative project around a vegetable garden they cultivated together.

The collaborative aspect in this case is relative to the participants of this open small community of citizens, which collaborate to the growth of the garden and the development of a series of social activities involving local citizens, and authorities; we could define the process as codesign within the association. In this case, no strict methodology can be found; in fact, the aleatory nature of the gathering is the key to its development.

As stated in some witnesses collected by Kuthz et al. (2023), the success of a participatory project often passes through an informal methodology untied from surveys and pre-structured settings, but from active collaboration based on listening to the needs of the place intended as territory and inhabitants.

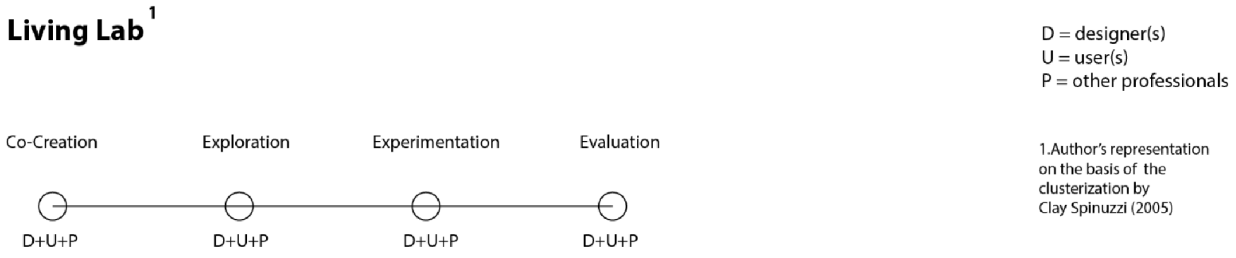

Figure 2. Living Lab methodology representation

5. Case studies

5.1 Torino City Lab

The section was developed based on the study by Cillo V., Del Giudice M. et al. (2020) and the consultation of the websites of Torino City Lab, Casa delle Tecnologie Emergenti, Comune di Torino, and Torino Social Impact.

Torino City Lab is an initiative promoted by the City of Turin with the goal of transforming the city into an open-air laboratory for experimenting with innovative urban solutions. Launched in 2018, the project offers companies, start-ups, universities, and research centers the opportunity to test new technologies and pilot projects in real-world contexts, facilitating public-private collaboration to develop solutions that improve citizens' quality of life and address concrete challenges and needs of the area.

In 2016, Turin inaugurated the first Living Lab in the Campidoglio district, with 29 experiments on environment, mobility, and tourism. In 2018, the focus shifted to a circular and collaborative economy. In 2021, The City promoted the application for the establishment of the Casa delle Tecnologie Emergenti (CTE NEXT) in close collaboration with the universities of Turin and other strategic partners. In 2022, the City was included among the 100 European cities committed to reducing emissions by 2030, becoming a "Mission City" and a hub of climate innovation and experimentation. In 2023, the City established the Living Lab ToMove, which builds upon and expands the goals and facilities of Torino City Lab and CTE NEXT, also pursuing energy and environmental sustainability objectives across the board.

Main actions:

- Collaborations and partnership networks to foster innovation through events and workshops;
- Field experimentation and testing of new urban technologies;
- Support for tech start-ups (incubation and acceleration);
- Smart mobility projects and IoT (Internet of Things) infrastructures;
- Initiatives for sustainable energy production and consumption;
- Digital education projects in schools and accessibility to digital technologies and development of innovative services for the community;
- Professional training programs and workshops for students, entrepreneurs, and professionals;
- Community participation through their involvement in the experiments of new technologies and the implementation of participation and public consultation platforms;
- Promotion of sustainable lifestyles, such as the use of renewable energies, sustainable mobility, and intelligent resource management, as well as urban redevelopment projects to improve public spaces.

Economic impacts:

- Increase in investments by tech companies and start-ups looking to test and develop their products;
- Growth in employment both in companies and related services (consulting, maintenance, technical services);
- Growth of the entrepreneurial ecosystem through support for local start-ups and Small and Medium Enterprises;
- Increased collaboration between universities, research centers, and companies, fostering the development of advanced skills in technology and innovation;
- Greater efficiency and productivity in traditional sectors through the adoption of new technologies.

Socio-cultural impacts:

- Reduction of the digital divide (greater access to technology for all segments of the population);
- Greater support for artistic and cultural initiatives that use technology for new forms of expression and audience engagement;
- Increased collaboration with local cultural institutions and with non-profit organizations and volunteer associations to develop projects with a strong social impact.

5.2 Farm Cultural Park

This section aims to describe the process of sustainable design, social innovation, and inclusion, triggered by the Farm Cultural Park in the historical center of Favara. It was developed based on the reading of several articles and contributions, including Faraci G. (2017), Tesoriere Z. (2023), Occhipinti F. (2017), and Mariani M. (2020), from the Farm Cultural Park website and related projects, listening to interviews available on the web, some direct experiences within its spaces, and, finally, a personal interview with one of the founders.

Farm Cultural Park is an independent cultural center located in Favara, a small town in the province of Agrigento (Sicily), which, since 2022, also has a location in Mazzarino (CL). It was founded in 2010 by the private initiative of notary Andrea Bartoli and lawyer Florinda Saieva, a couple of art collectors with a great passion for contemporary culture who dreamed of raising new generations - including their two daughters - in a socially and culturally stimulating environment.

The regeneration initially involved the area of Sette Cortili, a neighborhood in the historic center of Favara that, due to the collapse of some buildings and the death of two girls, was at risk of being demolished. The couple, returned from Paris, decided to take action to stop the neglect and marginalization of their city, accelerating the project's start and acquiring the area. With the involvement of artists, architects, and designers, both national and international, renowned and emerging, they transformed the disused spaces into places for the community with the intent to preserve the town's culture and identity. In addition to exhibitions and

installations, workshops, meetings, conferences, and festivals are organized. The place soon became a cultural reference point both locally and nationally and beyond, proposing itself as a replicable model in different contexts.



Figure 3. Farm Cultural Park's entrance, Sette Cortili, Favara (AG)

Over the years, Farm has expanded its exhibition spaces and participated in important international events, including the Venice Architecture Biennale. It established SOU, the School of Architecture for Children - focusing on educating young generations to create responsible and aware citizens - and Prime Minister, School of Politics for Young Women - to train and inspire them to become leaders and change agents in their communities - now spread throughout Italy.

Another significant moment was the inauguration in 2019 of Countless Cities, the Biennial of the Cities of the World, which aimed to shift the focus from the State to the Cities, emphasizing their growing importance concerning a country's economic, political, cultural, and social life. This event led to the reopening of Palazzo Micciché, a 19th-century noble palace, set up with the intention of redefining the meaning of a historical-monumental building, aspiring to become something else: "Human Forest" project, a place for meeting and bringing people closer to nature.

Andrea and Florinda, through the work of Farm, demonstrate that culture, art, the meeting of people, and the love for a place can be powerful catalysts for transformation and rebirth.



Figure 4. Human Forest, Palazzo Miccichè, Favara (AG)

Main actions:

- Cultural and artistic redevelopment;
- Promotion of cultural events;
- Education and training through workshops, labs;
- Educational programs for all ages on art, design, sustainability, and gender equality;
- Community involvement.

Economic impacts:

- Increase in employment, not only in quantitative terms but also qualitative, and reduced brain drain;
- Updating and professional qualification of local human resources;
- Growth of new entrepreneurship (start-ups);
- Investment in the historic center/culture combination by SMEs;
- Increase in tourism and opening of new businesses by the local population.

Socio-economic impacts:

- Increased social cohesion, sense of belonging, and collective responsibility;
- Positive and proactive attitude of the community;
- Increased cultural and artistic prestige of Favara;
- Greater attention to the maintenance and care of public spaces, the urban context, and the community's needs;
- Inclusion of vulnerable or marginalized individuals;
- Increased self-esteem and aspirations of the local population;
- Improved image of the territories and reduced antisocial behaviors;
- Perception of a greater sense of security by women.

5.3 Noi Ortadini

The section was developed based on the study of the Noi Ortadini website and related projects, listening to interviews available online, and a personal interview with Sara Simeone. Noi Ortadini APS is an Association for Social Promotion that manages a green space in the "Serra Venerdì" neighborhood of Matera. The idea originated in 2020, during the lockdown, from the private initiative of Andrea Grieco, a biologist and aspiring natural farmer, who started a horticulture project on land near his home in Matera. During the summer, he participated with his colleague Sara Simeone in a synergistic and regenerative agriculture course at the Serra Venerdì garden, and in the following months, new members joined, and activities began to expand.

In December 2020, Noi Ortadini formalized its structure as an APS. With the support of the community and institutions, it participated in strategic meetings to define guidelines for urban gardens and established collaborations with Basilicata Link, a local cultural association, as well as with young artists, architects, and both local and non-local networks. Over the years, it has proposed entrepreneurial initiatives and engaged in educational and cultural activities; it collaborates with national organizations and social cooperatives and amplifies the group's engagement within the community, aiming to regenerate the area and create a gathering space.

In June 2021, it joined the participatory discussions organized by Coalizione Civica Matera, involving various Third Sector Organizations around the theme of common goods, and it was recognized as a catalyst for urban regeneration, social inclusion, and sustainability, emerging as a virtuous example of community participation and sustainable development.



Figure 5. Noi Ortadini in the vegetable garden, Matera (MT)

Main actions:

- Urban agriculture and environmental sustainability through the creation of urban and shared gardens and the promotion of recycling and composting;
- Promotion of agricultural education through outdoor workshops and seminars on sustainable cultivation techniques;
- Community involvement in the design and management of urban gardens, community events, and farmers' markets;
- Collaborations with entities, associations, and local interest groups;
- Enhancement of the territory through the recovery of abandoned areas (about
- 4000 sqm) and the promotion of local heritage;
- Awareness programs related to the 2030 Agenda to inform the community on sustainable development issues.

Economic impacts:

- Training and acquisition of skills related to European project design, including participation in calls for proposals;
- Job opportunities for local youth;
- Interest and support from local institutions.

Socio-cultural impacts:

- Greater sense of community and solidarity and active participation of people;
- Increased connection of "ortadini" citizens with nature;
- Transformation of an abandoned space into a place accessible and open to the entire community;
- Greater involvement of both local and non-local youth;
- Increase in activities and services that promote intergenerational and intercultural relationships, with particular attention to migrants and people with disabilities.

6. Conclusion

The research questions brought to light different interpretations. As the case studies analyzed show, design can and does build collaborative relationships in the contemporary age. In Celaschi's essay, design acts as a bridge capable of connecting and integrating different areas of knowledge (Germak, 2008), metabolizing and synthesizing certain design practices and creating a "conscious collage" and a continuous reshaping of knowledge. Like an enzyme that sets in motion a process of (re) interpretation capable of generating new matter (Tufarelli, 2022). As can be seen from the collection and synthesis of the most widely accepted definitions, the different methodologies differ in definition but not always in methodology. Trying to categorize the case studies examined, the situation blurs to the point of asking a further question: how important is it to define a preset methodology, rather than to focus on creating a cohesive and adaptable approach? In a small scale and small community context, cohesion appears crucial, obsessing over the division of approaches and attempting to use the perfect methodology may not be the key to project success. The question also prompts reflection on further aspects such as the importance of context, creating a sense of unity and shared goals, the type of project or initiative, and the skills and experience of those involved. Prioritizing valorization, cohesion, community involvement and flexible approaches is key to succeeding in social and territorial regeneration. "Accepting the fact that non-experts also make critical contributions and should work alongside experts is a sign of progressiveness and maturity in the discipline of design" (Muratovski, 2022) and is reflected in the possibility that an approach works even without a clear and defined method, but, more precisely, despite having one. This hypothesis highlights the need for further research.

The comparison of the three cases highlighted the similarities and differences between the different methodologies. All three projects emphasize the active involvement of the local community, with a particular focus on education and training, and engage in territorial enhancement. Specifically, Farm Cultural Park and Noi Ortadini implement participatory projects and community activities. They offer educational and training programs on specific topics such as art, agriculture and sustainability. They are involved in the regeneration of abandoned spaces and the promotion of local heritage. Torino City Lab includes community participation in the experimentation of new technologies and organizes events and workshops to foster innovation and collaboration.

The differences between the different cases concern thematic focus, scale and impact, and types of intervention: Farm Cultural Park focuses mainly on art and culture as tools for urban regeneration, Noi Ortadini focuses on urban agriculture and environmental sustainability, and Torino City Lab is oriented towards technological experimentation and urban innovation. While the first two operate in more localized contexts (Favara and Matera respectively), with a strong community and territorial impact, Torino City Lab operates on a broader urban scale, aiming to make Turin an intelligent and innovative city. Finally, Farm Cultural Park and Noi Ortadini, carry out physical and tangible interventions (transformation of urban spaces, creation of vegetable gardens), and Torino City Lab focuses on technological and digital interventions (testing new technologies, smart city).

In conclusion, Torino City Lab, Farm Cultural Park, and Noi Ortadini represent three distinct models of urban regeneration and social innovation. Each of them has a specific focus and the common goal is the improvement of the quality of life of citizens and the promotion of sustainability and inclusion. Torino City Lab is the one with more industrial objectives and initiatives. For example, in collaboration with the company ABzero, urban trials are underway to develop innovative technological solutions and social acceptance for a drone-based autonomous transport system (Smart Capsule) designed to transport medical equipment in urban areas.

Assuming that the scale of the project influences the need for structuring, following rigid standardized methodologies is seemingly negligible. Flexibility and adaptation to individual needs, through the combination of different strategies, appears to be a strength that can transform and innovate cities and communities. For this reason, we cannot at present identify methodologies that are inherently more effective.

Design thinking emerges as a concept to support the theme in light of the above. In the context of social innovation, design thinking is particularly valuable because it allows for a humancentered approach to problem-solving (Kazuhiko, 2014). All those involved, whether designers or non-experts, employ their design skills during a project. They first identify and understand the problem, then they imagine a better solution. Finally, they translate those ideas into practical actions. Non-experts offer pervasive design skills through life experience and creativity. Design experts contribute by utilization of design tools and the capacity to facilitate co-design activities. Today, it is easy to find clear examples of these two groups working side by side in any design activity. Co-existence is accentuated when dealing with issues of social innovation (Muratovski, 2022).

In conclusion, despite the multiplicity of existing terms and methodologies, it is clear from this paper that these should not be considered static and rigid elements. On the contrary, their primary function is to facilitate the initiation of a process of collaboration and sharing of a common vision. In this sense, they can be understood as guidelines, to be used flexibly and adaptable to specific needs. To grasp the complexity of the phenomenon, it is necessary to continue the comparative analysis of further case studies.

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Notes

The authors shared the theoretical approach and the articulation of the contents of the paragraphs, even if the contributions are in particular attributed as follows:

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HOSPITALS OR HOMES: WHERE WILL WE BE CURED IN THE FUTURE? DESIGN CHALLENGES AND VISIONS IN THE RAPIDLY EVOLVING HOME CARE SECTOR.

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ABSTRACT | The healthcare sector, independent of national and international political organizations, allows people to receive medical care and assistance in specialized healthcare facilities, such as hospitals and clinics, or directly in patients' homes.

The degree of adoption of these places for care provision has proven to be unstable throughout history, being dependent on technological and societal conditions, as well as users' needs. Globally, home care services are becoming increasingly popular due to the global pandemic experience and the rapid technological advancements, that allow home-use medical devices (HUMD) to become increasingly usable by unprofessionalized users and capable of solving progressively complex medical needs. The home care industry is evolving at a steady pace and has great potential for growth in the coming decade due to the benefits and opportunities for the users introduced by its solutions (Precedence Research, 2024).

This phenomenon makes it necessary to investigate the potential of future scenarios in which home care services, such as telehealth and in-home medical assistance, could supplant other forms of care, particularly in economically and socially mature contexts.

In this evolving situation, designers and decision-makers should be aware of the emerging challenges that need to be addressed to meet market requirements.
This study is one of the ongoing results of a PhD research, whose main objective is to understand

the role and contribution that the design discipline can bring to medical device R&D, and the recognition of its most effective approaches to achieve this purpose. The objective of the initial phase of this research was to map the principal contexts of medical device utilization. Desk research was conducted to investigate two key issues: firstly, the longevity of sanitary structure and home contexts over the long term concerning their adoption as places of care, and secondly, whether the design of medical devices for different contexts necessitates the input of different design expertise.

The paper presents the findings of the first aim of this desk research, indicating that the relationship between care in healthcare facilities and home care is likely to maintain a sort of equilibrium in the long term, particularly in economically and socially mature contexts.

KEYWORDS | HOME CARE, HEALTHCARE DESIGN, MEDICAL DEVICE, DIGITAL TECHNOLOGY, SPECULATIVE DESIGN

1. Introduction: Hospitals and Homes as Places of Care

Healthcare services lay the foundation for the correct functioning of any modern society. In the current landscape, they are mostly delivered through a variety of healthcare facilities scattered throughout the territory such as hospitals, clinics, nursing homes, and ambulatories.

However, the position of these facilities, often heterogeneous between different areas, at least within the Italian territory (Bucci et al., 2021), poses accessibility problems to certain patients' limited range of motion.

Accessibility is here intended as "the characteristic of a device, service, resource or environment to be usable with ease by any type of user" (Bertini, 2003).

Physical and cognitive impairments can indeed transform reaching any place outside the home into an extremely complex task.

Home care services demonstrate their effectiveness in providing medical assistance to users with these difficulties. They are healthcare services provided within patients' homes: examples include caregiving, health data monitoring, and medical treatments (Bawa and Sinha, 2022). They can be divided into two main categories: those that can be provided remotely using telecommunication technologies, defined as telehealth or telemedicine services, and those that require the physical presence of dedicated professionals. The latter can be further divided into two sub-categories: doctor-on-call services, where the patient receives assistance at home at need, and nursing services, where a patient is not independent and needs constant assistance to perform daily tasks.

With the rapid technological development and due to the COVID-19 pandemic global experience, home care services have become a viable alternative to other forms of care for an increasing number of patients (Stepick and Tran, 2022). Indeed, benefits like fewer hospital readmissions, minor exposure to infectious diseases, minor health costs, more

accurate patient assessment, and higher patient autonomy (Stapleton and Bossie, 2024) are meaningful benefits for most typologies of patients.

For instance, telehealth services make it possible to receive increasingly complex medical care services without the patient having to reach dedicated healthcare facilities.

The potential of the home care sector to serve an increasingly larger audience has been outlined in a report published by Precedence Research (2024), in which it is stated that "the global home healthcare market size was valued at USD 373.56 billion in 2023 and is expected to reach around USD 1,469.92 billion by 2033 and is poised to grow at a CAGR of 14.81% during the forecast period from 2024 to 2033".

This consistent trend may prompt speculation as to whether the home care sector could potentially supplant the sanitary structure-based sector in the long term.

The recent history of the medical services sector in the USA provides a case study that demonstrates the degree of adoption of sanitary structures and patients' homes as places of care to be unstable and susceptible to societal changes (Bowman et al., 2017).

In this dynamic scenario, designers and decision-makers should be aware of the emerging design challenges that must be addressed to satisfy the market requirements, considering its expected growth in the following years.

2. Methodology: Desk Research and Contextual Mapping

The PhD research this study is part of has the general objective of understanding the role and contribution that the design discipline can bring to medical device R&D, and the recognition of its most effective approaches to achieve this purpose. To reach this goal, the research has been divided into four subsequent phases: (1) a map of the principal contexts of medical device utilization; (2) a review of methodologies currently adopted in medical device research and development; (3) the definition of the competences of the various professional profiles involved in the development of medical devices and comparison with those proper to the design discipline; (4) possible rethinking of project teams that include designers. This doctoral research is expected to lead to the following expected results: (1) a mapping of professional profiles, skills, and tasks in medical device design, along with their correlations, and (2) guidelines that help medical device manufacturers to purposefully integrate designers into their R&D teams. The present study is part of the first phase. The mapping process perpetrated by examining the MDR 745:2017 revealed the possibility of clustering medical devices into two principal categories: those intended for exclusive use by qualified personnel within controlled settings, such as healthcare facilities, and those designed to be used by unprofessionalized individuals, including patients and caregivers, in uncontrolled environments. Home Use Medical Devices

(HUMD) belong to this second category as they are mostly used by laypersons within patients' homes.

In light of this distinction, desk research was conducted to investigate the present and potential future design challenges associated with these two contexts of medical device use. This was done to investigate two key issues: firstly, the longevity of sanitary structure and home contexts over the long term concerning their adoption as places of care, and secondly, whether the design of medical devices for different contexts necessitates the input of different design expertise.

The paper presents the findings of the first aim of this desk research, indicating that the relationship between care in healthcare facilities and home care is likely to maintain a sort of equilibrium in the long term, particularly in economically and socially mature contexts.

3. Design Challenges for a Home-Based Sanitary System

Medical services and products are an integral part of people's lives, whether it's the case of wearing glasses for myopia or undergoing periodical dialysis due to renal failure. The definition of medical device provided in the MDR 745:2017 is broad and encompasses a diverse range of devices, many of which are significantly different from one another. Given these differences, primarily concerning factors such as associated risks during usage and contexts of use, envisioning home care as a comprehensive healthcare delivery model is ambitious and presents a multitude of design challenges.

This is because it is of the utmost importance to prioritize user safety and clinical effectiveness when designing and deploying any kind of medical device or service. In the current regulatory environment, these requirements are met through a combination of regulations, technical standards, clinical testing, and certifications. However, it is possible that future solutions may not yet be covered by such measures. To identify these challenges, many aspects of medical product and service development have been analyzed.

3.1 Users

Within the home care contexts, six major categories of users have been identified: people who are ill or convalescent, or who have to manage complex illnesses; people with disabilities; partially self-sufficient elderly persons; family members or persons related to the patient; formal caregivers (professionals); informal caregivers (laypersons) (Tosi and Rinaldi, 2015).

One of the most pertinent factors differentiating these users is their level of health literacy. The term involves many aspects of health understanding, including comprehending health information, navigating the healthcare system, and communicating healthcare needs (Simonds, 1974). Health literacy influences the appropriate use of medical devices, and

low health literacy is linked to the misuse of such products, possibly leading to extremely severe consequences (Kolnik, 2020). This factor determines the two main categories of users within the sector: laypersons and professionals. Laypersons are people who do not have specialized knowledge about healthcare disciplines, while professionals are those who do (Tosi and Rinaldi, 2015).

This differentiation is linked to medical devices' usability, learnability, and understandability, factors that determine a certain user's ability to use them safely while carrying out their intended purpose. Another factor to consider is the role of the users during medical device usage. It is important to note that some medical devices are intended for the self-administration of care, while others are designed to administer care to another person. While user-related design issues may arise in both cases, the first one may pose a greater design challenge. Indeed, the patient's ability to successfully use the product may be hindered by momentary or permanent physical or cognitive impairment (Collingsworth et al., 1997).

Traditional medical devices can be inaccessible to people with disabilities and, thanks to the purposeful design of medical devices, barriers for these users can be alleviated (Lemke and Winters, 2008).

Such disabilities would cause a patient to rely on caregivers to assist with self-care devices, possibly introducing unanticipated users into the product usage scenario.

This is of utmost importance in that home care services and devices should enhance patient autonomy, i.e. the patients' independence and right to make decisions regarding their treatment and medical attention (Atrak and Khoshdel, 2015). It is recognized as a modern principle in bioethics that respects personal freedom and the free choice of the patient in any degree of illness (Visbal, 2007).

A major user-related design challenge would be to enable stakeholders to use an increasing number of HUMDs while ensuring that limited health literacy has little negative impact on the clinical outcomes and safety of the product use.

Additionally, designers should find ways to successfully adopt the design-for-all paradigm into medical devices for self-care HUMDs, also due to patients' specific cognitive and physical abilities. It should be noted that eventual impairments can also be caused by diseases other than those treated with a certain medical device. The fact that many clinical conditions can coexist within a patient (Stapleton and Bossie, 2024) increases the possibility that some critical characteristics of target patients may not be considered during medical device development. The problem arises if these unforeseen characteristics hinder the usability of the designed medical device. Attention should also be paid to unforeseen users (e.g. caregivers giving support with self-care devices with insufficient patients), who could assist a patient using a self-care device.

Additionally, designers should also innovate techniques for remote interaction between users, allowing professionals to have more ways to intervene in situations where the presence of laypersons is not sufficient.

Considering the reported user differences, other design challenges involve social, communicational, and organizational phenomena (Di Fiore and Ceschel, 2017). Indeed, miscommunication between caregivers, physicians, and patients, also determined by cultural differences, poses a dangerous threat to patients' safety (Stapleton and Bossie, 2024).

Solutions should be implemented to reduce miscommunication to the minimum at various levels, whether cultural or health literacy-related, for example through the mediation of artificial intelligence.

3.2 Product characteristics

Designing medical devices for home use presents unique challenges. While developing solutions for healthcare facilities allows designers to work on known contextual data, home environments are unique and differ greatly from one another. Aspects related to the users and their activities, the physical and social environments, and other devices available can be highly unpredictable and not standardized as in hospitals. It is therefore essential that designers develop HUMDs that are capable of functioning effectively in a wide range of environmental conditions. General product requirements should include durability features, such as resistance to elements like dust, moisture, and mechanical shock, along with usability features, such as clear and illustrated instructions for use, understandable and comfortable morphologies, function names on buttons, and simple feedback systems to help users interact with the product as seamlessly as possible. One recommended approach to addressing this uncertainty would be to design devices with the assumption that they will be used in the most challenging conditions. Furthermore, certain medical devices, such as TAC machines, appear to be incompatible with the home setting due to their operational complexity and their physical dimensions, which can be contingent upon the dimensions of the human body.

These larger and less accessible instruments would be impractical for home care applications also due to their frequency of use. A significant number of medical devices are used to diagnose or treat conditions that a patient may never encounter during their lifetime. To address the reported issues, it would be necessary to determine the criteria according to which HUMDs would be provided, whether proactively in a standardized manner or when specifically needed. Connected to this, effective in-home medical device delivery methods would need to be established. While improved compactness of the devices would facilitate this aspect, many of them would be constrained by technological limitations and the physical ergonomics of the human body.

3.3 Technological aspects

In addition to the experience gained during the COVID-19 pandemic and the benefits it brought to the development of home care solutions, this sector has also seen rapid expansion due to technological advancements (Stepick and Tran, 2022). In the context of the pandemic, a range of medical services, including medical counseling and monitoring, were remotely delivered with effectiveness thanks to the use of digital tools that enabled seamless communication between patients and physicians. Telehealth services rely on telecommunications to establish meaningful interfaces between relevant stakeholders.

However, low technology acceptance among distrustful users (Park et al., 2021) may be another obstacle to the development of the home care sector, where device failures or misinterpretations can lead to serious consequences. Moreover, technological innovations in the healthcare domain can be rejected by different types of stakeholders also due to factors like their perceived ease of use and their perceived usefulness (AlQudah et al., 2021).

The issue of low technology adoption represents a significant obstacle to the evolution of the home care sector, slowing down its transition towards a paradigm shift. To facilitate the rapid development of the sector, it is imperative to identify innovative solutions to address this challenge.

Another challenge associated with technological advancements is to ensure that designers are adequately prepared to develop new solutions with emerging technologies. When properly implemented, novel hardware and software can facilitate novel solutions to existing problems. However, it is also necessary to consider the willingness of people to eventually entrust their lives to products with which they are unfamiliar. Furthermore, these technologies must guarantee user safety in addition to their usability. It is therefore essential that regulatory mechanisms evolve in parallel with the market's technological implementation requirements to provide guidance on emerging issues related to the implementation of these technologies.

3.4 Infrastructural and Economic Aspects

In order to gain insight into the practical implications of organizing a home-based healthcare system, it is beneficial to systemically compare the two models of healthcare provision under investigation in this study. Sanitary structures, such as hospitals and clinics, can be viewed as centralized nodes for the delivery of healthcare services. In these places, a large number of people can access a large number of treatments. In contrast, in a system exclusively established on home-based services, houses would function as decentralized nodes for service provision, which could result in increased logistical complexity. If a substantial quantity of

resources can be transported to a single, centralized location for the treatment of a large number of patients, a decentralized system would require the development of a complex capillary distribution system to treat the same number of individuals.

This would not only impact single-use items such as batteries, test strips, and medications, often essential for many medical devices to function properly, but it would also necessitate the availability of physicians to deliver the necessary equipment to patients' homes when required. This increase in complexity would have a considerable impact on the economies of countries, especially for those with public welfare systems, which would be required to make significant investments to construct a comprehensive infrastructure capable of reaching every residence within the nation.

Moreover, a decentralized model would also have a deleterious effect on the complex processes of medical device cleaning and maintenance. A hypothetical house equipped to provide a comprehensive set of home care services would likely include a rich array of HUMDs. As the variability in maintenance schedules is dependent on the specific device type and its frequency of use (Dabadi et al., 2023), it follows that each reusable medical device would need a distinct maintenance frequency and methodology. This suggests that individuals would be expected to perform these tasks independently. The challenge thus arises in designing effective methods for assisting laypersons, who typically possess lower health literacy than professionals trained in these processes, to successfully navigate the complexity introduced by HUMD maintenance. An alternative approach would be to develop a service to carry out these processes for users. However, this solution would be more complex due to the decentralized nature of this hypothetical healthcare model.

An additional area of concern regards the domain of emergency management. While hospitals can have trained personnel and a vast array of resources that can be rapidly deployed to manage crises and other unexpected threats to health, such interventions would not be as efficient within the home setting. Indeed, trained personnel would still have to reach the location via ambulance or other vehicles equipped to deal with emergencies, leading to an increased impact on infrastructure.

In addition to the identified challenges, there are other contextual barriers that hinder the innovation of the sector. There is an asymmetry between the development of innovations and their adoption in healthcare facilities, as these structures may not be ready for such changes without proper assessment and preparation (Leonard et al., 2019).

The rapid development of innovative medical devices and services is driven by the assumption that related infrastructures and resources are sufficient for these products to be implemented on a large and capillary scale. However, this favorable setting often

proves to be utopian, and interventions designed in this manner are unlikely to reach the implementation phase. In light of these limitations, designers must contextualize their work as much as possible, taking into account the constraints that determine the feasibility of new solutions.

3.5 The Potential of the Home Care Sector

The complexities introduced by the considerations made above indicate that the immediate availability of sophisticated medical devices and highly trained personnel provide healthcare facilities with a distinct advantage over home care settings in terms of clinical effectiveness and efficiency of the healthcare services provided. It seems unlikely that these characteristics are going to be replaced by HUMDs, despite how advanced they could become in the future thanks to technological advancements. Nevertheless, their potential for future improvements and the advantages they offer to every kind of patient will likely cause home care to remain a significant sector over the long term. From the aforementioned considerations, it could be hypothesized that these devices will progressively increase the number of clinical conditions that can be effectively treated at home and their efficiency in achieving their objective.

This will depend on the successful implementation into HUMDs of evolving technologies such as artificial intelligence and more capable sensors and actuators. At the same time, an increasing number of medical devices will likely become more usable by laypersons.

These facts would enhance all three main home care service typologies.

Telehealth services would increase the variety of health services that can be performed remotely. Nursing services will likely evolve in response to an increase in the usability of medical devices for laypersons. This would, in conjunction with the integration of new technologies, facilitate the treatment of a greater number of clinical conditions with a reduced reliance on specialized personnel.

With regard to the doctor-on-call service, the introduction of more compact and technologically capable medical devices would result in an upgrade of the doctor's equipment. This would increase the likelihood of successfully treating a wider range of conditions at the patients' homes, thereby reducing the necessity for their hospitalization in more serious cases.

Downstream of these hypotheses, it could be stated that home care objectively possesses a great margin for growth and improvement, but it will likely not have the potential to establish itself as the only type of care.

This relation between these two methods of healthcare provision will, however, work synergically and benefit each other.

The enhancement of home care in terms of usability and the range of services offered will firstly increase the benefits introduced by this sector, and secondly, facilitate the management and allow a more efficient optimization of healthcare facilities. The reduction of individuals receiving care within these structures and of the services they provide would allow optimization processes in terms of timing and quality of these services. Moreover, their structures would likely become less complex and spatially better organized.

Nevertheless, the acceptance of technology, the complexity of regulatory pathways, which can take anywhere from a few years to over a decade, and other factors mentioned above indicate that this scenario will only be achievable gradually in the future.

4. Conclusions: A Beneficial Coexistence

The complexity of the healthcare services domain is attributable to their objective of guaranteeing better health conditions to patients while also ensuring all the involved users' safety. As a result, the evolution of the healthcare sector has led to the development of various channels for delivering its services, as every context of care has its specific requirements. History demonstrates that the degree to which these types of care are adopted is susceptible to a multitude of factors, including technological and societal phenomena.

In this dynamic scenario, designers and decision-makers should be aware of these changes to identify emerging design challenges that must be addressed to satisfy market requirements. It is plausible that none of the types of care examined in this study can be wholly supplanted, as each possesses distinctive potentialities that align with particular contextual necessities and prerequisites.

In synthesis, an increasing number of therapies currently provided in healthcare facilities will be offered as home care services.

This is due to the fact that the technologies incorporated into HUMDs will diminish the need for professionals during their utilization.

However, there are limitations that will impede a complete transition toward home care services, even in the long term.

In fact, many characteristics of the healthcare facilities seem to make them valuable also in the long term.

Although the number of services offered in healthcare facilities may decrease due to the expansion of the home care sector, the quality of these services within these structures is also likely to improve.

Consequently, it can be hypothesized that the two types of care analyzed will likely continue coexisting in the long term.

The identified design challenges and the other findings align with the objectives of the study, which was to provide an overview of potential future developments in the various contexts of care. They are valuable for the doctoral research project as they provide a foundation for the second phase of the desk research, which aims at understanding whether the design of medical devices for different contexts necessitates the involvement of different design expertise. Moreover, they encourage the distribution of research efforts across all care contexts, as no area of application is likely to become dominant in the long term.

Nevertheless, existing and forthcoming regulatory and safety issues pertaining to HUMDs must be subject to continuous review in order to ensure the practical relevance of the research project. Subsequent to the findings of this study, further research could also be conducted to investigate appropriate methodologies through which designers could align the development of sophisticated medical devices and their application in diverse home environments as real-world contexts of use, with the aim of enhancing the likelihood of these devices to be adopted.

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“DESIGN TO CREATE VALUE: *MADE IN*... PARAGUAY FOR TRANSITION”

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ABSTRACT | The profound digital transformation currently underway, in every field and across the globe, undoubtedly leads to the creation of new forms of value (Roco & Bainbridge, 2013; Helmer et al., 2021). In this highly dynamic world, characterized by continuous global evolution and a high level of competitiveness, keeping pace is not merely a goal but a necessity. The enhancement of a country requires an integrated and systemic approach: design and its transdisciplinary nature play a crucial role as a strategic lever and driver of innovation, capable of creating short, medium, and long-term scenarios for value creation, thus initiating a real cultural, economic, and social transition (Tromp & Vial, 2022).

This contribution, which presents part of a project by the EDME research group at Politecnico di Milano, aims to identify opportunities and possible development paths for the state of Paraguay, a country chosen for its strong growth potential (Cepal, 2022) and its emerging digital transition as a driver of innovation not only in the South American context but also internationally (Cepal, coordinator Oviedo E., 2021).

Starting from the analysis of the current state of the art and trends in macro-identified areas, a comprehensive vision is presented from which to derive objectives for initiating and guiding the future development of the country while fully respecting and enhancing its indigenous culture and history.

Through case histories (smart mobility, smart cities, Healthcare 4.0, digital experience retail, smart agriculture, smart industries, smart tourism, smart services, etc.), the evolutionary trends of various sectors are presented to identify possible opportunities and strategic action lines. The key points of analysis for each area will be digitalization and perceived values (social/communicative values and economic/productive values).

Moreover, the common denominator, also at the methodological level, is “Design for the Common Good,” which encourages the development of cross-cutting innovations that transcend the limits of specific interventions to create new value on a systemic scale (Botta & Junginger, 2021).

The necessity of operating on a large scale places the concept of “infrastructure” at the center, conceived as the architecture and platform for managing the evolution that must permeate every aspect of the country’s social, cultural, and economic life, also involving the activation of networks among diverse stakeholders who are engaging in new relationships for the first time (Träskman, 2022).

The objective is to define representative scenarios of possible guidelines to be developed into targeted design activities aimed at positioning and enhancing the country’s image, expanding economic integration, and stimulating the activation of new relationships that contribute to the cross-fertilization of technology and knowledge.

A secondary but equally important objective is to raise awareness that guiding industrial choices within cultural pathways, behavioral trends and tastes, and lifestyle and consumption patterns in a turbulent and rapidly changing landscape requires transdisciplinarity, meaning the innovative transfer of skills across different fields and sectors.

KEYWORDS | DESIGN FOR COMMON GOOD, THINKING INFRASTRUCTURE, SMART CITY, INTERNET OF THINGS (IOT), SMARTNESS

1. Introduction

Latin America is developing solid growth in the digital ecosystem. With increasingly widespread 5G connections and a growing number of Internet users, the digital economy has become critical to the region's sustainable development. The rapid adoption of digital commerce and consumption of digital goods and services is becoming a key issue. This offers various stakeholders the opportunity to take part in an ecosystem that will foster digital transactions.In the research we present, which is still ongoing, we shine the spotlight on Paraguay to analyze the country's specificities and its digitization.

In line with the strong digitization process in Latin America, Paraguay is experiencing significant growth in mobile connectivity and network infrastructure. It has a population of more than 6.8 million and only 3% of the adult population in the country has a credit card, while 72% of adults have Internet access and 89% own a cell phone.

These figures indicate the country's evolution toward a more digital society: as a global trend, consumption of digital goods and services has grown substantially in recent years. Increased by the lockdown due to the pandemic, but consolidated in these very last few years, with a considerably young population (42.9 % between the ages of 18 and 44), Paraguay is well positioned to see digital consumption grow in the coming years. (Statista Market Insights, 2023)

From a methodological point of view, the EDME[1] research team mapped the state of the art in Paraguay through a critical analysis of the context according to different layers: geographic-political, socio-cultural, economic-productive, and technical-technological. Each layer represents a specific dimension of the Paraguayan context, offering a comprehensive and integrated view of the country's current conditions and future potential.

[1] EDME (Environmental Design Multisensory Experience) Interdepartmental Laboratory at Milan Polytechnic University. EDME Lab. offers a physical space where experiences of digital, multimedia and multisensory worlds can be developed and experienced; a space where a relationship can be created between virtual and physical, material and sensorized objects and visualized and created experiences that are not only visual, but also auditory, tactile, olfactory and synaesthetic.

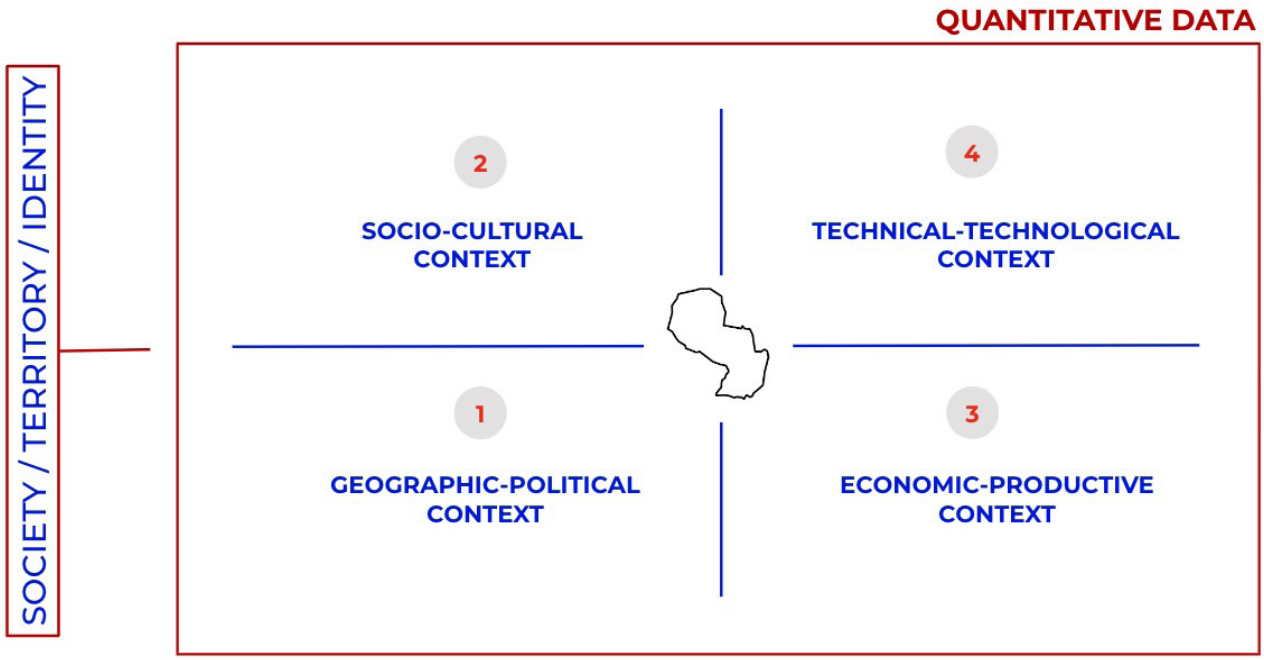

Figure 1: Multilayer mapping of Paraguay by EDME Lab.: geographic-political, socio-cultural, economic-productive and technical-technological analysis for sustainable and digital development strategies.

The methodology according to a multilayer approach has enabled the identification of both the strengths and weaknesses of the system, highlighting targeted strategies for digital transition and sustainable development.

The subsequent identification of case histories, selected based on specific parameters and keywords, enabled to bridge the gap between the current state of the art and emerging trends. This evolving scenario forms the foundation for constructing the theoretical framework outlining development lines and business opportunities for the country's system. The common denominator essential to the methodology used is "Design for the Common Good." This systemic approach aims to maximize results by focusing on the "Third Sector" related to social purposes. It emphasizes designing high-quality relational spaces and environments where these relationships occur, introducing the concept of "infrastructure" as both a structural and managerial element.

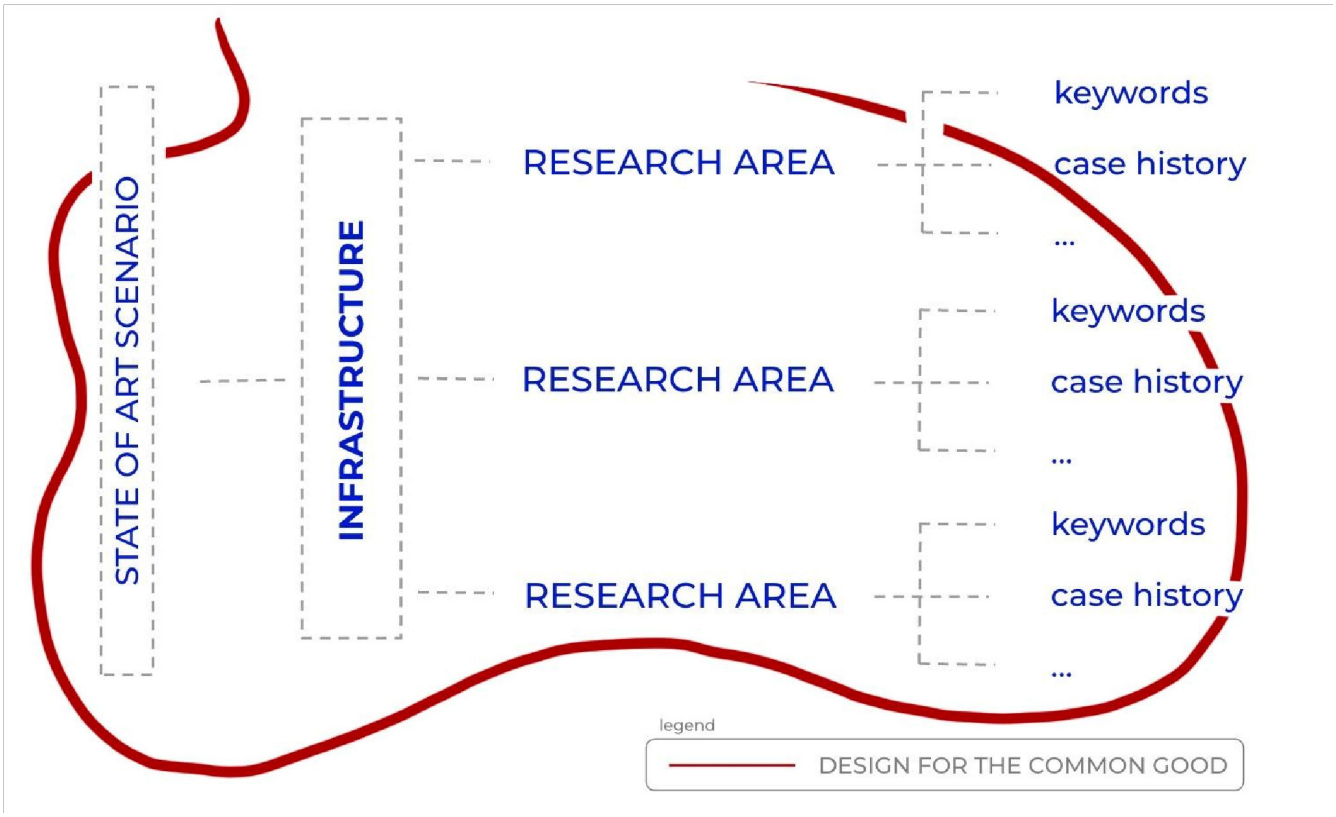

Figure 2 : Research methodology that from the reference scenario uses keywords and case histories to identify the gap between the state of the art and evolutionary trends. The expected result is the theoretical framework of guidelines for the development of the country system.

2. The South American context: trade and international relations

South America is a region characterized by considerable cultural, historical and geographical diversity. In recent decades, this area has seen a growing commitment to international cooperation and economic integration, with numerous bilateral and multilateral agreements aimed at strengthening ties among member countries (Oviedo, 2021). Major organizations promoting regional integration include the Common Market of the South (MERCOSUR), the Andean Community (CAN), and the Pacific Alliance. These bodies have been instrumental in facilitating trade and economic cooperation, enabling greater interconnection among the region's economies (Cepal, 2022).

Cooperation among South American countries from trade relations extends to areas such as education, health, security, and the environment. This fabric of relations provides a solid platform for the introduction and scaling of technological innovation processes. Indeed, digitization is recognized as a key factor for economic and social development, capable of profoundly transforming productive structures and improving quality of life (Roco & Bainbridge, 2013).

In this context, Paraguay emerges as an example of a country that can leverage

regional cooperation to advance its digital transition. As shown in the document prepared by Cepal (Oviedo, 2021): *"Assessment of South-South Cooperation in Six Selected Latin American and Caribbean Countries-Shared Challenges in the Implementation of the 2030 Agenda for Sustainable Development*", despite challenges such as the still-developing technological infrastructure and socioeconomic inequalities, Paraguay has shown a strong commitment to innovation and digitization. This is reflected in government policies and international collaborations that aim to promote the use of technology for sustainable development by laying the foundation for inclusive and resilient growth.

3. Development goals and cooperative actions

Paraguay's development goals align with global goals, such as the United Nations Sustainable Development Goals (SDGs). The country's strategy focuses on various aspects, including education, health, infrastructure, renewable energy, and digital transition. International cooperation plays a crucial role in achieving these goals, with the country benefiting from both regional and global aid and collaboration.

Openness and close relations among South American states provide a favorable environment for the implementation of scalable innovations. Digitization, as the central theme of this research, presents itself not only as a necessity to modernize local economies, but also as an opportunity to add value (social, cultural and economic) and improve competitiveness internationally.

And not only that. If competitiveness also means the ability to govern the economic dialectics of markets, then design culture is certainly one of the strategic resources for competing in the global market: it is an engine capable of orienting industrial choices within cultural itineraries, behavioral and taste trends, lifestyles and consumption styles, in a turbulent and rapidly changing landscape. A strong point is transdisciplinarity, that is, the transfer of expertise in an innovative way between different fields and sectors. In this context, the Politecnico di Milano in its own right can apply to be a partner in the development process precisely within the framework of the need for interconnection and exchange of knowledge, aiming to develop strategies to apply digital solutions that can be adopted and adapted in various contexts.

4. Paraguay: geopolitical context and development goals

Paraguay is a landlocked country characterized by contrasts between its development potential and the challenges it faces. Its geographical location and natural resources offer many opportunities for economic growth and the well-being of its people. In particular, it is rich in water resources, such as the Guaraní aquifer and the binational Itaipú and Yacyretá dams, which provide abundant water supply and clean, renewable energy production. The Itaipú dam, one of the most powerful in the

world (Pope, 1995), meets the entire domestic energy needs and supplies power to cities such as Rio de Janeiro and São Paulo (Mander, 2017).

With a population of about 6.8 million and an area of 406,750 km^2, Paraguay has one of the lowest population densities in South America. However, population distribution is unbalanced, with 60% of the territory, the Gran Chaco, inhabited by only about 2% of the population (INE, 2023). The largely informal economy is dominated by the agricultural sector, while the industrial sector is relatively small. The socioeconomic structure is characterized by the predominance of the latifundium, with 86% of land owned by 2% of the population (Ezquerro-Cañete, 2020), creating significant disparities in the distribution of wealth.

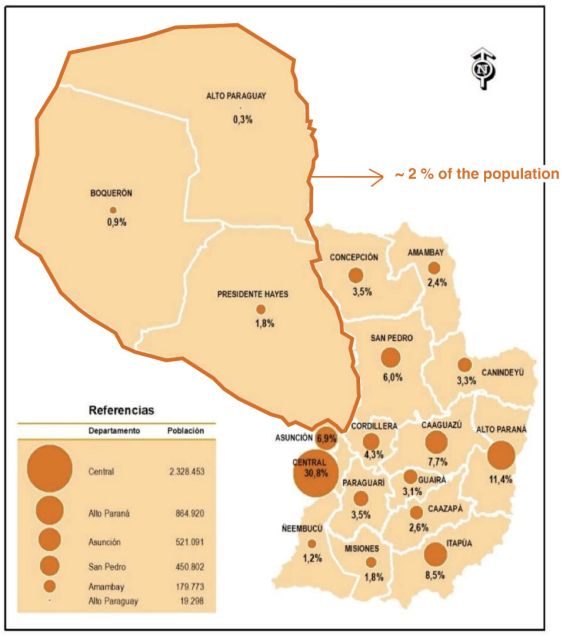

Figure 3 : Paraguay: population distribution by department. Year 2023. Paraguay's low population density and unbalanced distribution with 60% of the territory inhabited by only about 2% of the population. (Instituto Nacional de Estadística Paraguay, 2023). Image reprocessed.

Despite being a large producer of hydropower, most of its energy is exported at low prices to neighboring countries, contributing little to the national economy. In addition to these economic challenges, Paraguay's digital transformation is also hindered by a significant digital divide. While mobile connectivity has grown, many citizens, particularly in rural areas, lack the digital literacy skills necessary to fully participate in the digital economy. Addressing this digital literacy gap is crucial for ensuring equitable access to the opportunities offered by digitalization and fostering inclusive growth. Furthermore, targeted digital education programs could play a vital role in enabling the population to leverage digital tools more effectively and contribute to the country's sustainable development.

The political and institutional environment has seen modernization and transparency efforts, such as the System for Monitoring Recommendations (SIMORE), which has improved human rights management and international cooperation. However, Paraguay is ranked as poorly competitive in the World Competitiveness Index, highlighting structural and institutional difficulties that hold back the full exploitation of its resources (World Economic Forum, 2019).

Despite these difficulties, Paraguay has shown signs of economic and social progress. International cooperation, particularly in the context of the aforementioned MERCOSUR, has contributed to the consolidation of the democratic process and the strengthening

of productive competitiveness. Paraguay, located in the heart of Latin America, is a natural bridge between the region's emerging markets, with abundant natural resources and a tax policy characterized by low taxation, all factors that incentivize international investors.

The Paraguay 2030 Strategic Plan reflects the country's ambition to upgrade its infrastructure, not only internally but also to the global market. Targeted investments in roads, ports, and other physical connections are an integral part of this strategy, which aims to position Paraguay as a major trade and logistics hub in the region (Ministry of Foreign Affairs and International Cooperation Italy, 2019). Priority development goals include improving infrastructure, promoting education and health, and adopting sustainable technologies. Digitization is seen as a key tool for achieving these goals, with the Paraguayan government launching several initiatives to promote the use of technology in various sectors (digital documents, with related data protection issues, creation of digital/internet centers to ensure widespread access, the transnational smart road, etc.).

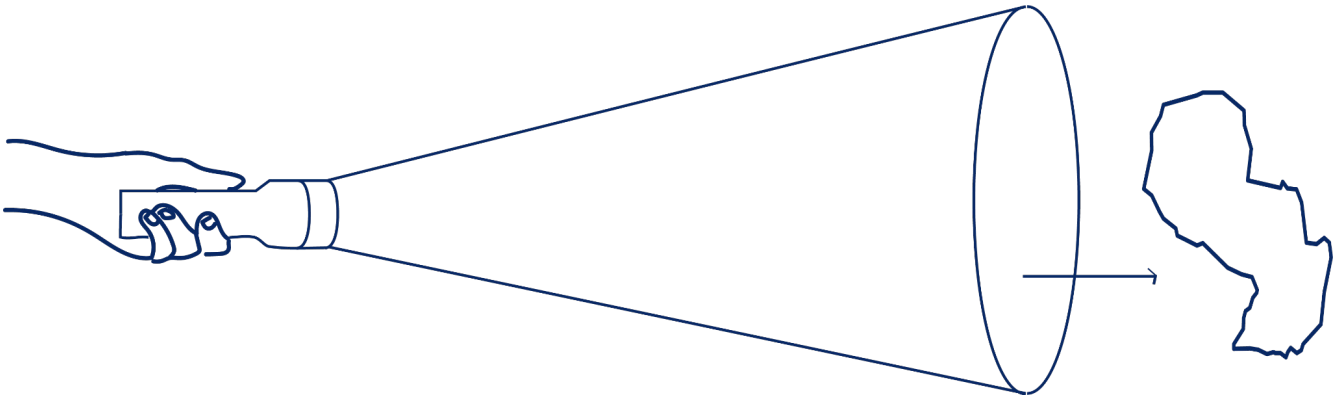

Figure 4 : The Paraguay 2030 Strategic Plan sheds light on infrastructure, education, health, and digitization, among others, positioning the country as a regional business hub.

The goal is to develop models of digital solutions, embedded in a strategy involving the various levels of public and private administration, that can foster Paraguay's transition to a more innovative and sustainable economy.

Creating synergies, with the goal of creating development and shared value, is an effective way to foster and incentivize international cooperation for innovation and sustainable development. The adoption of advanced digital technologies will not only improve the efficiency and competitiveness of Paraguay's country system, but will also help strengthen relations among the various actors involved, promoting an integrated and systemic approach to economic and social development.

The research of the EDME laboratory of the Politecnico di Milano fits precisely into this climate of great ferment that Paraguay is experiencing and promotes precisely the activation of knowledge and development "networks" in the context of international cooperation, encouraging a relationship with the economic and productive reality through experimental research and technology transfer.

5. Research introduction and objectives

The contribution aims to create a theoretical framework that suggests a set of guidelines for the development of practices toward digital transition by organizations of different entities. The application case used is Paraguay, for which strategies are identified to make innovation and foster the development of digital services and processes. Emphasis is placed on a systemic vision-the approach is posited as the foundation of the framework itself-with the aim of creating transdisciplinary projects that bring different stakeholders together to foster the sharing of experience and knowledge toward a paradigm shift in everyday life, laying the foundation for subsequent strategic development.
The framework is characterized by the construction of scenarios representative of actionable guidelines, flanked and supported by different types of case studies: these cases, mapped and analyzed with critical reading, were identified from well-known and widespread examples, thus already verified, and other more disruptive but still experimental projects under development, such as startups. This mix is crucial for a good reading of market trends: on the one hand, one looks at what is present and what is used most, and on the other hand, one looks at where interest is placed and which directions are preferred for future developments. The application of the framework, to enable a successful transition to digital, will need to be contextualized with respect to the area in which it is going to be designed, involving communities of place to create projects that are actually meaningful and shared.

A key element to the success of this framework is addressing the infrastructural and educational challenges faced by Paraguay. It is essential to ensure that the necessary technological infrastructure, such as high-speed internet and access to digital tools, is available across the country. In addition, increasing digital literacy through targeted education programs, particularly in rural and disadvantaged areas, will empower citizens to effectively engage with and benefit from digital services. Without these foundational steps, the digital transition risks leaving segments of the population behind, widening existing inequalities.

6. Digital transformation and the possibilities offered by Design

The digital revolution and the unprecedented acceleration of technological development, globally, have caused a real change of scenarios in all fields, from social and cultural to scientific and productive. The way of strategizing and innovation has changed.

Widespread digitization permeates profound changes in activities, processes and organizational capabilities, seizing and reconfiguring digital technological challenges into opportunities to create new value. To achieve this, however, it is necessary to implement a systemic approach that promotes a view of the whole and coordinates stakeholders in proactive and effective processes. In fact, digital transformation is defined as a process that aims to improve an entity by triggering significant changes through information, computing, communication, and connectivity technologies (Vial, 2019).

Consequently, digital transformation strongly engages organizations to remain attuned to technological turbulence that comes in the form of new possibilities, continuously evolving industries and customer expectations (Viaene, 2020).

While a systemic and transdisciplinary approach is crucial for digital transformation, practical implementation requires the creation of collaborative platforms that bring together stakeholders from various fields—government, education, technology, and civil society. These platforms will facilitate the exchange of knowledge, support the development of tailored digital solutions, and allow for testing in localized contexts. Additionally, involving local communities through participatory design processes ensures that the solutions created are aligned with their cultural and social needs, fostering both technological and social inclusion.

We can, therefore, say that, in contemporary global society, digital advances offer several opportunities to push the transformation of operating models concerning many different contexts. In this sense, governing a digital transformation process is a complex task, as it means guiding the process from exploring the broad spectrum of opportunities that digital technologies offer, to reducing this complexity to a final set of actions to be designed and executed.

In turbulent contexts, organizations face contradictory challenges that give rise to management tensions and paradoxes and require radical responses. (Vendraminelli, 2023).

Precisely by addressing organizational paradoxes-which consist of a persistent contradiction between interdependent elements (Schad et al., 2016) - Danneels & Viaene (2022) identify certain decision-making processes capable of making dynamic processes of formulating innovative proposals that are accepted and used by all.

This kind of process can be pursued through Design's own methodologies. In fact, there is no denying the central role of Design as a strategic lever in complex scenarios, an engine of innovation to drive even digital transformations. Design, as a new "connector," becomes the managerial and organizational paradigm to make innovation, and then to train new professional profiles adapted to the new context: director of knowledge and skills essential to make worlds not always connected (industries, institutions,

research centers, universities, territory) collaborate and contaminate.

Magistretti et. al (2020) propose five approaches typical of Design that prove essential to bring innovation to the systemic level. The first approach is “extending,” that is, amplifying the shared knowledge base through transdisciplinary collaboration of different stakeholders. Indeed, the complexity of the process must be addressed by considering the specific problem, but also by looking at how that problem is affected by and interacts with the organizational context, the market environment, and the stakeholder system (Dunne & Martin, 2006). Then we move to the dynamic approach of “debating” to promote, through debate, digital transformation processes by juxtaposing technological and human perspectives. Designers, able to understand the different perspectives of internal and external stakeholders, are able to build a constructive debate that allows the digital solution to be grounded in more robust insights. Next, “reframing” is identified as a dynamic approach that guides the selection of technology requirements based on users. The ability to empathize with users is at the heart of the discipline of Design and is fundamental to interpreting the amount of information that digital processes can create. The designer challenges the status quo with challenging questions, steering the innovation process toward experimentation and adoption of truly innovative directions (Verganti, 2016). The fourth dynamic capacity of design thinking is “interpreting” and is based on designers’ ability to predict future scenarios (Dunne & Raby, 2013), adopting different frames of perception to investigate different facets of the technological challenge. The last dynamic capacity of design thinking is that of “recombining,” combining technological and human knowledge within a holistic framework. Starting with sociocultural trends and narratives, creating future scenarios as starting points for the development of digital design solutions, it is critical to synthesize ideas pragmatically, creating concrete action plans for final design implementation.

7. Design for Common Good

Design for the Common Good is a design approach aimed at enhancing community quality of life through sustainable, inclusive, and ethical solutions. Evolving from Design for All, it is grounded in the concept of the common good (Hussain, 2018), focusing on the benefit of communities and public spaces at a broad scale, such as accessible healthcare and effective public safety systems. This approach emphasizes active end-user participation and interdisciplinary collaboration, promoting a positive and lasting societal impact. Design thus becomes a tool and facilitator of complex realities, activating innovative processes that trigger social and behavioral transformations. The goal is to create collective benefits by overcoming isolated interventions with an integrated systemic vision, in which the total is greater than the sum of its parts, quoting Aristotle. (Botta M., Junginger S.,2021)

In the case of Paraguay, a country that faces significant challenges in terms of economic development, infrastructure, and social inclusiveness, adopting a systemic approach can be an effective response to the state's current needs by proposing virtuous models to address social, economic, and environmental challenges in an integrated and collaborative manner, seeking solutions that generate collective and lasting benefits.

A systemic view implies recognizing that each intervention has ripple effects on other aspects of the system. For example, improving transportation infrastructure not only facilitates mobility and trade, but also has positive impacts on quality of life, access to education and health services. In addition, creating sustainable transportation networks can reduce environmental impacts, contributing to greater sustainability of the system as a whole. This type of approach recognizes that investment in one area can enhance capacity and opportunities in others, creating a virtuous cycle of development.

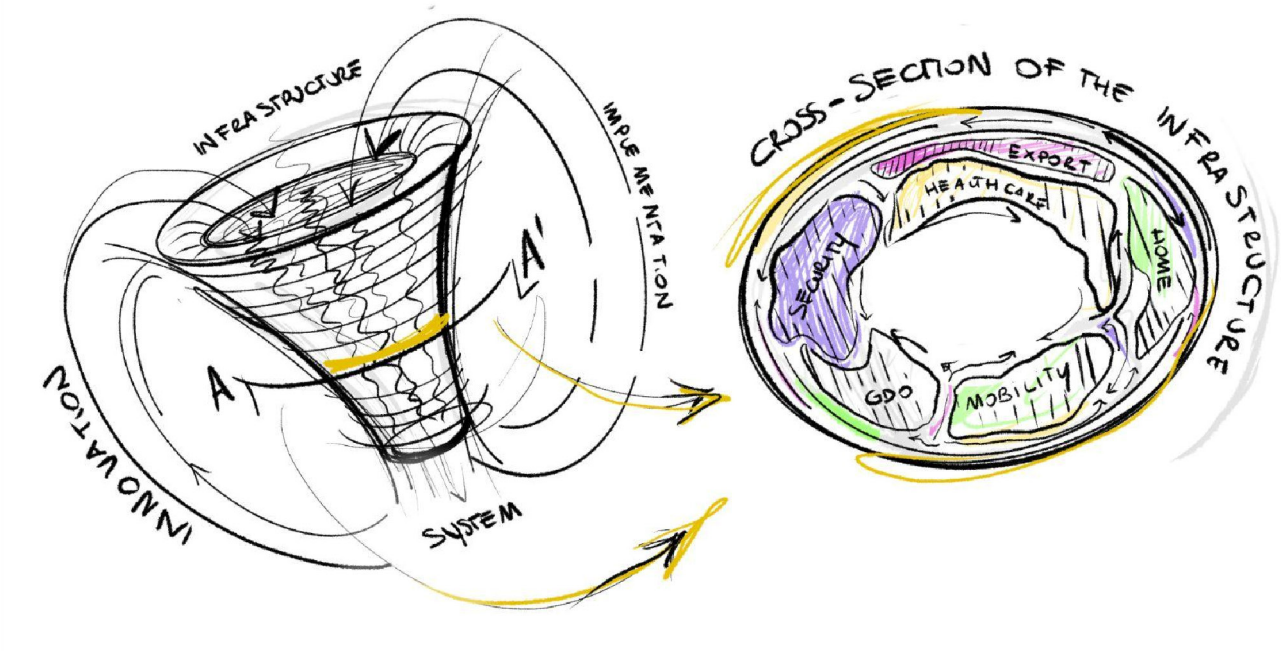

Figure 5: Virtuous cycles of approach applied to cross-cutting innovation approach, by EDME Lab.

Design for the Common Good also promotes social inclusion. Designing accessible and safe public spaces and infrastructure for all, including people with disabilities and disadvantaged communities, promotes equity, social inclusion, and common good. This approach not only improves the quality of life for all citizens, but also strengthens the social fabric, creating more cohesive and resilient communities.

For Paraguay, the enhancement of country-system infrastructure must include the development of smart and sustainable road

networks, the promotion of smart agriculture, and the integrated management of water resources. These interventions not only address immediate economic development needs to be translated into value, but also help create a more stable and secure environment for future generations.

Another crucial aspect of the systemic vision is the involvement of a wide range of stakeholders, including citizens, nongovernmental organizations, businesses, and government. This collaborative approach ensures that solutions are well integrated and truly meet the needs of the population. The active participation of diverse stakeholders facilitates the creation of more creative and relevant solutions, promoting a sense of shared responsibility and ownership.

8. The framework and objectives of the research

The authors' objective theoretical framework started from a state-of-the-art mapping aimed at identifying trends, lifestyle habits in different areas and some quantitative data. By means of a macro-scale filter, it was then possible to visualize a systemic image, returning an articulated vision and a general snapshot on which to subsequently go vertical in a specific and localized way, identifying the goals to aim for in order to initiate and guide the future development of the country, in full respect and enhancement of indigenous culture and history.

This need to operate on a broad scale has led to the focus on the concept of "infrastructure" as the architecture and platform for managing the evolution that permeates every sphere of the country's social, cultural

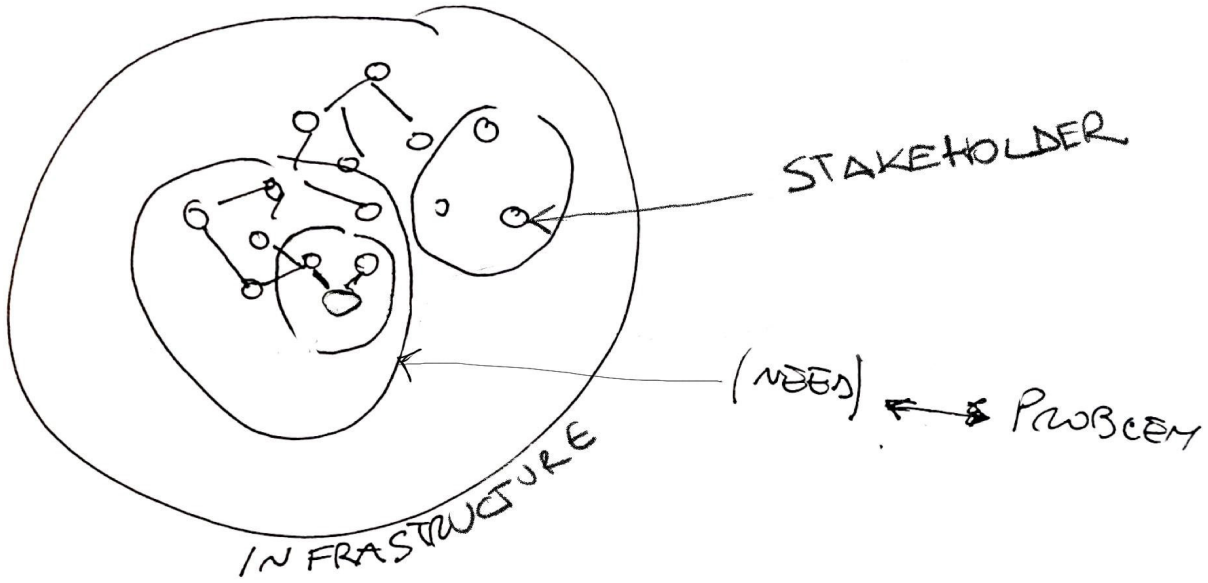

Figure 6 : systemic vision applied to the concept of infrastructure, by EDME Lab.

and economic life, including the activation of networks among different stakeholders called for new relationships for the first time. (Träskman T., 2022).

The goal is to define futuristic (future + possible) scenarios that can create suggestions and bring back best practices for the development of targeted design activities, positioning and improving the country's image, expanding economic integration and stimulating the activation of new relationships that contribute to the contamination of technology and knowledge.

In addition, in parallel, through training activities, including professional training, it is possible to increase awareness that guides industrial choices within cultural itineraries, behavioral and taste trends, lifestyles and consumption styles. (Mathis et al, 2019) This system is crucial in a turbulent and rapidly changing landscape, which, through transdisciplinarity, transfers skills between different fields and sectors in innovative and effective ways.

Paraguay's context, as reported earlier, is one of strong growth. Policies foster international cooperative relations-especially in the South American area-putting the country at the center of debates for social, economic and digital development and growth across the continent. In fact, increasing urbanization is observed in the country, with the construction of new residential neighborhoods and the development of urban infrastructure to support population growth. In terms of technological development, Paraguay faces the challenge of accelerating the country's digital transformation and continuing with the policies that have allowed the ICT sector to grow in recent years. Economic literature points to a country with a good business climate, where the public and private sectors have a good dialogue. It has a newly created digital agenda for the period up to 2025 that outlines specific goals for the sector and a telecommunications development plan that aims, among other things, to expand broadband coverage to 80% of the population by 2030.

In this context of great ferment and a strong propensity for societal development, aiming for a digitization of processes is intended to bring a number of extremely significant benefits to make services and infrastructure shareable and accessible to a large segment of the population. In order to achieve significant results, it is necessary to take a systems approach that encourages the design of strategies focused on the creation of community value. Through the discipline of Design, and embracing the theories of Design for the Common Good, we aim for a paradigm shift in design that is no longer for people, but for the land and all the actors who live in it. In this sense, the economic value generated by a person is not sufficient to represent that person's index of well-being; in fact, as enunciated earlier, it is calculated with respect to a series of broader factors, considering his psyche, his relationships with people and with Nature, etc. (Manzini, 2020).

In this sense, in order to actively engage communities, understanding their needs and proposing projects that are actually meaningful, it is crucial to preserve and enhance indigenous culture and history as much as possible, ensuring that development is respectful and beneficial to the local context.

According to McKinsey's (2019) "Tech for Good" report, "Technology can play a key role in reducing inequality and promoting social well-being". With this in mind, it identifies six main areas where technology can have a positive impact:

- improving job security
- raising living standards
- foster health
- innovate in education
- promoting environmental sustainability
- ensure equal opportunity

However, for these benefits to be fully realized, it is crucial to adopt a collaborative approach involving government, civil society and business in order to maximize the effectiveness of technology and efficiently manage labor market transformations.

To strengthen these relationships, it is essential to conduct careful mapping of society, identifying contexts and clustering stakeholders and related needs. Figure 7 shows a diagram, elaborated by the authors, of the connections between society, infrastructure and services, expanding the scope of research more and more while verticalizing each solution in a practical and concrete way, reporting comprehensible and easily implementable examples from which design processes can be activated.

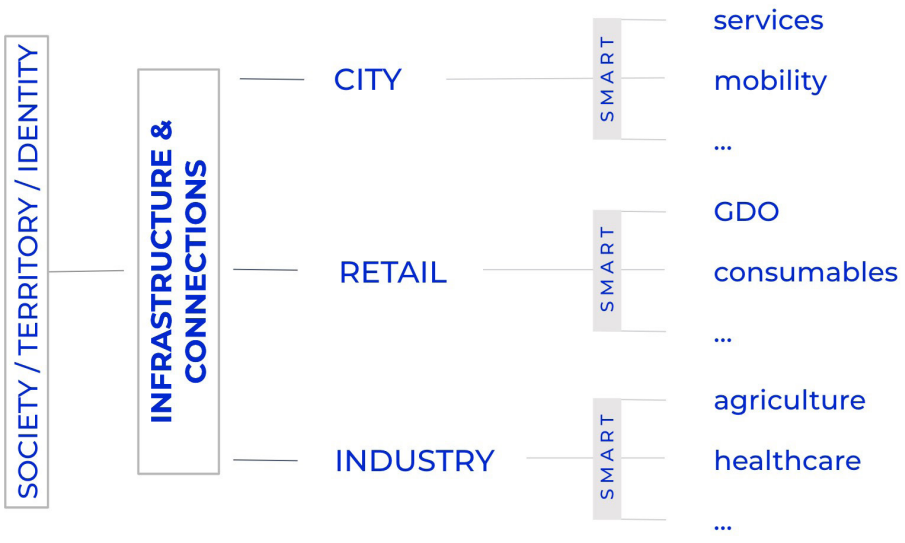

Figure 7 : The smart connections of society: a systemic look

The tree structure - which, however, does not start from a single resource, but from a cloud of contexts and elements related to the territory - helps define a “smart” society in relation to the systemic approach it takes in proposing design and development solutions, addressing problems of a complex nature in their totality and seeking vertically oriented solution activities from a local perspective. In addition - according to common and widespread thinking - the concept of “smart” refers to the intelligent and innovative use of technologies to solve problems, optimize processes and create solutions that improve the quality of individual and collective life by connecting functions

Combining these definitions constructs the “smart” approach as a process that, from societal issues in various contexts, takes the form of integrating data, sensors, algorithms and interconnected devices to make cities, infrastructure, services and products more efficient, sustainable and accessible.

9. Smart integration, case studies and possible interventions

Smart integration involves different scales of interaction between user and technology and is almost always mediated by a digital interface identified by a screen.

Starting from a broad scale, we can identify infrastructure systems designed to reinforce existing infrastructure, integrating with it and enhancing it for broader, faster, more effective and widespread operation. Some examples that can be reported in this regard are the digitization of identity and citizenship documents, or the creation of satellite networks capable of connecting every corner of the planet (Figure 8).

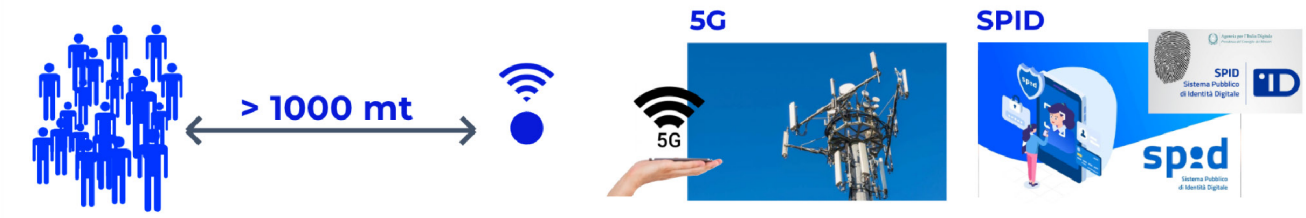

Figure 8 : Smart integration - Examples of large-scale applications.

Moving down to an intermediate scale we find experiences integrated with the user’s environment, offering products that place themselves at the user’s service to simplify everyone’s daily actions.

At this scale we find online commercial infrastructures such as e-commerce, or quick access infrastructure services to regulate flows and facilitate fruition. (Figure 9)



Figure 9 : Smart integration - Examples of application at the intermediate scale.

Finally, we can find the close scale, the one closely related to the user, in which advanced and personalized experiences are offered, working carefully on how the device is used. Here we can identify - as examples - automated home automation systems, wearable devices etc. (Figure 10)



Figure 10 : Smart integration - Examples of close-scale applications.

So, smart integration refers to the ability to connect and synchronize different devices or systems to create a unified and enhanced experience for users. In a product-systems design context, this approach could lead to new city dynamics, also revolutionizing the way we think about and enjoy public spaces.

These product-systems find their greatest application of use in Smart Cities, a city model that gets this name because it aims to optimize urban resources and processes through the use of digital technologies, with the goal of improving residents' quality of life, promoting social inclusion and strengthening communities. These smart cities use information and communication technologies (ICTs) to create more livable and sustainable urban spaces where citizens are at the center of policy and decision-making. Through the use of IoT (Internet of Things) sensors and digital platforms, smart cities monitor various aspects of urban life, such as public transportation, waste management and energy use, in real time, making services more efficient and accessible (Batty et al., 2012).

One of the most significant aspects of smart cities is the ability to actively involve citizens in decision-making processes. Digital platforms allow two-way communication between government and residents, facilitating civic participation and promoting transparent and collaborative governance. This participatory

approach helps create a sense of belonging and community, as citizens can directly contribute to the improvement of their urban environment (Nam & Pardo, 2011).

Smart cities also offer opportunities to address social inequalities and improve access to essential services. Technological solutions such as shared mobility apps, smart lighting systems, and connected healthcare networks help create more inclusive cities where all citizens, regardless of socioeconomic background, can benefit from a better quality of life (Allam & Newman, 2018).

However, the transition to a smart city is not without its challenges. Ensuring that technology implementation respects the privacy and security of citizens' data is essential (Kitchin, 2014). In addition, continued efforts are needed to ensure that all segments of the population can access and benefit from technological innovations, thus avoiding the risk of further widening the digital divide (Van Dijk, 2020).

In recent years, several cities have moved toward creating processes and infrastructure typical of a smart city. Singapore, for example, represents a successful model in implementing smart solutions to improve citizens' lives and optimize public services. Using technologies such as IoT and AI, it has created an interconnected and sustainable urban ecosystem with an efficient and integrated public transportation system, smart mobility solutions, and an advanced sensor network to manage public services efficiently. In addition, the digitization of government services has simplified interactions with citizens, improving public safety and demonstrating how the adoption of smart technologies can transform a city into a global hub for innovation.

A further virtuous example is Shanghai. Indeed, the Chinese metropolis has developed a highly efficient mobility system with integrated public transport and self-driving vehicles; in addition, citizens benefit from a digital platform that provides more than 1,000 services, from utility management to access to information and events. Smart street lighting and efficient buildings reduce environmental impact, while the creation of a digital twin of the city allows innovative solutions to be tested in a virtual environment.

In summary, smart cities represent an urban development model that aims to create more equitable, inclusive and sustainable environments, where technology is used not only to improve the efficiency of services, but more importantly to put people at the center of urban transformation.

From the research and themes identified, three significant macro-areas were highlighted that filter the development of possible pathways that are fundamental to the creation of futuristic scenarios. These themes represent the infrastructures of society and involve, on multiple scales and from a systemic perspective, various everyday dynamics for social, productive and economic development.

The macro-areas are identified as city, retail and industry and are positioned within the pathways to futures characterized by varying degrees of plausibility. Each pathway, depending on the macro-theme it encounters and the historical moment, develops distinct vertical actions that are implemented in delineated contexts. The work of the research team lies in being able to predict directions and project strategies that aim to achieve this prediction (Figure 11).

Actions that project into the future can be exploded into subtopics from the 3 identified filters: figure 12 shows all the possibilities that the research team has defined with the aim of opening up a wide range of opportunities for the development of practical actions.

The clustering of the sub-categories expanded several possibilities that emerged in the search for case studies and concrete best practices that would bring clear and concise examples of virtuous applications in the sector.

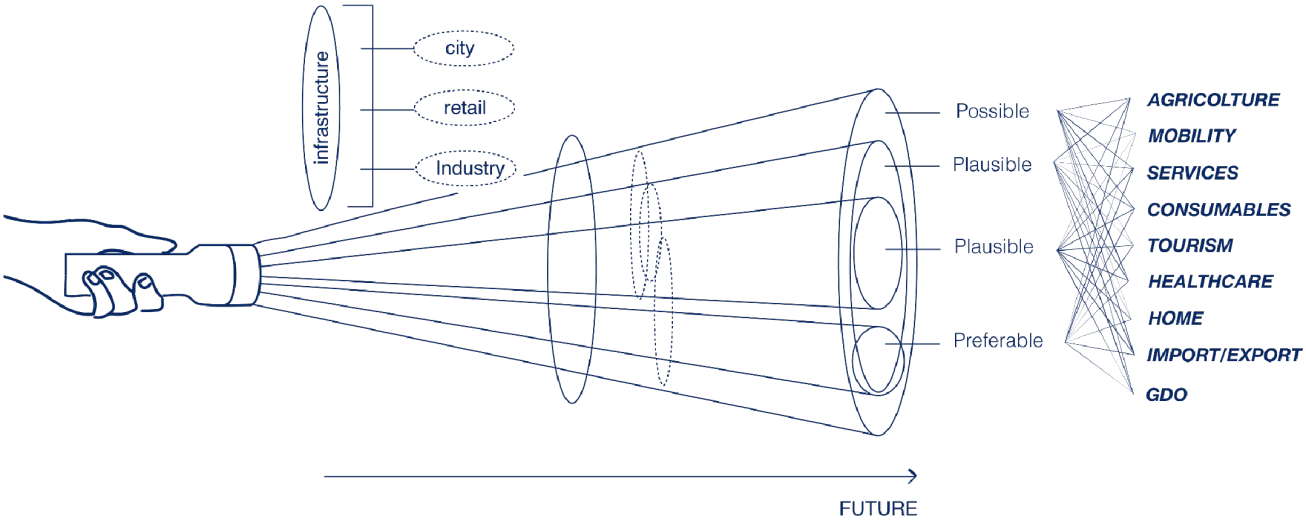

Figure 11 : Cone of futures applied to macro-areas for outlining futuristic scenarios (futures + possible) and development strategies.

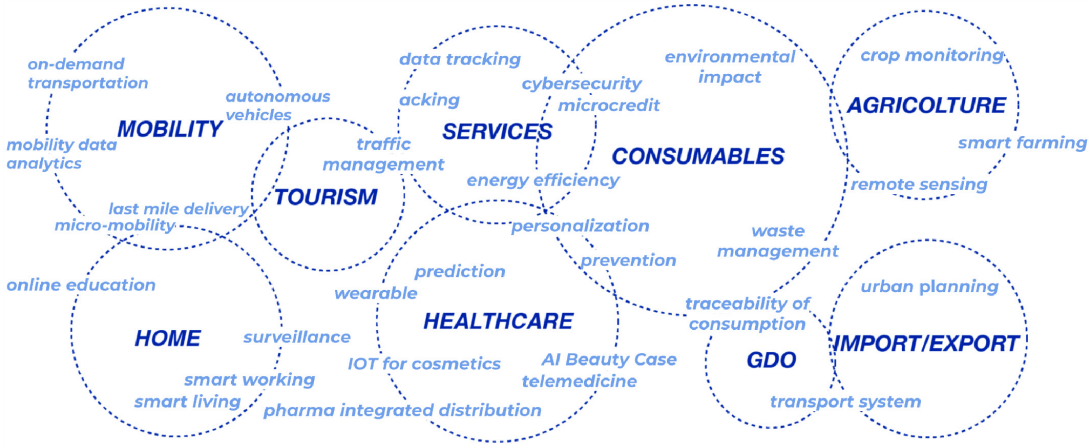

Figure 12: Macro-areas of intervention in outlining futuristic scenarios with sub-categories by subject area.

The first category identified is that of Mobility, in which sustainable on-demand transport services were identified that favor the transport of more people by reducing the flow of cars and energy consumption. In addition, focus was placed on micro-mobility initiatives to encourage the use of electric scooters and bicycles for travel and delivery services. Focusing on an infrastructural discourse, mobility data analytics systems are considered useful for monitoring consumption and developing strategies and policies favorable to the development of sustainable practices.

Another key category is Services, where data on microcredit and microfinance services are collected to help small entrepreneurs develop their businesses independently. In addition, several online education programmes are reported, useful for providing training or university courses and disseminating knowledge in a relatively direct way.

With regard to the country's economic development, the primary sector is identified as the founding and still dominant category throughout the country. Aiming at the digitisation of processes, there is great scope for economic and environmental development. In fact, some smart farming practices, which adopt sensors to monitor and maintain the land, can greatly improve the harvest, allowing for more constant control and savings in time and costs.

Telemedicine control practices have also been found in the Healthcare category. Telemedicine, in fact, is used to maintain direct contact between doctors and patients, allowing them to have a direct channel in case of need. Through the use of interconnected devices and smart sensors, it is possible to directly and remotely monitor a patient's condition, offering consultations based on real data and read out in real time.

The Home category, on the other hand, aims to implement smart processes to strengthen home automation control and improve people's everyday life, enhancing the security of their places and creating a concept of home that can converge well-being, family, but also sociality and work.

These are some of the main categories identified during the research and proposal mapping process. The case studies identified in relation to Paraguay have been contextualized so as to be able to better dialogue with the communities of place, without expecting users to adapt to the technology, but trying to respond to the needs that have emerged, raising awareness of the use of devices and smart objects.

10. Discussion: the limitations of the project

From the research presented in this study, there are a number of crucial challenges and potential obstacles that could hinder the implementation of digital transformation strategies in Paraguay. One of the main challenges is digital literacy, which must necessarily be implemented in order to bring an adequate level of digital competence

among the population, enabling technologies to be used in a consonant manner, making the most of the possibilities they offer. Therefore, it is crucial to implement digital education programmes that not only provide technical skills, but also a critical understanding of the use of digital technologies (Van Deursen et. al, 2020).

Another significant challenge is infrastructure development. Many areas of Paraguay, particularly rural areas, lack the necessary infrastructure to support full digitisation. Targeted investments in network infrastructure, such as high-speed internet access and the availability of digital devices, are essential to ensure that all citizens can benefit from the opportunities offered by digital transformation. These interventions are currently underway in the country, especially in terms of building communication channels to easily connect territories. With this in mind, it is of great importance to implement strategies that envisage the implementation of digital connections so as to further strengthen and facilitate physical ones.

In this context, socio-economic disparities represent a major obstacle for the implementation of interventions towards digitisation. Differences in income and access to resources between different regions and social groups can widen the digital divide, creating a society in which only part of the population can benefit from digitized services and processes. It is imperative, therefore, that digital transformation policies are designed with a focus on social inclusion, to ensure that no one is left behind. For this reason, a holistic approach is adopted, based on design for the common good, which can pursue - in the futuristic scenarios to come collaborative practices, designing for the community and the territory while respecting local identity and traditions.

In this approach there is a strong emphasis on transdisciplinarity, emphasizing how in a context of transition to digital is necessary to enable the applicability of transformation processes. It is useful to provide some practical insights into how these initiatives can be implemented effectively. For instance, the creation of collaborative platforms bringing together experts from various fields (technology, education, business, etc.) can foster the development of innovative and integrated solutions. Such platforms can facilitate the exchange of knowledge and resources, fostering a culture of continuous learning and change.

In summary, while the digital transformation strategies presented offer a promising framework for Paraguay's future, it is crucial to address social and structural challenges to enable the successful implementation of innovative practices and processes.
In this sense, the design discipline can effectively manage the complexity of the project, through an inclusive approach and transdisciplinary coordination: only in this way will it be possible to realize the full potential of digitisation and promote sustainable and equitable development that is respectful of the context in which it operates.

11. Conclusion

The theoretical framework presented in this study offers guidelines for creating a strategy towards digital transition in Paraguay. Its systemic and universal applicability makes it suitable for application in other developing countries as it addresses the specific challenges of developing shared and easily implemented strategies. In particular, the adoption of a systemic approach, characterized by a transdisciplinary component, makes it possible to develop innovative and integrated solutions that can be applied in different territorial and social contexts.

A crucial aspect of the framework is its focus on value, with particular emphasis on economic and social value. Digital transformation, if well implemented, can generate significant increases in productivity and business competitiveness, as well as create new job opportunities and economic growth. However, it is important to recognise that value is not limited to the economy. A Design for the Common Good approach also involves considering social and environmental value, promoting sustainable development that benefits the entire community.

The infrastructure of the country-system plays a key role in applying strategic investments to improve accessibility to digital technologies and to create a favorable environment for innovation and sustainable growth.

In conclusion, the exportability of the framework to other contexts lies in its flexibility and adaptability. The outlined strategies can be modified to meet specific local needs, taking into account different socio-economic and infrastructural conditions. The transdisciplinary approach facilitates collaboration between various actors, allowing synergies between different sectors to be exploited and solutions to be adapted to specific local realities. This framework can thus serve as a model for other countries, offering a solid framework on which to build digital transformation strategies that are sustainable, inclusive and capable of generating long-term value.

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DESIGN AS RESILIENCE: A MODEL FOR GLOBAL COLLABORATIONS

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ABSTRACT | Design education transcends geographic and cultural boundaries when it brings together designers from different countries and disciplines to share and create knowledge and understanding. These educational experiences impact designers in many ways, including developing cultural and historical empathy. This paper delves into an interdisciplinary, immersive learning experience, "Design as Resilience," in Siracusa, Italy, tailored for interior design students from a university in the United States. The artisans and designers of the region command widespread acclaim for their fusion of tradition and innovation, underscoring Sicily's enduring legacy as a cradle of creativity. Sicily presents a unique vantage point as a microcosm of diverse cultural influences owing to successive occupations by ancient Greeks, North Africans, English, French, and Spanish. While deeply interconnected with neighboring cultures via shared histories, the island remains physically isolated by the Ionian, Mediterranean, and Tyrrhenian Seas. Its ethos of craftsmanship and artisanal traditions, preserved and revered, forms a cornerstone of exploration. By delving into art, craft, and design, students can unravel the rich tapestry of Sicilian heritage, from the intricate mosaic-making techniques to its multitude of UNESCO World Heritage Sites.

Extensive research underscores the profound benefits of studying in unfamiliar locales, with most participants acknowledging its transformative impact on their comprehension of personal cultural values and biases. Beyond mere immersion, this program is fortified by several innovative components.

Faculty at both institutions - the university in the United States and a partner academy in Italy - have engaged in an iterative curriculum and program development process. Re-running courses allows for evolution that addresses international, interdisciplinary partners' needs, limitations, and opportunities. Although Sicily has a uniquely preserved and celebrated culture of craft and making, design education has been somewhat limited, with biases toward northern Italian universities. Since its inception in 2016, the Design Academy in Siracusa has sought to fill this significant gap. By partnering with international universities, the program offers opportunities to challenge students' perspectives continually.

A transdisciplinary research grant from the U.S. university was secured to support coursework focused on the materials of insular regions, specifically those of Sicily. A wood workshop involved scavenging driftwood that washed ashore near the workshop location. The various wood species, shapes, sizes, textures, and weights prompted questions about their previous uses and origins. The wood was assessed and then manipulated using hand and electric tools to practice making traditional wood joints.

The course also emphasized historical empathy as a tool to inform and ground contemporary design. A mosaics workshop involved using traditional tools to manipulate natural stone. This slow process of learning ancient Roman mosaic patterns and techniques offered insights into the thoughts and decision-making processes of the craftspeople who may have worked on the Villa Romana, a UNESCO World Heritage site we visited after the mosaics workshop.

In conclusion, designers can significantly benefit from developing skills related to cultural empathy, material reuse and its relationship with sustainability, and understanding how historical precedents can inform contemporary, resilient design strategies.

KEYWORDS | GLOBAL COLLABORATIONS, STUDY ABROAD, INTERDISCIPLINARY

1. Introduction: What is the value of a study abroad experience for the design student?

This paper probes the pedagogical objectives and outcomes of an interdisciplinary, immersive learning experience, "Design and Resilience," in Siracusa, Italy, tailored for interior design students from a university in the United States. Study abroad has long been touted as an effective means of providing students with opportunities to challenge preconceptions. Numerous studies have pointed to the positive benefits of studying abroad, including most respondents noting that the experience profoundly impacted their understanding of their cultural values and biases (Dwyer & Peters, 2004).

As economies become increasingly interconnected globally, there is mounting pressure for higher education institutions to foster intercultural awareness and global citizenship among students (Brooks & Waters, 2011). Global education necessitates engagement in learning processes that explore alternative worldviews, communication styles, personal assumptions, communities, and cultural perceptions, fostering cultural empathy. Yet, design curricula often need to focus on skill-building rather than creating opportunities for empathic awareness. International study abroad offers a holistic education approach, while higher education focuses on discipline-specific training and job preparation (Mendoza & Matyok, 2013).

Many academics, including Root and Ngampornchai (2013), Goode (2008), and Deardorff (2009), critique the assumed impact of study abroad programs on students. They argue that immersion in a different culture does not automatically lead to intercultural competency. For design students, mere exposure to different cultures is insufficient; they require deep immersion to transform study abroad experiences into meaningful, embedded encounters rather than superficial engagements (Mendoza & Matyok, 2013).

Reflecting on intercultural experiences with peers and professors can strengthen students' understanding of cultural similarities and differences (Brown et al., 1989).

To deepen the experience, students must first reflect on their cultural behaviors and norms. This self-awareness is crucial for students to understand that their cultural background is one of many rather than the standard to judge others (Root & Ngampornchai, 2013). According to Macdonald and MacLeod (2018), "Rather than focus on 'exposure', the internationalised education that design students need includes deep immersion and diverse contact in order to transform the study abroad tour into a layer of embedded experience rather than an artificial veneer" (p. 215).

Direct immersion and engagement through critical analysis offers an opportunity to deepen the study abroad experience. International learning opportunities enable students to expand their worldviews and develop empathy by exploring different perspectives, communication styles, personal assumptions, and cultural knowledge. These critical reflection skills can illuminate students' unconscious biases, worldviews, and ethnocentrism, fostering an empathic understanding of other perspectives—an integral aspect of the design process.

It is with this perspective that the co-directors of this program set out to create a unique learning experience for their students. Each professor has experience leading study abroad and domestic study away programs and determined the necessity for these explicit objectives: a partnership with a local institution with a similar pedagogical ethos, engaging local experts to expand worldviews and new pedagogical approaches, building in written reflections and discussions about these experiences to amplify the opportunity for critical inquiry.

The co-directors recognize that these global experiences often live on for months and even years afterward; thus, planting seeds for further development is an intentional program element. The Greek sophist Antiphon wrote that one's education is 'first among human activities' because "according to the seed which a man sows in the soil, so must one expect the crop to be. In the same way, whenever one plants a good education in a young body, it lives and increases for the whole of life, and neither rain nor drought destroys it." (Mintz, 2018, p. 414). Having led both study abroad and domestic study away programs, the authorsrecognize the imprint offered through these transformative experiences. After a program on the Eastern Shore of Virginia, one student reflected:

"One can be told a certain food is spicy, and the spiciness of the said food can be compared through giving examples of other foods. But until they try it for themselves, they will not fully know the exact level of spiciness, all the different tastes, and ingredients that come with it until they taste it and experience the

making process for themselves. These study away trips allow people to explore and understand a place from the inside looking out and from the outside looking in, not just the latter."

To enhance the program's content, the co-leaders incorporated prompts for research and reflection throughout the experience. Before the program commenced, students selected a site, building, or materials they would experience to research and present during the trip. Each student created a 4 ½" x 6 ½" card, accessible on their mobile phone during the program, to foster a sense of ownership over their education.

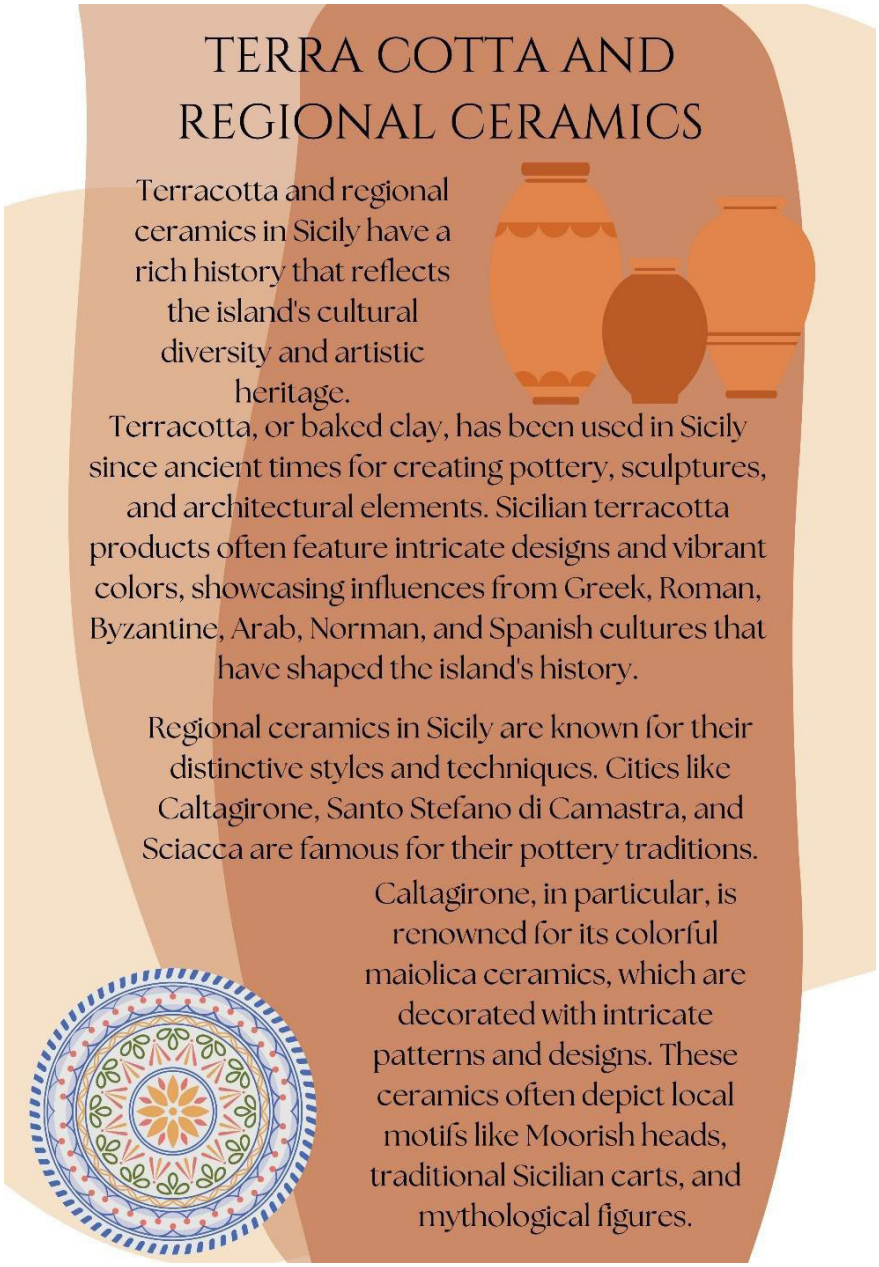

Figure 1. Here is an example of a research card created by a student and shared with the cohort before our departure for Sicily. Students were tasked with presenting their research both verbally and visually, utilizing skills such as drawing, and applying principles of hierarchy, balance, and color.

Additionally, students were encouraged to reflect on how the experience might influence their design process and ethos. Prompts included questions like: “As a designer, how do you balance rest and play with work? Are rest, play, and work distinct, or do they intersect? How do you practice self-compassion during frustration and disappointment when learning a new skill?” These reflections addressed cultural differences in perceptions of time and value, inspiring students to reconsider and adopt a more mindful approach.

2. Program Development and Implementation

As designers, we are tasked with grounding our ideas in the real needs of people and places while envisioning a world that has yet to be realized. While the world seems more accessible than ever, experiencing it through our many technological resources can sometimes feel superficial. Immersive learning experiences during a collegiate design education offer opportunities for personalized learning and authentic understanding of culture, place, and people, enriching students personally and professionally.

According to the Institute of International Education’s 2017 report, students who studied abroad in countries with less familiarity or were perceived as less similar to the United States experienced a more significant impact on skill development and career utility than those who did not study abroad. (Farrugia & Sanger, 2017). Like design practice, developing quality programs that provide these benefits requires an iterative approach to curriculum development, allowing for trials, adjustments, and experiments.

In 2016, one interior design faculty co-authors co-created a new interdisciplinary study abroad program for the university’s art school, focusing on the intersection of interior design and craft and material studies. The program involved the interior design faculty author and a craft and material studies faculty member from the same university. Twenty-two undergraduate and graduate students, interior design and craft and material studies majors, participated. The group spent four weeks in Florence, Italy, through a partner institution, the Santa Reparata International School of Art. Successful teaching strategies included an intentional mix of structured and unstructured blocks of time for sketchbook work and group reflections.

We observed that students would sketch alongside peers, sharing techniques and tools, asking each other questions, and sharing their thoughts, which deepened their understanding of their experiences. During group reflections, vulnerability increased as trust was built. The mix of backgrounds was evidenced in group discussions as universal and unique aspects of the different disciplines became apparent.

After the program concluded, the faculty decided to evolve the curriculum from tour- and event-based to workshop-based. Around this time, we were contacted by the

Accademia di Belle Arti “Rosario Gagliardi” Mediterranean Art and Design (MADE) program in Siracusa, Sicily. A degree-granting fine arts academy with instructors from all over Europe, MADE was newly established and wanted to partner with American universities. Discussions led to the interior design faculty author and the craft and material studies faculty member traveling to Sicily for one week in June 2017. During this visit, we spent time with MADE’s Dean and founder, Alessandro Montel, and several instructors focused on ceramics, textiles, and architecture, with whom we developed workshop curricula emphasizing the intersections of craft and design.

In 2018, the program in Sicily was launched with twenty students, including thirteen interior design majors and seven craft and material studies majors, three of whom were graduate students. Over four weeks, the students participated in three workshops led by MADE instructors, covering topics such as natural dyes, urban space, and ceramics. The urban spaces workshop was led by Moncada Rangel, an architectural design duo that also partners in our 2024 iteration. To highlight the value of iterative programs and their role in evolving strategic partnerships, our interior design faculty member, who leads a community design studio at their university, has identified a shared interest with Moncada Rangel over the years. We are now pursuing grants to bring Moncada Rangel to the United States in the spring of 2025 for collaborative projects.



Figure 2. In 2018, our students took part in a workshop titled “Conquering the Space,” where they were tasked with developing design proposals for the Porto Piccolo harbor that addressed prompts related to community identity. Students visited the site, worked in interdisciplinary teams, and ultimately presented their ideas to Moncada Rangel, their university peers, and MADE students for critique.

3. Background and Context: Why Sicily?

While Milan boasts the highest number of design schools and students in Italy, largely due to its proximity to many major industry brands, Sicily offers a variety of distinct advantages. Siracusa and its surrounding areas are significantly less expensive and less populated than Milan (Delmundo, 2024). According to Alessandro Montel, Dean of the MADE Program, the approach of most Milanese schools tends to be relatively homogeneous, focusing primarily on training students for rapid workforce entry, often emphasizing Interior and Product Design with a strong inclination towards what can be described as "pure decorativism." In contrast, the craft dimension retains significant importance in areas with less industrial presence.

Montel suggests that in a less "contaminated" context, students can experience firsthand what it means to design from primary needs, using natural materials and tools that often involve manual work. This approach may be slower but more deliberate, providing a solid foundation for future development. From the European Industrial Revolution to the advent of computer-aided design, technological advancements have continuously transformed the methods used to design and create interiors. While today's educators and practitioners are well-versed in modern tools, many still value traditional skills and handcrafting techniques. Scholars such as Alma Hoffman argue the importance of sketching and making by hand as a mode of thinking (Hoffman, 2020). This ethos is central to our department's pedagogy and MADE's.

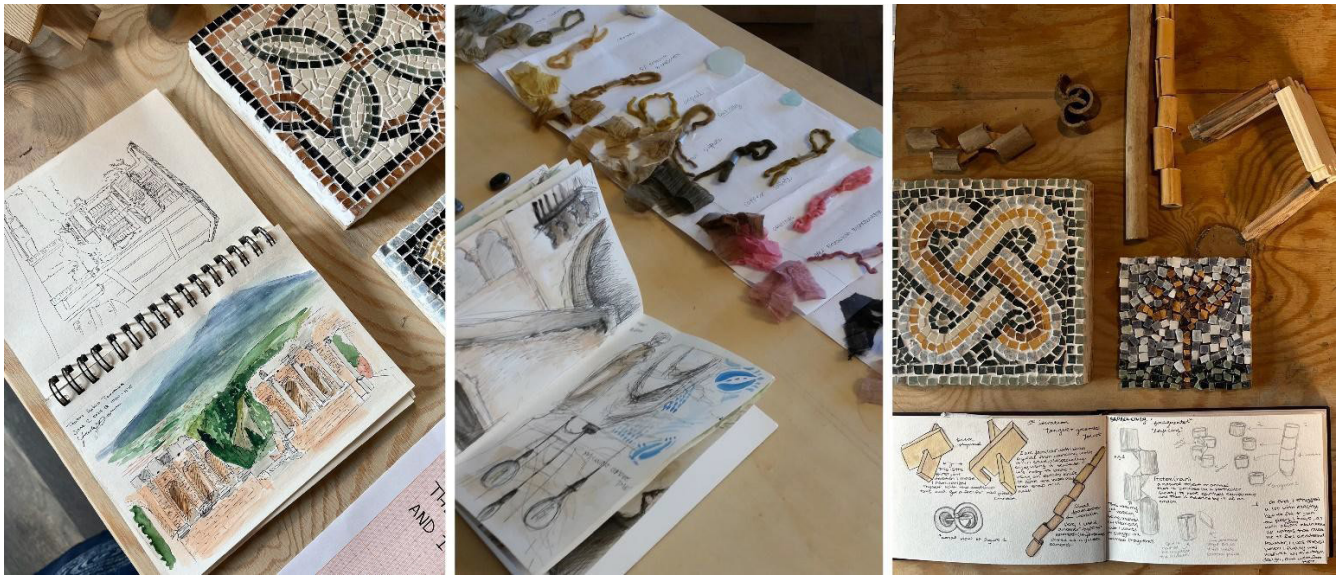

Figure 3. In 2018 (center image), a final exhibit of student work highlighted sketchbooks and hand-dyed yarns, with sketchbook media including graphite, ink, watercolors, and personal experiments. The fiber dyes were crafted from plants collected by students near Pantalica in Siracusa. In 2024 (left and right images), the final exhibit again featured sketchbooks, alongside mosaics and driftwood joinery experiments. Photos by co-author.

Sicily also presents a unique vantage point as a microcosm of diverse cultural influences owing to successive occupations by ancient Greeks, North Africans, English, French, and Spanish. While deeply interconnected with neighboring cultures via shared histories, the island remains physically isolated by the Ionian, Mediterranean, and Tyrrhenian Seas. Its ethos of craftsmanship and artisanal traditions, preserved and revered, forms a cornerstone of exploration. Students explore Sicilian heritage by delving into art, craft, and design, from ancient techniques to its multitude of UNESCO World Heritage Sites.

One of Sicily's great writers, Leonardo Sciascia, suggests, "to some extent this island serves as a metaphor for the entire world." The island's mythical narrative oscillates from assimilation to subversion, from its ancient Greek temples at Agrigento to its baroque architecture, markedly rich due to a massive rebuilding campaign after the 1693 earthquake. One is constantly reminded of the layered history evident across the island. For instance, the Cathedral of Siracusa on the island of Ortigia is built on the site of the 5th century BCE Ancient Greek Temple of Athena, revealing its Doric columns within the cathedral's walls. Building on themes of resilience and fragmentation, the co-leaders wove a thematic thread through various discussions, sketchbooks, and reflection prompts.



Figure 4. The fluted limestone Doric columns of the Duomo di Siracusa, a UNESCO World Heritage Site, are visible both inside and outside the building. Photos by co-authors.

During the 2024 iteration, twelve students and two faculty, one a design studio professor and the other a design historian, were based on the island of Ortigia, conveniently close to the MADE classrooms. The program featured two workshops led by MADE instructors, Ancient Mosaic Making and Traditional Wood joints, and included several field trips to nearby sites throughout the three-week session. These excursions helped students understand how the island's

geography and geology influenced the built environment over time. A key challenge of the program was balancing exposure to diverse sites with sufficient time for reflection. The program leaders attempted to thoughtfully intersperse these site visits with two essential workshops led by MADE instructors, ensuring a comprehensive and enriching experience for all participants.

Site visits outside of Ortigia included the 4th century CE Villa Romana del Casale, the 6th century BCE Ancient Greek city of Agrigento, Mt. Etna, and the Necropolis of Pantalica, where over four thousand rock-cut tombs were created between the 13th and 7th centuries BCE. In Siracusa, students visited several notable sites, including the Castello Maniace, a medieval citadel and castle, and the Palazzo Bellomo, originally built in the 12th century and renovated over the centuries, which houses an excellent collection of regional sculptures and paintings. Each location offered unique opportunities to explore the materiality and architectural features distinct to each era.

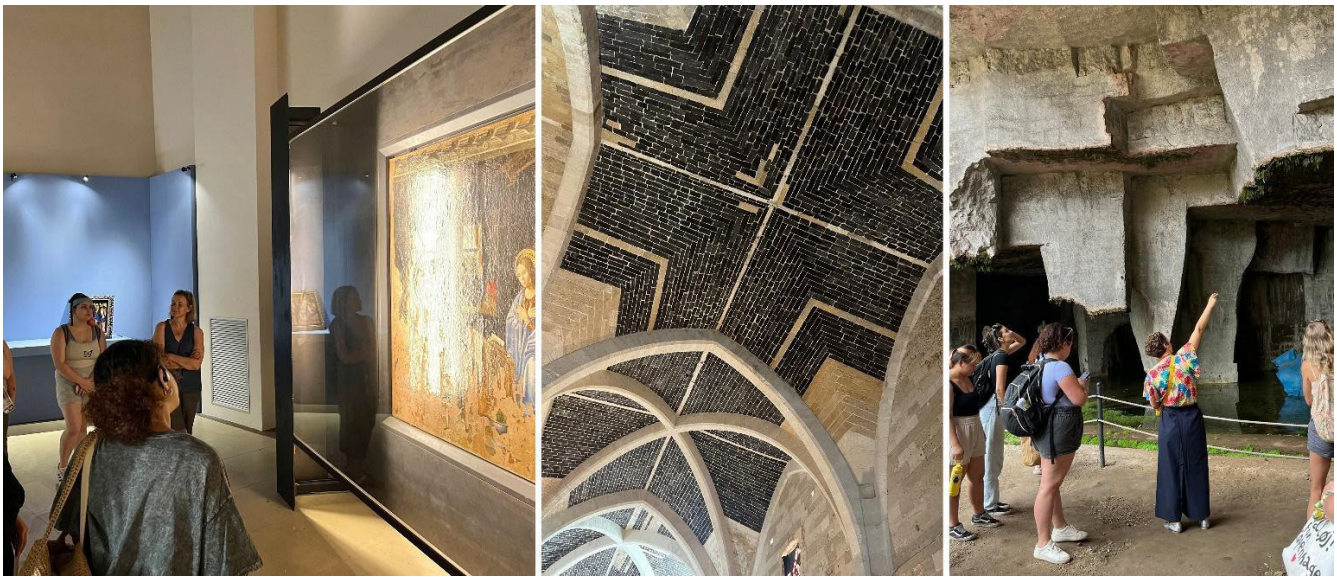

Figure 5. In the left image, students and faculty are gathered in front of Antonello da Messina's The Annunciation at the Galleria Regionale di Palazzo Bellomo di Siracusa. The center image showcases the lava stone ceiling of the Castello Maniace, which contrasts with the surrounding limestone and marble. In the right image, students pause to admire a pool inside one of the many caverns at the Parco Archeologico e Latomie del Paradiso, accompanied by faculty and tour guides Moncada Rangel. Photos by co-authors.

Students also visited the Parco Archeologico Neapolis in Siracusa, which includes Ancient Greek and Roman ruins. Local architects and MADE instructors Mafalda Rangel and Francesco Moncada, accompanied the group to provide context and prompts for further discussion. The ancient limestone quarry, Latomia del Paradiso in the Parco Archeologico, revealed historic extraction methods and the site's layered history. Once a dark and grueling prison, it became a cemetery and eventually transformed into an open-air garden after an earthquake collapsed the quarry

roofs. Program participants also attended a performance of the ancient Greek tragedy Phaedra in the 5th century BCE theater.

These sites' integrity, proximity to our home base in Ortigia, and affordability and accessibility all contribute to a rich experience.

4. Materiality, Empathy, and Making as Pedagogical Tools

Coastal insular communities provide opportunities to understand not only unique regional architectural vernacular but also the distinct materiality and influencing factors specific to these areas. Both faculty members of the Sicily: Design + Resilience program have collaborated for several years on coursework, research, and developing new study abroad and study away programs in insular communities, including Cuba (2016) and the Eastern Shore of Virginia (2022, 2023). Through repeated collaborations and evolving curricula, we have developed pedagogical strategies rooted in reflection and sketchbook practice that connect us to our personal experiences with place and the influencing factors that enhance our understanding of design possibilities.

For the 2024 iteration of the program, we incorporated a focus on materiality as a way of understanding place. One of the co-leaders of this program is a faculty researcher in our university's Materials Index Project and, through this overlap, developed coursework for the 2024 program in Sicily to support the project. In 2023, a university incubator fund supported the development of a Transdisciplinary Materials Research Lab, which subsequently fueled the creation of the Materials Index Project. Working towards climate justice requires re-evaluating the materials that enable our lives, from industrial and structural materials to the metals, fabrics, and plastics used in consumer goods. Understanding the nature and flow of these materials is critical to supporting a just transition to a circular economy and a sustainable society. Accordingly, the Materials Index Project is developing an interdisciplinary research method to understand existing materials and production processes and to develop new materials and processes that support a sustainable circular economy. Research is done on specific objects from various disciplinary perspectives and settings through collaborative research projects involving faculty and students. This approach allows us to acquire a more complete and integrated knowledge of the complex nature and impact of existing materials and production processes.

This Materials Index Assignment encouraged students to collaboratively create an index that encapsulates the questions we pose about materials, emphasizing their interconnectedness in various contexts. The assignment provided specific prompts, including phenomenological aspects (tactile, experiential, cultural, symbolic, spiritual) and end-use considerations (history, economy, environment, community, technology).

Prompts were provided, such as:

> Consider the materials as living beings, products, and beyond. Do we only perceive materials in relation to ourselves? What are this material's sensual, experienced, and phenomenological characteristics in its different stages of coming into being, use, and disposal? How do people relate to the material as a tactile presence? What qualities are felt and how? What does the material mean? What social, spiritual, symbolic, and economic values does the material hold, and for whom?

Students selected one specific material from each of their two workshops and one specific material from their daily experiences in Sicily to focus on for their assignment. An Ancient Mosaics workshop led by the Verona-based mosaicist Elisabeth Cozza used traditional tools to manipulate natural stone. For instance, one student reflected on Bianca Verona marble used in this workshop, from its formal characteristics to its inherent value. In terms of her material of choice from everyday life in Sicily, she chose terrazzo and explored its origins, how it is made, and where it is commonly used.



Figure 6. The Ancient Mosaics workshop focused on traditional stone-cutting techniques using tools such as a hammer and a metal pin mounted on a wooden stump. Students created their mosaics using five pattern templates and a selection of sixteen different marbles and travertines. The stones varied in their qualities - some broke more easily and in cleaner lines than others. Tesserae were required to be approximately 2 cm x 2 cm, with shapes including squares, trapezoids, triangles, and rectangles to provide different line types. Photos by co-authors.

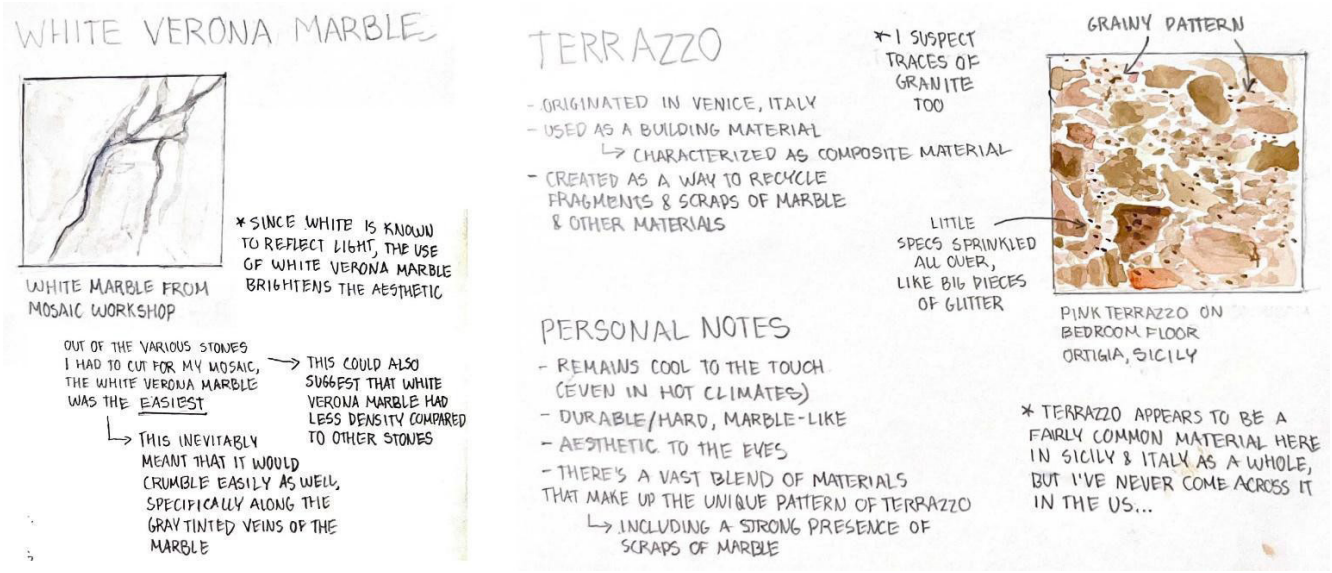

Figure 7. The image above displays notes and sketches by the student mentioned above, documenting their studies of Verona White Marble and Terrazzo. These notes detail tactile qualities and composition, providing valuable observations for us to review.

Driftwood was a focus for the second MADE workshop, "Traditional Wood Joints." Leading the workshop was Francesco Faccin, a master wood craftsman and professor from Milan, who studied and collaborated with the esteemed designer Enzo Mari. Mari's influence on Italian design emphasized a blend of artisanal and industrial techniques (Zanella et al., 2023). His vision for design education aligns with our program objectives; he once stated, "I say let's teach our kids to be craftsmen, to master again the art of drawing (a slow skill that requires thinking), to understand what was done in the past, and why and how" (Tartari, 2020).

Students worked with Faccin to gather driftwood from the northeast corner of the island of Ortigia. Driftwood originating from natural and anthropogenic sources is abundant in coastal regions and plays an important role in ecosystems, providing habitat, structure, nutrients, and carbon storage. (Murphy et al., 2021) The variety of wood species, shapes, sizes, textures, and weights sparked curiosity about their previous uses and origins. Participants assessed the wood and then used hand and electric tools to practice creating traditional wood joints. The workshop encouraged students to reimagine this found material for new uses and narratives rather than considering its story complete.

These immersive experiences profoundly impacted students, from the activation of traditional materials to revelations about personal biases and perspectives. One student reflected on the reuse of driftwood in the workshop:

"The convergence of so many different worlds is apparent through our extensive collection of driftwood. I felt as though

I was rummaging through years of history with every piece I turned over - stones and archives of times passed spilling out into the open… I hope our presence is welcome and not disturbing the environment's natural rhythm… In the end I do think that our 'disturbance' of this space has an overall positive impact on the materials we gathered as it allows these objects to be transformed and used in a way that they never would have been before."

"In the weeks we have been here, I have come to learn that, to me, the beauty of Sicily is seeing how everything is reused and cherished. Everything here has a past and is being used, It is not taken down, but restored and reused for as long as possible. The materials are reused and sourced from the nature around like lava stones from Mt. Etna, sandstone, limestone and marble. It is beautiful to see the pride and history around us."

Another student made note of an ethos of adaptive reuse on the island beyond the wood workshop:

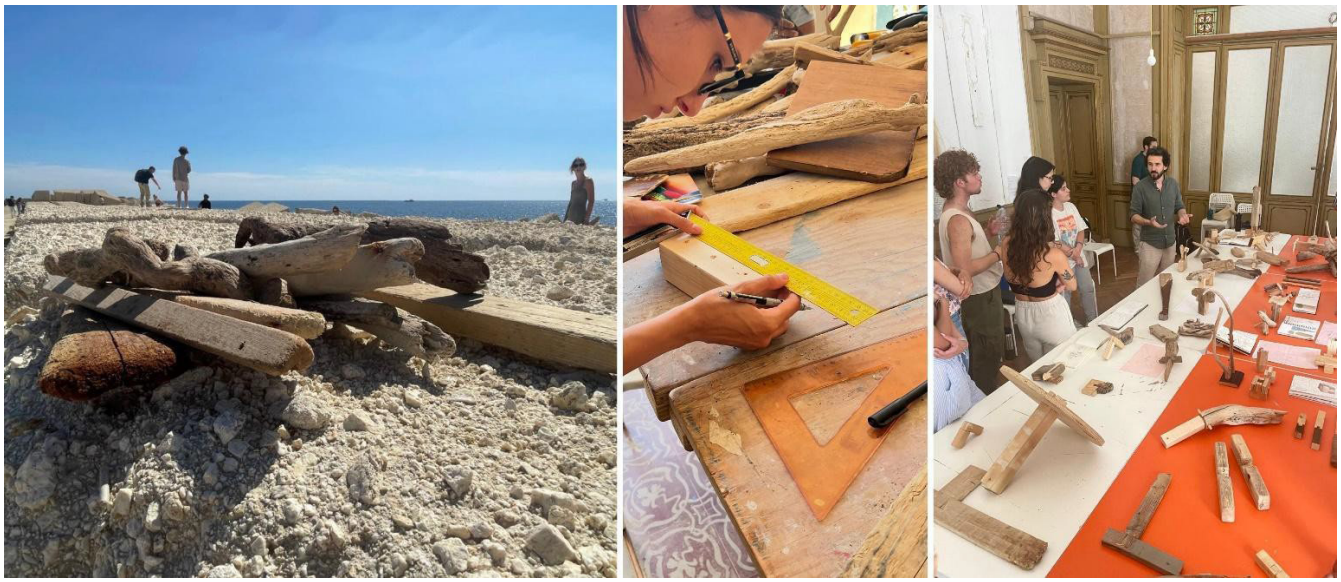

Figure 8. During the Traditional Wood Joints workshop, students collected driftwood, evaluated each piece's unique properties, and used basic woodworking techniques to join them together. The workshop was a collaborative effort, bringing together our university students with peers from MADE. At the conclusion, participants presented their joints for critique.

The Sicily: Design as Resilience program emphasized historical empathy as a tool to inform and ground contemporary design. For instance, the slow process of learning ancient Roman mosaic patterns and techniques offered insights into the thoughts and decision-making processes of the craftspeople who may have worked on the Villa Romana del Casale, a UNESCO World Heritage

site visited after the mosaics workshop. Scholars such as Carl Knappett have noted the value of finding the material and immaterial in the study of material culture, noting, "an artifact holds and encapsulates both action and thought." (Knappett 2005: 170). If we accept that mind and matter achieve codependency through the medium of bodily action, then it follows that ideas and attitudes, rather than occupying a separate domain from the material, actually find themselves inscribed "in" the object (Knappett 2005: 169).

While it is impossible to recreate the constraints and historical context by which ancient mosaics were made, using the same tools and stones within a 10" x 10" design allowed students to understand mosaics' physical and temporal nature. The scale of the Villa Romana's 3,500 m2 mosaics and their excellent state of preservation underscored the labor and skill needed for such a feat. One student noted in her sketchbook:

"This entire process has also definitely had its highs and lows; While I love this art form, its actual production is so much more involved and tedious than I previously thought… I found it frustrating to make accurate cuts in the stones. I have a newfound respect for mosaic artists."

Another student made notes and drawings in her sketchbook, referring to the relative facility of each marble type and the best use of shapes for organic forms.

Historical empathy exercises have been utilized in educational settings to assist students in interrogating the actions of an individual or group, given their circumstances. Acknowledging the bias of one's contemporary existence and the lack of complete knowledge of the past is vital. In the vein of Walter Benjamin's notion of the fragmentary nature of history, noting, "History is made up of fragments and absences. What is left out is as significant as what is included" (Benjamin, 1968), the co-leaders emphasize the superficial nature of a three-week immersion not as a negative experience, but as a way to grapple with the complexities of today. Benjamin also notes, "The true method of making things present is to imagine them in our own space and not imagine ourselves in their space" (Benjamin, PAH, 23). This activation of historical methods and techniques for exploration and discovery was evident in the program's second workshop, "Traditional Wood Joints."

Beyond the program content, students were immersed in a classroom environment alongside international peers, including those from Italy. This unique setting sometimes created discomfort for U.S. students, who were unaccustomed to the Italian instructor's pedagogical style. Some perceived the instructor's approach as a lack of consideration for alternative design processes. The co-leaders used this opportunity to engage the entire cohort in a broader discussion. Helping students distinguish between discomfort stemming from cultural differences and personal slights

was an integral part of their experience, complementing the workshop content.

Educators have long noted that building empathy in resilience leads to higher emotional intelligence. MacDonald (2021) defines emotional intelligence as "an individual's capacity to recognize, manage, and express emotions and the ability to perceive, understand, interpret, and respond to the emotions of others. EI enables us to confront our everyday problems with patience, insight, and imagination." Working through discomfort by parsing out the emotional responses to the situation supports students in evolving their emotional intelligence.

As mentioned earlier in this paper, time is a key area of cultural difference. Mosaic instructor Elisabeth Cozza remarked that our students often worked without taking breaks and then typically crashed by 4pm. In Francesco Faccin's workshop, he asked students to refrain from eating in the studio setting, something that is more common in our American university, which led to confusion and embarrassment. In one of the daily prompts, it states,

"American culture often deems time as a commodity - time can be saved, wasted or spent wisely. Listening to our bodies for signs of hunger or fatigue often doesn't match the work day. When you eat your first bit of food today, slow down. Try not to multitask. What does it taste like? What are the textures? Try to bring that sense of mindfulness of the present moment with you today."
In response, one student noted:

"It is so important to take a step back to breathe and look at things from the perspective of growth, not perfection. I tried to slow down on my walk to MADE this morning and while I wasn't able to sit while eating due to time, I tried to enjoy both my slow walk and my breakfast croissant.

I allowed myself to stroll to MADE instead of my usual speed walk. I took in my surroundings and paid closer attention to smaller details around me present in the shops and buildings along the way. I noticed these gorgeous wrought-iron flowers on a balcony I pass daily that I never noticed before."

Our faculty frequently discuss how a studio ethos can develop organically, for better or worse. Often associated with political or corporate settings, groupthink is also relevant in educational contexts. It is "a psychological phenomenon that propels well-intentioned individuals to follow the behavior or opinion of the majority and make suboptimal decisions for the sake of conformity" (Tankala, 2023). If studio time is equated with a positive work ethic, students may start spending excessive time in the studio without breaks, even eating at their desks. By removing themselves from this insular way of thinking, they were exposed to a new model in which students took short breaks throughout the day and finished later.

5. Reflection, Challenges, and Opportunities



Figure 9. Following our visits to Mount Etna (image on the left) and the Villa Romana del Casale (image on the right), students were encouraged to reflect on their experiences through poetry. At the end of the program, we curated an exhibit of their work in a street-level studio space open to the public (center image). Alongside their work, students shared handwritten personal reflections on their program experiences.

On the final afternoon of our 2024 Sicily: Design and Resilience program, we held an exhibition at MADE, where students showcased their work from the Ancient Mosaics and Traditional Wood joints workshops, along with their sketchbooks. Each student also responded with a written reflection to the prompt: “In your experience, how is Sicily’s built environment and material culture an expression of its layered and nuanced past and present?” This celebration of the program’s accomplishments also included discussing opportunities for growth and improvements for future iterations.

The feedback from students was overwhelmingly in favor of extending the program’s duration. They desired more time in Sicily, particularly more downtime to sketch and reflect on their experiences. Initially, the decision to make the program three weeks instead of four was based on the belief that a shorter program would reduce student costs. However, the savings were minimal. Comparing the sketchbooks from the month-long course in Florence (2017 and 2019) to those from the three-week course in Sicily (2024) suggests that the program would benefit from being longer. Daily sketching and sharing offer more opportunities for an iterative process, allowing students to refine their techniques; additionally, revisiting locales for sketching fosters iterative growth and deeper understanding.

Leading study abroad programs in popular tourist destinations presents the challenge of recognizing and addressing our impact on local communities. The effects of mass tourism on local infrastructure have been profound, with platforms like Airbnb significantly altering neighborhoods, driving up property prices, and displacing long-time residents from historic areas. In their co-edited volume, Study Abroad and the Quest for an Anti-Tourism Experience, Bodinger Uriarte and Di Giovine (2020) explore the evolution of the ideal traveler, noting:

"Study abroad is a form of mobility that encapsulates anti-touristic values: traditionally slow and immersive, based on education and quality local interaction… and aimed at breaking down ethnocentrism and creating cosmopolitan 'global citizens' rather than transient visitors…" (p.284).

Balancing the economic benefits of tourism with the preservation of social, cultural, and environmental resources is indeed a complex challenge. In Ortigia, Siracusa, for example, the port serves as a stop for cruise ships that bring hundreds of tourists to explore historic sites and local culture. However, many of these tourists choose to dine on the ships, which provide their own meal plans, rather than patronizing local restaurants. This arrangement limits the economic benefits to local eateries and hotels, which cannot fully capitalize on the influx of visitors. Peer-to-peer rentals, with Airbnb leading the charge since its inception in 2008, have significantly impacted the gentrification of local communities. The pandemic underscored the profound effects these short-term rentals can have on historic city centers (Higgins et al., 2023). As a result, it is crucial for study abroad participants to be mindful of their impact and to actively collaborate with local institutions and stakeholders to address these effects. While the 2024 iteration of our program touched on these issues, we did not have the chance to explore them in depth through workshops or design charrettes. However, the relationships established between our institutions present a valuable opportunity for further development. To optimize our approach to sustainable tourism in Ortigia, aligning our curricular priorities with collaborative decision-making to minimize our environmental and tourism impact would be beneficial. For example, lodging represents a significant area of concern. If we stay outside the historic district, it would be advantageous for students to grasp the importance of reducing our footprint. This understanding would help them appreciate the broader implications of our choices and the benefits of sustainability in tourism.

After extensive experience leading study abroad and domestic study away programs, the program co-leaders have determined that short-term immersion must be complemented by local collaboration to provide students with meaningful insights into local challenges beyond the typical tourist experience. Our materials studies methodology involves: 1) immersive engagement with place, 2) collaboration with regional craftspeople,

3) a phenomenological assessment of materials and processes, 4) identification of potential end-uses, and 5) reflective analysis of outcomes. Establishing thematic threads before and during the program can enrich the student experience, helping them navigate the overwhelming influx of new information and experiences. Additionally, providing ample opportunities for reflection allows for more profound, long-term growth.

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SPACE EXPLORATION: COMMUNITY OF INTERCULTURAL IDENTITY THROUGH MEMORY SHARING.

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ABSTRACT | How can design guide future scenarios of space exploration through systems-actions-visions that continue to create connections that transcend the limits of space and cultural boundaries? As emerges from current trends, in the coming decades, the human presence in space will expand from low Earth orbit to the lunar surface and the crew will be made up not only of astronauts but of new users with heterogeneous purposes and missions. Today, the International Space Station (ISS) is a place of strong cooperation, where boundaries are not defined and people, thanks to long selection processes and shared training, acquire a strong empathy so that cultural differences are not perceived as a limitation. In the future, this balance may change significantly. In fact, the risk of a larger presence of "space travelers" with their short stay, is that the space habitat becomes just a "crossing" space without an identity, without a shared memory, a non-place.

The paper investigates how design in synergy with humanistic and technological fields can encourage the creation of a new community not only of interest, but with a shared intercultural identity within these new extreme environments.

The research, through a Responsible Advanced Design, is mapping and analyzing which analogic and virtual practices can activate a "memory" in Space habitats capable of developing a system for transferring the experiences of places and emotions from one user to another, beyond the boundary of time and exceeding it, to give continuity to a story and eliminate the meaning that it is just about experiencing the micro-gravity space for oneself.

KEYWORDS | ADVANCED DESIGN; FUTURE STUDIES; SPACE HABITAT; INTERCULTURAL IDENTITY; MEMORY

1. Introduction

The dream of reaching the moon is centuries old. Our satellite has always aroused human curiosity, making the sky more than just an inanimate blanket of stars, but a space worthy of exploration. The time has come to change things. Not only are there spectacular explorations by space heroes heading into the unknown, like the moon landing that still ignites human imagination, but also consider that in the last 24 years, the International Space Station has hosted approximately 273 astronauts and cosmonauts from 24 different countries[1]. Current trends indicate that in the coming decades, human presence in space will expand from low Earth orbit (about 400 km from the surface) to the lunar surface, with crews composed not only of astronauts but also new users with diverse purposes and missions. If today the International Space Station (ISS) is a place of strong cooperation where boundaries are undefined, and people, through long selection processes and shared training, acquire strong empathy so that cultural differences are not perceived as limitations, the future does not foresee such "harmony" when constructing new vehicles and space stations. In the future, this balance may change significantly, especially since by 2031 (Bartheles, 2024), the ISS will undergo significant modifications, if not dismantled entirely. F.e. Space X's Starship program promotes the idea that the developed vehicle could carry up to 100 people for an interplanetary journey[2], while Falcon 9 carries 7 passengers. The goal is no longer a destination within our planetary system but interacting with the space surrounding Earth in various ways.

Currently, ensuring greater psycho-physical well-being and a better quality of life for travelers within space modules seems to be one of the main objectives. However, a further step is needed: regenerating the emotional relationship and spatial and bodily interconnection among people who will experience the space habitat presumably for shorter periods, with different interests and objectives than actual astronauts. The psychological negative factor addressed in this paper concerns the risk that the space habitat becomes just a "crossing" space without identity or shared memory, a *non-place* for "space travelers" with their short stay.

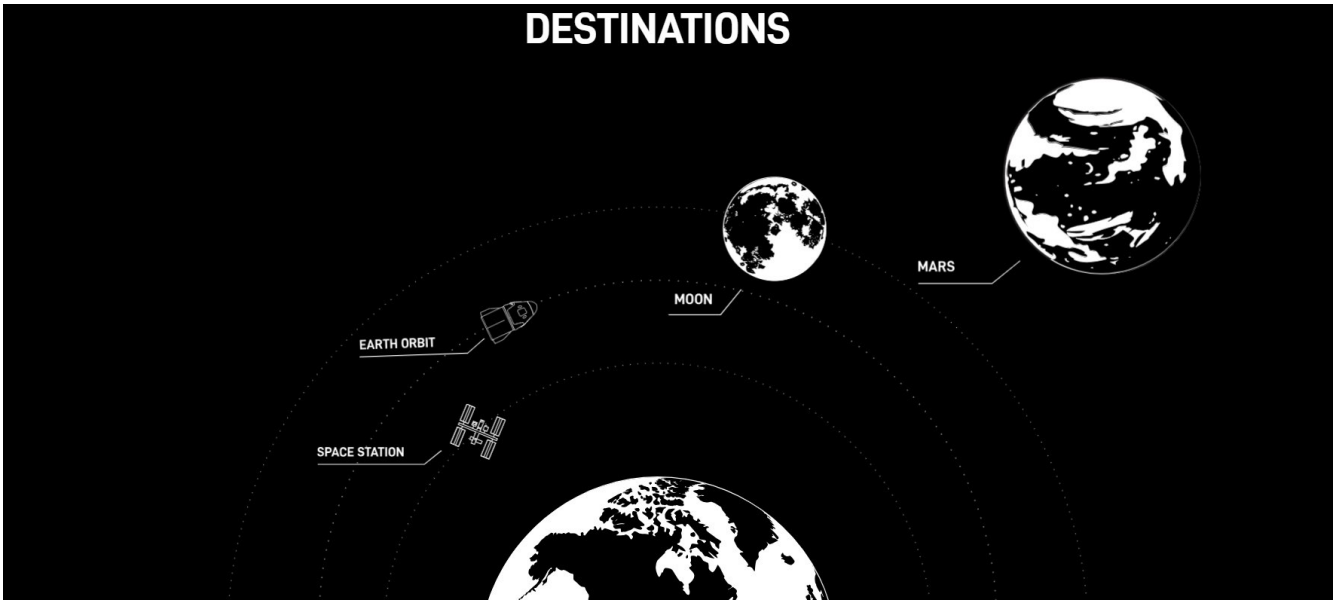

Figure 1. Image taken from the SpaceX website - Human Spaceflight

2. Concept of Belonging

Marc Augè defines a place with no personal connection as a Non-Place, devoid of narrative and functional at any point of use. In contemporary experience, Giaccardi and Magatti (2001) address the co-interest in social space as a resolution to loneliness. Places and non-places "interlock and mutually penetrate each other; the possibility of a non-place is never absent from any place," as Magatti reiterates Marc Augé's (p.44) statement on the coexistence in social space of places of solitude, non-permanence, and instrumental and contractual interaction. With current developments, space habitats in orbit can be seen as transit and crossing spaces not designed for relationships, where one does not recognize oneself as belonging except for artefactual details inserted over time by those who experienced these environments. Thus, thanks to the principle of community identity, an apparent non-place can become a place for someone who works and lives there. This distinction of attitude, not substance, must also be designed in new scenarios where innovative design approaches become the drivers of this interpretation.

What makes the environment livable is our relationship with it. Relationships with others, sensory memories, light, rhythms, physicality; these connections compose a multichannel perception capable of generating poetic images (Mallgrave, 2015, p.112) extracted from the experiences the body has lived. In the transposition of the space habitat becoming home, the

[1] Buon compleanno, ISS! - Infini.to (planetarioditorino.it), website consulted in July 2024

[2] SpaceX – Starship, website consulted in July 2024

place where we spend time beyond just functional activities like shopping but staying to eat, sleep, and interact with space and relationships with others, it is evolving from a "container/machine" towards an idea of an ecosystem that, thanks to the multiplicity of infrastructural networks (Mitchell, 1995), is increasingly interconnected with the objects and people inhabiting it. In new types of living spaces, according to Flusser (2003, p.88), "relationships are 'attracted'"; the habitat is no longer a place of protection but is "creative as a node of an interpersonal network." The infrastructures shaping the habitat are elements that compose that open network, opening new design fronts for space and life in relation to others. But also segregation with the intensified use of digital communication tools. People can relate more easily to a product, service, or experience when they can connect to it on a personal level and thus recognize in it languages, forms, and behaviors they have already experienced and can dialog with, whether effectively or not.

Zygmunt Bauman (2011, p.113) connects Richard Sennett's thought to the definition of empty space by Jerzy Kociatkiewicz and Monika Kostera, highlighting the difficulty of generating relationships, cohesion, and coexistence in spaces without meaning. For the same reason, the lack of meaning, the loss of identity, the lack of stratification of memory, and the disintegration of the collective element of *non-places*, according to Augé, make them alien to man in the process of participation, sharing, and association. If the connections generated between people and places do not participate in building personal, collective, and identity memory, they become meaningless and without hierarchies, failing to acquire value in human life.

Therefore, design must create a narrative that, in turn, generates memory, leading to the research question of this article: How can design guide future scenarios of space exploration through systems-actions-visions that continue to create connections transcending spatial and cultural boundaries?

3. Memory and Space-Time

Maldonado asserts that there is an evident connection between memory and identity in their relationship with dwelling and, consequently, with the objects accumulated within.

"'Dwelling means', said Walter Benjamin, 'to leave traces,' and traces are the imprint of memory. As has been said many times, in the Western world the accumulation of objects, considered as traces, represents one of the most important means of defining one's space and identity. We have seen so far how literature bears witness in an almost sculptural way to this character of our material civilization."

(MALDONADO, 2005)

This relationship lives through what is defined as bodily memory, resulting from the layering of past motor experiences the body has perceived and lived in relation to itself and

others or objects it has come into contact with. Considering the weakening relationship between man and things due to a changed nomadic configuration dictated by the increasingly digital consumption of content is another design area to consider for a general rethinking of our living systems.

The present research reveals that current space habitats are built to respond to survival and work functionalities, not to welcome passengers and placing their belonging needs in the background. It is a sense of multiple belonging: primarily physical, belonging to the station/vehicle crew, which could also be defined as a "common destiny." The other sense of belonging is to the home on Earth, with which the connection system has technically improved significantly over time, and organizationally, for example, the ISS astronauts' agenda includes space and time to correspond to this need. The sense of belonging to a space seems linked to the time spent in it. For example, on a long train or plane journey, the seat we occupy gradually becomes ours, and we identify with it. When we stay longer in a hotel room, we start moving furniture. And if years imprisoned, appropriation occurs even under the form of inscriptions on the wall, like the first humans on earth who testified their presence with a hand reproduction on the cave wall. We leave traces of our presence, like hearts carved into the tree where we encountered our first love.

3.1 Time in Relation to the Individual and the Community

As seen until now, beyond spatial and temporal factors in future space explorations, it is important to consider the relationship between the individual and (travelling) community, as well as the institution of reference.

The relationship between the individual and the community today is regulated by procedures, training paths, and highly concentrated physical-psychological preparation and the creation of a strong sense of cooperation and cohesion. People, thanks to long selection processes and shared training, acquire strong empathy so that cultural differences are not perceived as limitations. In contrast, the relationship between the community and governance is defined and protected by international agreements between public institutions, preserving a common good: extraterrestrial space and the multicultural nature of missions.

As expressed at the beginning of this contribution, the paradigm shift is defining new systems of governance of outer space, new forms of space occupation and resource use, new dynamics of partnerships between international non-profit entities and companies, focusing less on the social and cultural implications of these important changes (Pasa & Sinni, 2024).

All this brings up further questions: How will the future users relate to each other? How can living space be made qualitative for

multicultural cohabitation? How can living space be designed to be cohesive?

In this complexity, time can be a driver of innovation by using the timely succession of people in the orbit at different moments as a community building resource: If considered as a variable of design (Celaschi et al.,2014), it can work on the design process to keep individual identity connected with being an active part of a community and a promoter of an international and multicultural cooperation system.

4. Action – Research

The Advanced Design Unit research group at the University of Bologna, through a project funded by the European community called *Made in Italy Circolare e Sostenibile* (MICS) - PE11 – PNRR, is carrying out the " Beyond the Space Life. Digital Living Lab for human life in space " project within the research line of Spoke 1. The work team involves various scientific fields in academia, such as design and mathematics, and an important aerospace company, Thales Alenia Space Italia (TASI).

This synergy between research and industry allows the investigation of the phenomenon of space exploration, particularly related to life in micro-gravity space habitats, through two lenses: 1) tangible factors such as the sustainability of tools and design processes, circularity of innovation strategies, use of technologies concerning the environment or people (Van Ellen, 2023; Valori et al., 2020) , and 2) intangible values such as inclusion, well-being/care of the individual, community, and space, cooperation, that belongs to the concept of Responsible Innovation (Stilgoe et al., 2013). Of particular interest for this contribution is the second research thread closely related to the elements, needs, and opportunities described earlier. As already emphasized, the reference context is an extreme environment, not comparable to life on Earth. Microgravity, the absence of natural stimuli, and altered sensory perceptions bring the human body into a new dimension and to live uncoded experiences. If until today astronauts have been able to overcome adaptability difficulties, social isolation, and identity sense thanks to their backgrounds and learned abilities, in the near future, this will not be possible due to the much shorter preparation of space travellers as described previousely.

The objectives and lines of intervention of this second track are multiple: on the one hand understanding who the new users will be and designing for the awareness and ethics of people undertaking these explorations, redesigning the experience from including ergonomic and sensorial perspectives (Burattini et al., 2014; Dominoni & Quaquaro, 2023; Inglese et al., 2024) on the other hand focusing on the design that allows to share memory and experience of travellers through time creating a new kind of "space community".

In this line of intervention, TASI's involvement is ensuring good experimentation of the project, guaranteeing related humanistic

and technological skills on a basic research level and to put theoretical visions into action by collaborating with further industry companies. The complexity of this research area, influenced by human, spatial, temporal variables, and unpredictable factors, requests combining knowledge and know-how from different fields through an interdisciplinary approach (Kopec et al. 2024).

To avoid interdisciplinarity remaining a theory and to bring to light shared design strategies, the working group takes design discipline as the engine of innovation. Design is not just seen as an innovation bearer of a product, service, or experience, but of a process; a design that assumes the role of mediator among multiple actors and disciplines and becomes an anticipator of possible futures (Iniguez et al. 2014; Succini et al. in press).

4.1 Methodology: From Human-Centered Design to Responsible Advanced Design

Today, the most widespread design approaches in the field of Space Design are guided by methodological tools typical of engineering disciplines or oriented towards design-driven methodologies. The most widespread is Human-Centered Design (HCD) (Long et al., 2022), which allows consideration of human factors, ergonomic criteria, and user experience throughout the design development. In recent years, other approaches have developed that, starting from HCD application in this field, have elaborated actions and tools that take into greater consideration the movements and changes in gestures characterizing this context, an example is Use and Gesture Design (Dominoni, 2021).

The complexity of this project led to studying these approaches and analyzing others related to solving wicked problems (Rittel & Webber, 1973) to find in Responsible Advanced Design (RAD) (Formia et al., 2023; Succini & Ciravegna, 2022) a synthesis of characteristics and tools capable of addressing not only the project from the perspective of space, human factors, and experience interaction but also considering time, the creation of extraplanetary interpersonal relationships, and the social and cultural impacts of this new paradigm shift in the entire design system. An approach where imagination is not only a factor of creativity but of desirable future design.

Advanced Design has been dealing since 2009 with the “relationship between the evolution of the time factor and innovation driven by design (Celi, 2010)” (Celaschi, Celi & Formia, 2014 p.22). Within this approach, time is not intended as a continuum but opens up to imagination and various possible, probable, or potential solutions (Celaschi, Formia & Franzato, 2018).

The relationship between future, anticipation and design (Celi 2015; Poli 2019) aims to “anticipate change” (Celi & Morrison, 2019) by transitioning from a user-centred approach to forms of collaborative design (co-design) in which each actor involved contributes

knowledge and experience by activating forms of cross-fertilisation along the value chain (Celaschi et al.; Iniguez et al., 2014).

Responsible Innovation (Stilgoe et al., 2013; Salamanca et al., 2019) introduces or reaffirms a design responsibility where everyone is an active part, a concept of innovation more focused to inclusion, care for the future, impacts not only tangible but also intangible, and the value of the community within a design process.

Therefore, the interaction between these two approaches has led the Advanced Design Unit since 2020 to develop a design model starting from this method to then experiment it in various contexts. The model consists of macro-actions that decline the concept of responsibility in four areas of design: Responsible Design, Responsible Thinking, Responsible Production, and Responsible Community, each characterized by design strategies and tools typical of design, enhanced by RI-oriented principles (Succini, 2023). Depending on the research area in which one operates, the approach can adapt, considering in the analysis, design, and experimentation process only some of these areas (macro-actions).

Specifically for the ongoing project concerning the creation of a bridge between research and experiments related to memory, space, and time in extraterrestrial contexts, strategies and tools related to Responsible Design and Responsible Production have been activated.

Below are schematically reported the RAD actions and tools considered and the purpose of their use:

Responsible Design

- Actions: Activation, Observation
- Tools: Observatory; Collaborative spaces and tools
- Objective: Mapping and observation in other contexts of memory activation systems; peer-to-peer reading and clustering of research through collaborative tools and shared definition of reading keys to identify new design strategies for activate a community space.

Responsible Production

- Actions: Experimenting; Co-producing
- Tools: Design Workshop; Checklists
- Objective: Co-produce through collaborative and multi-actor workshops, a case studies analysis system centered on project's key factors (bodily, sensorial, time, intercultural relationship, spatial inclusion, community, etc.), and possible futuristic scenarios where the concept of memory becomes the glue of these new forms of exploration and life in extreme contexts.

During the research, the two macro-actions have intertwined, and the results of one activity are defining the drivers for applying subsequent tools. Thanks to an iterative process between source research, case study

research, and field collaborative actions, the first conjectures theorized through literature are being validated.

4.2 Memory as an Inclusive and Multilevel Design Framework

Thanks to the approach described above, the research is mapping and analyzing which analogue and virtual practices can activate a "memory" in space habitats capable of developing a system for transferring experiences of places and emotions from one user to another, beyond the boundary of time, giving continuity to a story and eliminating the notion that experiencing microgravity is only for oneself.

The analysis begun with the study of the ISS, bringing to light current practices related to the concept of memory, such as the Space Mission Patches. Those stickers are attached in different parts within the ISS and can be read as a visual sign/reminder of those who have experienced the station in previous missions (fig. 2). This analysis was extended through research in other areas outside the domain, with the aim of identifying other products or experiences of memory activation and transfer.

This observation mode, inserted within the Responsible Design macro-action is allowing us to find drivers for change (Celaschi, 2016) and is highlighting design strategies and characteristics to develop systems within habitats where the memory element generates a bridge beyond time boundaries. Shared memory can be seen as an activator of relationships, interpersonal bonds, and recreates empathy among people and communities.

The interaction and iteration between design-driven observation systems (which

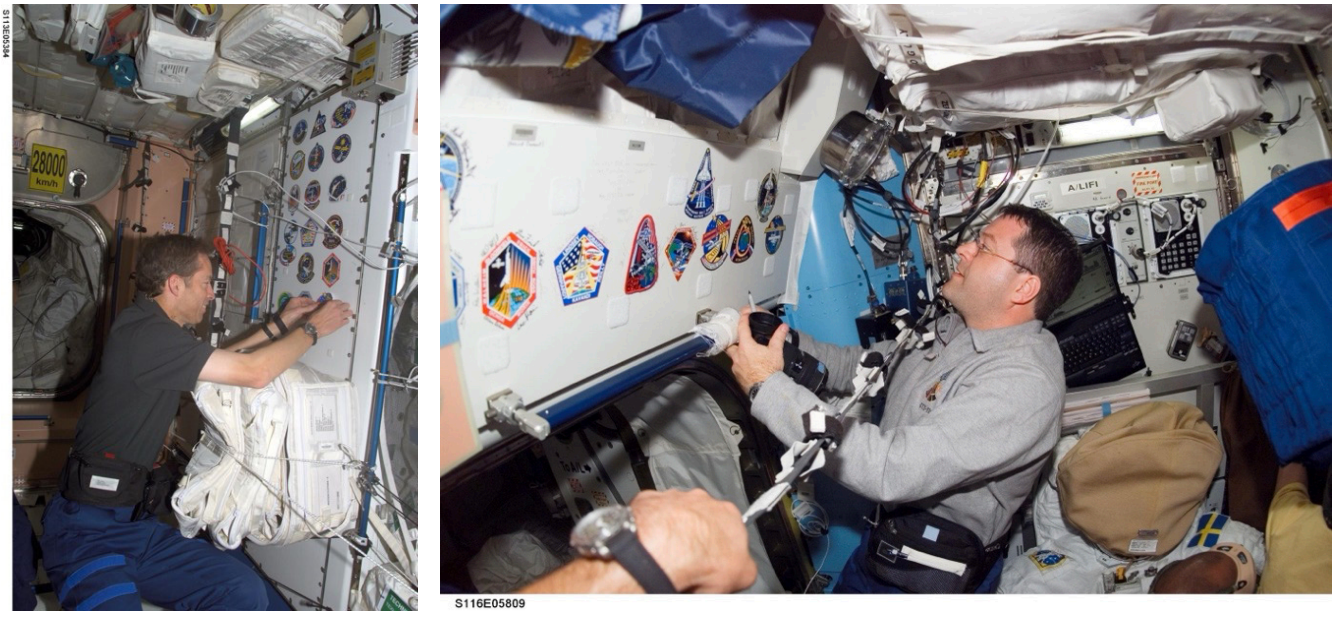

Figure 2. Images of mission patches on space habitat panels in the ISS – Source: Nasa Image and Video Library

use collaborative open-source tools for data collection) and peer-to-peer workshops among researchers, young designers, and company operators have led to a first reading of the memory concept concerning the future users' needs in space explorations. The corridors and intervention lines can be summarized in four categories:

- Body Memory: Linked to gestures and postures that lead to reliving a memory or transferring sensations already experienced through coded movements or related to proprioception (Koch et al.,2014);
- Symbolic Memory: Connected to artifacts and visual elements that establish a stronger relationship with the surrounding environment;
- Ritual Memory: Linked to ways of acting. It becomes a sense-producing element that, through a series of actions, connects the individual with the community, the past to the present and future (Durkheim in Segalen, 2002), and can generate new rituals;
- Sensorial Memory: Closely connected to our senses, whether a single sense or their combination, leading the person experiencing it to relive the intangibility of a memory or experience (Bruno, 2022).

These categories are also connected to two possible ways to keep this memory alive through analog artifacts, digital artifacts, or their combination. Main task of the work team will be to define the best balance between these four categories. It can be taken into consideration that some routine activities executed on a daily basis in the extreme environmental context become part of one's body memories, but most likely transform eventually into ritual memories. Further it is to be considered that digital memories have often short effect and need to be recalled "artificially" while analogue memory keepers guard better a symbolic memory of events and people. On top of this, the placing of by travelers added memory elements that can transport a *space community* feeling over time, is not necessarily related only to one specific area in the habitat, but populates in different ways specific spots, from crew quarter to newly created co- habituative areas. Most likely the design intervention, based on co-designing principles, needs to create tools that over time allow the individual creativity of travelers to express their *"I have been here"*, that bridges to the next testimonial of human presence in space, just like the colored hand in the preistoric cave. In the very end, the first foot print of Neil Armstrong on the moon does not tell anything else to the next traveler who will land on the moon, providing with a first sense of "settling".

5. Conclusion and Future Development

Applying the RAD approach in an extreme and high-risk environment has highlighted how its adaptability is not only related to the cultural, social, or territorial factors of a context but also to the flexibility of integrating the use of tools and methods typical of other methodologies.

In our case study, to redefine the future space habitats experience systemically, analyzing the phenomenon with the proposed approach (RAD) was useful, but for the next step, which will see the development of individual components, HCD will remain important reference. Indeed, it is assumed that these two approaches will interact throughout the design process because it will always be necessary to bring the micro to the macro and verify if the actions taken respond to the initial objectives.

As already emerged from the paper, the research is in an intermediate phase of its development, and the following actions will include: 1) integrating this factor within the activities, needs, and functions of space habitats to identify areas where it is necessary to integrate it, 2) creating a taxonomy based on the spaces identified of interaction between the categories (body, symbolic, ritual, sensorial) and the values it should enhance or recreate (sharing, interculturality, inclusion, etc.). This can become a design tool for products/services/systems memory that enhance a community Space identity 3) creating study prototypes of these elements to validate them with the design community.

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APPLICATION STRATEGIES OF ARTIFICIAL INTELLIGENCE TECHNOLOGY IN ART AND DESIGN EDUCATION: A MULTI-CASE STUDY FROM THE PERSPECTIVE OF INTERDISCIPLINARY THINKING CULTIVATION FEASIBILITY.

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ABSTRACT | With the rapid advancement of artificial intelligence technology, its application strategies in art and design education have become a focal point in teaching aimed at cultivating interdisciplinary design thinking. This study employs a multi-case research method to explore the feasibility and methods of applying AI technology in the process of design thinking cultivation at four higher art and design education institutions. This study explores the relationship between artificial intelligence technology and strategies for cultivating design thinking through case analysis and comparative research using statistical methods. The findings reveal that in the early stages of interdisciplinary design thinking cultivation, higher art education institutions adopt AI technology analysis strategies, focusing on the development of students' aesthetic abilities and the establishment of knowledge graphs. During the cultivation process, generative art, as a crucial component of AI technology, becomes a key skill in design thinking cultivation, enhancing students' interdisciplinary thinking abilities and innovative multidimensional pathways. Therefore, in exploring the application strategies of AI in interdisciplinary design thinking cultivation, it is important to consider using AI to assist in forming knowledge graphs and knowledge systems in the early stages and integrating AI technology as a professional technical skill in the training programs during the teaching process.

KEYWORDS | ARTIFICIAL INTELLIGENCE TECHNOLOGY, ART AND DESIGN EDUCATION, INTERDISCIPLINARY DESIGN THINKING, CASE STUDY.

1. Introduction

Artificial intelligence has permeated various sectors of society, including education. Art and design education is currently experiencing a transformational opportunity brought by technological innovation. With the rapid development of emerging technologies like big data and artificial intelligence, the form and methods of art education are being reshaped. The integration of AI technology not only meets the demands of the era but also becomes a crucial force in driving innovation in art education. Teachers and students in design education and related fields need to have a comprehensive understanding of design disciplines in the age of artificial intelligence and specifically enhance three key capabilities: professional expertise, interdisciplinary strength in design studies, and post-human social skills.

This paper conducts a multi-case study using five typical art schools and comprehensive university art academies as examples to formulate a general education curriculum teaching plan for art and design majors. It establishes control and observation groups to conduct comparative analysis of teaching outcomes, aiming to explore strategies for the application of artificial intelligence technology in art and design education.

2. Literature Review & Case Analysis

2.1 Literature Review

The application of Artificial Intelligence (AI) in art and design education is increasingly becoming a key factor in innovating teaching methods and enhancing learning efficiency. Literature emphasizes the tremendous potential of AI technology in personalizing instruction, enhancing design expressiveness, and stimulating student creativity. At the same time, concerns are raised regarding privacy protection, intellectual property rights, and technology dependence. Teachers play a crucial role in this process; they need to master the use of AI tools and integrate them into their teaching to foster the development of students' critical thinking and innovative abilities. The related research focuses on

several key themes, including the shift in educational philosophy, the expansion of curriculum content, innovation in teaching methods, enhancement of practical teaching, and the integration of technology and art. Some representative views on these topics are as follows:

Mayo (2024) emphasizes the collaboration between AI and teachers in art education, highlighting the importance of providing teachers with AI tools and proficiency in technology. It explores the potential impact of AI in art education, including creativity and educational practices. Zhang, Y., &Zhou, X. (2023) discusses the potential of AI to enhance teaching efficiency and personalize instruction in art and design disciplines. He points out the risks of privacy invasion and intellectual property violations associated with the application of AI, as well as the potential psychological pressures it may impose on teachers and students. Zhang, T. et al (2024). Analysis of curriculum construction in the integration of AI into art and design teaching from the perspective of "integration of art and science". Discussion includes the model of interdisciplinary training of design talents, involving the integration across teaching staff, curriculum resources, and educational platforms. Zhao, L., et al. (2024). AI technology is widely used across various fields and applications for accurate recognition and detection processes. In art education, AI is employed to simulate certain aspects of human intelligence, performing specific tasks such as the AI-based Education in Art Teaching Framework (EATF) and AI-Assisted Art Design and Teaching (AI-ADT). They also proposed an integrated data representation model assisted by regression learning (IDR-RL), aimed at enhancing multimedia-based educational performance. This model provides necessary data tailored to different teaching methods/ subjects based on course and student needs.

In summary, the teaching strategies for integrating AI into art and design education are not yet clearly defined. The research presented in this paper aims to provide insights that can guide further studies in this area.

2.2 Case Analysis

Art and design institutions worldwide are increasingly integrating the intersection of art and technology into their curricula, exploring innovative educational models to enhance academic and practical skills. The Royal College of Art in the UK has developed pioneering courses and collaborative programs with other universities, focusing on interdisciplinary innovation.

Similarly, the Rhode Island School of Design in the US is promoting interdisciplinary education by collaborating with Brown University to establish a comprehensive "Art + Science" framework. The School of Design at Politecnico di Milano in Italy emphasizes the development of collaborative design capabilities, preparing students for the complexities of modern design practices. MIT's Media Lab further exemplifies this trend by concentrating on the intersection of design and technology, fostering a research

environment that encourages the synthesis of diverse disciplines. These initiatives reflect a broader academic recognition of the necessity for interdisciplinary approaches in higher education, aiming to equip graduates with the competencies required to address complex global challenges and drive future innovation in the creative industries.

Select 5 cases from arts or design Colleges and Universities for study and comparative analysis. The institutions include:

- Tsinghua University Academy of Arts & Design;
- Tongji University School of Design;
- Beijing Institute of Fashion Technology;
- Huazhong University of Technology:
- The Royal College of Art;

Tsinghua University Academy of Arts & Design: Since 2023, Tsinghua University has embarked on a cutting-edge educational innovation—integrating artificial intelligence teaching assistants. This assistant system is based on an advanced multimodal large language model (GLM) with hundreds of billions of parameters, aimed at providing comprehensive support for interdisciplinary teaching and learning activities. The core advantage of the AI assistant lies in its ability to offer 24/7 personalized learning guidance, perform intelligent assessments and feedback, which not only significantly enhances learning efficiency but also effectively promotes students' critical thinking and creativity. The introduction of AI assistants at Tsinghua University signifies a major shift in educational paradigms. By 2024, the university plans to develop and launch 100 innovative courses that incorporate artificial intelligence technologies. These courses will deeply integrate the capabilities of AI assistants and AI teachers, continuously optimizing the teaching environment and educational strategies to bring students a richer, more interactive, and personalized learning experience. This innovative initiative not only highlights Tsinghua University's leadership in educational technology but also sets a benchmark for the intelligent development of higher education globally. With the aid of AI assistants, teachers can focus more on innovating course content and improving teaching methods, while students can gain a deeper understanding and a broader exploration of knowledge through personalized learning paths. As artificial intelligence technology continues to advance, future education will increasingly focus on cultivating students' innovative spirits and abilities to solve complex problems, training more talents with international perspectives and innovative capabilities for society.

Tongji University School of Design: Tongji University's School of Design has set three phased goals for the development of its artificial intelligence laboratory, aiming to promote in-depth research and practice of AI art. Phase One: Defining the Boundaries of AI Art. Initially, the school is committed to clarifying the scope and boundaries of AI art

through interdisciplinary discussions. The goal of this phase is to bring together experts from various fields to discuss and define the application range of AI in the art domain, and how it impacts and transforms traditional art creation methods and expressions. Phase Two: Interdisciplinary Collaboration and Technology Integration. Leveraging Tongji University's rich multidisciplinary resources, the School of Design plans to pair artists with professionals from different backgrounds, such as scientists, to explore the profound potential of AI art. The development of AI art is believed to require not only technological support but also artistic creativity, industry integration, and a deep understanding and application of tools. Through such interdisciplinary collaboration, the lab hopes to foster a deep integration of technology and art, creating innovative and practical art works. Phase Three: Production and Diverse Expression of Artworks. Building on the first two phases, the goal of the third phase is to produce impactful art works and express them in diverse forms. Currently, AI art works globally are mostly concentrated in the visual arts.

However, the forms of artistic expression extend far beyond this scope. The AI lab at Tongji University's School of Design aims to go beyond the visual aspect, exploring sculptures, installations, and even performance arts to achieve diversified and in-depth artistic expressions. The lab's vision is to not only theoretically explore AI art in depth through these three stages but also practically create innovative and artistically valuable works. Through these efforts, the school hopes to advance the development of AI art, bringing new perspectives and possibilities to the art world, as well as providing new creative tools and methods of expression for artists and designers.
Beijing Institute of Fashion Technology:
Beijing Institute of Fashion Technology has collaborated with Alibaba Cloud on a two-week innovative design education course, an initiative that integrates education, technology, and the fashion industry. The aim is to ignite students' creativity and drive the innovative development of the national fashion industry. The application of Alibaba Cloud's AI tools in the design process offers students several advantages, significantly enhancing creativity and efficiency. Firstly, AI tools can analyze design trends and historical data to inspire creativity, helping students rapidly generate new design ideas. With AI-assisted image generation tools, students can obtain preliminary design sketches within seconds, accelerating the design iteration process. Personalized customization is another major advantage of AI tools; they provide customized design suggestions based on user preferences and behavioral data, enabling students to create designs that better match the tastes of their target audience.

Additionally, AI can analyze the color coordination and layout balance of design elements, offering optimization suggestions to enhance the visual appeal of design works. In terms of efficiency, AI tools save students' time by automating repetitive design tasks, such as image cropping and color adjustment,

allowing them to devote more energy to developing creative and design concepts. The intelligent layout feature of AI tools can automatically adjust the arrangement of text and images based on content, ensuring the neatness and readability of design works. Real-time feedback is another crucial feature of AI tools; they provide immediate design feedback, helping students promptly identify and address potential issues in their designs. Moreover, the collaborative features of the AI platform allow multiple students or designers to work on the same design project, sharing and discussing progress in real time, enhancing teamwork efficiency. AI tools can also serve as educational tools, helping students learn and master design principles and best practices. Integrated into existing design software, students can leverage AI capabilities in a familiar work environment, further enhancing the fluency and innovation of design work. They are able to combine their knowledge with practical issues, leveraging their professional strengths to contribute design power to society. The AI tools and computational resources provided by Alibaba Cloud offer robust technical support for design work, making it more efficient and innovative. This workshop not only provides students with a platform for learning and practice but also offers new ideas and directions for the future development of education and industry.

Huazhong University of Technology: The China Artificial Intelligence Art Education Collaborative Innovation Platform, spearheaded by the Key Laboratory of Optical and Interaction Service Technology for Culture and Tourism at Huazhong University of Technology, is a collaborative network comprising 345 universities. This platform is tasked with the mission to integrate art design education with artificial intelligence technology, striving to comprehensively revolutionize art and design education in the era of AI. The vision of the platform is to cultivate a new generation of art and design talents who possess modern concepts, master AI technology, and are proficient in art and design methods. To achieve this goal, the platform will implement three major strategies: “AI + Curriculum,” “AI + Practice,” and “AI + Research.” Firstly, “AI + Curriculum” will integrate AI knowledge into art and design courses through textbook writing to update educational content. Secondly, “AI + Practice” aims to enhance students’ practical skills through organizing workshops and project practices, enabling them to apply AI technology in real projects. Lastly, “AI + Research” encourages teachers and students to participate in research projects, enhancing research levels through funding applications and scholar visits.

The Royal College of Art: The Royal College of Art (RCA), a globally renowned art and design institution, has collaborated with the Hong Kong Polytechnic University (PolyU) to establish the Artificial Intelligence Design Lab (AiDLab). AiDLab is the first research platform in the Asia-Pacific region that integrates artificial intelligence with creative design, dedicated to fostering the merger of AI and design to drive innovation and sustainable

development, and to make a positive impact on industry and society. The institute conducts joint master's and doctoral training with the RCA, focusing on research in ergonomics and inclusive design, innovative product and service design, and smart fashion design and quality control. These research areas aim to use AI technology to improve the design processes of everyday products and services, enhancing human-computer interaction and user experience. AiDLab has also developed an interactive AI fashion design assistant (AiDF), which enables students to quickly produce diverse original designs inspired by their creativity with the help of AI (Laboratory for Artificial Intelligence in Design, (n.d.)). The executive director of AiDLab and Professor of Fashion at PolyU, Wing-Yung Cheng, stated, "The institute aims to nurture research talents in AI and design, and in the future, to extend its research achievements to the Greater Bay Area and the international market."(PolyU, 2021))

2.3 Comparison and Development of Educational Plans

Based on the teaching plans for AI design general education courses offered at various schools, compare at which stages AI is used, resulting in the following table:

Table 1. Comparison of AI usage in the teaching processes.

	Introduce Basics	Design Research	Design Sketch	Design Iteration	Project Presentation
Tsinghua University	1	1	1	1	0
Tongji University	0	0	1	1	0
Beijing Institute of Fashion Technology	1	1	1	1	0
Huazhong University of Technology:	1	0	1	1	0
The Royal College of Art	1	0	1	0	1

2.4 Setting up the teaching plan

Based on the comparative study results from the above cases, it can be observed that most art and design institutions typically use artificial intelligence-assisted design during the theoretical instruction, design inspection phase, and sketch design phase. Therefore, in this course, artificial intelligence technology is used to create knowledge graphs during the theoretical knowledge phase and the PBL (Problem-Based Learning) teaching method is applied. During the design inspection phase and the sketch design phase, AI generation technologies and other teaching methods are used.

3. Research Subjects and Methods

3.1 Research Subjects

A convenience sampling method selected 142 graduate and undergraduate students from the design program at Tianjin Academy of Fine Arts, between April and June 2024. The group consists of 30 male and 112 female students; 19 are undergraduates and 123 are graduate students. These students are aged between 18 and 24 years, with an average age of 22.21 years. After completing their initial theoretical courses, all students will proceed to the next phase of their education, which may involve further studies or internships. The artificial intelligence design course is structured in two-week cycles, with each cycle involving 90 students.

3.2 Research Method

According to the teaching plan implemented based on case analysis, and in comparison with regular teaching classes:

- Grouping;
- Control Group;
- Observation Group;
- Evaluation Method.

Grouping:
The study participants were divided into a control group and an observation group based on the sequence of their internships in the SICU. Eighty undergraduate and graduate students from the design discipline who participated in the course in April 2024 formed the control group, which used traditional teaching methods. Sixty-two undergraduate and graduate students from the design discipline who joined the course in May 2024 constituted the observation group and were taught using a PBL (Problem-Based Learning) approach combined with artificial intelligence. There were no statistically significant differences between the two groups in terms of age, gender, educational background, or course grades (all $P > 0.05$), making them comparable.

Control Group:
The traditional art and design innovative teaching method employed is the "Theoretical Foundation—Design Research—Design Sketch—Design Proposal Iteration—Project Presentation" teaching model.

Observation Group:
The teaching method combines artificial intelligence technology with PBL (Problem-Based Learning). During the teaching preparation phase, teachers formulate teaching plans and objectives according to the requirements of the syllabus, sort out the knowledge points that students must master during the course, create a knowledge map and upload it to the Smart Tree platform. These knowledge points are listed in the form of questions and reasonably distributed to various stages of learning. At the same time, in conjunction with the students' majors, three representative cases of the use of artificial intelligence technology are compiled,

including environmental design cases, visual communication design cases, and digital media art design cases.

The teaching implementation is divided into five stages: The first stage is 1-2 days, where professional teachers explain the basic theoretical knowledge and design cases according to the requirements of the syllabus, using the PBL teaching method and arranging students to expand their learning on the Smart Tree platform in accordance with the knowledge map. The second stage, from the 3rd to the 7th day, mainly uses artificial intelligence technology to collect data for desk research and complete user research under the guidance of teachers to identify design opportunity points. The third stage, on the 8th and 9th days of the course, mainly uses AI large models to complete the production of design sketches, during which the teacher will use 2 class periods to explain the prepared design cases. The fourth stage is from the 10th to the 13th day of the course, where students use AI large models for generative art design and plan iteration. The fifth stage is on the 14th day, where students report their plans in groups.

Evaluation Method:
Evaluation is the evaluation of the learning effect of students. It is not only necessary to evaluate the final learning effect, but also to evaluate the learning situation before and during the class (Wang, 2021). Therefore, theoretical knowledge learning needs to be assessed through closed-book exams. From the 400 questions generated on the Zhihuishu platform based on the knowledge map, 20 questions will be selected, each worth 5 points, totaling 100 points. The design plan and final design grawings is to be presented on the last day of the course, and a group of teachers will score it. A questionnaire survey will be conducted on the observation group regarding the application strategies of artificial intelligence technology combined with PBL (Problem-Based Learning) in art design teaching, assessing whether it can enhance the nursing students' autonomy in learning, interest in learning, self-learning ability, problem identification ability, language organization and expression ability, analytical and problem- solving ability, teamwork ability, learning capacity, and broadening their scope of knowledge. The survey includes 9 items, each evaluated on a 10-point scale. After the course, students are organized to evaluate the teaching satisfaction with the instructors, rated as 'Very Satisfied,' 'Satisfied,' 'Neutral,' 'Dissatisfied,' and 'Very Dissatisfied,' with corresponding scores of 4, 3, 2, 1, and 0 respectively.

3.3 Statistical Processing

Data analysis was conducted using SPSS statistical software. Quantitative data were presented asx ± s deviation and analyzed with t-tests; categorical data were shown as case numbers and percentages and analyzed using chi-square (x^2) tests. Satisfaction comparisons were performed using the U test, with differences considered statistically significant at $P < 0.05$ or $P < 0.01$.

4. Results

4.1 Assessment scores

The theoretical and practical examination scores of the observation group's nursing students were significantly higher than those of the control group, and the difference in examination scores between the two groups was statistically significant ($P < 0.05$), Table 2.

Table 2. Comparison of the examination scores between the two groups of students (x ± s, points).

Group	Number of Participants	Theoretical Knowledge	Design Proposal
Control Group	99	85.03±5.28	86.74±3.10
Observation Group	93	86.33±4.96	88.21±5.98
P-value		0.041	0.029

By preparing knowledge graphs of the essential concepts that students need to master in advance and distributing them in the form of questions at different stages of learning, and integrating these into both foundational theory studies and design creation practicum, significant improvements have been made in comprehension and mastery of the material. This approach involves using the Zhihuishu platform's knowledge graphs for learning, coupled with group discussions and interactive learning presentations to replace traditional lectures, significantly enhancing students' grasp of the knowledge points.

Problem-Based Learning (PBL), which is a teaching methodology oriented around guiding students to explore, identify, and solve problems while enhancing their critical thinking abilities, places students at the center of the learning process with instructors leading and facilitating. It is an interactive teaching model that integrates theory with practice. By combining this with AI- supported knowledge graph learning methods, student learning efficiency has been notably increased. This innovative educational approach not only makes the learning process more engaging and effective but also leverages technology to better prepare students for practical applications of their knowledge.

4.2 Teaching effectiveness satisfaction

There is a statistically significant difference in the teaching effectiveness between the two groups of students ($P < 0.05$), Table 3.

Table 3. Comparison of teacher satisfaction between two groups.

Group	Number of Participants	Very Satisfied	Satisfied	Neutral	Dissatisfied	Very Dissatisfied
Control Group	99	28	55	6	0	0
Observation Group	93	75	17	1	0	0

4.3 Survey results of the observation group students

A total of 93 questionnaires were distributed, and 93 valid questionnaires were collected, with a valid recovery rate of 100%. The feedback on the evaluation of the PBL combined with CBL dual-track teaching method by the students in the observation group had an average score of (8.59 ± 0.48) points, which is at a relatively high level. See Table 4.

Table 4. Evaluation of the teaching planning by the students in the observation group ($\bar{x} \pm s$, points).

Survey Item	Score
Increase in learning autonomy	8.02±0.55
Increase in learning interest	8.70±0.21
Improvement in self-study ability	9.13±0.52
Improvement in problem identification ability	7.92±0.88
Improvement in language organization and expression ability	8.01±0.12
Improvement in analysis and problem-solving ability	8.51±0.27
Improvement in learning and consolidation of design innovation ability	8.83±0.63
Improvement in team cooperation ability	8.58±0.46
Broadening of knowledge scope	9.64±0.72

5. Discussion

5.1 Using artificial intelligence to help teachers build knowledge graphs

In the rapidly evolving field of education, the cultivation of design thinking has become an essential component of educational reform. Particularly in the early stages of fostering design thinking, the development of aesthetic capabilities is crucial for students. This development not only affects students' perception and understanding of beauty but also directly impacts the quality and expressiveness of their creative works. Enhancing aesthetic abilities is the cornerstone of continuous progress in the fields of art and design.

The intervention of Artificial Intelligence (AI) has brought revolutionary changes to this cultivation process. By analyzing a vast array of art and design works, AI helps students quickly establish an understanding of fundamental aesthetic elements such as color, shape, and composition. These elements are the basics of artistic creation and design practice, and the learning capabilities and data processing power of AI make this process more efficient and precise. Using machine learning algorithms, AI can identify and predict various design trends, providing students with a constant stream of inspiration and creativity. This trend analysis not only helps students understand current design fashions but also inspires them to explore future design possibilities. This capability of AI opens a door to the world of innovation for students. Additionally, AI can provide personalized feedback and suggestions based on students' design works. This feedback is based on an in-depth analysis of students' works, including color coordination, shape usage, and compositional balance. Through these specific suggestions, students can continuously optimize and improve their designs, thus advancing further on their design journey.

In the process of cultivating interdisciplinary design thinking, the application of AI extends beyond just enhancing aesthetic abilities. It also promotes the development of logical thinking, innovative thinking, and critical thinking among students. For instance, AI can assist students in data analysis during the design process, helping them better understand user needs and market trends. This analytical capability enables students to meet the practical demands of designing products or solutions more accurately. The application of AI in interdisciplinary design education also helps students build bridges connecting knowledge across different disciplines. Taking environmental art design as an example, students can integrate knowledge from architecture, environmental science, and socioculture with the help of AI. Through data analysis and pattern recognition, students can achieve interdisciplinary collaboration on real projects. This approach not only broadens students' knowledge horizons but also encourages them to adopt a more comprehensive and innovative approach in their designs.

In the field of design education, the application of AI is also reflected in providing rich learning resources, personalized feedback, and immersive learning experiences. These resources and experiences effectively enhance students' aesthetic abilities and promote their comprehensive competence in the design field. As AI technology continues to advance and its application in education deepens, it will play an increasingly important role in design education. In summary, the application of AI in design education provides students with a new learning platform. It not only helps enhance their aesthetic capabilities but also promotes their comprehensive development in the design field. With continuous technological progress, we have reason to believe that AI will play an increasingly vital role in design education, making a greater contribution to nurturing design talents with innovative spirits and practical abilities.

5.2 Generative art is a key skill in the cultivation of design thinking

Generative art, as a critical skill in the cultivation of design thinking, represents not only an innovative form of artistic expression but also serves as a significant mode of thinking and problem-solving method. In design education, the practice of generative art helps students develop a dynamic, flexible, and creative thinking pattern. It emphasizes the process over the final product. This artistic approach encourages students to explore multiple possibilities, continually experimenting and adjusting until the most satisfying solution is found. This process-oriented method aligns seamlessly with the iterative processes of design thinking, helping students to continually optimize and refine their creativity when addressing design challenges.

Generative art typically involves the use of algorithms, computer programs, or other technological means to create artworks. This requires students to possess not only an artistic sense but also a significant level of technical proficiency. During this process, students learn to integrate technology with creativity, a crucial skill in modern design fields. In this study, students in environmental design use AI to assist with environmental lighting analysis, acoustic simulation, and pedestrian flow predictions, providing a scientific basis for their design proposals. In the realm of visual communication design, AI supports students in tasks such as image recognition, color matching, and layout design, offering personalized design suggestions. For instance, AI algorithms can recommend color schemes and visual elements based on the design theme and the preferences of the target audience, enhancing the design's appeal and communicative impact. Through AI technology, students gain a more accurate understanding of the relationship between space and environment, and the impact of design proposals on the environment. Students engaged in visual communication design can create unique visual patterns and structures through the application of programming and algorithms, enhancing their aesthetic capabilities while also honing their logical thinking and problem-solving skills.

The practice of generative art also fosters students' critical thinking. During the creative process, students are required to evaluate and reflect on their work, considering ways to improve and better convey their design concepts. This self-critical process helps students develop a deeper understanding and a critical perspective on their design works.

However, the practice of generative art should not replace traditional design education methods but should be seen as a complement to them. Students still need to learn fundamental design principles, color theory, and composition. In the observation group of this study, students utilized generative art as a tool or method to delve deeper into exploration and innovation on top of this foundational knowledge. As a result, the design solutions were more effectively realized, and the application of theory and foundational knowledge was enhanced.

5.3 Artificial intelligence enhances students' aesthetic abilities in the early stages of cultivating interdisciplinary design thinking.

In the early stages of cultivating design thinking, the development of aesthetic ability is crucial for students. This aspect not only influences their perception and understanding of beauty but also directly impacts the quality and expressiveness of their creative works. A strong aesthetic sense allows students to appreciate and evaluate art and design with a critical eye, which in turn informs their own creative processes.

AI plays a significant role in this educational stage by providing tools and insights that can rapidly enhance students' understanding of fundamental aesthetic elements such as color, shape, and composition.

AI can analyze a vast array of art and design cases, allowing students to quickly build a comprehensive understanding of different styles and trends. Through machine learning algorithms, AI identifies patterns and correlations within artistic and design elements, helping students to discern and predict emerging trends. This capability serves as a rich source of inspiration and creativity, offering students new ways to approach their work and expand their artistic horizons.

Moreover, AI can provide personalized feedback and suggestions based on students' individual design projects. By evaluating the unique aspects of each student's work, AI helps them identify strengths and areas for improvement, fostering continuous refinement and enhancement of their designs. This personalized approach not only accelerates the learning process but also ensures that students develop a deep, nuanced understanding of design principles.

In the broader context of interdisciplinary design thinking, AI's application extends beyond mere aesthetic enhancement. It also promotes the development of logical, innovative, and critical thinking skills. For instance, AI can assist students in conducting data analysis during the design process, enabling them to gain a clearer understanding

of user needs and market trends. This information is invaluable for designing products and solutions that are not only creative but also practical and market-relevant.

In interdisciplinary design education, AI helps students bridge the gap between different fields of knowledge. In this course, students majoring in environmental art design can use AI to integrate concepts from architecture, environmental science, and social culture. AI facilitates collaborative work on real projects through data analysis and pattern recognition, highlighting how various elements can work together effectively. This approach not only broadens students' knowledge horizons but also encourages them to adopt a more comprehensive and innovative style of thinking in their designs.

AI's role in connecting different disciplinary insights is transformative. It enables students to see beyond the confines of their immediate field, encouraging a more holistic and integrative approach to problem-solving. Such cross-disciplinary linkages are essential for fostering a new generation of designers who are equipped to tackle complex challenges in a rapidly changing world.

In conclusion, artificial intelligence, when applied in the early stages of interdisciplinary design thinking, enhances students' aesthetic abilities and promotes their comprehensive competence in the design field by providing rich learning resources, personalized feedback, and immersive learning experiences. As AI technology continues to evolve and its application in education deepens, it is poised to play an increasingly significant role in the field of design education. This progression will help prepare students for the future, equipping them with the skills and insights needed to excel in an era where technology and creativity intersect.

6. Conclusion

The results of this study indicate that in general education design courses, the integration and optimization of artificial intelligence technology with PBL (Problem-Based Learning) teaching methods create a new, effective teaching approach. This method can fully engage students' interests and initiative, cultivate their abilities to analyze and solve problems, and enhance learning efficiency. At the same time, it also improves the completeness of design schemes, making it a valuable and effective teaching method for art and design education worth promoting.

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UPDATING WAYFINDING LITERATURE AND TEACHING METHODOLOGY

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ABSTRACT | The introduction of a theoretical course on wayfinding, offered for the first time to secondyear interior design students at the Università Iuav di Venezia, was the starting point for reflecting on the methodology of teaching wayfinding design. By the structuring of the course, it emerged that the disciplinary bibliographical apparatus, although foundational, is meager and dated, where the most recent volume dates back about ten years. This analysis highlighted the need to implement the common bibliography primarily from a contemporary design perspective, thus offering a selection of interdisciplinary theoretical and methodological contributions to build a common background among students.

These theoretical and methodological reflections have set off the absence of any disciplinary tool capable of integrating both the load-bearing and historical aspects of the discipline and the knowledge on complementary contemporary design themes, that together can shed light on the many facets of wayfinding. One of the main results of the course is the construction of a glossary of up-to-date wayfinding design, written and designed by the students in a co-partecipative way. In the form of an analog flexible design artifact, it can be used as a teaching tool in future classes and it can be expanded by future students, even in an asynchronous co-creation model.

KEYWORDS | DESIGN EDUCATION, TEACHING METHODOLOGY, WAYFINDING, CO-CREATION, GLOSSARY

1. Starting and positioning the wayfinding design teaching

In the 2020-21 academic year, the new Interior Design curriculum was envisioned within the Bachelor of Product and Communication Design at Università Iuav di Venezia - a study program already existing for more than 15 years. The “Wayfinding Design” course was included as compulsory teaching in the second and final year and it was first taken by students in the 2022-23 academic year.

Beforehand, the new curriculum had to be accredited by the Italian Ministry of University and Scientific Research, following a documentation process involving several key steps until final approval and actuation. Alongside this, a documentation was conducted to justify the activation of the new curriculum by comparing it with the offerings of other actual degree programs at national level. The comparative reconnaissance carried out consulting the ministry’s database showed that there are 15 public universities (including Università Iuav di Venezia) who make it possible to earn a degree in product design and/or visual communication - these are broadly the names of the curricula accredited since the beginning of the 2000s - to which are added 2 Polytechnics and 4 ISIAs - Istituto Superiore per le Industrie Artistiche/ Higher Institute for Artistic Industries, for a total of 21. Each of these institutions propose Bachelor’s degree programs, while only 12 of them (including Università Iuav di Venezia) also offer Master’s degree programs.

Overall, only 2 institutions explicitly had a curriculum in Interior Design before 2021-22.

Regarding the inclusion of the teaching of wayfinding design in the new study track, an equally articulate comparative study was not required by the ministry. Nevertheless, we - the lecturer in charge since a.y. 2022-23 and the teaching assistants for respectively the years 2022-23 and 2023-24 - have conducted a reconnaissance aimed at verifying the existence of a similar subject, in order to best define the content of the new teaching. The observation, conducted consulting the curricula submitted by each university on its respective website, revealed that none of the 21 product/ visual/ interior design degree programs included a compulsory teaching class that dealt explicitly with wayfinding design.

This does not mean that topics related to orientation and signage systems have never been the subjects of theoretical studies or design studios before. More likely, they might be addressed within intensive workshops or in shorter activities than the stated teachings, or they can be addressed in specific extracurricular activities, or else it can be that wayfinding is the subject of studies or exercises within courses and labs identified by different names, usually more generic ones (e.g., “Visual communication studio,” “Product design studio”).

This reconnaissance shows that the Wayfinding class in the Interior Design curriculum at Università Iuav di Venezia, approved by the ministry and first activated in a.y. 2022-23, is - still - the only one available in Italian public universities.[1]

The Wayfinding course was thus born closely related to the Interior Design curriculum at Università Iuav di Venezia. The teaching of interior design is as scarcely practiced at the university level in the country as much as the teaching of wayfinding, and each of them still needs further reflections for their theoretical definition, in a mutual and continuous cross-reference between the two parts.

The nature of interior design has been the subject of a series of lectures and classes given cross-curricularly at Università Iuav di Venezia in the academic years 2021-22 and 2023-24. Richard Buchanan, who conducted an online lecture to design students, defined it as the field that deals with the transformation of the space around us into an environment that enriches the human experience in a meaningful and substantial way (Buchanan, 2019). In truth, this attitude is shared among many areas of design, ranging from graphic and industrial design to interaction design, service design, organizational design, and complex systems design. Indeed, all areas of design involve the transformation of the surrounding space into the environment. This concerns both physical and digital aspects because design must also deal with how to transform information space into an information environment (Buchanan, 2019) and how to connect and integrate physical and real aspects with virtual and digital ones (Buchanan, 2019). As it has been highlighted by reflections conducted at Università Iuav di Venezia in the framework of crosscurricularly lectures, interior design is a pluralistic practice with different dimensions of attention to the issues and practices of communication, artifact construction, and interaction design (Bonini Lessing et al., 2024). Thus, interior design would be the discipline that is able to provide responses appropriate to the contemporary condition in which we live and operate, because of its constitution, its dimension and mediation between technical-scientific components and cultural and people-relationship ones. In a few words, the ideal framework in which reflections on wayfinding training can be developed.

1 A more recent reconnaissance still in progress showed some new results:
NABA - Nuova accademia di belle arti, a private institution based in Rome and in Milan that grants a degree recognized by the ministry, proposed in a.y. 2023-24

1.1 Wayfinding Design course preparation

These briefly exposed remarks, aimed at defining what interior design is about, were fundamental in structuring the new teaching course of Wayfinding Design, in a substantial absence of comparisons in the Italian university system.

Moving from the specific field of interior design to other design fields, academics agree that we all operate in complex and interconnected systems, characterized by disciplinary transversality which therefore require an interdisciplinary approach (Norman et al., 2016; Dubberly, 2017). In Italy the need for transdisciplinary dialogue and research has been repeatedly stressed too, including in scientific meetings among SID - Società scientifica del design/ Scientific Society of Design members (Di Bucchianico et al., 2019).

Rejecting the call for hyperspecialization that was widely popular in the last decade of the twentieth century, what would then be the disciplines that should lay the ground for interior designers today? What scientific fields of research should cooperate among each other? Can wayfinding teaching play a role in such a context?

These questions were essential in guiding the preparation of the didactics of the Wayfinding course, which was structured along two main lines: the definition of a specific and historically consolidated field-related bibliography, the search for insights in the contemporary design debate that can reframe wayfinding in our society.

In other words, the purpose was to define a body of specific consolidated knowledge on wayfinding enriched by other design studies "transversal" to it, like visual communication design, product design and others. In this way, the teaching of wayfinding would become an ideal area of experimentation within interior design, understood as a pluralistic and systemic dimension of all forms of design that responsibly intervene in an ecology of relationships between people, the natural and artificial environment (Buchanan, 2019).

As it will be seen in the next section, we conducted an extensive literature search to sustain the choice of the topics and of the scopes of each lecture. Then we decided to present students with a set of broad and multifaceted references, so as to stimulate further multidisciplinary research, rather than narrowing the knowledge down to a few specific contributions. In the same direction went the request to the students to cooperate, to debate and eventually collectively construct the most suitable disciplinary and didactical tool still missing, the glossary of wayfinding terms, which will be accounted for in a dedicated section of this contribution.

Here it is worth pointing out how the most recent edition of the volume "Environmental Graphic Design" (Calori & Van den Eynden, 2015) has been a central point in defining the

course objectives and has significantly oriented the approach of the course, since it includes diverse areas of design theory and practice that deal with the themes of orientation and signage in a broader sense. The authors of the book identify environmental graphic design as the discipline that aims to transform spaces into places, proposing a synthesis between the needs to identifiably connote a public space, provide narrative, analog or digital support to users, while encompassing design aspects of orientation and signage. The volume proposes the need for a mix of professional expertise to operate in the areas of placemaking, signage, interpretation (Calori & Van den Eynden, 2015, p. 5), which go beyond the skills of graphic or product designers. The design project, which involves continuous intersections between different fields, would thus become a stimulus to continuous solicitations, narratives and evocations, and never as a definitive landing place of knowledge.

In Italy, there are relevant contributions reflecting on the opportunity to juxtapose different areas of design theory and design, aware that this implies the blurring of boundaries between them, activating processes and leading to final results that re-discuss the integrity and existence of design in the traditional sense (Bortoloni & Dal Buono, 2020; Bucchetti, 2020; Lussu, 2010). This assumption also implies an idea of direction of both theoretical and factual components of design that no longer empowers only one discipline in the coordination of the others (Anceschi, 1988). Instead, its driving force would lay in the need to mediate among all actors involved in the design process (Celaschi, 2008), from design concept phase to the final fruition of the physical space - often enhanced including the digital dimension - , involving complex and interconnected domains of knowledge, through a plurality of tools (Trocchianesi, 2024). Another assumption that played fundamental role in structuring the teaching was to confer to the theory and design of wayfinding not only a functional value of spatial orientation, but also the cultural orientation, stimulating the knowledge of the people who resort to such supports. Fostering orientation in an additional cultural sense facilitates the process of identifying people with spaces/places unfamiliar to them through design artifacts and systems, analog or virtual (Cerri, 2022), with potentially unprecedented social and ethical reverberations. In this way, wayfinding becomes an area of contact between narrative and functional, theoretical and design components, conferring coherence and connection between the parts.

2. State of the art: bibliography of references

Communication, product, interiors, urban planning: wayfinding design can be placed in each of these areas, and from each of them it can be differently approached depending on whether the emphasis is on the message to be communicated, the medium to be used, or the positioning in space. Given the multidisciplinary nature of the topic, which is one of its intrinsic richness, it was necessary

to determine the appropriate angle for the course: it is precisely from the analysis of this cross-disciplinarity that some texts emerged as cornerstones of the discipline. The first text examined, the one that can be called foundational to the discipline, is “The Image of the City,” written by Kevin Lynch in 1960. In this text, the term wayfinding is coined as a word composed of the two English terms that stand for “finding the way.” In this first definition, Kevin Lynch inscribes wayfinding within the framework of urban planning. The author is an urban planner and therefore he works mainly on the aspect of wayfinding related to the city and its key elements, he takes into consideration other disciplines as well: among them, psychology, linking it inseparably to some of the pivotal themes presented in the book, such as the definition of the five elements that contribute to the creation of a mental image of the city and the concept of imageability of urban space. This text, which is still considered a reference for the field of planning, left behind a gap of about thirty years before another equally relevant one could stand alongside it in establishing a bibliography on the subject. The second book analyzed is therefore “Wayfinding. People, Signs and Architecture” by Paul Arthur and Romedi Passini from 1992, which reconsiders and expands the earlier hypotheses, moving them from the purely urban field to the architectural design field. Nevertheless, in this text as well as in some other relevant papers of the same years, the two authors emphasize how wayfinding is a multidisciplinary field, placing alongside the architectural approach that of visual communication design and some aspects drawn from the human sciences proper to the perceptual field, such as psychology. Although the professional practice of wayfinding design has continued over the years with numerous major design projects and some issues on spatial orientation are dealt with in other texts pertaining to the human sciences - think of Reginald Golledge (1999) and his studies on mind maps -, another ten years or so go by before another volume on the subject is written. This time not from the point of view of urban planning nor from that of architecture but from that more purely of communication design. “Wayshowing. A guide to environmental signage,” written by Per Mollerup in 2005 and reissued in 2013, posits a shift in perspective from the theory to the practice of wayfinding, bringing the work of the wayfinding designer to the center by proposing the meaning of ‘wayshowing,’ that means, showing the way rather than finding it. In this paradigm shift, Mollerup invests great relevance in the figure of the wayfinding designer, who, in his design action of wayshowing, integrates the many aspects of professional practice by not limiting it to one area. The author also reiterates the importance of design practice as a level of reading and communicating of and with place, placing special emphasis on the communicative aspect of wayfinding systems.

If Per Mollerup stresses the communicative issue, Chris Calori and David Van den Eynden, only a few years later, emphasize the link between the communicative aspect and the environmental one of the design

intervention, dealing in a broader sense with Environmental Graphic Design, in another of the founding texts for the discipline, "Signage and Wayfinding Design" of 2007. In this contribution, the authors devote ample space to the methodological part focusing on the three main components of a wayfinding system namely the information contained, the graphic system and the structural system.

A few years later, all these arguments are projected into the growing debate around the public space. In 2009 David Gibson writes "The Wayfinding Handbook: Information Design for Public Places," which positions itself as a useful tool for practitioners and anyone interested in better understanding the profession of the wayfinding designer.

Thus, our review of the books that are considered fundamental in the creation of a bibliography related to wayfinding design, a shift emerged from the earliest in chronological order that deal with the subject from a purely theoretical point of view, to the latest that instead turn out to be almost manuals for professional practice. Many other volumes have since been published that are mainly collections of case studies and projects carried out in the field of wayfinding, categorized by distinctive features, but rarely introducing theoretical or major innovations for the discipline. In addition, in recent years there has been a growing publication of papers that, however, have only partially explored the topic, although in some cases they have brought interesting reflections. Examples include Quentin Stevens' "The Shape of Urban Experience: A Reevaluation of Lynch's Five Elements" (2006), which proposes a revision of one of the most relevant concepts addressed by Kevin Lynch (1960) considering the contemporary social and economic system, and Lund's (2003) "The public debate on Jock Kinneir's road sign alphabet", which takes up a historical case to address issues of typographic legibility applied to signage and it explores the possibilities of applying scientific research methodologies to this field. Also relevant are the ethical aspects of wayfinding addressed by Linda Knight's (2021) contributions, which touch on issues related to the sense of caring for the history and politics of a place and its inhabitants. In this perspective, the strong and rapid social changes that have taken place in recent decades highlight the need to place the historical assumptions of wayfinding in a contemporary design perspective, exploring them in a more coherent and extended way. We placed great importance on how the issue of wayfinding was addressed in Italy, enhancing some perspectives that could mirror the multidisciplinary nature of the topic. Considering at the same time that the interior design curriculum does not offer any historical, theoretical or design teaching specific to the field of visual communication, we felt it was also relevant to enhance the bibliographic references from that field and others bordering it. Among these, we selected the text "The Images of the City"[2] by Mario

2 Translated by the authors from the original title "Le immagini della città", Piazza (2009)

Piazza (2009), which reconnects the theme of wayfinding to the concept of territorial visual identity by considering the perspective of communication design applied to urban public space. Mario Piazza approaches the issue from a historical point of view, highlighting some case studies of design and historical relevance in Italy, such as Mimmo Castellano's wayfinding and visual identity of the Aeolian Islands, which began in 1976 and developed over several years. With the same framework based on case studies, but this time contemporary, Susanna Cerri (2020) in "Sign in the public space" deals with the theme of visual communication applied to public space from the perspective of orientation, identity and participatory design. Bonini Lessing's two texts on Luigi Ghirri (2014, 2019) deal with some timely aspects related to cartography and its graphic representation, a specific but relevant issue in wayfinding systems. Also considered was Raffaella

Trocchianesi's volume "Design and Narratives for Cultural Heritage"[3] (2014), which expands the theoretical field to include the concept of communication of place as storytelling, moving from the urban environment to the built environment of the museum space, becoming a kind of link with interior design and leading to an in-depth examination of the theme of orientation and signage in museum spaces.

Continuing in this vein, therefore, "In Praise of the Labyrinth Museum"[4] by Salvatore Zingale and Fiorella Carità (2013) and "Museum Accessibility"[5] by Dina Ricc (2024) were examined in depth. The first because it deals with the theme of orientation as inherent in the organization and planning of space with a point of view that articulates from semiotics toward interior design. The second one because it integrates aspects proper to communication design to the museum context by opening the field to the issues of inclusion and accessibility to multiple categories of users, a pivotal theme of a contemporary wayfinding approach.

3. The participatory glossary: a teaching tool for wayfinding design theory

Parallel to the construction of a theoretical-critical apparatus of references capable of highlighting the multidisciplinary nature of wayfinding, we found it necessary to identify a teaching tool suitable for the course's educational objectives.

As highlighted in the previous paragraphs, one of the major critical issues encountered was precisely the scarcity of specific literature, most of it dating back to the 1990s or the very early 2000s, and therefore not sufficiently up-to-date on contemporary instances. Thus, we identified the construction of a "wayfinding glossary" as the most appropriate teaching tool.
Students were asked to identify and compose a corpus of foundational and representative lemmas of the discipline that takes into account the terms already covered in the

3 Translated by the authors from the original title "Design e narrazioni per il patrimonio culturale", Trocchianesi (2014)

4 Translated by the authors from the original title "Elogio del museo labirinto", Zingale e Carità (2013)

5 Translated by the authors from the original title "Accessibilità Museale" Riccò (2024)

wayfinding literature, but also, and above all, to find new ones to meet the theoretical and design needs of the current contexts of space use, with the aim of implementing the theoretical and action field. Thus, first pupils studied in depth the bibliographic sources proposed by the professors and, second, they identified terms of different nature derived from publications and references not necessarily pertaining to the field of wayfinding or other design areas (e.g. literature, arts, ect.). In addition, working on word definitions characterized by ambiguous meanings was encouraged, along with the possibility of clarifying them through the visual support of selected virtuous or successful design examples.

This teaching tool is centered on a co-participation process in which students are involved on several levels: all of them are required to construct the content apparatus, while few of them, because of their personal interests, were involved in designing the graphic layout through a cross-over discussion with one of their colleagues from the Communication Design curriculum at Università Iuav di Venezia, during the academic year 2022-23.

Before continuing with the description of the organization of the content and specifications of the graphic layout of the glossary co-developed by the students, it is necessary to present the analog and digital models taken by us as pre-reference and to explain the selection criteria applied. As for the analog examples - the publications -, the choice fell on the volumes with apparatuses dedicated to both bibliographical and iconographical in-depth references of the topics covered, while for the digital examples the participatory and choral approach was preferred.

3.1 Typological references for the construction of the glossary

The first type of publications examined is that of design dictionaries and encyclopedias, in which the foundational terms of the discipline are collected. The survey began with international volumes, such as “The Bloomsbury Encyclopedia of Design” edited by Clive Edwards and published in 2015. This volume, in addition to providing coverage of terms relating to 250 years of design history and theory, falls within the two criteria identified: it presents both images and reference and further reading accompanying the various headings, and it is a choral operation, as each term is written by leading international scholars and design historians. A further relevant aspect is the division of terms into a container term, to which terminological subcategories refer to principles that were used in the construction of the course glossary.

The second volume analyzed is “Design Dictionary. Perspectives on Design Terminology” edited by Michael Erlhoff and Tim Marshall in 2008, a handbook designed for all those who deal with design in the profession or in education, which is enriched by the choral work of several academic figures and a number of designers and which provides in-depth bibliographical references.

Unlike the “Bloomsbury Encyclopedia”, it does not supply images.

The last category observed is the anthological collection of specific design themes. Reference is made to Grahame Brooker’s 2018 volume “50/50 Words for Reuse - A Minifesto: an anthology of terms on reuse practices” containing an iconographic and bibliographical apparatus, boosted by added sitographical and illustrative project references inherent in each term presented, providing the reader with a complete picture of the subject matter. In addition, the volume proved very useful particularly because of its pocket format, a feature taken up in the design of the graphic layout of the course glossary.

Then several international contemporary online archives were observed, starting with “The People’s Graphic Design Archive” (https://peoplesgdarchive.org/about), born from the idea of three designers and teachers - Brockett Horne, Briar Levit and Louise Sandhaus - to launch from the bottom (crowd-sourced) an archive capable of expanding the history of graphic design, in as inclusive a way as possible, continuing to the participatory project of the Portuguese graphic design studio Itemzero “Design Words. Glossary of definitions and meanings” (https://itemzero.com/design-words/back-cover/), a glossary on graphic design lemmas, permanently updated through the active participation of users, invited to collaborate through an on-line form. The component of expansibility typical of digital tools has also become a fundamental aspect of the educational purpose of our glossary. Indeed, such a formula allows it to be implemented from year to year by new Wayfinding students, progressively building the essential foundation of the discipline. Thanks to the analysis carried out, the content and organizational aspects of our glossary have been identified: the treatment of terms in Italian and English[6], the annual implementation of its words, the presence of an iconographic apparatus made with original photographs taken by the students - useful for facilitating the understanding of some lemmas, especially the more ambiguous ones, - and a bibliographical reference apparatus for each lemma.

3.2 The graphic structure of the glossary

The idea of making a flexible, implementable and easily transportable tool affected several graphic-formal aspects of the glossary.

First, we worked on the organization of the content, considering the need of dividing the students into working groups of 5 to 6 persons each. We asked each group to first identify the container term, of which to return the definition (min 400 strokes, max 1090) by selecting the most relevant entries found in the Treccani online Italian vocabulary. This operation was considered essential to demonstrate how (little) the most well known generalist dictionary is able to help define the theoretical and operational system of design. For this reason, students were asked to rework the same term, writing their own

6 The Italian students drew from an Italian and English bibliography, but preferred to write in Italian, while the English terms were written by the Erasmus students, who drew from a bibliography mainly in English.

definition together, selecting the sources they felt were most appropriate. Subsequently, they associated secondary words, the contained terms on which to work individually, chosen for the affinity of meaning or understood as nuances of the previous word (min 3500 strokes, max 6000). The working process was similar to the container term: each person started from the Treccani definition of the selected word to move to their own “design-oriented” definition of it.

The textual apparatus of both categories of terms is accompanied by a bibliography - at least 5 references, 3 of which proposed during the lectures -, and by an eventual iconographic apparatus consisting of diagrams and schematics made by the students themselves, or, alternatively, photographs taken by them of existing projects considered virtuous, as an aid to understanding the identified lemmas.

Regarding the order of the terms in the final glossary, it was preferred to chronologically distinguish the results of the two years from each other, giving priority to the academic year 2023-24 and then presenting the results of 2022-23. Both sections are preceded by a table of contents and a colophon providing information about the corresponding year. In turn, the terms for each year section are organized alphabetically for ease of use [Figure 1].

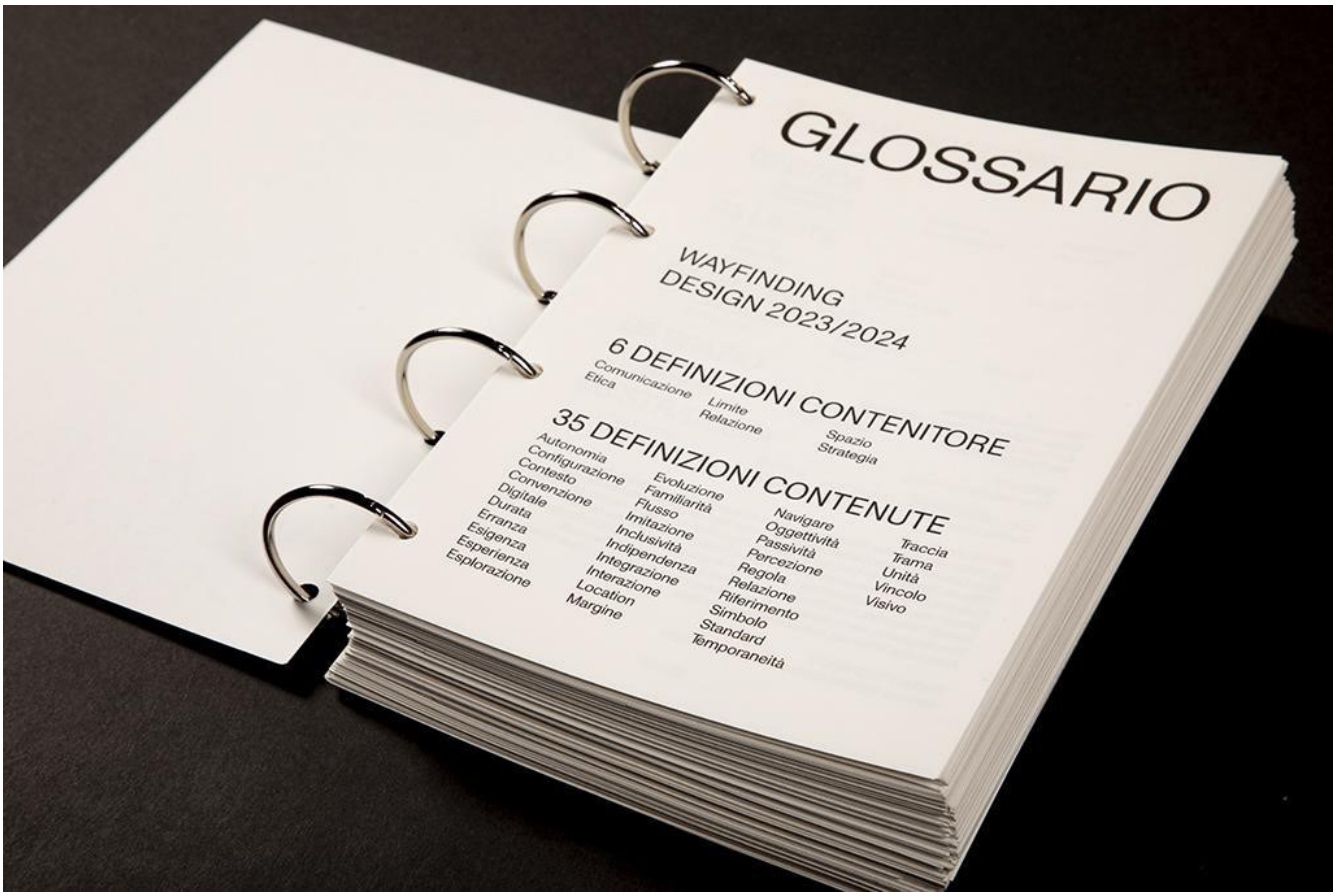

Figure 1. Glossario: index of the chosen words.

What remains unchanged throughout the two years is the organization of the textual apparatus; while the graphic layout was designed during the first annual teaching by two first-year students with the collaboration of one of the Communication Design curriculum. The glossary's graphic layout mainly took into account the need to design a tool that can be implemented over the years, flexible to the different characteristics of each individual lemma and easily transportable. Therefore, the proposed artifact is a paper filing cabinet with a ring binder in A5 format [Figure 2].

To especially highlight the hierarchy between container term and content term students developed a layout that is articulated in two double pages, one suitable for the generic term and the other one for all secondary ones. The textual elements of the first double page are precisely the main lemma and its definition-positioned on the right-hand opening page-and the bibliographical apparatus on its corresponding back page. The layout of the double page of the generic term is also taken for contained terms, differing only in the body of word text and in the addition of a space dedicated to notes. For content terms, three different types of pages dedicated to the inclusion of iconographic apparatus are possible, through the introduction of a special accordion fold available in different sizes - a f.to A5 + ½ A5, a f.to A5 + 12.85 cm, a f.to A4 horizontal 12.85 cm -. This variation was introduced especially for cases where images with strong horizontal orientation were needed, e.g., maps [Figure 3 and 4].

Finally, from the typographic point of view, the use of a stick typeface, ABC Monument Grotesk designed by the Swiss Kasper-Florio studio in 2018, was preferred in order to give an appearance of objectivity to the publication.

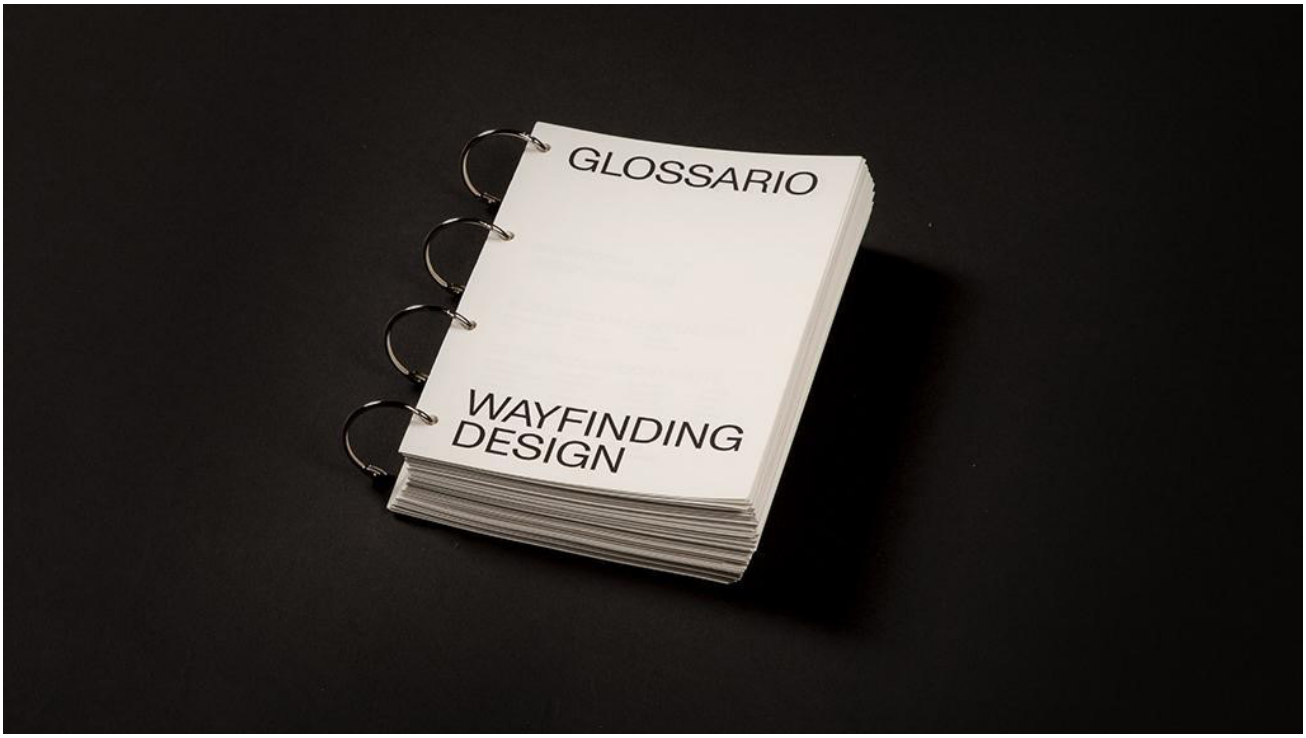

Figure 2. Glossario: cover and binding



Figure 3. Glossario: example of a plain text page.



Figure 4. Glossario: example of a page with text and image.

Table 1. The wayfinding lemmas identified during the academic year 2022-23[7]

Coerenza	correlazione	gerarchia	identità	univocità
Decodificare	contaminazione	prossimità	sistema	stratificazione
Equilibrio	invisibilità	ridondanza	sintesi	visibilità
Fruizione	accessibilità	barriera	comportamento	densità
	suggerimento			
Identità	codice	coerenza	gerarchia	linguaggio
	pittogramma	riconoscimento	sistema	stratificazione
Orientamento	guidare	riconoscere		
Segno	messaggio	narrazione	nomenclatura	percorso
	pittogramma	segnaletica	tipografia	uniformità
Usability	accessibilità	leggibilità		

7 The lemmas presented in the table have been kept in the original language, for consistency with the printed glossary. he container term is marked in bold, in regular the related content term.
Here follows the translation provided by the authors:
Consistency: correlation, hierarchy, identity, uniqueness
Decoding: contamination, proximity, system, stratification
Balance: invisibility, redundancy, synthesis, visibility
Fruition: accessibility, barrier, behavior, density, suggestion
Identity: code, coherence, hierarchy, language, pictogram, recognition, system, stratification Orientation: guidance, recognition
Sign: message, narration, nomenclature, route, pictogram, signage, typography, uniformity
Usability: accessibility, readability

Table 2. The wayfinding lemmas identified during the academic year 2023-24[8]

Comunicazione	digitale	interazione	simbolo	standard
	visivo			
Etica	esplorazione	familiarità	imitazione	indipendenza
	oggettività	passività		
Limite	durata	inclusività	location	margine
	regola	temporaneità	traccia	
Relazione	configurazione	evoluzione	percezione	trama
	vincolo			
Spazio	contesto	esperienza	flusso	integrazione
	navigare	relazione		
Strategia	autonomia	convenzione	erranza	esigenza
	riferimento	unità		

8 The lemmas have been kept in the original language, for consistency with the printed Glossary.
The container term is marked in bold, and in regular the related content term.
Here follows the translation provided by the authors:
Communication: digital, interaction, symbol, standard, visual
Ethics: exploration, familiarity, imitation, independence, objectivity, passivity
Boundary: duration, inclusiveness, location, margin, rule, impermanence, trace
Relationship: configuration, evolution, perception, plot, constraint
Space: context, experience, flow, integration, navigate, relationship
Strategy: autonomy, convention, wandering, need, reference, unity

4. Conclusions

We have described how the activation of the Wayfinding course in Università Iuav di Venezia in the academic year 2022-23 provided the impetus for a broad reflection on the theory and teaching of wayfinding design in the university setting and how the topic of signage and orientation, historically linked to the analysis of urban space with Lynch's volume compiled now about half a century ago, needed an update that takes into account both the contemporary social and technological condition and the design outcomes developed in other fields in more recent years. The positioning of the teaching in the field of interior design saw the need to initiate an extensive bibliographic survey, both at international and national level. The ultimate goal was to identify texts that specifically embraced the perspective of interior design on wayfinding, while maintaining a multidisciplinary gaze demonstrating the multifaceted nature of the subject, not only referable to architectural or graphic-communicative issues, but as part of a broader and more inclusive approach.

The glossary was chosen as a useful teaching tool to identify concepts for understanding the discipline of wayfinding, and addressing issues not fully investigated and theorized at the academic context yet. It was interesting to observe the reaction of astonishment of the students of the year 2022-23 in front of the printed artefact, almost of disbelief, given that the Interior Design curriculum does not require graphic designer skills. While Students in 2023-24 were urged to participate in a call to action to implement the previous year's work. In both cases, alternating face-to-face lectures, conducting exercises in analyzing concrete spaces and the participatory glossary construction constituted a valid method of inquiry. The intention of the authors' working group is to continue with the development of wayfinding theory through the preparation of lectures, the administration of specific exercises and the fostering collaboration with students on the implementation of the glossary in the next academic year. The possible participation of students from the communication curriculum in the next Wayfinding class will certainly provide interesting stimuli and new scientific perspectives.

The glossary, which is still planned to be implemented in paper format the next academic year, may be transformed into an online and open-access tool in the future, so as to speed up the implementation process and facilitate open discussion among scholars of the subject.

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EXPLORE BOUNDARY SPACE: DESIGN STRATEGIES FOR STREET RENEWAL IN BEIJING'S HUTONG NEIGHBORHOODS BASED ON THE IDEA OF SYMBIOSIS

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ABSTRACT | In recent years, urban planning in China has shifted from the original incremental expansion to stock development for the purpose of enhancing the quality of urban space. The traditional hutong street environment preserved in Beijing's old city center is rich in daily life activities. Residential, commercial, and office functions are mixed with trivial details of daily life as the main spatial characteristics. Therefore, it is often difficult to improve the street quality of hutong through government-led top-down governance. Hutong communities that are not effectively governed can hardly satisfy the residents' demand for quality of life. In the face of the complexity and contradiction within hutong communities, this paper utilizes the sharing and co- production characteristics of symbiosis to solve these problems.

Based on the symbiosis perspective, this paper will summarize the human behavior in the boundary space and construct the renewal mechanism of the street. From the dimension of spatial composition, the characteristics of sharedness and coproduction advocated in the concept of symbiosis will be transformed and applied to promote the renewal within the hutong community. This strategic design of street renewal in Beijing's hutong communities can better coordinate the relationship between broom hutong and the surrounding area, and achieve the goal ofsymbiosis between people and the environment.

KEYWORDS | BOUNDARY SPACE, SYMBIOSIS IDEA, BEIJING HUTONG NEIGHBORHOOD, STREET RENEWAL

1. Introduction

Since the founding of the People's Republic of China, a program of renovation of Beijing's old urban areas has begun. Between 1949 and 2003, Beijing underwent a total of three renovations. The first was in the 1950s, when ancient buildings such as city walls and pagodas were demolished as obstacles to urban construction, and the second was in the 1990s, when the national economy recovered and the city underwent a second large-scale renovation program. Due to the lack of correct direction, the renovation program of the old city not only failed to achieve the expected purpose, but also caused problems in various aspects (Song, 2010). The third time was during the millennium, when the government planned to renovate all dilapidated buildings in Beijing in five years.After 2003, there was no more government-led top-down large- scale renovation of the old urban areas in Beijing, but rather small-scale pilot renovations initiated by various social organizations.

In terms of scale, there are now two ways to renovate Beijing's Hutong: one is to start with the renovation of the siheyuan, the basic constituent unit of the Hutong; the other is to renovate the Hutong themselves, including the buildings and their traffic roads, greenery, and other surroundings (Wu, 2015).

The current Hutong environment and renovation and renewal methods are no longer able to meet the needs of the current society, so it is necessary to explore a new renewal mode to coordinate the relationship between Hutong and the surrounding area, and to achieve the goal of symbiosis between people and the environment.

2. Symbiosis theory and its developmental lineage

2.1 Concept of Symbiosis Theory

"Symbiosis" is based on mutual benefit, collaboration, self-fulfilling equilibrium, heterogeneous unity and communication. The concept of "symbiosis" was first proposed by the German biologist De Berry in 1879 (Zhang et al, 2003). Kisho Kurokawa describes his philosophy of symbiosis in The New Symbiotic Thought (Kisho, 2009),

in which he argues that symbiosis is the creation of a creative relationship between opposites and contradictions.

Theories based on metabolic and open structures, intermediate domains, and ambiguity constitute symbiotic thought (Shen, 2013). Facing the problem of loss of local culture and national characteristics in the mechanical age, Kisho Kurokawa introduced the "symbiosis theory" into the field of architecture, urban design and planning, and put forward his own symbiosis ideas, including metabolism, metamorphosis, and change of life, etc. (Qin, 2003).

2.2 Development of Symbiosis Theory

Many ideas in traditional Chinese culture contain the expression of symbiosis, such as the Confucian ideals of "Harmony of Life" and "Cosmos" (Guo, 2021). Originating in biology, the idea of symbiosis has gradually taken on a way of thinking that is applicable to modern life, which inherently embodies and requires the sharing and co-existence of equality, reciprocity, and in- depth cooperation between subjective positions (Wang et al, 2021).

At present, "symbiosis idea" is applied in many research directions such as architecture. Wu Liangyong puts forward the concept of "organic renewal" from the perspective of transformation and development of old cities, which coincides with the concept of "symbiosis" in the development of urban architecture; at the level of landscape design, Hou Yiming puts forward the design principles and design methods of symbiotic urban streetscapes from the perspective of time and space, culture and landscape (Hou, 2015); at the level of urban renewal, the idea of symbiosis is applied to old industrial areas, and the design methods are applied to old industrial areas.

At the landscape design level, Hou proposed the design principles and design methods of symbiotic urban streetscapes from three aspects: time-space, culture and landscape (Hou, 2015); at the urban renewal level, the idea of symbiosis is applied in the research and practice of old industrial areas, historic districts, as well as heritage preservation and so on (Gao et al, 2017).

The design principles of functional mixing, cultural diversity, symbiotic coexistence, and ecology in the symbiosis idea provide a lot of valuable experience in the field of architecture and planning, but there is still a lot of research potential for the boundary space as a concrete space to implement the benefits of symbiosis and the strategy of symbiosis.

3. Defining the boundary space of the Hutong

3.1 Boundary space

Urban boundary is the boundary between various spatial areas in the city, which plays the role of separating and linking at the same time. Boundaries are generally linear in shape, but in reality, all boundaries have a certain

width, and when the width of the boundary line is wide enough to accommodate human behavioral activities, it can be understood as a "boundary domain" (Yuan, 2010), which is the object of spatialized research. Boundary is not simply a line without thickness, especially for the boundary of urban space, it should be regarded as a place, an area with volume (Su, 2012).

3.2 Boundary Space in Hutong

From the perspective of spatial composition, the physical composition elements of the Hutong boundary can be categorized into four types: vertical interface, horizontal interface, top interface and opposite interface. The boundary space carries different urban functions and reflects the role it plays in the urban functional system (wu, 2023).

Horizontal interface is the ground, and the horizontal interface elements of Hutong include roads and streets, public space, ecological landscape space, etc.

The vertical interface elements of Hutong include buildings, plant landscape, fence and railing, which can appear in various plane forms. Vertical interface elements of the Hutong include buildings, plants and landscapes, fences and railings, etc., which can appear in various plane forms.

The boundary of the Hutong takes structures and green landscape as the top interface, specifically including landscape pergola, store canopy, green space shade, etc.

The interface of the opposite view refers to the end or the turning surface seen along the boundary forward, that is, the end of the closed line of sight, and the interface of the opposite view can be composed of plants, landmark buildings, landscape structures, etc.

4. Beijing Hutong case study

4.1 Symbiosis Home Model

The courtyard houses in Beijing's hutongs were once the ideal homes for Chinese people. However, after the founding of the People's Republic of China, due to the surge in population and changes in the concept of family structure, the courtyard of a large family has become a "compound" for several families to live together, and the living environment in the compound has gradually become out of touch with modern life, with lack of light in the rooms, chaotic layout, cold in winter and hot in summer, and the kitchen and toilet are the biggest problems, and all kinds of illegal construction has destroyed the traditional architectural pattern and damaged the overall appearance of the old city. Destroyed the conventional architectural pattern, but also damaged the overall appearance of the ancient city.

Professor Wu Liangyong in The Old City of Beijing and Juer Hutong's book put forward the theory of "organic renewal", advocating the use of small and flexible ways of urban renewal, based on sustainable development, the demolition of dangerous, old houses, repair and transformation of the general

residential compound, to retain the form of the complete residential compound. After some architects' attempts in the hutongs, the demonstration effect brought by star architects is after all limited, and it is better to form an effective mechanism to promote the people's self-renewal of their houses. The 2019 Beijing Municipal Government Work Report puts forward the idea of "symbiotic courtyard" renovation, which opens the door to a new world for the preservation of old cities, and some districts have already begun the pilot project of "symbiotic courtyard".

No. 16, 18, and 20 Yu'er Hutong, a typical "symbiotic courtyard" in which URBANUS Urban Practice participated in the renovation design, is mainly inhabited by the original residents. According to the concept of a "symbiotic courtyard", the original mixed elements in the courtyard are expressed in a unified architectural language. Public spaces are set up to stimulate the residents to spontaneously maintain the beauty of the public areas and cohesion of neighborly relations, as well as to add small apartments in the miscellaneous yards to meet the living habits of the single youths, to attract young tenants and bring new vitality to the courtyard. They are bringing new vitality to the miscellaneous courtyard.



Figure 1. URBANUS Urban Practice Participates in the Renovation Design of Yu'er Hutong

The pilot "Symbiosis Courtyard" in the Caochang area restores and protects the courtyard landscape and adds basic living facilities. 9 courtyards with about 16 sets of rooms have been launched in the pilot project, which is functionally positioned as "youth apartments", introducing young people with high levels of knowledge to be neighbors with the old Beijingers. Neighborhood. After completing the signing and vacating of part of No.7 Yinzhuoqiao Hutong Courtyard in the Shichahai area, the B&B business was introduced, and the tourists can live together with the remaining 4 residents, and the "outsiders" and the "local households" are constantly exchanging, bonding and sharing, and No.7 Yinzhuoqiao Courtyard has been transformed into a neighborhood.

has become a “shared home” among neighbors.

The model of symbiosis proposed by the Beijing Municipality includes three meanings: “symbiosis of old and new buildings, symbiosis of old and new residents, and cultural symbiosis”. The symbiosis of old and new buildings is the restoration and protection of traditional architecture and texture, while at the same time meeting the needs of modern living so that the original functions of the neighborhood can be continued while new functions are put in. In the Dongcheng District of Beijing, several historic and cultural districts have piloted “symbiotic houses”, which on the one hand, restore and protect the appearance of the vacated houses, add modern living facilities, and improve the living environment for the residents; on the other hand, it attracts new residents, reuses the vacated houses, and injects new vitality into the hutongs (Xu et al., 2020).

4.2 Symbiotic Neighborhood Model

The “symbiotic courtyard” model of “architectural symbiosis, resident symbiosis, and cultural symbiosis” proposed by Beijing has been recognized by the relevant plans and has been put into practice in many ways, and relevant studies have pointed out that “symbiotic courtyard” can also be expanded to the level of “symbiotic neighborhood”. Relevant studies have also pointed out that a “symbiotic courtyard” can be expanded to the level of a “symbiotic neighborhood”, and after the whole courtyard is vacated, symbiosis can be realized between courtyards of different functions and forms. Relevant practices have been carried out in historical and cultural neighborhoods such as the Guanyin Temple and the Fayuan Temple in Beijing.

The Guanyin Temple area of Beijing Dashilan is a densely inhabited neighborhood rich in historical and cultural elements, and the sustainability of the residential function and cultural value needs to be realized in symbiosis. The renewal project expands the form of symbiotic courtyards and puts forward the concept of “symbiotic neighborhoods,” optimizing space through the neighborhood model, and creating a livable environment that ensures the needs of the original inhabitants while at the same time creating a livable environment and ensuring the living needs of the original residents, the project also explores the connotation of the area and integrates it with the surrounding cultural resources to form an experienced route for cultural visits.

The concept of symbiosis is extended from courtyards to neighborhoods, and through the example of the Dashilan Historical and Cultural Neighborhood, it explores the possibility of realizing symbiosis through a wider range of population decongestion, resource allocation, and functional coordination (Lou et al, 2020). The Fayuan Temple Historical and Cultural Neighborhood, in the planning of the “symbiosis neighborhood”, preserves the historical art and cultural symbols of the alley while maintaining the texture of the alley and the historical buildings; strengthens the cohesion of the residents through diversified sharing; and injects new vitality into the old city. It also injects new vitality into the old city and brings new ecology to the old city.

5. Renewal Design Strategies for Broom Alley

5.1 Status of Broom Hutong

Broom Hutong belongs to Dazhalan Street, adjacent to Chaji Hutong and Charcoal Hutong. The length of Broom Hutong is 250m, the width is 4m, the height is 3m, and the direction of the Hutong is east-west. The total number of houses in Broom Hutong is 123. In March 2022, the Hutong was selected to be on the List of Traditional Geographical Names Protected in the Functional Core Area of the Capital. There are schools, tourist attractions and commercial stores around the Hutong.

Through the research on the site, many problems of the Hutong are found. At the level of spatial layout: 1. low functional vitality, which is manifested in closed boundaries, negative boundaries, and weakened humanistic attributes; 2. poor road network. At the level of spatial environment: 1. weakening of historical and cultural attributes, 2. insufficient utilization of public space, 3. low satisfaction of crowd perception.

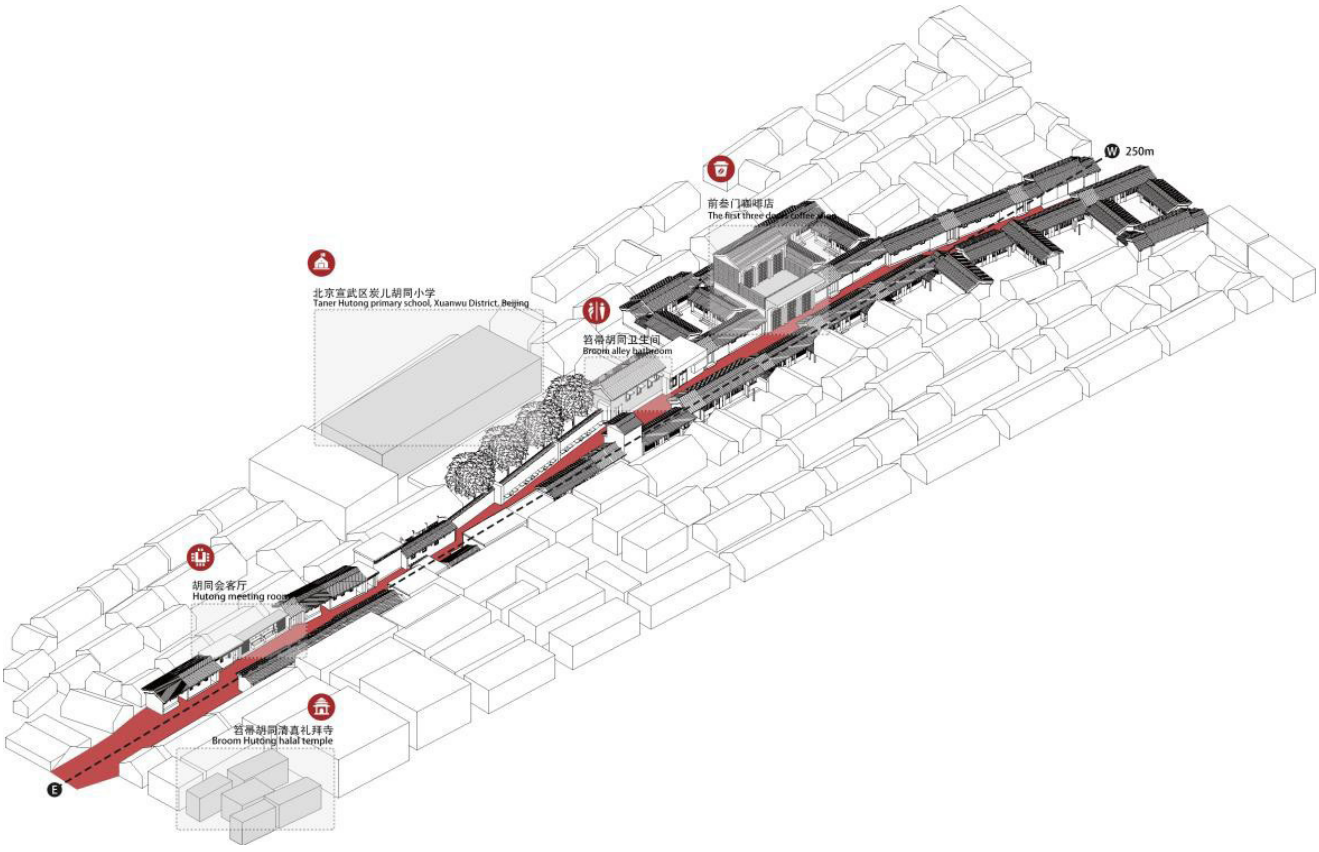

Figure 2. Status of the Broom Alley site

5.2 Broom Alley System Layer Strategy

The construction of the renewal mechanism based on the symbiosis perspective provides a symbiotic environment and basis for proposing spatial renewal, and the boundary transforms and applies the spatial attributes advocated in the concept of symbiosis in the dimension of its spatial composition, generating spatial symbiosis strategies and sharing strategies of the boundary, and ultimately realizing the goal of spatial symbiosis.

For the broom Hutong in the system layer strategy has two aspects: the first is the symbiosis strategy, and the second is the sharing strategy. The symbiosis strategy includes functional symbiosis, cultural symbiosis and ecological symbiosis. Functional symbiosis refers to the protective restoration of old buildings while improving the quality of the buildings and the living environment of the residents, and at the same time, new businesses such as cultural and creative industries can be introduced in the vacated courtyards or houses. Ecological symbiosis refers to the transformation of the vacated gray space and the planning of vegetation in the Hutong. Cultural symbiosis refers to the symbiosis of modern living concepts and the cultural concepts of the Hutong courtyards, through the introduction of new residents, while inheriting the culture of the old city courtyards, new cultural vitality is also injected.

Sharing strategy: I. Space time-sharing, the crowd behavior of Hutong boundary space use has time-sharing characteristics, combined with the needs of group behavior, to create conditions for the development of group behaviors such as morning exercises and visits in this space (Du, 2020). This kind of behavior carried out at the boundary of the neighborhood helps the neighborhood to share resources, promotes communication between neighborhoods, enhances the local characteristics of the community boundary zone, and strengthens the spiritual activities of the crowd. Carrying more civic activities and accomplishing more urban functions in the same space makes the border space more active, effective and safe.

Second, the sharing of all-age people, the functional types of the border are diverse, even for the same residential function, the composition of the residential population in different communities is also different, in the design of the border space, it is necessary to combine with the design of the street building space and road space, and give full consideration to the needs of different age groups and different behavioral purposes of the crowd's passage, stay, play and other needs. Third, the composite space sharing, for the same facilities in the boundary space can have different facilities to use the scene, such as the Hutong parlor can not only be a place for community residents to chat, but also a place for tourists to visit the Hutong culture or rest.

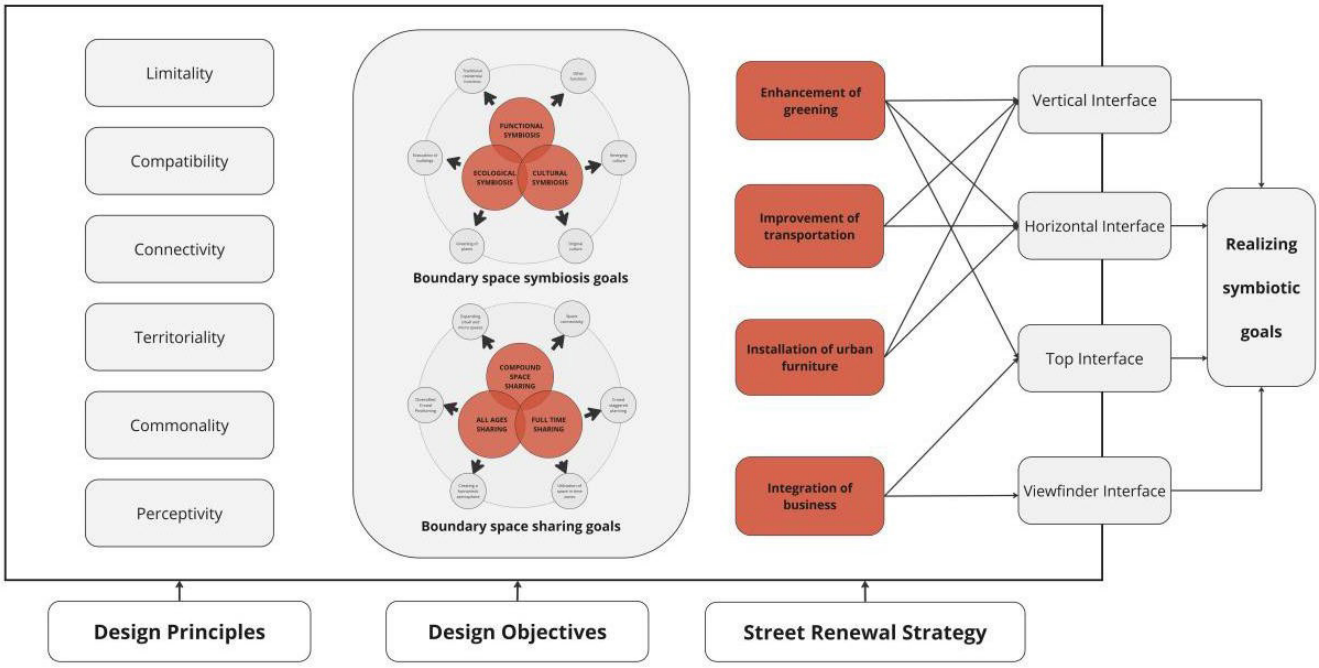

Figure 3. Broom Hutong Boundary Spatial Renewal System

Broom Alley Implementation Layer Strategy
On the basis of the system layer strategy for the Hutong boundary space specific update design strategy:

First, upgrade the greening and determine the main spatial location of the greening of Broom Hutong: top boundary space, horizontal boundary space, vertical boundary space. Using different Hutong greening methods, designing flexible planting devices, and selecting plant varieties adapted to the Hutong environment and conducive to winter ornamental plants, so as to improve the green landscape of the Hutong.

Secondly, to improve the transportation, we put forward an update strategy on static transportation using the boundary space as a carrier. For motor vehicle parking problems, the use of shared parking, three-dimensional parking and other ways to maximize the use of Hutong parking space. For non-motorized parking, the demand for temporary and fixed parking for bicycles is considered, and functions such as planting, power generation, and rest are integrated into the parking area, so that the single-function parking area is transformed into a composite public space.

Thirdly, planning activities, as a kind of common public space in the old city of Beijing, there are many possibilities for the daily use of Hutong, such as drying, bird-walking, chatting, chess and cards, trading, etc., and these activities tend to have a “tidal wave” in time. Two levels of leisure activity circles are designed: a pocket park circle within 50m and a leisure micro-space circle within 250m, the former containing Hutong, sports and leisure micro-gardens, and the latter containing living, recreational and ornamental installations, with a view to perfecting the activity functions of the public space on the basis of the continuation of the daily functions of the Hutong and improving the quality of daily life.

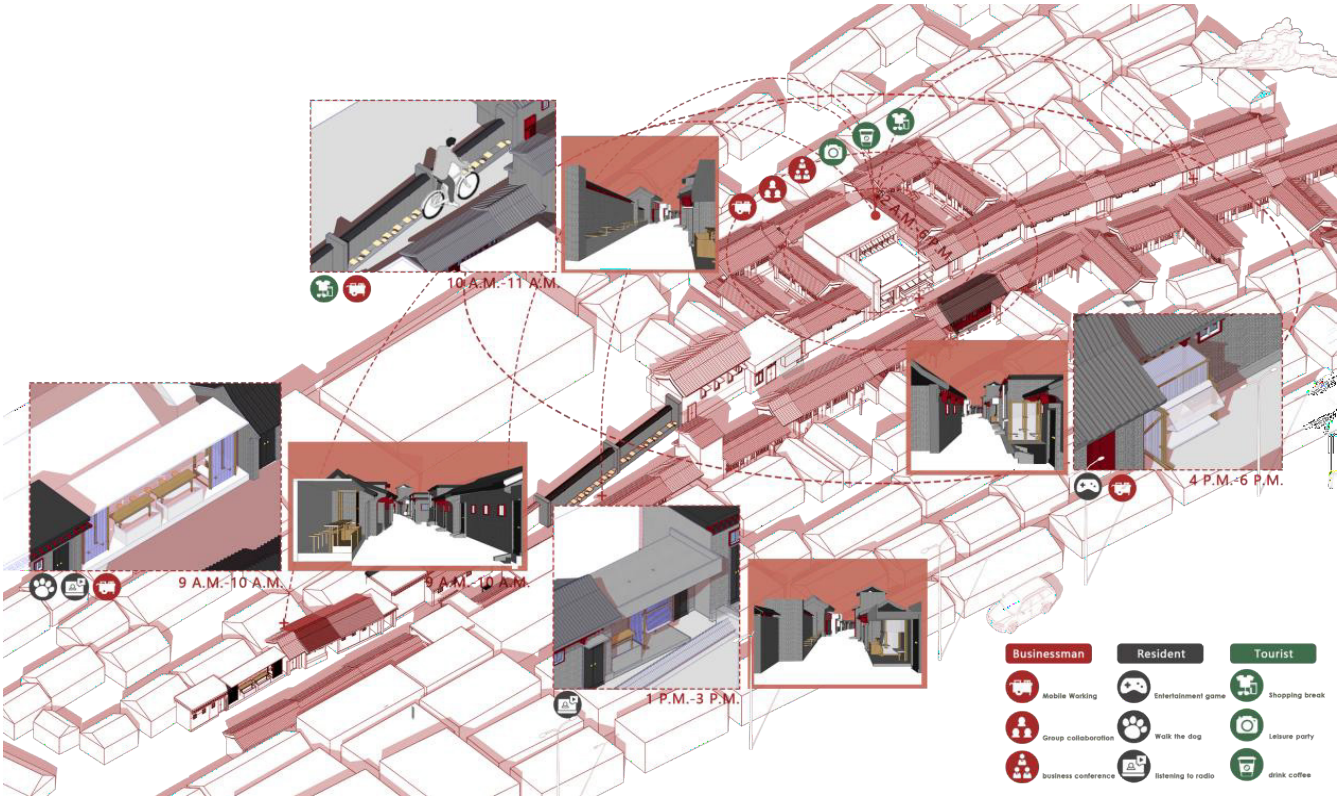

Figure 4. Broom Hutong Street Renewal Design

6. Conclusion

In summary, as China's current urban development shifts from expansion to sustainable development of land resources, the renewal of Beijing's Hutong needs to improve the surrounding environment through bottom-up progressive micro-renewal. Based on the symbiosis perspective, this paper categorizes the symbiotic influencing factors of the boundary space, and proposes a renewal strategy at both the system level and the implementation level, which can better harmonize the relationship between broom Hutong and the surrounding areas and thus achieve the purpose of solving the contradiction between the old and new areas of the city.

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IDENTITY CONSTRUCTION AND SPATIAL PRODUCTION: THE EVOLUTION OF MILAN'S CHINATOWN

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ABSTRACT | Postcolonial scholar Homi Bhabha's "Third Space" theory elucidates the ambiguous spaces characterized by cultural hybridity formed during intercultural exchanges. Milan's Chinatown, one of the largest and oldest Chinese immigrant communities in Italy and one of the earliest Chinese settlements in Europe, exemplifies this postcolonial "Third Space" with a history spanning over a century. This paper, based on literature review and empirical research, focuses on Milan's Chinatown to study its historical evolution, spatial characteristics, and impact on urban culture within the framework of Chinese immigrant identity construction and urban neighborhood space production.

The first part of the paper systematically reviews the historical evolution of Milan's Chinatown from the early 20th century to the present, detailing its four main historical stages: "spatial creation - spatial development - spatial conflict - spatial integration," and analyzing the interactions between each stage and the spatial evolution of Milan. The second part focuses on the specific clues of immigrant identity construction and neighborhood space production. Through map analysis and empirical research, it summarizes the spatial evolution characteristics of Milan's Chinatown and explores the manifestations of spatial order, spatial types, visual symbols, color patterns, and other aspects in the process of cultural integration between immigrants and the local community. The third part further discusses the unique value of the "Third Space" as a symbol of Milan's urban space and culture in integrating contemporary Milanese urban activities and shaping the city's form.

Through this research, this paper aims to reveal that Milan's Chinatown is not merely an immigrant community but a dynamic space full of cultural exchange and integration. This space, in its continuous adaptation to and influence on the city it inhabits, displays multi-layered and multidimensional cultural implications, providing a valuable case for studying urban space production and identity construction in a postcolonial context. Ultimately, this study not only offers new perspectives on understanding the spatial evolution and characteristics of Milan's Chinatown but also provides important theoretical and empirical support for broader urban studies and immigrant community research.

KEYWORDS | THIRD SPACE, CULTURAL INTEGRATION, IMMIGRANT

1. Introduction

As a unique urban space and cultural phenomenon among immigrant communities, Chinatown have become spatial symbols and narrative emblems of the Chinese diaspora worldwide. According to statistics, there are now over 200 Chinatown globally, with a population exceeding 600,000 living in these areas. Since the establishment of diplomatic relations between Italy and China in the 1970s, bilateral cooperation has increased, leading to a growing number of Chinese immigrants settling in Italy. The Chinese population in Italy rose from around 400 people in 1975 to over 20,000 by 1993. (Carchedi, F., Ferri, M., 1998) Entering the 21st century, the number of Chinese immigrants to Italy continued to rise, surpassing 300,000 in 2013 and reaching its peak in 2016, stabilizing at a hundredfold increase in population over 50 years. Today, Chinese immigrants are the third-largest immigrant group in Italy, with more than 30,000 Chinese residing in Milan. Milan, Italy's second-largest city, is renowned globally for its fashion and design industries, making it a popular destination for Chinese immigrants, surpassing other Italian cities in this regard. (Ministero del Lavoro e delle Politiche Sociali, 2020) While most Chinese residents in Milan are dispersed throughout different city areas, Chinatown remains a symbolic landmark that connects the Chinese community's living and emotional needs. Some Chinese media rank Milan's Chinatown as the fifth largest in Europe, and excluding the UK, Milan's Chinatown is only surpassed by those in Paris and Amsterdam, ranking third on the European continent, underscoring its influence. (Chinatown, 2022)

Academic research on Chinese immigrants in Italy tends to focus on Chinese language education, Chinese business economies, Chinese media, and cities with larger Chinese populations, such as Prato, within China. Outside China, research often emphasizes immigration policies, the integration of Chinese immigrants into local work and life, and anthropological and sociological studies of Chinese social phenomena. From a design research perspective, scholars have noted the spatial changes in Chinatown and their relationship with urban morphology.

However, few researchers have focused on the connection between identity construction among immigrant groups and the everyday life and micro-scale spaces of Chinatown. Therefore, this study is based on the author's personal experiences living in Milan and observations of Chinatown. It combines the postcolonial theorist Homi Bhabha's theory of the "Third Space" to trace the spatial evolution of Chinatown, summarize the characteristics of its current spatial presentation, and attempt to analyze the reasons behind these characteristics.

2. Spatial Evolution of Milan's Chinatown

Milan's Chinatown is located in the eighth district in the northwest of the city. Broadly speaking, Chinatown is an area centered around the pedestrian thoroughfare Via Paolo Sarpi, home to thousands of Chinese shops, and is a traditional commercial district in Milan. (Figure 1) In a narrower senwwse, Chinatown often specifically refers to Sarpi Street itself, the representative street of Milan's Chinatown. The first wave of Chinese immigrants to Milan can be traced back to the 1920s and 1930s, with most originating from Wenzhou, Zhejiang. Wenzhou people are known as the "Jews of the East" for their

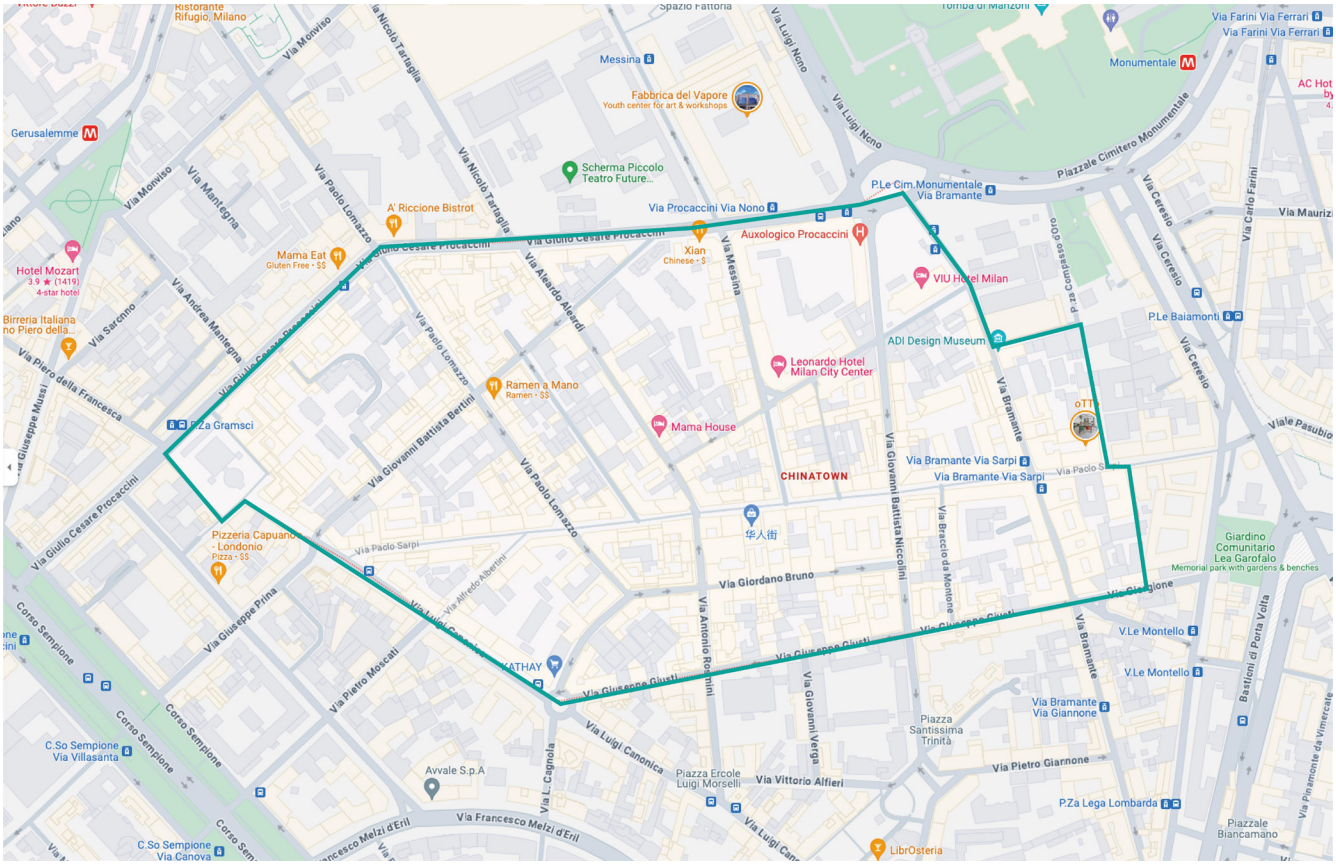

Figure 1. Milan's Chinatown.

intelligence and business acumen. Bordered on three sides by water, Wenzhou has limited access, a high population density, and scarce resources, and it did not experience significant development in its history before China's economic reforms. During World War I, the Chinese government, as a member of the Allies, sent more than 140,000 Chinese workers to Europe as laborers. After the war, some workers chose to stay in Europe to work and live, and Milan became one of their destinations. (Figure 2) In the first 20 years, they lived in the Canonica-Sarpi area and progressed from street vending to running workshops and shops. Most of the buildings in this area were multi-story residences developed in the early 20th century, with commercial shops on the ground floor facing the street. (Figure 3) Chinese immigrants initially earned profits by selling leather and textile products, which provided them with the original capital for long-term business in Milan. It is important to note that the spatial clustering of Chinese communities in the early stages of immigration was due to the convenience of commercial activities rather than government-led immigration policies. As a result, Chinese immigrants have never been the majority population in this neighborhood, setting the stage for future conflicts between the Chinatown commercial district and community residents.



Figure 2. Earlier Chinese immigrants in 1920s.



Figure 3. Milan's Chinatown in 1928.

Between World War II and the 1970s, the number of Chinese immigrants did not increase but gradually decreased, leaving only about 700 Chinese living in Italy by the early 1970s. (Overseas Chinese Affairs Office of the State Council of the People's Republic of China, 2004b)

Beginning in the 1980s, thanks to the establishment of diplomatic relations between China and Italy and Italy's immigration policies, Italy and Milan once again became destinations of choice for Chinese immigrants. A significant portion of these immigrants also came from Wenzhou, often joining relatives or attracted by stories of fellow countrymen seeking economic opportunities. Two Chinese immigrants from Wenzhou whom I interviewed mentioned that they arrived in Italy in their teens in the early 1990s to join relatives. They obtained residency permits and legal status through Italy's amnesty policy in the late 1990s and early 2000s and settled permanently in Milan. During this period, many Chinese in Milan engaged in the wholesale clothing business, benefiting from China's foreign trade market and Italy's fashion industry. Due to the rapid increase in immigration, new immigrants also began operating restaurants, supermarkets, hair salons, and other service-oriented businesses to serve the emerging Chinese community. Meanwhile, unlike the burgeoning Chinese economy in Chinatown, the number of

Chinese residents living in the area decreased again during this period, with Chinese immigrants gradually relocating to other parts of Milan. (Cologna, D., 2008) For them, Chinatown was merely a place to earn a living, not a place to settle down and live. This phenomenon led to the marginalization of the Chinese immigrant community for an extended period, with little interaction between Chinese businesses and the Italian residents living around Chinatown. As a result, Chinatown became an isolated space, with limited real connection to urban activities.

Since most of Chinatown's businesses were in clothing wholesale, supermarkets, and other commercial services, freight transport and unloading became the primary street activities, leading to the disorderly development of the street space, negatively impacting the sanitation and tranquility of the area. (Figure 4) At the same time, Milan's government began implementing policies to protect Italian-operated businesses and exclude Chinese businesses, leading to growing tensions between the Chinese community and local residents and authorities. In 2007, these tensions culminated in large-scale street riots and demonstrations involving clashes between Chinese individuals and Italian police. Following these events, the Milan government engaged in negotiations with the Chinese immigrant community, ultimately relocating most wholesale businesses out of Chinatown. In response to these events, to improve commercial operations and traffic order, the Milan city government began renovating Via Paolo Sarpi in 2008. Over nearly three years, the street was transformed into a commercial pedestrian street. The renovation plan involved redesigning the streets and facilities, using materials, shrubs, and urban furniture to divide the street into different zones to better serve pedestrians and shop owners. The renovated Via Paolo Sarpi Chinatown reopened in 2011, and contrary to the pessimistic expectations of many Chinese business owners before the renovation, the street achieved significant improvements in spatial environment and business scale compared to before the renovation. The micro-scale design of the street undoubtedly enhanced the spatial order and pedestrian experience of Chinatown, improving its previously closed and chaotic state and creating better opportunities for new Chinese immigrants and the Chinese community to integrate into the city.



Figure 4. A pushcart war in the streets of Milan's Chinatown in 2007.



Figure 5. The redevelopment of the streetscape of Chinatown.

Since 2010, Chinese students studying in Milan have emerged as a significant source of new Chinese immigration to the city. According to statistics, in 2020, study-related immigrants accounted for 50% of the newly registered immigrant population in Italy, a proportion that continues to rise. Notably, women constitute 59% of this group. (Immigrants.Stat, 2020) The increasing presence of young immigrants with advanced educational backgrounds, alongside the growing number of female immigrants, has facilitated the formation of a clearer group identity, which in turn has significantly enhanced the integration of Chinese immigrants into Milan's urban fabric. The proliferation of mobile internet and the advent of new social media platforms have further accelerated this process. Within the Chinatown community, a portion of these young immigrants has chosen to establish businesses after graduation, introducing

innovative Chinese business models and brands. This has attracted a younger clientele, including both Chinese students and Italian youth. As a result, Chinatown—particularly Via Paolo Sarpi—has evolved from a space traditionally dominated by Chinese merchants into a more diverse area. Today, local residents and tourists from various countries increasingly frequent the district, drawn by its Chinese restaurants and supermarkets.

Encouragingly, the development of the Chinese immigrant community has prompted the city of Milan to propose a comprehensive redevelopment plan for Chinatown. This initiative aims to enhance urban transportation and street infrastructure in commercial areas adjacent to Via Paolo Sarpi, such as Via Bramante and Via Mesina, with the goal of stimulating economic activity and urban vitality while fostering closer integration between Chinatown and the surrounding city spaces. (华舆, 2020)

3. Homi Bhabha's "Third Space" Theory

The "Third Space" refers to an "in-between space" formed by the amalgamation of two or more cultures. Homi Bhabha, a postcolonial cultural scholar at Harvard University, is one of the key figures discussing the concept of the "Third Space." Bhabha, from the perspective of postcolonial cultural critique, argues that the traditional binary notion of space cannot explain the processes, mechanisms, and outcomes of cross-cultural exchanges. He focuses on the "in-between" spaces of two or more cultures, considering it a space that transcends the binary concept of space and is widely inclusive, known as the Third Space. (Zha, R., 2011) Homi Bhabha believes that cultures cannot maintain their purity during interactions; the collision of multiple cultures inevitably creates a new domain. This domain cannot be simply classified as "self" or "other"; it is necessarily an intermediary position that includes features of both cultures. From the name "Milan Chinatown," the combination of the nouns "Milan," "Chinese," and "street" undoubtedly possesses the characteristics of the Third Space. However, the reality is that Milan's Chinatown, as a Third Space, did not form at the moment of its naming but rather went through a long process. Bhabha contends that any culture, including its inherent factors such as race, class, gender, and beliefs, can engage in dialogue and discourse within the Third Space. However, Bhabha also points out that this exchange "will not always be cooperative or dialogical; it may also be deeply oppositional, confrontational, or even incommensurable." (Zha, R., 2011)

Considering the spatial evolution of Milan's Chinatown, although the Chinese working and living in Milan have a long history throughout the 20th century, Milan's Chinatown did not exhibit the characteristics of a Third Space before the 21st century. This is because, in the 20th century, Chinese immigrants in Milan were not closely connected to the city in terms of work or life. Even though the residents

living in Chinatown were primarily Italian, the Chinese who traveled across the ocean for business had a clear goal: to earn more money rather than integrate into the city and local community. This resulted in a disconnect between Chinese immigrants and the outside world in terms of space and daily life. Chinese immigrants were not interested in establishing deep connections with local residents, who, in turn, viewed Chinatown and the Chinese as a closed space and community. In both name and reality, the Chinese immigrant community in Chinatown was marginalized. Therefore, it is not difficult to understand the conflict between Milan's local residents, the government, and Chinatown merchants in 2007. After the conflict, the streets of Chinatown were redesigned to improve the connection between the street and urban spaces. Although this transformation was primarily a top-down operation led by government intervention, from a design perspective, the physical renovation of Chinatown provided opportunities for interaction and integration between Chinese immigrants and local residents. In recent years, due to the ongoing urban space updates in Chinatown, changes in business types, the younger demographic of immigrants, and increased cultural activities between the two countries, interactions between Chinese immigrants and local residents have strengthened. The characteristics of the Third Space, with Chinatown as its medium, are continuously forming.

4. Current Characteristics of Milan's Chinatown from the Perspective of the Third Space

4.1 Cultural Controversy: The Paifang as a Symbol of Chinese Culture

The *paifang*, or Chinese archway, is an iconic traditional architectural form, characterized by a sloped roof supported by multiple pillars. In ancient Chinese architecture, *paifang* served as the entrance to a space, its towering presence signaling the transition into a new realm. In Chinatown around the world, *paifang* often marks the boundary between the Chinese community and the rest of the city, symbolizing, to a large extent, the perception of Chinatown by outsiders. (Figure 6) Milan's Chinatown has seen several proposals to construct an archway at the street entrance, but due to differences between local Milanese residents and the Chinese immigrant community, a permanent *paifang* has yet to be built at the entrance of Via Paolo Sarpi.

The debate over constructing the *paifang* reflects long-standing cultural differences and a lack of mutual understanding between the two communities. For some Chinese immigrants, the *paifang* represents a sense of identity and emotional connection for Chinese people living abroad. It also symbolizes a "gateway of friendship," welcoming local residents into the immigrant community. However, for local Milanese residents, the construction of a *paifang* would brand their

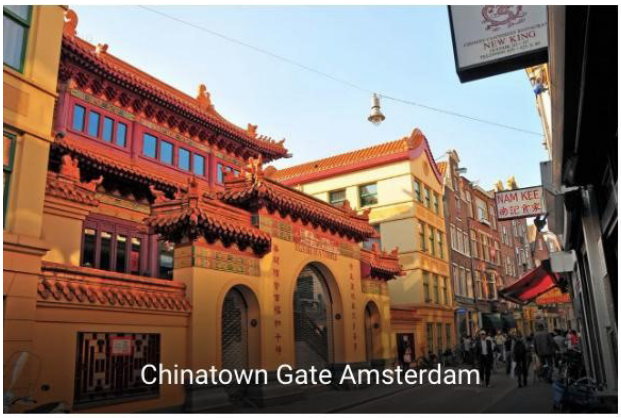















Figure 6. Chinatown Gate in the World

neighborhood with the label of a foreign culture. During the 2015 Milan Expo, a temporary compromise was reached, with a temporary archway erected at the entrance to Chinatown to welcome visitors. (Figure 7) A series of cultural activities during the Expo helped local residents gain a deeper understanding of the cultural significance of Chinatown. Increasingly, people began to explore Chinatown, experiencing its restaurants and purchasing traditional Chinese products from its supermarkets.

Over the past decade, as Chinatown has undergone spatial redevelopment and integrated more deeply with the city's fabric, official and community-led Chinese cultural activities have become more frequent, attracting large numbers of local residents. Cultural differences have gradually diminished, and mutual understanding has grown. Local residents' participation in Chinatown's everyday life reflects greater awareness and interest in Chinese culture, while Chinese immigrants have embraced the practice of decorating Chinatown for specific festivals rather than insisting on a permanent *paifang* as a cultural marker.

In 2024, during Milan Design Week's "China Week," an Italian designer created a temporary *paifang* infused with Chinese elements at the entrance to Chinatown, naming it "Our Gate." This installation became



Figure 7. Milan Design Week 2024 in Chinatown.

one of the highlights of Design Week. The phrase inscribed on the structure, "Different, but together," underscored Chinatown's transformation into a "third space" that embraces both cultures. In the future, it is possible that Chinatown will be permitted to construct a permanent *paifang*, but it will likely serve as a "symbol" of the community's successful integration into Milan's urban and cultural life, rather than a contested "marker" of cultural division. (Overseas Chinese Affairs Office of the State Council of the People's Republic of China, 2024)

4.2 Spatial Integration: Streets and Communities Harmoniously Connected with the City

Unlike other well-known Chinatown around the world, Milan's Chinatown was formed through the concentration of Chinese commercial activities rather than the settlement of Chinese immigrant communities. As a result, for nearly a century, Milan's Chinatown has lacked the prominent traditional Chinese cultural elements, visual symbols, and architectural decorations that are typically seen in Chinatown like those in London, New York, or San Francisco. When pedestrians enter Milan's Chinatown, they do not immediately notice a significant difference from other nearby streets.

From an urban spatial perspective, Milan's Chinatown is closely integrated with the city center. Since the 2008 redevelopment, the street has maintained the same scale as surrounding areas, and the redesign has introduced green spaces that delineate clearer pedestrian pathways and create more comfortable environments for leisure. This approach has enhanced the walking experience in Chinatown while maintaining a harmonious spatial relationship with neighboring residential areas, encouraging local Italian residents to naturally enter the district. This, in turn, increases opportunities for local residents to engage with Chinese businesses and culture within Chinatown.

Visually, the lack of traditional Chinese elements in Milan's Chinatown can be attributed to the different composition of its immigrant population compared to other Chinatown like those in New York or London. The latter two were initially populated by immigrants from Hong Kong, Guangdong, and Fujian provinces in the early 20th century, whose distinct Southern Chinese culture and customs shaped the visual identity of those Chinatown to closely resemble Hong Kong. For example, the vibrant, eye-catching shop signs lining the streets evoke the stereotypical imagery associated with Chinatown. However, it is worth questioning whether such visual elements foster opportunities for cultural exchange between Chinese immigrants and the local society, or if they merely reinforce cultural imagination within the immigrant community and perpetuate stereotypes of Chinese culture among outsiders.

In contrast, Milan's Chinatown lacks these visual symbols. While temporary decorations featuring Chinese cultural elements have been introduced during recent festivals, the

street design and decor remain restrained. The Wenzhou community, known for its practicality, along with a younger and more open-minded generation of immigrants, has focused more on business operations and daily life than on creating a visually distinct environment. Today, Milan' s Chinatown bears more resemblance to the atmosphere of a third-tier Chinese city. In China, commercial districts in first-tier cities typically attract the elite and tourists, often accompanied by complex traffic conditions and large crowds. In contrast, third-tier cities offer commercial streets that cater more to everyday citizens, providing a better walking experience. These streets encourage both locals and visitors to stroll leisurely and gather, fostering a casual, community-focused environment that Chinese people describe as "smoke and fire" (*yanhuo qi*)—a phrase symbolizing the vitality of everyday life. Increasingly, this ambiance is becoming more apparent in Milan's Chinatown.



Figure 8. Chinatown in New York and Milan.

4.3 Communication Platform: Recreational Space Integrating Chinese and Italian Lifestyle Cultures

A continuous observation of the commercial landscape in Milan's Chinatown reveals that in recent years, newly opened Chinese restaurants, specialty snack shops, bubble tea stores, and supermarkets have attracted a substantial number of both Chinese and international customers.

Many of these establishments are "internet-famous" restaurants, popular among young Chinese for their delicious offerings and widely promoted through online platforms,

making them highly sought after. These venues have also gained the affection of Milan's local residents and foreign tourists, not only due to the appeal of the cuisine but also because Chinatown provides a familiar and comfortable dining environment.

In other Chinatown around the world, most restaurants follow the traditional format of Chinese "restaurants" or "dining halls," with both the interior design and menu geared primarily toward Chinese communities living abroad, rather than the local population. Even when some of these restaurants adapt their dishes to better suit local tastes, they rarely attract a regular local clientele. Milan's Chinatown, however, offers a different experience. Many restaurants feature outdoor seating and sun canopies, allowing diners to become part of the street scene while enjoying a leisurely meal. This integration of dining spaces with the street is common in Milan and other European cities but is rarely seen in large Chinese cities or traditional Chinatown elsewhere. It has drawn more local residents to engage with and experience Chinese cuisine in Chinatown, facilitated by the pedestrian-friendly, small-scale streets and pub-like dining spaces that invite people to stroll, relax, and enjoy convenient street-side dining. For Chinese immigrants and tourists, Chinatown offers a taste of home, while for local residents and international visitors, it serves as a space to explore Chinese cuisine and unwind. As previously mentioned, young Chinese students studying in Milan often bring their local friends to Chinatown for gatherings and relaxation—an urban scene rarely witnessed in Chinatown a decade ago.



Figure 9. Recreational Space Integrating Chinese and Italian Lifestyle Cultures.

5. Conclusion

The century-long development of Milan's Chinatown reflects the history of Chinese people living in a multicultural society, with the construction of identity and spatial production of the Chinese community undergoing various stages of change and challenges. From the perspective of Homi Bhabha's theory of the "third space," the exchange between two cultures is not static, and the third space is not a fixed form or location, but rather an evolving process influenced by history, culture, policy, economics, space, and community dynamics. The origin, development, conflicts, and eventual integration of Milan's Chinatown illustrate the continuous interaction between cultures and the impact of these multifaceted factors.

From a design research standpoint, spatial redevelopment has played a crucial role in the integration of Milan's Chinatown into the local culture. The focus of this redevelopment is not about "new" versus "old" or specific design styles, but rather about identifying the "core issues" of spatial phenomena. This involves determining how to reasonably allocate street space and optimize the environment to create an urban experience that fosters daily life and cultural exchange. In the context of widespread cross-cultural exchange and the growing importance of cross-cultural design, the spatial form of immigrant communities is becoming a key area of interest for researchers. Whether in terms of urban design, neighborhood planning, visual design, or design history, the evolution of Milan's Chinatown offers a representative case study for the design research of immigrant cultures.

For designers, understanding the reasons behind the specific design of a region and making improvements requires an inquiry into the historical and cultural factors that shaped the current phenomenon. It also necessitates a critical examination of design phenomena, looking at design issues from perspectives beyond the discipline of design itself.

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ARCHEOLOGY IN TRANSIT

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ABSTRACT | The paper outlines the research methodology and initial results of the exhibition "Arqueología en Tránsito" opened in Tijuana (Mexico) and San Diego (USA) during two Design Weeks (Tijuana on May 4-5, 2024 and San Diego on September 19-25, respectively). The project employed a collaborative design research strategy involving researchers from Tecnológico de Monterrey across various Mexican territories, from Chiapas to Chihuahua, to collect and analyze artifacts reflecting migrant experience.

"Archaeology is the only way to access the present," philosopher Giorgio Agamben writes at the beginning of his essay "Creazione e anarchia" (Agamben, 2017). Grounded in these premises, the research and the exhibition emphasized the analytical exploration of the relationship between individuals and artifacts as an essential framework for examining the complexities of contemporary migration.

The methodology was centered around generative and co-creative workshops, where participants selected and scrutinized artifacts based on designated criteria. The selected artifacts, which included everyday items such as modified plastic bottles alongside more symbolic objects, transformed from mere silent witnesses into central figures in a narrative that vividly portrays the profound human stories intertwined with issues of migration and borders. The exhibition served as a reflective platform to consider the dynamics of current global borders, highlighting the paradox whereby the construction of more barriers coincides with increased migrations and conflicts. It invited attendees to delve deeper into understanding the objects silently accompanying migrants on their journeys. In addition, this project suggests that the archaeological study of objects can enhance the design process by offering insights into the potential impacts of functional objects. Through "Arqueología en Tránsito," the project

provided valuable insights into the complex interplay between human lives and the objects that are both part of and witness to these life-changing experiences, enriching the dialogue on migration, cultural heritage, and human resilience. Furthermore, the exhibition underscored the transformative power of design and research in fostering greater empathy and awareness about global societal challenges.

KEYWORDS | OBJECTS, HUMANS, BEHAVIORAL CHANGE, COLLABORATIVE DESIGN RESEARCH, MIGRANT EXPERIENCE, GENERATIVE DESIGN WORKSHOPS, ARCHAEOLOGICAL RELEVANCE

Introduction

Mexico is experiencing a significant shift in its migration landscape, transitioning from being primarily a country of emigration to one facing substantial internal migration flows. The country is now receiving an increasing number of migrants who transit through and settle within its territory, along with a rise in the arrival of asylum seekers and refugees. Despite the growing importance of migration, Mexico lacks a comprehensive and coordinated policy to effectively integrate newcomers, leading to potential social cohesion issues and increasing the vulnerability of migrants (Sánchez-Montijano & Ortega, 2022).

Migration patterns between Mexico and the United States have undergone significant transformations in recent years, driven by a confluence of economic, social, and policy factors. These changes have notably affected migration flows' demographics, volume, and nature. The demographic profile of Mexican migrants has diversified, with a noticeable increase in the number of women and older individuals participating in migration. Additionally, the geographic origins of migrants have expanded, now including previously considered stable states (E. Valdez et al., 2015; R. Sáenz, 2015). The migration of women and children from Mexico and Latin America to the United States has been a significant phenomenon in recent years. This movement is driven by various factors, including economic opportunities, family reunification, and the need to escape violence or persecution. Understanding the trends and patterns of this migration is crucial for developing effective policies and support systems. Men primarily migrate for employment opportunities, while women are motivated by both family reunification and economic reasons. Notably, daughters exhibit a high propensity to migrate for work, paralleling their male counterparts. The increase in the number of women and children migrating from Mexico and Central America to the United States can often be attributed to structural vulnerabilities and traumatic experiences (E. Valdez et al., 2015; G. Valdéz-Gardea, 2009; Marcela Cerrutti & D. Massey, 2001). The migration dynamics in Mexico have evolved significantly, with the country increasingly becoming a transit

route for migrants from Central and South America heading to the United States. Various socioeconomic and political factors, including violence, economic opportunities, and immigration enforcement policies, drive this shift. As a result, Mexico has become a crucial transit country for migrants from Central America, particularly from the Northern Triangle (El Salvador, Guatemala, and Honduras), who are fleeing violence and seeking better economic opportunities in the United States. However, the journey through Mexico is fraught with significant violence and exploitation. Migrants often face organized crime and human rights abuses, exacerbating their already precarious situation. Particularly vulnerable are migrants, especially children, who encounter severe humanitarian challenges during their transit through Mexico. These challenges include exposure to violence, exploitation, and inadequate access to healthcare (Benjamin J. Roth et al., 2020; F. M. Flores, 2020; L. Pries et al., 2023; Laura Naranjo et al., 2023; W. Vogt, 2013).

Tijuana, a city on Mexico's northern border, has emerged as a significant hub for migrants, particularly those aiming to enter the United States. Various factors have shaped this role, including legal frameworks, economic opportunities, and the city's strategic location. Notably, Tijuana's position as an industrial center and its location on migration routes from Central and South America to the U.S. attract both internal and international migrants (J. Hennebry et al., 2018; M. Marchand & Adriana Sletza Ortega Ramírez, 2019).

The city's export-processing areas create a complex interaction between local and global labor markets, reinforcing its status as a migration hub. Many migrants initially arrive in Tijuana with the intention of crossing into the United States. However, due to various obstacles, they often settle temporarily, which can become permanent as they find work and other commitments in the city—additionally, deported Mexican men in Tijuana experience a state of "permanent temporality," navigating their lives in a borderscape that mediates their mobility and emotional wellbeing. This phenomenon underscores the complex social and emotional dimensions of migration in Tijuana, highlighting the multifaceted challenges migrants face in this critical border city (Renato de Almeida Arao Galhardi, 2022).

As designers, educators, and researchers, it is essential to understand complex situations deeply through a design perspective. The migration phenomena should no longer be perceived merely as a constant emergency to manage. Instead, it must be approached as a multidisciplinary, interconnected, and complex issue. Addressing migration requires implementing a systemic approach, which allows for a comprehensive understanding of its various dimensions and interdependencies. This exhibition emphasizes the importance of a holistic and strategic perspective in dealing with migration. Specifically, product design plays a crucial role in shaping the relationship between objects and society by creating artifacts that reflect human life's cultural, emotional, and functional aspects. These artifacts act as boundary objects, bridging

knowledge gaps and fostering emotional and identity connections. By learning from long-lasting artifacts for sustainability, understanding the mutual influence between products and societal change, and using previous products as carriers of engineering knowledge, product design underscores its multifaceted role in creating meaningful and sustainable connections between objects and society. Design artifacts promote shared representation, transform design knowledge, mobilize for action, and legitimize design expertise, highlighting the importance of design in our daily lives (D. Orth et al., 2018; G. Mark et al., 2007; L. Bucciarelli, 2002; S. Walker, 2006). The intersection of design and anthropology provides a unique perspective to understand contemporary living conditions, particularly for migrants. By examining material cultures and relational paradigms, researchers can gain deeper insights into the lived experiences of migrants, including their challenges and adaptive strategies. This interdisciplinary approach is crucial for uncovering the complex realities of migrant lives and their socio-economic integration. It enhances our understanding of contemporary living conditions and offers practical tools to support migrants' journeys (D. Schultheiss et al., 2011; P. Basu & S. Coleman, 2008).

With the specific issue of migrations, it is a good start to see what objects are left behind from these activities. The objects that migrants leave behind in inhospitable areas while crossing the border, such as in Sonora, provide us with a deeper understanding of their situation in various ways. Firstly, these objects reflect the bodily techniques and repeated experiences migrants have developed to face the dangers of crossing. For example, the visible wear on shoes, bloodstained socks, and sweat-stained clothing can offer intimate details about the hardships of the crossing process, evidencing their daily suffering (De León, 2013).

This research was genuinely inspired by Jason De León's work by identifying the water bottle as an agent of change: De León argues that the water bottle emerges as a crucial change agent in the migrant experience, particularly in the context of crossing the Sonoran Desert. It is essential for survival, as the lack of water is a leading cause of migrationrelated injuries and deaths, primarily due to hyperthermia. The bottle provides hydration and symbolizes resilience and adaptation in the face of harsh desert conditions and border surveillance. Additionally, water bottles have been modified to attempt to evade Border Patrol detection.

Migrants have adopted black plastic gallon bottles, which are less recognizable from a distance. This adaptation illustrates how an everyday object can become a tool of deception, highlighting the creativity and ingenuity of migrants using their material culture to avoid detection. Over time, changes in the design and use of these bottles reflect the socio-economic and political conditions migrants face. For example, before 2009, many bottles were clear plastic, making them more detectable. The shift to camouflaged bottles indicates a response to increased border security.

Furthermore, some companies have capitalized on the preference for black bottles among migrants. After 2009, certain companies began producing black plastic gallon bottles, reflecting a technological shift in response to migrant necessities. Migrants perceive these dark bottles as a tactical advantage for avoiding detection, although this assumption does not always hold up against the surveillance technology used by authorities. In addition, the year 2009 emerged as a significant chronological marker for archaeologists, distinguishing a clear shift in bottle color from white to black. This change is particularly noteworthy as it illustrates the dynamic relationship between supply and demand; the necessity for adaptation prompted a response from the market, which accommodated to this new demand. Finally, the repeated use and recontextualization of the water bottle by migrants reveal patterns of suffering and vulnerability. Dependence on these objects while navigating a hostile environment normalizes the experience of migration, which is fraught with constant risks.

In summary, the water bottle symbolizes the struggle for life and resilience in a context of violation and oppression, playing a central role in the experiences and hardships of migrants attempting to cross the border (De León, 2012). Understanding the complexities of artifacts and their relationship with people and culture is essential for design scholars. This knowledge aids in creating designs that are not only functional but also culturally relevant and meaningful. The water bottle example by De León serves as an excellent case study for this research. We also recognize that the outcome of this research should be an exhibition. Research like this, disseminated through public exhibitions, can engage participants in community conversations and elicit thoughtful, in-depth responses. Collaboration between academic researchers, curators, and designers is crucial in presenting academic research in an engaging and visually appealing way in physical exhibitions (Alyssa Tang & I. Nakarada-Kordic, 2022; Anda Boluža, 2023)

Methodology

The School of Architecture, Art, and Design (EAAD) at Tecnológico de Monterrey holds a unique position compared to other institutions due to its presence on 19 campuses nationwide (ITESM, 2024). This provides a significant opportunity to conduct research incorporating diverse perspectives, localities, and scopes to understand migration through the artifacts left behind by migrants.

Criteria

To effectively identify, evaluate, and align the criteria for this study, we needed to efficiently involve various design researchers, faculty members, and other stakeholders.

Given the impracticality of gathering all participants in a physical space, we faced the challenge of engaging faculty members in a time-effective manner. We needed to

involve them quickly, allowing them to work independently while producing high-quality content. The first challenge was to align how all participants analyze the objects through specific criteria. Aligning research criteria and analysis is crucial in design research and archaeology, especially when analyzing artifacts. This alignment ensures that the methodologies used are appropriate for the research questions and hypotheses, leading to more reliable and valid conclusions (Hoadley, 2004).

The first criterion was to analyze the relevance between fabrication and use. Understanding the intersection of design and manufacturing enables design scholars to create designs that are not only innovative but also feasible and efficient to produce (Fillingim et al., 2020; Pradel et al., 2018). By applying this criterion, we excluded informal and handcrafted artifacts that might present attractive individual solutions but fall outside the scope of this research.

The second criterion analyzed how emotionally charged the objects were, as this can create a significant emotional connection with their users (D'Souza et al., 2010).

The third criterion considered the product's impact on behavioral change among individuals, industries and institutions. Understanding objects as agents of behavioral change allows designers to integrate key insights from behavior change theory into the traditional design process (Cash et al., 2017).

Finally, the last criterion analyzed the archaeological relevance, which was necessary to understand this particular situation's contemporary narratives. The water bottle served as an excellent example for understanding more objects that would build this exhibition research, assuring that our design researchers could find similar, impactful artifacts:

1. **Fabrication and Use:** Water bottles are essential for migrants, serving as practical objects designed to help them survive in a hostile environment. They are crucial for providing the necessary hydration to combat hyperthermia in the desert, effectively keeping people alive.
2. **Emotionally Charged Objects:** For migrants, water bottles symbolize the struggle for survival and the experiences endured during a dangerous journey. These objects become touchpoints connecting to the personal narratives of those attempting to cross the border, evoking emotions of hope and despair.
3. **Agents of Behavioral Change:** Migrants' selection and use of water bottles influence their behavior and interactions with their environment. Migrants understand that using dark-colored water bottles might help them avoid detection by border authorities, representing a shift in their survival strategies despite potential health consequences. And the bottle has also has an impact on the local area by causing a behavioral change in some entrepreneurs who have been starting to produce the bottle using the color black since 2009.

4. **Archaeological Relevance:** Water bottles, commonly found at migrant stations, allow for studying the use and evolution of border-crossing practices over the years. Analyzing the "use" of these bottles highlights patterns reflecting migrants' suffering and experiences, providing valuable insights into the historical and contemporary narratives of migration.

As we can see, water bottles not only fulfill practical functions but are also intrinsically linked to migrants' emotional narratives and the changes they provoke in their behaviors and surroundings. This multifaceted understanding is crucial for design scholars aiming to create culturally resonant and impactful designs.

Co-Creative Workshops

Having established criteria, we needed to design a way to bring all interested participants together for collaboration. We decided that remote co-creation workshops were the most cost-effective method. Utilizing platforms like MIRO and Zoom, these workshops effectively united diverse stakeholders to align criteria, workflows, and quality standards in archaeological analysis. They offered increased flexibility, reduced costs, and high levels of engagement and interactivity (A. Boone et al., 2023).

We designed the co-creative activities in two workshops. The first workshop focused on brainstorming, where participants identified artifacts in their localities related to migrants. Early brainstorming sessions are valuable for initiating archaeological research, especially involving many participants (Runa M. Korde & P. Paulus, 2017; T. Connolly et al., 1993). Each participant then used MIRO boards to analyze the artifacts, focusing on fabrication and use, archaeological relevance, emotional impact, and their role as agents of behavioral change. The session concluded with presentations and feedback from the group.

Following the brainstorming session, participants conducted self-managed research using ethnographic interviews, news articles, and academic papers to validate their ideas. Integrating evidence from these sources is essential for generating comprehensive insights. Academic papers provide rigorous, peer-reviewed data; news articles offer timely and broad coverage; and ethnographic interviews deliver deep, contextual understanding. By combining these sources, researchers can achieve a more balanced and thorough perspective, enhancing the reliability and depth of their findings (Michael K. Martin et al., 2013; Simon Cottle, 2007). This validation process took about two weeks. The second workshop was then held to present the results and select the most exciting artifacts identified by participants. Invitations to the online co-creative workshops were distributed through the design department chairs in each region, resulting in about 15 participants.

One challenge we faced was that some participants needed help understanding the importance of the constraints of the criteria, often disregarding the manufacturing

criterion and bringing artifacts that were more anecdotal than empirical. These anecdotal artifacts were not selected as participants could not find further evidence of their importance. Another challenge was commitment. Some participants who attended the first session did not participate in the second one; if they did, they needed to work more on validating their findings. While commitment issues may go beyond our methodology, group research activities must combine group and individual participation and validate findings through ethnographic research, academic papers, or news articles. Nevertheless, after this exercise, we collected many artifacts that provided valuable insights into the migrant situation in Mexico.

The Exhibition

The objects selected for the Tijuana Design Week 2024 were clustered for the exhibition curatorship according to 5 macro areas, representative of the changes in behavior that occurred at the company, migrant, user, and designer levels (figure 1).



Figure 1. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024



Figure 2. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024

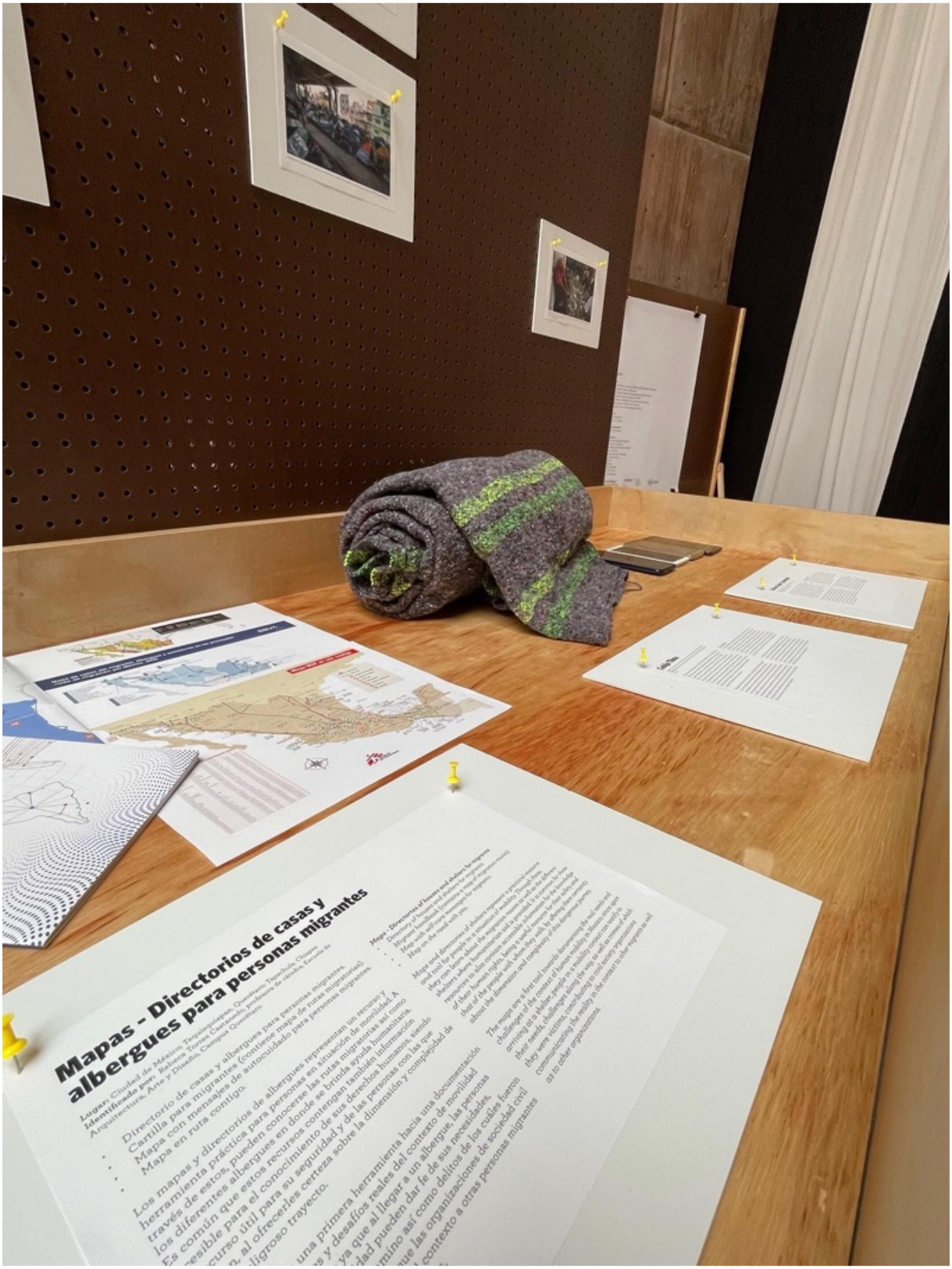

Figure 3. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024



Figure 4. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024



Figure 5. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024



Figure 6. Exhibition Arqueología en Tránsito at CECUT, Tijuana, May 2024

1) The first section is **"Tools"**. The tools migrants use are vital to their journey toward the border area. These tools include a wide range of resources and equipment that enable them to overcome obstacles and navigate unknown territories safely. Among them, we find ropes, which serve as anchors and support while crossing rugged terrains, ensuring a safer passage. Colored bracelets identify migrants, encoding important information such as their place of origin, health status, and those who have paid a fee to cross. Modes of transportation, such as trains, buses, planes, and trucks, are another crucial element, allowing migrants to cover long distances efficiently and economically. Shoes are a fundamental item, often overlooked but extremely important, as they provide protection and support during long walks on variable terrains, including paved roads, rugged trails, or arid deserts. The objects included here are as follows:

Polypropylene Hollow Braided Rope:

The rope is a historical object whose use has persisted across various cultures since prehistoric times. It is an instrument employed in many fields, including construction, navigation, sports, and recreation. In the absence of safe mobility options, undocumented migrants seek irregular migration routes to reach U.S. territory. Often, these routes are well-known by smuggling groups, coyotes, or organized crime bands, who, in exchange for large sums of money, promise to help migrants cross through "weak" points of the border with less surveillance or seemingly lower risk. However, any situation endangers their integrity. The Mexico-U.S. border has become the "most dangerous" land migration route in the world, according to the United Nations (UN), with a significant number of deaths due to drowning. Ropes have become a commonly used tool among these smuggling groups, who use them as a safety measure to face the currents of the Rio Grande and to help groups of migrants cross into U.S. territory.

Location: Piedras Negras and Ciudad Juarez.
Identified by: Zara Alexandra González Aguirre, Director of ESC Entry and Director of the LDI Program, Campus León.

Camouflaged Shoes

The shoes worn by migrants along their journey between Mexico and the United States are emblematic of the migration experience, representing one of this journey's most significant and symbolic objects. These shoes can be considered part of the "tools" category for migrants, playing an instrumental and functional role in the migration process and being indispensable for reaching the desired destination.
The footprints left on the soles and the evident wear are tangible testimony of the challenges, efforts, and sufferings people face during their journey. These marks not only tell individual stories but also represent a tangible symbol of the collective struggles

and shared experiences of migrants on their path to a new life. Some models of footwear used by migrants are modified to minimize the footprint left on the ground during their journey. These shoes are characterized by having additional layers of material, such as carpet or other soft fabrics, applied underneath the sole. This measure plays a crucial role in optimizing the effectiveness of such footwear in masking footprints. In the desert context, where even a minimal footprint can attract the attention of authorities or individuals monitoring the border, these additional layers can enable a more discreet crossing and avoid detection.

Location: Sonoran Desert.
Identified by: Pier Paolo Peruccio, Visiting Professor at the School of Architecture, Art, and Design, Campus Mexico City.

Bracelets

Plastic wristbands commonly used for identification and control at events, concerts, and hospitals emerge in the migration context as a perverse strategy to mark and categorize people who, unfortunately, traverse territories governed by cartels. These bracelets, often brightly colored and inscribed with the words “deliveries” and “arrivals,” indicate that the wearer has paid their “ticket” to access areas controlled by coyotes and clandestine networks, allowing them to continue their journey. For migrants, they represent an “amulet” or “code” that provides some security against robbery, kidnapping, or even death. Each bracelet carries an emotional and significant information load: it reveals personal stories names, has been in contact with the wearer’s skin, indicates how much they paid and consequently their status, where they have walked, and who the traffickers involved are. The cost of these “protection” bracelets ranges from 300 to 700 dollars, a sum that goes directly into the pockets of the cartels that plan these operations. These sophisticated and structured criminal organizations have created a “business model” that ruthlessly profits from the dignity of vulnerable human beings desperately seeking a better life.

Location: Banks of the Rio Grande, U.S.-Mexico border.
Identified by: Edgar Ludert, Regional Director of Art and Design, Campus Sonora Norte.

2) The second area of investigation is **“Evolving Needs.”** The “Evolving Needs” section aims to highlight the ongoing changes in the profile of immigrants. Until about ten years ago, the migration flow across the United States-Mexico border was mainly composed of young single men from rural areas, especially from Mexico. The migration landscape has changed considerably: families, often with children, are the primary migrants crossing the border. Even the objects left behind or forgotten by migrants reflect this new identity: alongside backpacks and caps, we now see baby slings for carrying infants during the journey, document holders for the family, or simply stuffed animals. These

are now the essential accessories of the journey. Here we have the following items selected for the exhibition:

Fular

The northern regions of Central America, Mexico, Haiti, and Venezuela host one of the largest and most complex child migrant crises in the world. Currently, the largest group of child and adolescent migrants consists of those under 11 years old, representing up to 91% of displaced children. Some flee violence, political persecution, and extreme poverty, compounded by political conflicts, climatic phenomena, and the chronic dysfunction of state institutions. Others leave accompanied by their parents seeking more significant opportunities and a better future for their children or wanting to reunite with family abroad. Additionally, it is essential to note that many women in transit give birth along the way, although there are no exact figures. The physical risks along these irregular routes are innumerable, especially for children. Parents traveling with their infants use the full as a means of transportation to provide warmth and containment and ensure infants' care and integrity in migration situations. "This year in Latin America and the Caribbean, a record number of children in transit on the main migration routes has been reached. Even more worrying is that the majority group of child migrants is made up of those under 11 years old," said Garry Conille, Regional Director of UNICEF for Latin America and the Caribbean.

Location: Migrant Caravans from Honduras, Haiti, Guatemala, and Mexico.
Identified by: Zara Alexandra González Aguirre, Director of ESC Entry and Director of the LDI Program, Campus León.

Document Holder Bag

Identity and health documents, along with family photographs, are more than just papers for migrants; they are symbols of resistance and humanity in contexts where fundamental rights are denied. These artifacts carry the narratives of their lives, roots, and hopes, revealing stories of struggle and connection with often distant loved ones. Each document affirms identity and existence, demanding recognition and respect from the institutions responsible for protecting migrants. These emotional objects act as tools of modern archaeology, allowing the discovery and retelling of hidden narratives of resistance through the ages. Essentially, documents and photographs are living testimonies of human dignity, challenging perceptions and social dynamics and fostering change toward greater understanding and protection of migrants in our contemporary world.

Location: Querétaro, Querétaro.
Identified by: Rebeca Torres Castañedo, Professor at the School of Architecture, Art, and Design, Campus Querétaro.

Plush Toy

Historically, plush toys have been companions for children in various contexts; in the case of migration, they become valuable companions. They vary depending on personal taste and are mostly simple and industrially manufactured, although some can be crafted or handmade by their families. Their primary purpose is play, but they often become more than that. They should be light, soft, and preferably small to be carried throughout the journey, as there is only space for the essentials during the trip. In many cases, they are also used as pillows and comfort objects, showing a strong connection between the children and their families during migration. These objects are laden with stories and emotions that remind children they are loved. They are gifts from parents or grandparents that become friends and loyal companions, even helping children feel brave and protected when separated from their families. In other cases, plush toys are given to children in migrant shelters or refugee centers to lighten the emotional burden of the journey. They have also been used in campaigns and protests, symbolizing the innocence and rights stripped from children when separated from their families.

Plush toys represent the significant change in migration trends. Initially, migrants were single men who had left their families searching for a better future for them. Later, couples migrated, and then pregnant women migrated. Currently, whole families are migrating with small children.

Location: Monterrey, Nuevo León.
Identified by: Griselda Esthela Oyervides Ramírez, Assistant Professor, Department of Design, Tec de Monterrey, Campus Monterrey.

3) The third is the **"Functional"** section. It focuses on practical and functional tools that facilitate migrants' journeys in all aspects. Among these, the cell phone stands out as an essential travel companion for migrants: the device offers a wide range of crucial functionalities during the journey, enabling quick and reliable communications with family and friends and access to vital information such as maps and other services. In addition to digital maps, migrants also carry physical maps, which are more reliable because they are consistently functional, independent of phone infrastructure, and provide valuable information about essential services, such as the location of shelters, food and water distribution points, and safe resting areas. Blankets and other accessories to protect against cold or adverse weather conditions are also essential for facing problematic conditions along the migration route. These devices can make the difference between the success and failure of a journey, especially considering the long distances and environmental challenges that migrants must face on their way. The following items were selected in this section:

Maps - Directories of Migrant Houses and Shelters

The directories of houses and shelters for migrants represent a practical resource and tool for people in mobility situations. Through these, migrants can learn about migratory routes and the various shelters providing humanitarian aid. It is common for these resources also to contain accessible information about their human rights, serving as a valuable resource for their safety and the people they travel with, offering them certainty about the dimension and complexity of this dangerous journey. Maps are a primary tool for documenting the real needs and challenges of the human mobility context in Mexico; upon reaching a shelter, people in mobility contexts can attest to their needs, challenges along the way, and crimes they were victims of. These maps contribute to civil society organizations communicating the reality of the context to other migrants and organizations.

Material and Manufacturing Process: Digital Printing on Couché Paper, Bond, or similar.
Location: Mexico City, Mexico; Tequisquiapan, Querétaro; Tapachula, Chiapas (most houses/ shelters have this material).
Identified by: Rebeca Torres Castanedo, Professor at the School of Architecture, Art, and Design, Campus Querétaro.

Tilma Blanket

In various shelters in Mexico City and other regions of the country, blankets are widely distributed to migrants, becoming an essential and common item among them. This textile, characterized by its softness to the touch, offers refuge against the cold, providing a sense of warmth and tranquility to those who often face adverse conditions. The design of these blankets generally features a grid graphic in various scales and colors, adding an element of visual diversity that breaks the monotony and reflects the cultural variety of the users. Besides serving as a personal cover, these textiles have a multifunctional use within the shelters; for example, they are used as insulators in tents, offering additional protection against the cold ground. This versatile use of blankets not only improves the temporary living conditions of migrants but also provides small yet significant comfort in their arduous journey, demonstrating how a simple object can profoundly impact the daily lives of people in vulnerable situations.

Material and Manufacturing Process:
30% Cotton, 30% Polyester, 30% Acrylic, 10% Various.
Location: Migrant camps in major city centers (Mexico City).
Identified by: Gerardo Sandoval Osio, Full Professor, Campus Mexico City.

Cell Phone / Smartphone

Cell phones have transformed the way migrants travel. Thanks to technology, the migratory journey seems more manageable and more achievable. Digital maps and real-time location allow them to find directions and follow routes without getting lost. Instant messaging and internet access provide communication channels with smugglers and coyotes who offer their services for border crossing through social media posts, somewhat professionalizing these human trafficking services. On the other hand, cell phones allow migrants to keep in touch with their families occasionally and have photographs of their loved ones. These objects strongly speak of human connections; a cell phone in today's culture is an extension of the person, carrying significant information and the intimacies and stories of the owner. In this sense, it functions as a double-edged sword: providing security through contact with loved ones while increasing the chances of being located, leaving a trace of their crime when crossing the border.

Material and Manufacturing Process:
Cell phones are manufactured through various industrial processes and assembled in manufacturing cells. Regardless of the brand, modern cell phones are made from a wide variety of materials, such as aluminum, copper, plastic, cobalt, tungsten, silver, neodymium, gold, indium, and palladium.

Location: Monterrey, NL.
Identified by: Griselda Esthela Oyervides Ramírez, Assistant Professor, Department of Design, Tec de Monterrey, Campus Monterrey.

4) The **"Emotional"** section delves into the most emotional dimension of the migratory journey. It examines how particular personal objects gain significant importance on the emotional level for migrants. These objects range from family photographs to religious items such as the Bible or a rosary and even include identity objects like the flag of the country of origin or a hat of a specific color. The portfolio stands out among this range of objects, undergoing a transformation in its function during the journey. From simply a container for money, it becomes an organizer for images or other elements of symbolic personal value. The objects included here are as follows:

Phillies Cap

In daily life, caps are helpful for outdoor activities. In the migrant context, caps offer protection against the sun and rain and serve as a representative object for a person in a state of mobility. White caps are the most characteristic because their color helps reflect sunlight and prevents the head's temperature from rising. Additionally, this color symbolizes peaceful transit; in contrast, dark or black caps are associated with criminal groups. Strong bonds form between groups traveling together throughout the journey. They rest in the same shelters, eat together, take care of each other, and often

only cross once everyone is ready. In the case of the Phillies, the cap goes beyond its purpose of sun protection; it symbolizes the union of a group in a state of mobility. Additionally, it serves as a place to write down phone numbers or other personal information so that in case of death, this information can help identify the body and locate their relatives. “It was more of a gift to distinguish ourselves from each other,” adds Elmer Josué Rivera, a native of Santa Bárbara. “They saw that we got along very well and gave them to us.”

Material and Manufacturing Process: Personal accessories made from common materials such as synthetic fabrics, cotton, polyester, plastic, and embroidered brands that are predominant in our visual culture. Their practical and functional purpose is mainly to protect the head from the sun, offer shade to the eyes, and protect the face from rain and sweat. They can also be used as a form of personal expression or style. Manufacturing a cap involves several steps, including material selection, cutting, assembling, sewing, and finishing.
Location: This object was identified in a migrant caravan from Honduras to Mexico. Among the sea of people, 18 men and 2 women stand out, all wearing the same cap: the Phillies of Philadelphia. These are the Phillies of Honduras, or the Red Cap group, friends who met during the journey and now want to arrive and live together in the United States. (https://www.plazapublica.com.gt/content/personajes-de-la-caravana-migrante-los-phillies-de-honduras)

Identified by: Zara Alexandra González Aguirre, Director of ESC Entry and Director of the LDI Program, Campus León.

Wallet

Wallets, commonly used by migrants, function as essential objects for storing money and important documents such as IDs and photographs, prayers, and personal mementos. These objects are foldable and have multiple compartments that facilitate access and organization of their contents, making them portable guardians of personal stories and symbolic values. In the migratory context, wallets acquire a more profound meaning by transforming into “containers” of migrants’ identity and memory. These objects not only hold items of economic value but also carry significant emotional weight, being repositories of the ties and memories of loved ones left behind. The variety in their designs, from dark leathers to colorful embroidered fabrics, reflects the diversity of their owners and their cultures, contrasting visibly with the personal images and saint cards they protect, evidencing their faith and hopes. Laura M. Holson relates a relevant anecdote in The New York Times, where Tom Kiefer, a janitor at the Customs and Border Protection Office in Arizona, discovered numerous discarded wallets in 2012, still with intact IDs and credit cards. “It was so cruel. They were safe with me, but it didn’t seem right that a janitor could find these things. They should be secure,” Kiefer commented. This story highlights the vulnerability of migrants and the importance of these objects as links to their identity and dignity.

Material and Manufacturing Process: Wallets, traditionally made from tanned leather in black or brown colors, have evolved in design since the late 20th century, diversifying into materials such as PVC and embroidered fabric and enriched with a variety of colors and designs since the 1980s, following the introduction of Velcro closures in the 1970s.
Location: The Border Patrol finds these items as confiscated items and takes them to the Customs and Border Protection Office, where they are cataloged, stored, and discarded.
Identified and Reconstructed by: Luis Arturo Gil Islas, M.A. Professor and Coordinator of Transversal Concentration in Design, Innovation, and Technological Entrepreneurship, Campus Estado de México.

Scapular

Scapulars, more than simple garments or accessories, are symbols deeply rooted in Catholic religious tradition. Initially, scapulars manifested devotion, representing the yoke of Christ, and were worn by monks and nuns as part of their religious habit. However, in the hands of Norma, a Honduran migrant sheltered in an association in Chiapas, they acquire a new dimension of meaning and transformation in the migration context. These scapulars, acquired by Norma and her daughter before embarking on their dangerous journey to the United States, represent their faith and their search for divine protection in a journey filled with uncertainty and danger. As they face the journey's challenges, the scapulars become emotional anchors, reminding them of their connection to faith and their desire for safety for themselves and their daughter. As they progress, the scapulars acquire new layers of meaning, transforming from simple devotional objects into potent symbols of hope and resilience amid adversity. They are silent witnesses to their determination and maternal love, providing comfort and strength in the most challenging moments of the journey. In this sense, Norma's scapulars illustrate how traditional religious objects can adapt and acquire new meanings in the migration context, serving as sources of comfort, protection, and hope for those facing extraordinary challenges in their quest for a better life.

Location: Chiapas, at the Hospitality and Solidarity A.C. shelter.
Identified by: Zita Carolina González Guzmán, Full-Time Professor, Campus Guadalajara.

5) Finally, the **"kit"** section represents a set of essential food products, ranging from tortillas to rice beans and nutritional bars and water, designed to face the migratory journey. These kits are primarily conceived and produced for humanitarian purposes by people who care for migrants, such as "Las Patronas," and by humanitarian associations and organizations. Besides food, the kit includes sanitary towels, specific medications for menstrual pain, and personal hygiene products. These elements are a significant indicator of the evolving migrant profile, with increasing attention to the female gender. Including specific products for female needs indicates greater awareness and sensitivity

to the challenges and requirements of women migrants. This highlights a shift in how society and humanitarian organizations address and understand the complexities of the migratory phenomenon, recognizing the importance of considering gender as a significant factor in providing assistance and support to migrants during their journey. The items shown in this section are:

Migrant Kit

The migrant kit includes wet wipes, a roll-on deodorant, a razor, a 500 ml water bottle, a small sunscreen, a sizeable black-handled bag, a small toy if the recipient is a child, and a map of migrant houses, shelters, and food kitchens along the main migration routes in Mexico. To avoid theft, these items are provided inside a conventional, unmarked plastic bag to migrants passing through Casa del Migrante Galilea in León, Gto. Migrant kits provide people in mobility situations with essential items to meet their basic needs, even for a short time. Addressing needs such as food, hygiene, and medical care helps preserve people's dignity regarding mobility, including a toy for children that explicitly targets their emotional well-being and helps mitigate the psychological impact of migration. The specific contents of migrant kits can vary depending on the context, migration routes, and the particular needs of people in mobility situations.

Location: Human Mobility Center Casa Del Migrante Galilea, A.C. in León, Gto.

Identified by: Zara Alexandra González Aguirre, Director of ESC Entry and Director of the LDI Program, Campus León.

Food and Water Bags for Direct Aid on Train Tracks

Thousands of people in human mobility contexts use freight train cars to cross Mexico. Known as "La Bestia" or "The Death Train," migrants are exposed to high temperatures, without water or food reserves, organized crime, and security guards patrolling the trains. The train, connected to Mexico's railway network, often passes through different communities where many residents, primarily laypeople, live their faith radically by providing food, water, and personal hygiene items to migrants traveling on the freight train.

In Tequisquiapan, Querétaro, a family-formed civil organization, has dedicated over 20 years to assisting people in mobility contexts. Each day, they provide direct and immediate humanitarian aid to an average of 400 migrants. This organization is mainly sustained by donations and is known among migrants for the bread and cakes often included in the food bags. It is common to hear migrants shouting, "Thank you, mother," as the train passes.

Location: Estancia del Migrante González y Martínez, A.C. Tequisquiapan, Querétaro.
Identified by: Rebeca Torres Castanedo, Professor at the School of Architecture, Art, and Design, Campus Querétaro.

UNHCR Kit

Menstruation during mobility poses a significant challenge for women and adolescents. UNHCR, known for its work with asylum seekers and refugees, provides self-care kits that are not conditional on refugee status. These kits include essential items such as sanitary pads, laundry soap, diapers, and multipurpose soap, which are crucial for personal hygiene and well-being. In Mexico, some civil organizations complement these kits with emergency pills, addressing the gender-based violence faced by women in mobility. During an interview, the experience of a teenager who had her first menstruation in transit was highlighted. Access to this kit allowed her mother to explain the changes in her body, making the experience less traumatic. This support addresses immediate needs and dignifies women and girls in migration contexts, recognizing their specific challenges from a gender perspective. The kits, funded by civil society, not only provide essential items such as food and water but also emphasize the complexity of gender needs in migration and humanitarian aid efforts, underscoring the importance of hygiene and ongoing care in the lives of migrant women.

Location: Estancia del Migrante González y Martínez, A.C. Tequisquiapan, Querétaro.
Identified by: Rebeca Torres Castanedo, Professor at the School of Architecture, Art, and Design, Campus Querétaro.

Conclusion:

"Arqueología en Tránsito" provides a window into the human stories behind each artifact, inviting deep reflection on migration and its inherent challenges . Through these objects, visitors gain insights into the complexities of migratory experiences and the indomitable hope of those seeking new lives far from home. The exhibition underscores the transformative power of design and research in fostering empathy and awareness about global societal challenges. From an academic perspective, this project illustrates that archaeological analysis of objects can significantly contribute to the design process by providing a foresight into the potential impacts of functional items. For designers, it is crucial to consider not only usability but also the emotional resonance of a product to enhance the overall user experience (Demir et al., 2009).

There are more than 80 borders worldwide, most erected in the past two decades. Despite this, increased barriers correlate with heightened migration and conflict. The exhibited objects, representing human suffering and resilience, underscore the deep-rooted human instinct for creating boundaries, tracing back to Jericho's earliest known barriers from 12,000 years ago. Barrier, wall, fence, and fortification indicate a physical infrastructure or natural element (like the Mediterranean) separating two or more sides. They can all evoke a range of ideas, including separation and terror. After the terrorist attacks of 11 September 2001,

and especially in the last two to three years, they seem to be playing a central role again around the world.

The theme of the exhibition is, therefore, very relevant. Once silent witnesses, objects speak to us of human suffering and become protagonists of a diverse migration narrative. Moreover, the subject and research methodology can be easily replicated in other geographical contexts with partners such as local universities and non-profit organizations working with migrants. Based on the behavioral changes provoked by objects, we envision replicating this investigation methodology in locations currently central to migration flows, such as southern Italy, a primary destination for migrants from Africa heading to northern Europe. The scalability of the research and the potential design of an exhibition to present the findings will need to be evaluated on a case-by-case basis with local partners. Furthermore, this approach underscores the research's universal relevance and adaptability, making it a powerful tool for understanding migration dynamics in different regions. By collaborating with local entities, we can ensure that the exhibitions resonate with each area's specific experiences and contexts, thereby enriching the overall narrative and impact. This strategy not only enhances our comprehension of migration but also fosters a more nuanced and empathetic dialogue about the experiences of migrants worldwide.

1 The exhibition was part of Tijuana Design Week which was held from the 1st to the 5th of May at CECUT in the City of Tijuana. Attended by design professionals and students, primarily from the San Diego-Tijuana region and bilingual in Spanish and English, it also attracted design enthusiasts and users from the same region, mainly from the middle class, as well as the general public and casual visitors, including organic visitors to showrooms, tourists, and attendees of CECUT and its surroundings. The event, held in over 40 venues, featured more than 300 designers and drew an estimated 8,000 attendees over the 5 days. This included 3,796 participants via the WHOVA app and approximately 3,400 visitors to showrooms, with 60-100 attendees per day (Tijuana Design Week, 2024). The exhibition also served as a reflective platform to consider contemporary border dynamics. It gained recognition within the local design community and was featured by the San Diego Local Press (Aere, 2024). Furthermore, the exhibition was opened in San Diego in September 2024 as part of San Diego Design Week, following an invitation from the board of the World Design Capital. Additionally, the School of Architecture, Art and Design at Tec de Monterrey is working on book on the exhibition, which will include a catalogue of the objects and detail the research methodology employed.

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EXPLORING THE CONCEPT OF MULTIESPECIES DESIGN: PERSPECTIVES FROM MEXICO.

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ABSTRACT | Since the 1970s, a network of disciplines has emerged to address the environmental crisis, starting with biological and atmospheric sciences and expanding to include international environmental law, engineering, and design. Our understanding has evolved from the human environment to sustainability, and now concepts like biophilia, biomimicry, regeneration, circular economy, and life-centered design are prominent. Intersections between ethology, epistemology, philosophy of mind, and posthuman studies are offering new ways to consider worlds beyond humanity. The interest in multispecies or more-than-human design stems from the political nature of design, which challenges our behavior towards other life forms and our planet.

Experts argue that the current crisis demands a new language to reveal systemic frictions and reassemble our understanding of the world beyond cyborgs and hybrid networks. This era of kinship and hyper intelligence involves reinventing relationships and meanings with non-human intelligence, present in our daily lives with agency and complexity. This shift towards a planetary ethic seeks to foster deep empathic relationships with other species and address the multicrisis we face.

Ecophilosophical and ecopedagogical principles are being incorporated into education to build new forms of human action and mutualism. This study aims to historically review and integrate paradigms of life-centered, non-human, and multispecies design into designer training. The research focuses on Mexico, highlighting environmental and social degradation, threats to ecological balance, and the potential of multispecies design to offer new thinking and practices. The final part presents case studies from Mexico, illustrating how multispecies design can drive innovative solutions.

KEYWORDS | MUTIESPECIES, DESIGN, BIOINFRASTRUCTURE, MEXICO, DESIGN HISTORY

1. Introduction: changing towards the non-human

Understanding ecological systems and climate dynamics is now a matter of design (Nardi, 2019). But it was during the 1970s that several disciplines emerged to confront the environmental crisis. First were the biological and atmospheric sciences that influenced international environmental laws (Botkin & Keller, 1999; Gunningham, 2009; Krupp & Wann, 1994), that addressed transboundary pollution and protection of global commons (Bollier, 2013). The significant agreements, mostly during the 1980s, about our commons such as the Our common future report (Brundtland, 1987), Kyoto Protocol (Böhringer, 2003) and the Paris Agreement (Seo, 2017) placed sustainable development as a priority. Engineering disciplines adapted to these challenges by focusing on sustainable development efforts and green technologies, creating innovations in renewable energy, waste management, and sustainable infrastructure (Chan et al., 2022) which in most cases were anthropocentric.

Design disciplines began to integrate principles of ecology and sustainability, leading to the emergence of ecological design and sustainable design (Anker, 2010; Birkeland, 2002; Chapman & Gant, 2007; Egenhoefer, 2017) on the 1990s, which helped to minimize environmental impact through thoughtful material selection, energy efficiency, and lifecycle analysis (Andersen et al., 2022; Braungart & McDonough, 2009; Koltun, 2010) transforming industry and consumption at the beginning of this millennium.

Nowadays our understanding of how we relate to our environment places us to shift the sustainability paradigm (Boehnert, 2017). Today, at the design academy, we talk about biophilia (Rosley et al., 2014), biomimicry (Kellert, 2016), regeneration (Wahl, 2016), circular economy (Lofthouse & Prendeville, 2018), and very recently life-centered design (Borthwick et al., 2022) , non- human-centered design (Ooms et al., 2022), and ultimately multispecies design (Gionata Gatto & John R. McCardle, 2019). These terminologies are manifesting new intersections between ethology (Beaujouan et al., 2021), epistemology (Price & Chao, 2023) and post-

humanities (Forlano, 2017; Nicenboim et al., 2023) offering original arguments to think about worlds beyond humanity. Such transdisciplinary phenomenon suggests that design studies are approaching a new era.

Hence, this research is raising a question from the design academy and our current contemporary society: Why are we interested in understanding the conceptual genealogy of multispecies or more- than-human design? If every design seeks to solve or question a situation, problem or conflict, which is always political or challenges our conception of reality. Are we humans capable of changing our behavior in relation to other life forms? Why design, as discipline, is now making agency towards these life-meaning inflections?

Experts affirm that the current crisis needs a new language (Stibbe, 2020), looking to uncover a system that is constantly creating frictions and seeking to disassemble and reassemble the facts of the world (Ekomadyo & Yuliar, 2015; Latour, 2009), beyond cyborgs and hybrid networks (Fuller, 2021; Wilson, 2009).

This new era of kinship in which we are reinventing our relationships and meanings in a world of a more-than-human intelligence (Haraway, 2016; Tsing, 2021) is present in our everyday life with all their agency, complexity and knowledge. Our time of hyper intelligence is also called an era of enlivenment (Weber, 2019), novacene (Lovelock, 2019) or symbiocene (Albrecht, 2019) which denotes a change and moral behaviors towards a planetary ethic. Through such notions we do not seek to decentralize design for our human centredness or sensitivity to be humane but to expand the capacity of the designer; and along with other disciplines such as anthropology or biology to promote new capabilities, expand our collective intelligence towards the non-human.

It is an urgent need to create deep empathic relationships with other species in our built environment to face the multicrisis (Nathwani et al., 2021; Wijkman & Rockström, 2012) we are living in. To solve this several ecophilosophical and ecopedagogical precepts have already been incorporated into new educational schemes to build new forms of human action and mutualism. Such as the ecoliteracy movement (Kahn, 2010; Stone, 2017) or deep ecology (Anderson & Guyas, 2012; S. Harding, 2009; Sessions, 1995) where in some cases triggered the conformation of new schools, such as Schumacher College (S. Harding, 2011) or new educational programmes like Permaculture courses (Cassel & Cousineau, 2018; Zimmer, 2016) This brief 'localized' study aims to develop an understanding of these notions and what are the efforts we are making as academics. The following section (2) refers to the state of the art and which are the genealogies that place us on this kind of multispecies studies. Section 3 present Mexico as case study and Section 4. presents examples of what we can call bioinfrastructures and affordances. Our study is part of the Advanced Design Processes for Sustainable Transformation research group.

2. State-of-the-Art and Genealogy

2.1 Historically review

The state of the art of multispecies studies is at the same time very old, and very young and innovative. All human cultures have their own philosophies and cosmovisions about nature and non- human intelligences and interactions with them. In the Western tradition probably the first thinker on these issues was Aristotle, who was Plato's student but eventually departed from his teacher in important respects, because investigated areas of philosophy and fields of science that Plato did not seriously consider. Aristotle was a sharp observer of nature, and developed an early theory of biology, centered on his thoughts about change and form. His theory is very comprehensive, it covers everything from metabolism to information processing and inheritance. He wrote several books on biology, and they are about a quarter of his writing that exist today. They are the *History of Animals, Generation of Animals, Movement of Animals, Progression of Animals, Parts of Animals, and On the Soul. His student, Theophrastus, wrote Enquiry into Plants (Bos, 2010)*. The biology works of Aristotle were influential well into the beginning of modernity, when scientists like Galileo and William Harvey rejected his errors, but his observations about marine biology are well respected. He was the first who tried to explain the color changes in the octopus.

Multispecies design is an emergent field of study, with different points of origin, from biology, but also from anthropology, history, epistemology, ecology, geology and other disciplines. Design has been changing rapidly in the last century. Its name has changed too, from being industrial design to ecological and sustainable design, and more recently to biodesign and regenerative and multispecies design. More than trying to define each concept, we will present some works that we think have enabled this field to emerge, from the ideas of different sciences and disciplines.

Epistemology:

· Bogost, Ian. (2012) Alien phenomenology. University of Minnesota Press, Minneapolis. He explains very clearly how humankind is losing the center of philosophical thinking, develops an object-oriented ontology where everything can communicate their existence.

· Grusin, Richard. (2015) The Nonhuman Turn. University of Minnesota Press, Minneapolis. This is the first compilation of a wide array of current critical, theoretical, and philosophical approaches under the concept of the non-human turn. Non-human is understood in a variety of ways: in terms of animals, affectivity, bodies, materiality, technologies, and organic and geophysical systems.

· Other minds, by Peter Godfrey-Smith (2016). Animal intelligence studies have focused on mammals and birds, but late research has found a very high intelligence between cephalopods, commonly known as octopus. The author says that they are

the closets we will come to meet intelligent aliens on Earth. What we can learn from this is the enquiry into his work.

· Enfield, N.J.; Kockelman, Paul. (2017). Distributed agency. Oxford University Press, Nueva York. Presents an interdisciplinary exploration about the consequences and possibilities that opens a distributed agency in many systems.

· Ways of being. Animals, plants, machines: the search for planetary intelligence, by James Bridle (2022). What does it mean to be intelligent? Evidence grows that it is not only human property. These other intelligent systems (animals, plants, machines) are revealing their agency and how to think in an intelligent non-human world.

Social sciences and humanities:

· A green history of the world, by Clive Ponting (1991), presents a panoramic view of human history and environmental change.

· Tsing, Anna (2015). The mushroom at the end of the world. Princeton University Press. This already classic work shares multispecies ethnography, botanic studies to present a Japanese mushroom in a very different way, showing all the connections it holds.

· Staying with the trouble: making kin in the Chthulucene, by Donna Haraway (2016). The author proposes a feminist multispecies theory as response to the environmental crisis. She escapes from the idea of Anthropocene, to think of new more humbler ways to share the planet with other species.

· Art of living on a damaged planet, by Anna Tsing et al (2017). A compilation of different authors that explore the relationship between environmental degradation, anthropology and art.

Design, history and territory:

· Loren, BK. (2013). Animal, mineral, radical. Essays on wildlife, family and food. Counterpoint, Berkeley. Personal essays about placemaking, encounters with other intelligences and what does consciousness means.

· Brown, Frederick. (2016). The city is more than human. An animal history of Seattle. University of Washington Press. Seattle has changed from the 1850s to the present, from its foundation amid existing Indigenous cultures, to late 19th century livestock friendly to its pet-friendly modern existence. Animals have changed in categories and places, as a way of asserting power over them, and other people.

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2.2 A Multispecies Design Genealogy

Throughout history, humans have drawn inspiration from nature, integrating its principles into various forms of design and development. This timeline highlights key moments and movements where bio-inspired design has evolved, from early agriculture to contemporary life-centered design.

· Early Agriculture (c. 10,000 BCE) Sedentary life and trade marked a control mainly over plants. Domestication and fences appeared to be common.

· Ancient civilizations (c. 3000 BCE – 500 CE) Mimesis towards the natural world denoted a desire to express an artistic language in hieroglyphs (Egyptians), dances (Greeks) and architecture (Mayans). Animals and medicinal plants seem to be sacred.

· Middle Ages (500 – 1500). Premises of imitating the invisible. A lot of symbolism and expression of what is thought internally arose in crafts. Humility and simplicity before nature transformed into myths and new beliefs. Understanding the world and the emergence of cities.

· Renaissance (1500-1600s): Imitation of nature became an invention; Art imitates the laws of Nature rather than its appearances. The biomorphic and anatomic studies of Da Vinci (1452- 1519) represent the appreciation of natural forms.

· The enlightenment and Academies of Sciences (1700s). Nature begins to be reasonably verifiable.

· Industrial Revolution (1800s) Humboldt wrote on the harmonic order of the Universe, or “Kosmos,” a concept borrowed from ancient Greek philosophy (Von Humboldt, A., & Bromme, T., 1845) and Haeckel in 1866 coined the term ecology (Haeckel, 1866). At this time other life expressions were looked through the lenses of science but used art as a means for expressing its understanding from western society. Nostalgia for country life, Separation and specialization of disciplines promote Biology and Natural Sciences to catalogue nature.

· Arts and crafts movement (1880- 1920s): Machines diminished artisanal skills, country life and respect for nature and vernacular techniques became a norm.

· Art Nouveau (1890- 1914): Organicism, vegetal forms, and artisanal skills mixed with technologies denoted the appreciation of nature in interiors and architecture.

· Bauhaus (1919-1933) The school’s emphasis on form following function and its interdisciplinary nature can be seen as early precursors to bio-inspired design.

· Agroecology and Conservationism (1928-50) Restoring ecosystems, protecting and preserving natural resources and dynamics created new bioinfrastructures, such as the national parks (Nash, 1967; Wakild, 2015) and new policies for forest and agricultural management. (Besin, 1928).

· Bioinspired technologies (1940-74) The study of capacities of animals and plants to develop new inventions arose. Velcro developed by George de Mestral, (de Mestral, 1954) is a good example.

· Bionics (1950-1970). Term coined by Jack Steele in 1958 (Roth, R.R., 1983). Applications on electronics, the military and aerospace technologies represented the ingenuity of living organisms. Architectural applications also found a biomorphic presence. The works of Otto Schmitt (Barthlott et al., 2016) influenced the term.

· Modernism and Organic Design (1930-1960s) This period saw an increasing appreciation for the efficiency and beauty of natural forms, which influenced design aesthetics and functional principles.

· Gaia Theory and The Operating Manual for Spaceship Earth (1969-1971): Lovelock and Margulis (1972) and Buckminster Fuller (1969) Defined the Earth as a living organism with self- regulatory dynamics influenced ecological thinking. Papanek (1971) placed Design for the Real World and the need for ethical stance towards exploitation of “the environment”.

· Permaculture (1978-present) Observing nature, feedback and self-regulation with plants and animals’ cycles and patterns are included in its principles. Bill Mollison and David Holmgren (1978) still promote this movement.

· Biophilia (1980-present) Term introduced by Eric Fromm during the 1960s (Gunderson,2014) and further developed by biologist Edward Wilson in the 1980s (Wilson. 1990), the concept suggests that humans have an inherent affinity for nature. This idea has influenced architectural and urban design, leading to the incorporation of natural elements into built environments that improve human well-being by fostering connections to the natural world.

· Mexican Organicism (1980-1989). Over this decade a few active designers and architects embraced the crafts and vernacular ways of creating with local resources and the observation of natural landscape. Authors like Hagerman (Martí, 2019), Senosiain(2003) and Porset (Sheppard,2018) were notable.

· Sustainable Design (1985): The aspects of sustainability influenced the incorporation of the “environmental” aspect by integrating economy and society. Caring for Nature and reducing human impact are key.

· Ecological Design (1990s) Ryn and Cowan (1996) argued for a seamless integration of human activities with natural processes to minimize destructive environmental impact.

· Biomimicry (1990s-present) This

movement explicitly focused on studying nature's best ideas and emulating these designs and processes to solve human problems. Biomimicry advocates for sustainable innovation by learning from ecosystems and organisms that have evolved over millions of years. Connie Lange Merrill (The Complete History of Biomimicry (with Examples), n. d.) and Benyus (2002) are the main figures.

· Posthumanism (1990s-present) This movement challenge traditional human-centered (anthropocentric) perspectives, recognizing the value and agency of non-human life forms and entities. Decentering the human influenced a new posture in design disciplines on ethics and agency. Main promoters are Dona Haraway, Ana Tsing and Katerine Hayes.

· Organic Essentialism (2008) Ross Lovegrove (designboom,n.d) as promoter of this concept, recalls the term "organic" in material, form, process, etc., and use only what is needed.

· Bio-Design and biomateriality (2010s-Present) "An emerging and often radical approach to design that draws on biological tenets and even incorporates the use of living materials into structures, objects and tools" (Myers, 2012). Neri Oxman (2020) is one of the greatest exponents.

· Multispecies Design (2015). Multispecies Design is proposed and developed as a theoretical framework for supporting the shift to more biodiverse human and non-human habitats. Metcalfe (2015) published his work from a design perspective.

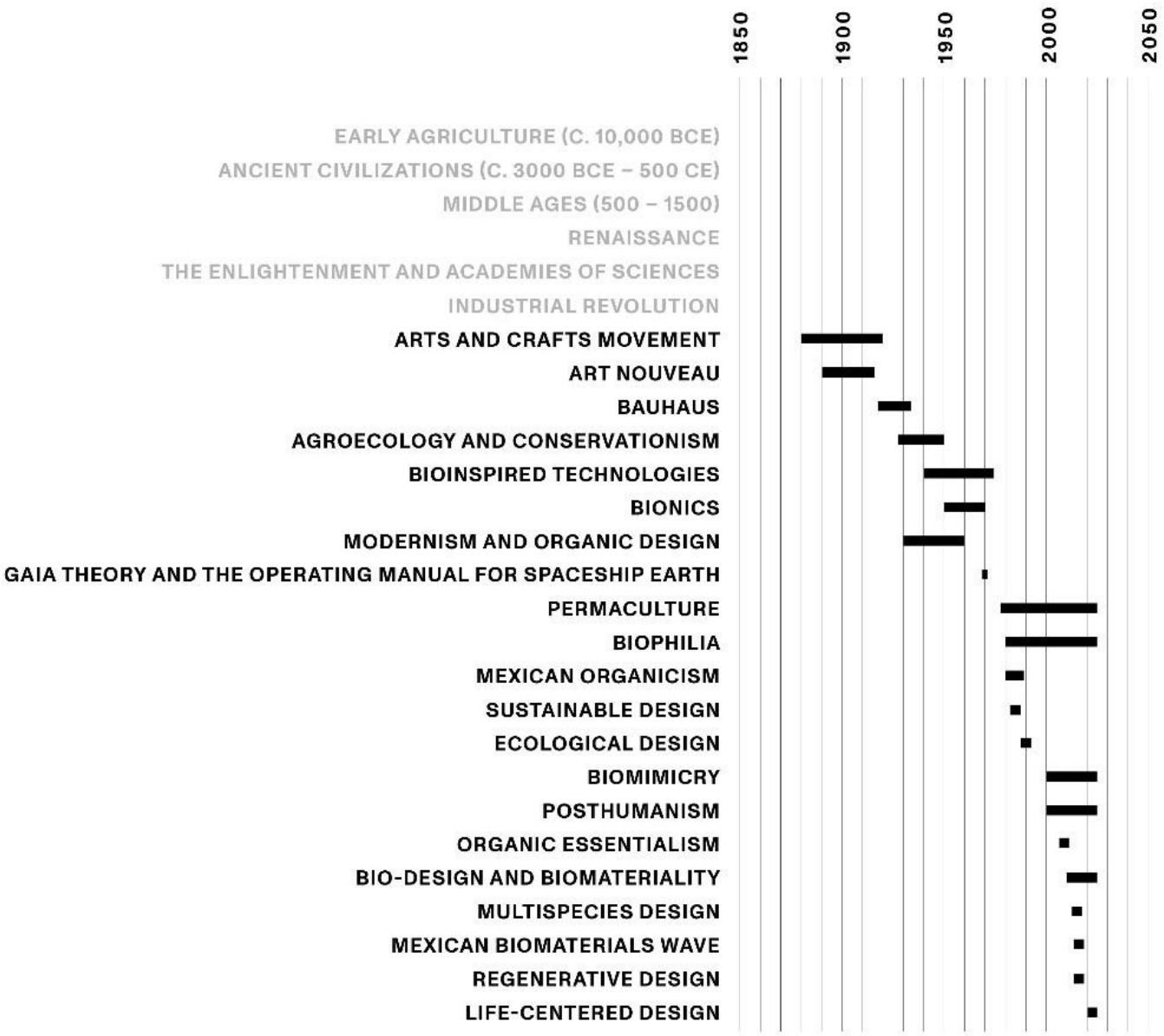
· Mexican Biomaterials wave (2016) Biology Studio (n.d), Polybion(n.d), Radial (n.d) and Fernando Laposse (n.d) epresent the use of vegetal fibers, bacteria and fungi.

· Regenerative Design (2016) Regenerative design goes beyond sustainability to focus on restoring and renewing ecosystems through design. This approach is rooted in ecological principles and aims to create living systems that are resilient, adaptive, and regenerative. Regenesis group (Mang et al., 2016) and Wahl (2016) were the main promoters.

· Life-Centered Design (2020-Present) Recently the importance of shifting human-centred aspects has been explored to a holistic perspective by Spoelstra (2022).

The following figure (See Fig.1) reveals this genealogy.

Figure 1. Genealogy of multispecies design defined as



timeline.

2.3 Integration of paradigms of life-centered design, non-human and multispecies design

In response to the modern capitalist world and its anthropocentric consequences, several alternative ways of thinking from all over the world are appearing that involve the seeking of a greater harmony with nature and minorities. This includes alternative approaches and models for more sustainable-regenerative development, such as degrowth theories, sufficiency, repairing, and sharing (Schranz, 2023).

Recent advancements in natural sciences, moral philosophy, and politics have increasingly questioned the rigid separation between human and non-human life that

underpins modern legal and human rights frameworks. Biologists emphasize the similarities between humans and other species, while moral philosophers delve into the concept of justice for animals. Ecocentric movements further dissolve traditional boundaries between humans and nature, challenging our conventional understanding and advocating for a more inclusive perspective (Rodríguez-Garavito, 2024).

These efforts are introducing transformative concepts to the design discipline. Escobar (2018) promotes a "pluriversal" understanding of life, emphasizing collaborative, sustainable, and indigenous wisdom, technologies, and thought systems that harmonize with nature. Watson's (2019) "Lo-TEK" highlights remarkable projects that intersect with radical indigenism and non-mechanical ecosystems, showcasing innovative solutions found in mountains, forests, deserts, and wetlands. These ideas are reshaping how we approach design by integrating diverse perspectives and ecological considerations.

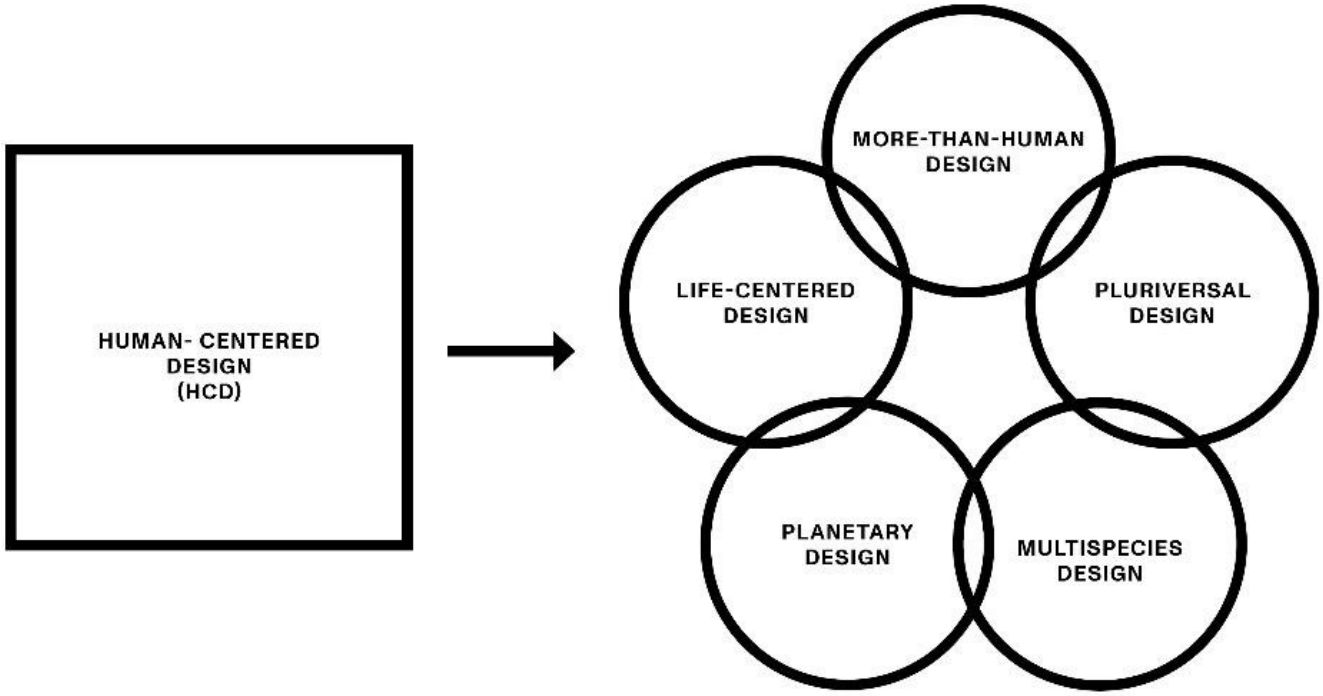
The American philosopher David Abram (1996) introduced the pioneering concept of the "more-than- human" world. He emphasized the profound interconnectedness between humans and the natural world, arguing that our sensory experiences and consciousness are profoundly shaped by our interactions with animals, plants, fungi, landscapes, and natural phenomena. Abram posits that modern societies have lost this essential connection, resulting in a diminished experience of the world. He advocates for recognizing the agency of non-human entities due to their significant influence on language and perception, suggesting that this acknowledgment can foster a deeper ecological awareness.

The "multispecies" concept (Castro et al., 2023) exposes artistic, speculative, and activist practices addressing this interconnection and proposes ways of thinking-with, doing-with, becoming-with, and forming kinships with non-human worlds. These practices stem from a perspective on situated futures, grounded in cultural and environmental histories, and emphasize the unique narratives of specific territories. This vision is interested in the epistemological, ethical, and political implications of recognizing the agency of myriad forms of life beyond human intentionality. This proposal embraces the idea that scientific knowledge cannot be the sole authority on the link between humans and non- humans, accepting the challenge of integrating various types of knowledge. The "Multispecies Constitution Project," launched in 2023, involves an innovative exercise drafting a speculative constitution that includes both humans and non-humans as political subjects. Their aim is to create a language that emphasizes multispecies mutualism instead of human exceptionalism and collective intelligences rather than individualized human knowledge (Berggruen, 2023). It's about shifting towards cross-species forms of knowledge production. This vast community encompasses all inhabitants of the biosphere: animals, plants, fungi, bacteria, and viruses. It includes rivers, seas, winds,

stones, and clouds that sustain and influence us. These living forces, our companions on the journey of time and existence, have much to teach us and have already imparted significant knowledge; our identity and survival are intrinsically linked to them (Bridle, 2022)

To understand the term “life-centered,” we must look to Edward Wilson and his book “Biophilia,” where he underscores the importance of not only understanding life but also preserving it. Wilson discusses the inherent affinity humans have for all living beings, the need to connect with other forms of life, and the sense of connection with nature. He highlights the emotional bond with other living systems, habitats, and surroundings, emphasizing the fragile connection that ties humanity to the earth. This heartfelt connection motivates those who strive to preserve the remaining environment and living beings (Wilson, 1984). Life is a far wider system, an incredibly complex interdependence of matter and energy among millions of species beyond (and within) our own skin (Bridle, 2022). Life- Centered Design (LCD) emerges as a design philosophy and approach that prioritizes all life forms, not just human needs. It advocates for the inclusion of biological ecosystems and non-user communities that have traditionally been excluded from the design process. The ultimate aim is to restore natural ecosystems by fostering new relationships between nature and society (Spoelstra, 2022). LCD and Planetary-Centered Design (PCD) are frameworks striving to replace the stagnant paradigm of Human-Centered Design (HCD). Figure 2 describes the current change and intersections.

Figure 2. Shifting the paradigm to multispecies design diagram.



2.4 Adoption and development in future designers.

With this previous framework, design must recognize the deep interconnections among all living beings, extending beyond human-centered concerns to include the broader ecosystem of life. This means embracing a holistic approach that values and respects the contributions and perspectives of all species. In practice, this design approach should emphasize the importance of rebuilding and nurturing our relationships with each other and the natural world. It calls for design solutions that are not only functional and aesthetically pleasing but also promote harmony with the environment, ensuring that human activities support the delicate balance of life on Earth. By doing so, design becomes a tool that enhances the well-being of the entire planet, reflecting a commitment to the seamless integration of life and design (Verhoeven, 2023). This new paradigm must reconcile our technological prowess and human uniqueness with an earth sensibility and attentiveness to the interconnectedness of all things (Bridle, 2022).

A non-human design discipline uncovers its own unique ecology, gradually shifting from the isolated confines of specialized practice and research towards a more expansive interaction with the wider world. This vision amplifies the perspective that everything is interconnected and all entities influence one another. It's a practice that allies with all forms of non-human intelligence, recognizing that wisdom and creativity are not solely human attributes. For instance, octopuses, known for their remarkable problem-solving skills and adaptability, offer insights into flexible and resilient design solutions. Fungi, with their intricate networks and ability to decompose and recycle nutrients, inspire systems of circular design that minimize waste and promote sustainability. Forests, as complex ecosystems, demonstrate the value of collaboration, diversity, and long-term thinking in creating sustainable and resilient environments.

The ecology of design is deeply concerned with the interrelationships between its praxis and the world it inhabits. In terms of materiality, designers must recognize that human-made artifacts are not isolated creations but are intrinsically connected to the more-than-human world through the materials used (Abram, 1996). For example, the wood in furniture carries the history of the tree it came from, embodying the natural processes and ecosystems it was part of. Similarly, synthetic materials, though man-made, are derived from natural resources like petroleum, a product of ancient biological matter. By acknowledging these connections, designers can create a heightened sense of responsibility and awareness of the broader ecological impact of their work.

3. Perspectives from Mexico

3.1 The Mexican context

Mexico is the link between Latin America and North America. It has many indigenous groups living with low human development indicators, and at the same the post NAFTA economy has integrated the Mexican economy with the US and Canada. The country has, because of its geology and climate, an extraordinarily rich biodiversity. All these factors combine to present today a complex socio- environmental problem. The country now has a population of 130 million, and by 2050 the OECD says that it may arrive close to 150 million. 2023 and 2024 were critical years for water supply in many regions. Climate change is present with different impacts: from severe drought to stronger hurricanes, like the case of Otis that went over Acapulco in October 2023 with a Category 5 strength. We think the present Mexican multispecies problematic – the increasing conflict between humans and non-human intelligences – can be understood looking for: a) bioinfrastructures b) affordances and c) design case studies.

3.2 Bioinfrastructures

The journal Roadsides of the University of Zurich published an issue dedicated to urban bioinfrastructures in autumn 2023. Raúl Acosta and Lukas Ley explain the concept in this way in the introduction: "Cities rely on numerous infrastructures that support their life: pipes, cables, antennas, roads, and other technologies that facilitate the distribution and use of water, energy, information, and people. Current theories of urban flows are integrated into infrastructure systems; however, they are often biased towards the perseverance of human life at the expense of other forms of life. Does this conceptualization of life limit our understanding of the true capacity for life that exists in urban infrastructure? The contributions to this thematic issue interrogate the sociological configurations of urban infrastructure that not only sustain life in the city but are in turn constituted, outlined, and modified by it." (2003: 1) The authors state that this problem "raises urgent questions about the multispecies design, appropriation, and direction of infrastructure, such as what qualifies as 'environmentally friendly' urban planning. Infrastructure is never just a single entity or object but rather an evolutionary set of multispecies and material relationships. As Maan Barua states: the "more-than-human intersections and mixtures with infrastructure, where corporeality and substratum merge and the habitat and habits of living beings become synonymous with infrastructural environments, point to a broader infrastructural ontology (2021: 1467)."

Acosta and Ley focus on the urban, but it is clear that there are also rural bioinfrastructures: monocultures are perhaps a great example. In Mexico they range from the tequila maguey fields in Jalisco, to the avocado cultivars in Michoacán or the vegetable fields in the Bajío. Everything connected to water, electricity, and logistics

transportation networks. The recent emergence of bioinfrastructures remains with little theorization. They claim that history shows examples of experiments where humans and non-humans have co-existed differently than today. Imagination applies to designing new futures, where humans and non-humans can not only co-exist but co-design in more fraternal ways. According to Google's Books Ngram Viewer, the use of the word "bioinfrastructure" – sometimes with the separate bio – began in 1990 but skyrocketed in 2008.

However, one of the papers that best begins to use it is that of Maria Puig de la Bellacasa (2013). She explains that we are dealing with a relational ontology, which links the human with the non-human:

"For this purpose, I am drawing from Susan Leigh Star's work on "residues" and "infrastructure" — developed particularly in different collaborations with Geoffrey Bowker and Karen Ruhleder. Surely, what comes to mind when we think of residual Categories within working infrastructures are mostly human-built technoscientific arrangements. But what happens if we approach a bioinfrastructure such as soil with Star's mode of attention? What kind of "invisible work" becomes visible? And at what cost? The material, cultural, and ecological significance of soil appears not only to be that of the final home to all residues but also of a vital, although disregarded, infrastructure of bios. In what follows I first discuss the changing significance of soil as "residue" through contrasting epistemic sites. Soil shifts from container of worlds to a world, showing how its worth—from residual to essential—is not fixed. Secondly, the notion of infrastructure acts as a revelatory of the "working" quality of this universe, opening into the perception of a whole world of invisible labors that are more than human." The author's premise is to make visible the invisible, in this case, the processes that link the human and the non-human, the living and the non-living, which in turn create a bioinfrastructure.

The Mexican case presents a paradox because at the same time, it is the country that invented the "milpa" - a biocultural ecosystem that peasants have designed for thousands of years, where corn grows next to tomatoes, varied species of chiles, beans, and wild herbs (quelites). Together they have been co-evolving with the people that have been in the territory that now is Mexico. The milpa adapts to every microclimate of every region. This bioinfrastructure has fed people for centuries. Milpa is probably the most important bioinfrastructure in Mexico because it has developed 60 distinct kinds of corn, that is also the most cultivated cereal in the world.

3.3 Affordances

In other hand, the country lives now a rapid environmental deterioration. This analysis wants to focus on one category of bioinfrastructures. The ones that have an operational function as an affordance. What is an affordance? It is the capacity that an object or a system to call for its use or function.

For instance, ergonomics is that capacity in many industrial design objects. But in nature, trees have that capacity, being the home and food supply of many species. “Landscape affordances, what the environment offers an animal, are inherently species-specific to the extent that each taxon has unique needs and responses to landscape characteristics”, say Niesner et al (2021).

The López Obrador government has engaged in a series of decisions that had a significant impact on ecosystems, from the tren maya in the Yucatan Peninsula to the signing of the latest version of NAFTA, that does not have provisions about climate change. These two policy decisions have a cascading effect on many others, provoking lock-in consequences that can last decades. They connect in a bigger trend: the nearshoring of global manufacturing, from China to North America, and that has been impacting many species. The rapid urbanization of the country, with the accelerating deforestation of territories because of the expansion of monocrops like the cultivars of avocado and agave for tequila production, are also transformation entire wild landscapes into human bioinfrastructure.

3.4 Cases from Mexico

In this section it is enlisted a few situations and conflicts involving bioinfrastructures and multispecies design questions which exemplifies the interspecies complexity in which Mexico is involved. The selection is situated in different geographies of the country and involves different scales, from the small objects and local urbanization conflicts to the geopolitical scale. A small section is dedicated to four exercises developed by students at Tec de Monterrey in the past few years.

3.4.1 Refugio

“Refugio” is a Mexican design project intended to foster a closer relationship between cities (humans) and nature (bees). This initiative was conceived initially as a series of objects that provide shelter, water, and food for various species of solitary bees (Calvillo, 2020). In 2023, Refugio started to collaborate with sylviculture communities of *Melipona beecheii* in Yucatan developing shelters and wax structures to help the bees kick-start their honeycombs. The project has been constantly developing and increasing in scale and impact, an example of this are the pollinator gardens and sanctuaries that have been implementing in Mexico City (2023, 2024).

3.4.2 Totomoxtle

“Totomoxtle” is a project created by Fernando Laposse in collaboration with the community at Tonahuixtla, Puebla. The project seeks to develop economic alternatives for the community, which was dedicated to corn production for generations and, because of the NAFTA agreements, the traditional milpa agriculture had to shift to GMOs, causing the depletion of the soil. *Totomoxtle* recovers native corn seeds and incentives its traditional production changing the commercial value of the corn from the seed to the leaf. The dry leaves are now transformed into marquetery

by the women at Tonahuixtla and sell as luxury objects and furniture abroad. The remaining corn seeds are then used as food for the community and as stock for next season's plantations. By returning to milpa agriculture, it also helps to regenerate the soil for future generations.

Fernando Laposse is a Mexican designer with a degree in product design from Central St. Martins. His practice is material driven and focuses on transforming humble natural fibers such as corn husks, sisal, or loofah into design pieces and new architectural materials. (s. f.). His website. https://www.fernandolaposse.com/totomoxle

3.4.3 Santa Catarina River in Monterrey

In June 2023, Nuevo León government deforested 13 hectares of the Santa Catarina River justified as necessary for the safety of the population against catastrophic droughts caused by hurricanes in the future years. This event triggered the biggest ecological movement in the history of the city: *"Unríoenelrío"*, which aims to unify the voices of activists, scientists, academics and public in general to look after the environmental stability of the city. The current primordial discussion (2024) centers in the future of the river and its riverbanks as it is disputed between real state companies, urban infrastructure development projects (originated by the exponential urban expansion and lately the 2026 football world cup) and the defense of one of the most important urban forests in the city which helps reducing the temperature in its surroundings approximately by 6 degrees Celsius and, as argued by specialists, reduces the waterflow significantly because of the drag resistance of the riparian vegetation.

3.4.4 Mayan honey from Campeche.

More than two decades ago, Mayan women from the state of Campeche began a beekeeping practice with a very singular species endemic to their region: *Melipona beecheii*, but that the Mayas name as Xunáan Kab, "the honey lady". These Mayan women formed the "Colectivo de Comunidades Mayas de los Chenes" and have learnt to deal with powerful corporate interests that have affected their beekeeping (Gómez Durán, 2020) . In 2012, the federal government gave permissions to Monsanto to cultivate GMO soy – without the legal consultation to the indigenous communities. This impacted their practice, because the bees produced honey that the traceability tests showed had pollen from transgenic soy, so their exportations to Europe were at risk. A product labeled organic loses its certification if it has GMO content. In 2015, the Mexican Supreme Court said the government had violated the rights of the indigenous communities. In 2017, the food safety agency cancelled the authorizations to Monsanto to cultivate GMO soy in seven states.

3.4.5 Academic Cases at Tec de

Monterrey

In 2019, the exercise “Animal Centered Design” (AXD) was implemented at the experience design course conducted for third year undergraduate level. A set of animal centered design (AXD) tools were developed, and specific objectives were assessed to develop a product to promote interaction with the chosen animal and their context, thus improving their quality of life. The students’ final submissions identified innovation attributes and socio-environmental achievements. The tools generated with this academic exercise can serve as a continuation and basis for designers, architects, and urbanists in the definition of multispecies design.

In 2022, Sonora Norte worked hand by hand with CRIFFS, a non-profit organization committed to the protection and conservation of Mexico’s native wildlife. The aim was that students co-create objects with the help of the volunteers that assist injured or vulnerable fauna like turtles’ nests and stranded cetaceans.

At CDMX Region four multispecies design exercises, led by Mariana Solis between 2022 and 2023, where developed focused on designing for a plant. “Diseño para una planta” aimed to develop sensitivity towards other forms of life, in this case one that is apparently inanimate and sometimes difficult to relate. The results express a clear empathy towards the necessities of the different plant species considering their biology and context within their interactions with humans.

In 2023, in collaboration with Isla Urbana, 4th semester students from Tec de Monterrey Campus Ciudad de México developed the project “Fuentes de re-abastecimiento”. This project researched into the fragmentation of wildlife habitats in Mexico City and its relationship with water scarcity both for humans and non-human.

4. Conclusions

Interdisciplinary approaches based on the study of human and non-human interactions have significantly reshaped our understanding of our current perception of sustainability and regeneration. From biological sciences to the integration of design, our proceed towards addressing the environmental crisis has become more holistic. The rise of concepts like biophilia, biomimicry, and multispecies design reflects a growing recognition of the need to transcend human-centric perspectives and embrace a more inclusive, life-centered ethic within our built environment. This shift is crucial as we face complex environmental and social challenges that demand innovative and empathetic solutions. This work highlights the importance of incorporating these paradigms into education and design practice, particularly in Mexico, that is facing an acute ecological and social crisis. We are witnessing the start of a process: pioneer ecofeminist movements, new biophilic entrepreneurs, the redesign of academic thinking. The current multicrisis will only be transformed with a new multispecies perspective acceleration, and

this will only be possible with the cooperation of other non-human intelligences – animal, vegetal, fungi and, even geological. We are only beginning to seriously listen to these other voices by fostering new forms of human design and mutualism, by changing the idea infrastructure to bioinfrastructures and the dynamics in everyday life affordances to interact with non-humans. These are efforts that can foster the way for a more resilient and harmonious relationship with our planet.

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EVENT-BASED EDUCATION IN DESIGN: A CASE STUDY ON FOSTERING CRITICAL THINKING AND SOCIAL IMPACT.

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ABSTRACT | Event-based education in design education is increasingly recognised as an effective learning mode (Page et al, 2016; Juraschek et al, 2020). It involves activity-based teaching strategies and learning processes in which knowledge comes through 'experiencing' tools and environments with which one learns the context, actors and relationships in design projects (Kolb, 2014). Incorporating agile prototyping and service learning enhances this model, fostering rapid development, innovation, and real-world application of knowledge.

This paper presents a case study of a five-day educational event for Bachelor of Arts (BA) and Master of Arts (MA) design students from the same institute. The event, conducted using systemic design approaches, involved the design of products, services and public benefit systems with public and private entities within the territory where the design school is located. The educational operation included the participation of students, organized into groups, the majority of the faculty serving as instructors, and a group of alumni acting as tutors.

The authors of this paper propose a qualitative investigation aimed at studying the "designer education" model implemented during a five-day event, approached from a lifelong learning perspective (Fischer, 2000; Freitas & Almendra, 2021). The study examined how knowledge, skills, and critical thinking abilities were imparted to students and explored how both students and educators can effectively address contemporary, complex, and multidisciplinary challenges in a critical, technological, and ethical manner (McCoy, 2003; Davis, 2011; Noël, 2020) within a short timeframe.

The learning environment of the dissemination event itself was an objective of design and validation, aimed at studying its pedagogy and determining the appropriate learning space for today's designers. This approach emphasizes the "how" and the "why" of designing, aiming for social, environmental, economic, and cultural impacts (Rowe, 2020). Qualitative data was collected. For qualitative data, pre- and post-event attitudinal research, questionnaires, in-depth interviews, and focus groups with students, faculty, tutors, and external entities were employed. This paper presents the results of the research on the multigenerational and multidisciplinary working method applied during the 5 days event, as well as the study of the teaching model implemented. The collected data validated the pedagogical model and provided insights into monitoring and tutoring methods applied during the event. Furthermore, data analysis identified several recommendations for managing transdisciplinary relationships among academic, public, and private sectors in similar events. Innovative approaches to fostering a more empathetic relationship with stakeholders and increasing awareness of the impact of their projects are essential tools for helping young designers strengthen their values and create a more cohesive team-building environment among faculty, tutors, students and stakeholders.

The authors conclude by suggesting an improvement of this educational model. It identifies research avenues for co-designing new pedagogical and organizational methods to enhance the critical capacity of both students and faculty, and to improve cooperation between design schools and local community. These efforts aim to increase public benefit impact through such collaborations and service learning.

KEYWORDS | EVENT-BASED EDUCATION, ACTIVITY-BASED TEACHING, CRITICAL THINKING, DESIGN PEDAGOGY, SOCIAL DESIGN

1. Introduction: The Evolution and Impact of Design Education in Contemporary Society.

As society undergoes significant cultural and technological transformations, design education is undergoing a process of evolution in response to these changes (Nöel, 2020; Pontis & van der Waarde, 2020). The quintuple helix model emphasizes the importance of academic institutions engaging in collaborative endeavors with a diverse range of stakeholders, including representatives from government, business, civil society, and the environment (Carayannis et al., 2021). This model encourages the creation of creative and innovative environments for research and organizational development (Carayannis et al., 2021), prompting a re-evaluation of traditional educational practices in order to align them with the demands of a complex modern world. The capacity to cope with complexity is a foundational driver of change in design education (Morin, 1999; Davis, 2011). The field of design offers a distinctive set of competencies, including systems thinking, the visual representation of information and processes, effective communication, planning, creativity, and empathy for stakeholders (Montt-Blanchard et al., 2023). These skills are of paramount importance as designers increasingly move beyond the confines of traditional specializations and disciplinary boundaries, thereby contributing to a more comprehensive and integrated methodology for problem-solving.

Significant developments in design education, particularly in pedagogical approaches, have been driven by the necessity to align the content of education with the requirements of professional practice and of society more widely. This evolution requires the ongoing enhancement of knowledge and skills in order to address emerging challenges effectively (Kuure & Miettinen, 2017). The overarching objective of contemporary design education is to produce responsible, knowledgeable, and skilled professionals who are able to assist individuals in achieving their desired outcomes in a more effective manner.

Nevertheless, conveying this concept within the educational context remains a significant challenge, as students frequently prioritize the acquisition of fundamental technical skills over pursuing critical enquiry (Tovey, 2015; Pontis & van der Waarde, 2020).

There is a challenging trade-off between the refinement of existing skills and the development of competencies that may become more important in the future (Redström, 2020). It is imperative that design education adapts to the prevailing changes and continues to provide future generations of designers with a robust foundation of knowledge, tools and skills (Pontis & van der Waarde, 2020). The current transition in design education requires the development of a pedagogical model that enables novice designers to navigate external shifts and rethink traditional modes of education (Tovey, 2015). Conventional design education frequently relies on emulating professional practice, although there is a growing tendency towards experiential methodologies (Rowe, 2020). Event-based education instead provides students with the opportunity to engage with a diverse range of stakeholders, including individuals, locations, and communities. Such engagement is of critical importance for the professional development of designers, equipping them with the skills to transition from the role of expert to that of facilitator (Montt-Blanchard et al., 2023).

It is essential that learning experiences instill a sense of motivation to contribute to the creation of a resilient and sustainable context (McCoy, 2003). Motivation is of paramount importance for effective creative and analytical thinking, which are essential soft skills in today's world. A significant number of institutions now offer project-based learning that is firmly rooted in realworld problems (Pontis & van der Waarde, 2020). This approach has the advantage of enhancing student-teacher interaction and ensuring community-wide participation, including students, faculty, governance, and alumni.

It is important that students receive learning experiences that adequately prepare them for the complex, large-scale, and interdisciplinary challenges that they will inevitably face in their professional lives (Rowe, 2020). As well, students should receive the necessary support not only to secure employment, but also to enable them to flourish as the discipline progresses and evolves. Designers should exemplify the complexities and ambiguity inherent in the workplace, demonstrating the ability to navigate systemic change and transformation with discernment. One of the most effective pedagogical approaches for community engagement in design education is experiential learning (Kolb & Kolb, 2006). In fact one of the principal objectives of design education is to inculcate in students the understanding that design is about creating possibilities (Danzico, 2011). It is the responsibility of academic institutions to innovate and maintain an approach that is open to experimentation and free from the constraints of business logic. One area of experimentation is the design of the educational experience itself, with

the objective of fostering an environment conducive to the flourishing and innovation of future designers.

The incorporation of experiential learning, agile prototyping and real-world engagement into novel forms of academic events has been demonstrated to be highly beneficial for the personal and professional growth of design students (DeJaeghere, 2009; Lizzio & Wilson, 2004). Such approaches not only equip students with the requisite skills to personally grow and navigate the complexities of the design profession, but also foster a deeper understanding and motivation to contribute positively to society.

2. Theoretical framework

The theoretical framework of event-based education is gaining recognition as an effective pedagogical approach within the field of design education. This format encompasses brief, intensive events, typically spanning a period of between one and five days, with a primary focus on innovation and educational pursuits (Juraschek et al., 2020). The objective of such events is to address challenges, complete design tasks, develop concepts, convey learning content, build skills, share knowledge, create visions, disseminate best practices, and build communities (Blume et al., 2015; Juraschek et al., 2020).

These experiential and challenge-based learning opportunities confer significant benefits upon design education, as they permit students to engage in design activities within a controlled and secure environment (Kolb & Kolb, 2017). This reduces the barriers of abstraction that may otherwise arise from the abstract nature of the subject matter, by enabling students to apply their learning in a real-world context (Juraschek et al., 2020). For example, Page et al. (2016) argue that hackathons foster a sense of personal fulfillment among participants by facilitating collaboration with individuals from diverse backgrounds. This form of event-based experience has been demonstrated to be an effective teaching tool in design education, where knowledge is created through practical engagement and experience.

Three key frameworks underpin event-based learning in design education: experiential learning, collaborative learning, and sprint design.

In their 2006 study, Kolb and Kolb posit that experiential learning represents an efficacious pedagogical approach to enhance teaching and learning in higher education. This cyclical approach alternates activities that involve different cognitive attitudes, including concrete experience, observation, conceptualisation, and active experimentation. In the context of design education, concrete experience frequently manifests as project-based learning, which entails the resolution of authentic challenges through a process of investigation, research, data collection and interpretation, design, and the communication of results (Kokotsaki et al., 2016).

Lizzio and Wilson (2004) posit that this type of learning is a significant contributor to the development of students' professional skills within a lifelong learning (LLL) framework (Fischer, 1999). From this perspective, it is of paramount importance to promote metacognitive abilities that encourage reflexivity (Field, 2000) and transversal competencies, such as the capacity to "learn to learn" (Hoskins & Fredriksson, 2008).

The collaborative aspect is of paramount importance in event-based education. Collaborative learning is an educational approach whereby students with varying abilities work together in small groups to achieve shared objectives, address challenges, or undertake collective project design. In contrast to competitive methodologies, collaborative learning encourages consensus through the collective efforts of all group members (Laal & Ghodsi, 2012). A comprehensive list of the benefits of collaborative learning, as identified by Johnson and Johnson (1989) and Pantiz (1999), has been summarized by Laal and Ghodsi (2012) into four categories: social benefits, psychological benefits, academic benefits, and alternative assessment techniques for students and teachers.

The temporal aspect is another defining feature of event-based learning, frequently addressed through the sprint design methodology (Winfield et al., 2022). The design sprint, which originated in the field of IT development, has been introduced into the academic context through the incorporation of design thinking practices (Dell'Era et al., 2020). Knapp (2007) proposes a framework based on iterative cycles compressed into five days, which stimulates rapid and flexible decision-making and facilitates the development of knowledge management skills in both teachers and students (Bates, 2022). This is especially advantageous for those engaged in knowledge work within volatile, uncertain, complex, and ambiguous (VUCA) environments (Adamson, 2012).

While the theoretical framework provides a robust foundation for proposing event-based education as an effective training model, the specific knowledge gap this study aims to address is the lack of empirical research on how event-based education, specifically using design sprints, impacts long-life learning (LLL) skill development and stress management in students.

Additionally, this study seeks to investigate how the deceleration of design sprint processes can foster deeper reflective practices in educational settings. For instance, while the design sprint methodology is an effective approach, it requires considerable energy and focus, which could potentially lead to stress and impact the development of LLL skills (Knapp, 2007). Moreover, the implementation of design sprint approaches in an educational setting may necessitate the utilization of a decelerated model to facilitate reflective processes (Schell, 2023).

In conclusion, event-based educational formats, which incorporate agile prototyping

and realworld engagement, are of significant value for the personal and professional development of students. Such approaches equip students with the requisite skills to navigate the complexities of the design profession, while fostering a deeper understanding and motivation to contribute positively to society. This study will investigate these knowledge gaps through the case study of the Rome Design Experience (RDE), using a combination of qualitative and quantitative methods to deepen the understanding of how event-based education can best foster student development in design professions.

3. The Roma Design Experience (RDE): A Case Study in Design Education and Stakeholder Innovation

The Rome Design Experience (RDE) is a five-day educational event promoted by a public design institution in Italy, serving as the case study for this research. Now in its sixth edition, the RDE occurs annually, temporarily suspending regular teaching activities and involving Bachelor (BA) and Master (MA) design students from across the institution. All students at the school participate, organized into mixed working groups according to their interests, covering a range of topics and stakeholder challenges. Each group, comprising 15 to 20 students of varying ages and academic levels, includes participants from first-year BA students to undergraduates (Table 1). These groups are facilitated by

Degree	Year	Course	Average Age	Amount of students
BA	I°	Design	20,36	51
BA	II°	Design	21,84	46
BA	III°	Design product oriented	22,21	13
BA	III°	Design communication oriented	22,21	15
MA	I°	Systemic design product & services oriented	24	26
MA	I°	Systemic design communication oriented	24,13	30
MA	II°	Systemic design product & services oriented	24,95	22
MA	II°	Systemic design communication oriented	24,92	27
			23,0775	**230**

Table 1.Student demographics.

an internal professor, a tutor, and either an internal or external expert in the relevant field.

Each group collaborates with a stakeholder from the private or public sector, who provides a project brief and engages in ongoing dialogue with the group to monitor project progress. At the conclusion of the event, a public presentation is held for the relevant organization and the school. Stakeholders are selected from local or national institutions, companies, foundations, associations, non-profit organizations, or entities involved in cultural, social, environmental, or care fields (Table 2).

The potential outcomes of each group include future scenarios of physical or communication products, facilities, and services designed with a systemic approach, aiming for territorial growth and the empowerment and involvement of all system actors (Carrino & Spera, 2021). The mission of the RDE is to create a link between academia and the real world, bringing students into contact with local workplaces and providing stakeholders with an environment for fast and proactive innovation (Salvatori & Datti, 2024).

The RDE functions as a pedagogical laboratory where participants face challenges in managing time, resources, and relationships, contributing to their social, environmental,

Type	Sector
Public	Cultural Heritage, Education
Public	Cultural Heritage, Tourism
Public	Cultural Heritage, Urban Planning
Private	Social Innovation, Circular Economy
No profit	Social Services, Education
Private	Digital Transformation, Industry 4.0
Public	Public Communication
Private	Cultural Heritage, Arts
Public	Cultural Heritage, Humanities
Private/Public	Financial Services, Artificial
Public	Scientific Research, Scientific Dissemination
Public	Cultural Heritage, Tourism

Table 2. Mapping of stakeholders' type and sectors selected for the sixth edition of the Rome Design Experience (RDE6).

economic, and cultural understanding. This approach fosters the personal, relational, and professional development of students by integrating experiential learning, collaborative problem-solving, and sprint design methodology. By incorporating real-world challenges provided by stakeholders, students are exposed to the complexities of designing sustainable solutions that address not only immediate needs but also long-term impacts.

Projects emerging from the RDE exhibit a strong connection to the local social and cultural context, aiming to create positive territorial growth. These projects prioritize long-term, sustainable solutions that reflect environmental and economic resilience, involving the collective engagement of key stakeholders in co-creating outcomes that are both innovative and contextually relevant. The collaborative process fosters a willingness to compromise and adapt to real-world constraints, helping students understand the intricate balance of social, environmental, and economic factors in design.

Additionally, significant aspects of the RDE learning process include both formal and informal monitoring, flexibility in renegotiating objectives, and guidance from an experienced facilitator, ensuring that the projects align with the overarching goals of sustainability and stakeholder empowerment (Massari, 2024). This process encourages students to engage in reflective practices, allowing them to explore the cultural impacts of their design solutions while addressing the economic and environmental realities of the local context.

3.1 Aswsessing social impact

While the RDE primarily focused on developing students' critical thinking and design skills, the assessment of broader social impact remains an important consideration. Although no formal social impact assessment framework was employed in this study, future evaluations could incorporate the Social Return on Investment (SROI) methodology. This widely recognized approach quantifies the social, economic, and environmental outcomes of a project by measuring the value created for stakeholders and communities. Additionally, the use of a Theory of Change (ToC) framework could help map the pathway from project activities to both short- and long-term social outcomes, such as community empowerment, local economic development, and stakeholder engagement.

Though specific methods were not used to measure these impacts, qualitative feedback from stakeholders indicates positive social benefits, particularly in community involvement and collaborative work. Implementing these methodologies in future studies would provide a more comprehensive and measurable assessment of the social impact of the RDE, allowing for a clearer understanding of its outcomes.

4. Research study

The research focuses on the sixth edition of the event-based design program (RDE6), which included the participation of 150 students, 24 faculty members, 24 tutors, and 12 institutions, organized into 12 workshops centered around three themes: technological innovation, social impact, and cultural heritage. The event spanned five days, culminating in a final public presentation held four months later (Figure 1). The final event comprised a day of exhibition and presentation of the outcomes achieved during the five-day workshop. This open-to-the-public event featured presentations to local institutions, dialogues, and roundtable discussions focused on the three core themes around which the workshop activities were clustered. The event predominantly attracted students and faculty, alongside family members, friends of the students, stakeholders, and relevant actors from related fields.

The event included interactive corners where attendees could provide comments and feedback, as well as areas dedicated to collecting interviews and media material for the follow-up of the fiveday workshop. These components facilitated comprehensive feedback collection and documentation of the entire experience, supporting a thorough evaluation of the results and guiding future initiatives.

This five-days workshop and the follow-up event were included in the research to gather

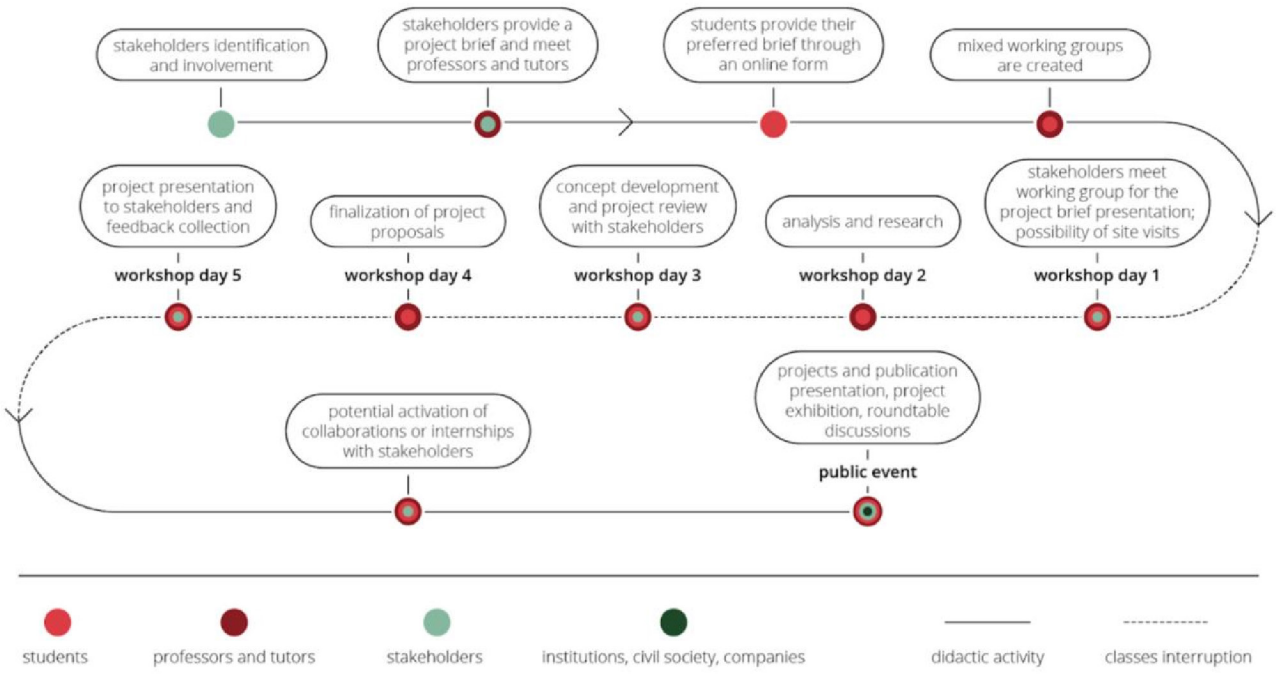


Figure 1. Organizational architecture of the Rome Design Experience.

comprehensive data. A mixed-methods approach was employed, predominantly utilizing qualitative techniques targeting students, institutions, faculty, and tutors. The objective was to assess the impact of the RDE teaching and learning experience on the knowledge, skills, and professional development of the participating students through diverse research methods, including online questionnaires, focus groups, semi-structured interviews and citizen science data collection.

4.1 A mixed-methods approach

Students were given an online questionnaire to complete before and after RDE6. The aim was to enable self-assessment of knowledge, skills, and work autonomy, to understand any changes during the educational event. The theoretical framework for the survey was based on the National Qualification Framework (NQF), aligned with the European Qualifications Framework (EQF) (ANPAL, 2022). The NQF and EQF aim to enhance the quality of training and skill development from a personal, civic, social, and professional growth perspective within a European framework. The framework comprises eight levels, defined by descriptors based on three dimensions:

- Knowledge: Skills ranging from the assimilation of theoretical or practical information to critical and interpretative abilities.
- Skills: Cognitive and practical abilities to apply knowledge to complete tasks, solve problems, develop ideas, and engage in social interactions.
- Autonomy and Responsibility: The ability to apply knowledge and skills independently and responsibly, including the capacity to coordinate and supervise.

The practical implementation of the questionnaire referenced the NQF levels' summary table, which provides a taxonomic profile of each EQF level, using the revised Bloom's taxonomy (Krathwohl, 2002) for

descriptors (Table 3.).

Table 3. Descriptors for self-assessment of qualification level in relation to Skills, Objectives and Context, reformulated on the basis of the National Qualifications Framework (NQF), European Qualifications Framework (EQF) and Cognitive

	Skills	Objectives	Context	Cognitive Process	Knowledge
1	Concentrate and memorise	Perform a task within the prescribed parameters	Perform tasks under direct supervision	Remember (Recognising, Recalling)	Factual Knowledge
2	Interact and participate in processes	Coordinate with other people	Perform tasks in a structured context with a variety of situations	Understand (Interpreting, Exemplifying, Classifying, Summarising, Inferring, Comparing, Explaining)	Procedural Knowledge
3	Make logical connections	Achieve expected results	Cope in a structured context with changing situations	Apply (Executing, Implementing)	Procedural Knowledge
4	Cooperate in multitasking	Integrate activities and results of others	Cope with a predictable context, but subject to unforeseen changes	Analyze (Differentiating, Organizing, Attributing)	Procedural Knowledge
5	Manage critical issues	Plan revision and improvement interventions	Coordinate a determined context subject to recurrent changes	Analyze (Differentiating, Organizing, Attributing)	Conceptual Knowledge
6	Synthesise and motivate	Reschedule objectives and implementation methods	Coordinate a non-determined context subject to recurrent change	Evaluate (Checking, Critiquing)	Conceptual Knowledge
7	Manage complex social interactions	Integrate knowledge and elaborate strategies	Manage a non determined context subject to unpredictable changes	Create (Generating, Planning, Producing)	Metacognitive Knowledge
8	Master thinking systemic vision	Promote innovative processes, foreseeing scenarios and solutions	Design an innovative context, not comparable with already known contexts	Create (Generating, Planning, Producing)	Metacognitive Knowledge

Process and Knowledge Dimensions of Revised Bloom's Taxonomy.

Additionally, the questionnaire included a self-assessment section for the following soft skills, based on the twenty competencies identified by Freitas & Almendra (2021) that included the three competencies highlighted by the OECD (2018) for tackling 21st-century challenges:

Communication, Critical Thinking, Creativity, Problem Solving, Curiosity, Research and Exploration, Decision Making, Open-Mindedness, Systematic Thinking, Empathy, Collaboration, Participation, Flexibility/Adaptability, Learning to Learn, Teamworking, Self-direction/ Selfmanagement, Ethic/Compromise, Judgement, Leadership, Entrepreneurship .

An online post-event questionnaire was also sent to external organizations participating as stakeholders to identify whether their expectations were met and to gather insights on the strengths and weaknesses identified by their representatives. They were asked to evaluate the projects proposed by students and the educational format used, offering suggestions for improvement. A section of this questionnaire focused on the hard and soft skills (Freitas & Almendra, 2021) deemed important for a professional designer.

After RDE6, a focus group with participating students was organized to delve deeper into the data collected through questionnaires. The aim was to assess the transformative value of the event and understand the perceived social impact of their collective work. Techniques such as “If it were...” (e.g., “If RDE were an animal, what would it be?”) were used to facilitate the discussion. Simultaneously, participating stakeholders were involved in a focus group during the dissemination event to identify strengths and weaknesses of the five-day educational event and stimulate debate, exploring certain responses from the online questionnaire and uncovering additional insights. Techniques such as the metaphorical comparison of the educational event to a “journey” were used to facilitate discussions.

Semi-structured interviews were conducted with at least one faculty member and one tutor from each workshop to gather evaluations on the learning environment. The interviews utilized both a set of questions and narrative interview techniques (Atkinson, 2007) to generate anecdotes and impressions on the work process, its impact on institutions, and student engagement. Additional in-depth semi-structured interviews were conducted during the dissemination conference with faculty who participated in the five-day educational event to gather insights on pedagogical challenges, group management, and achievement of working group results. Techniques such as narrative reification processes, using “If it were” and “How might we” frameworks, were employed.

During the dissemination conference, a citizen science installation was developed, to gather data from all event participants, including RDE participants and visitors. The objective was to explore the future role of design in society and evaluate the RDE learning environment. Activities were designed to be simple and playful, providing bottom-up data.

The data collection involved:

- A four-quadrant matrix where participants placed adhesive markers according to their opinions. To facilitate

the clustering of the data in the collection analysis, the markers were distinguished with a color code assigned to each type of expected attendee at the dissemination event: students, faculty, stakeholders and others (Figure 2).

· Five postcards with statements such as “A designer is afraid of,” “A designer does not have,” “A designer only designs when,” “A designer aspires,” and “A designer believes that.” Inspired by the Empathy Map tool in design thinking methodology (Gray et al., 2010) , these incomplete statements were used to assess designers’ fears, aspirations, opportunities, ideals, and perceived threats regarding their professional role. Using the cloze test technique (Lucisano & Salerni, 2022), participants were asked to complete the postcards with a phrase, word, or drawing, and then place them in collection boxes. The anonymous data collection method encouraged participants to engage freely without fear of discrimination or prejudice (Figure 3).

This mixed-methods approach allowed for a comprehensive evaluation of the RDE6 edition, highlighting its impact on students’ knowledge, skills, and professional development while assessing stakeholder satisfaction and identifying areas for improvement in the educational format.

The research methodology employed in this study involved a detailed collection and analysis of both quantitative and qualitative data. Quantitative data was gathered through questionnaires, focusing on key variables aligned with the study’s research objectives. Specifically, participants were asked to provide self-assessments of their skills before and after the event, using Likert scales to measure abilities in areas such as collaborative problem-solving, design thinking, and project management. Additionally, the questionnaires sought to capture participants’ perceptions of the Rome Design Experience’s (RDE) impact on their professional development, particularly in relation to acquiring practical



Figure 2. Citizen Science Data Collection Installation: Participants discuss in front of the four-quadrant matrix.



Figure 3. Citizen Science Data Collection Installation: Participant inserting postcard into a box.

knowledge relevant to the design profession. Engagement levels and satisfaction with the event's structure, including the clarity of briefings and the quality of stakeholder engagement, were also assessed. The data collected was analyzed using descriptive statistics, allowing us to identify patterns and trends in participants' responses, which in turn helped evaluate the overall effectiveness of the RDE in achieving its educational and professional development goals.

Citizen science data collection was limited to the dissemination event, as this marked the culmination of the RDE, providing participants with the opportunity to reflect holistically on their experiences. This timing allowed us to capture feedback on the educational impact of the event, the challenges encountered, and how participants addressed them, as well as the practical application of the skills they developed through engagement with stakeholders and real-world problem-solving scenarios. Focusing on the dissemination event provided more comprehensive, reflective responses that spanned the entire learning process, from initial ideation to the final project presentation. Although this approach provided valuable insights, a longitudinal study with follow-up data collection could further enrich the findings, and this is an area for potential future research.

The data collection methods included both quantitative questionnaires and qualitative focus group discussions. While the questionnaires provided structured, quantifiable data, the focus group discussions allowed for a more in-depth exploration of the students' experiences, especially in relation to collaboration and the application of design thinking methodologies. The analysis process for the quantitative data involved statistical methods, such as calculating mean scores and standard deviations, to highlight shifts in participants' self-reported skills and perceptions. The qualitative data from the focus groups was transcribed and subjected to thematic analysis, which revealed recurring themes related to the educational model of the RDE, stakeholder collaboration, and alignment with professional development objectives.

This comprehensive approach to data collection and analysis strengthens the study's alignment with its research objectives, providing valuable insights into the RDE's impact on both students and stakeholders.

4.2 Results

The data collected in this study are not intended to be exhaustive. The value of the mixedmethods approach lies in its ability to cross-reference and contextualize data, leading to a more nuanced understanding. For example, some data gathered through questionnaires were further clarified and elaborated upon during focus groups and interviews. A significant limitation of the questionnaire results is the response rate. A total of 103 students completed the pre-RDE6 survey, whereas only 50 participated in the post-RDE6 survey. This discrepancy affects the reliability of the results and highlights

the need to employ additional data collection strategies and to analyze the data through a cross-sectional lens.

The student questionnaire results suggest that participants made substantial progress during the five-day event in their ability to manage complex situations characterized by a multitude of variables and unexpected scenarios. Insights gained from interviews and focus groups corroborated that the environment of the five-day event necessitated and fostered this ability, which was crucial for achieving the desired outcomes. Notably, there was a marked improvement in the students' capacity to adapt to unforeseen changes and to plan subsequent actions in a more organized and systematic manner, a finding that emerged from both student selfassessments and focus group discussions. However, most of the remaining self-assessment subdescriptors completed by students showed a slight decline. The impact of the RDE on critical thinking (ANPAL, 2022), for instance, is particularly intriguing and warrants further investigation, as even the focus groups failed to pinpoint the cause of this decline in self-assessed competency. A long-term follow-up study, conducted some time after the event, might provide deeper insights into how students perceive and define critical thinking.

Regarding feedback from stakeholders, 7 out of 12 respondents completed the survey. Their responses indicate a high level of satisfaction with the RDE outcomes and alignment with the project briefs. Stakeholders' evaluations of the RDE results and the group work were overwhelmingly positive. The skills deemed most important by stakeholders included creativity, teamwork, and problem-solving. In contrast, entrepreneurial skills and decision-making abilities were not considered as high priorities. This finding is particularly noteworthy in light of the RDE's goal to foster innovative processes within participating public and private organizations.

These findings underscore the need for further investigation to enhance the impact of the RDE on the development of critical and entrepreneurial competencies, which are essential for promoting integrated innovation between academia and the real world. Additionally, the results highlight the necessity of implementing measures to ensure a higher response rate for post-event evaluations, thereby facilitating the collection of more comprehensive data. Overall, the data collected emphasize the significance of experiential learning in a collaborative setting, while time emerges as a variable closely linked to the unexpected.

The focus groups yielded significant insights into students' perceptions and experiences during the event. Despite initial feelings of helplessness regarding their ability to effect concrete changes, students demonstrated a profound potential for growth and impact. One student observed, "I should be attuned to social issues, yet I am not; I am unaware of them, and they seem remote from me." However, this sentiment evolved in a positive

direction as another participant shared the following: “I had not previously believed that designing for social issues could have a tangible impact.”

It became evident that the role of the stakeholders was of paramount importance in determining the success of the project. As one participant observed, the effectiveness of the project depends on adopting a stakeholder-oriented approach. In the context of social projects, the process is of greater consequence than the outcome. It necessitates the involvement of the user, the stakeholder and the designer in a mutual exchange and joint exploration. This emphasizes the significance of collaborative processes over hierarchical relationships, as they foster democratic interactions that promote innovation and respect for all parties involved.

It was determined that the use of narration and experiential learning (Kolb & Kolb, 2017) were instrumental in fostering student engagement and comprehension of the project theme. These techniques facilitated an emotional connection to the issues at hand, which was identified as a crucial element in the success of social projects. It was generally agreed that to ensure the success of social projects, it is essential to transcend traditional power dynamics typical of commercial projects. This approach was seen to promote open exchanges that are innovative, respectful, and constructive for all stakeholders.

Another focus group discussion engaged 6 of the 12 institutions involved in RDE6. The feedback from these sessions indicated a favorable perception of the event and its outcomes, particularly in terms of the rapidity and efficacy with which innovative scenarios were generated. It was emphasized by participants that the RDE experience was pivotal in providing a multiplicity of perspectives and in identifying hitherto unconsidered strategies and resources. One participant described the RDE as “a journey of surprise and discovery about how we are perceived,” while another stated that the RDE “allowed us to embark on a new journey that we hope to extend to other citizens”. These remarks illustrate the transformative influence of the RDE on institutional perspectives and strategic planning (Juraschek et al., 2020; Carayannis et al., 2021). With regard to the subject of educational models, a particularly noteworthy observation was made. The RDE provided a clear path to follow, enabling the translation of a spontaneous activity into a replicable educational process. This highlights the role of the RDE in the formal structuring of innovative and spontaneous activities. Furthermore, feedback was provided regarding the schedule of the event. Some participants proposed extending the duration of the workshop, with intermissions between the intensive activity days. This recommendation emphasizes the necessity for a balanced scheduling approach that optimizes productivity while facilitating reflection and recuperation.

In the analysis of interviews conducted

with faculty and tutors, 16 individuals were interviewed, the majority being faculty members. The interviews focused on the influence of the learning environment and the effectiveness of different pedagogical strategies. Faculty members noted that workshops incorporating physical visits during the research phase or hands-on activities during the prototyping phase resulted in greater student engagement. Tutors highlighted that clearly explained phases of activities enabled students to self-organize more effectively. Tutors themselves played a crucial role in linking subgroups within each working group, facilitating communication and collaboration. Regarding the skills necessary for students working on projects with real clients, tutors emphasized the importance of the ability to interpret and critically analyze the challenges and briefs provided (Pontis & van der Waarde, 2020). Stakeholders underscored the heightened sense of responsibility and the adrenaline associated with designing for real-world contexts, such as an oncology department in a hospital. The opportunity to demonstrate the transformative potential of design in public service settings was found to be highly motivating. However, risks identified included hierarchical modes of operation (academic model: professors, tutor, students), performance anxiety, and the impact on the relationship with the partner organization or stakeholder.

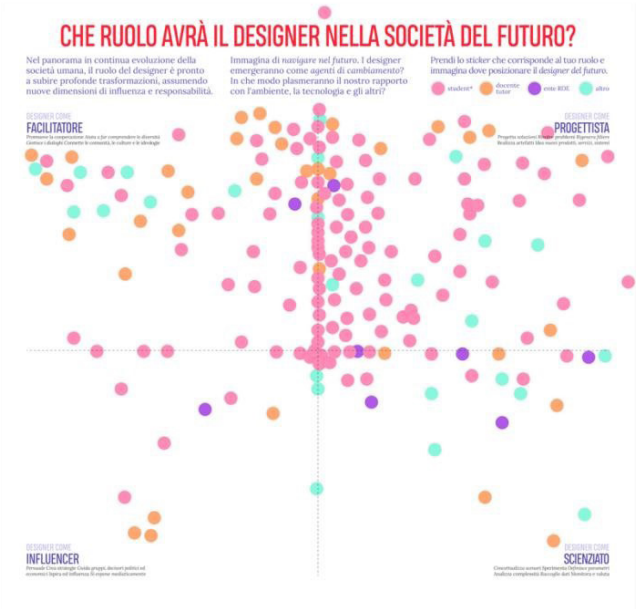
The citizen science installation collected 187 responses to the scenario canvas and 127 completed postcards. The mapping of future scenarios for the role of the designer revealed that students envision a future designer more aligned with the roles of a creator and facilitator. Stakeholders, on the other hand, perceive the future designer as more of a scientist, while faculty responses were varied but leaned towards seeing the designer as a facilitator.

Key insights from the installation include:

- Designer Fears: The most common fears among designers are related to failure, such as “designing something insignificant” and “lack of inspiration.”
- What Designers Lack: Frequent responses indicated that designers often lack time and a work-life balance.
- When Designers Design: Responses highlighted the value of inspiration and ideological or economic stimuli as motivations for design.
- Designer Aspirations: Predominant responses focused on the desire to create change for societal improvement and personal well-being.
- Designer Beliefs: Half of the responses expressed the belief that designers have the tools to change society for the better.

These insights from the interviews and the citizen science installation provide a comprehensive understanding of the dynamics within the RDE6 event, shedding light on the perceived roles, motivations, and challenges faced by design students,

tutors, and stakeholders. The data emphasize the importance of practical, real-world engagements and the critical role of facilitation



in educational design projects (Figure 4).

Figure 4. Citizen Science Installation: Four-quadrant matrix with results. Students are pink, faculty is orange, stakeholders are violet, others are light blue.

5. Conclusions

This study presents a case of RDE (Event-Based Education) as an educational approach centered around event-driven learning. The case study concretely demonstrates how design education can effectively employ experiential and collaborative methods within a limited timeframe, leveraging challenges derived from external, non-academic sources (challenge-based approaches). The mixed-methods data collection process allowed for a nuanced analysis, revealing that this fiveday event successfully implemented multigenerational and multidisciplinary work methods in an educational context. The collected data enabled the authors to analyze the relationship between the projects developed by student groups and the pedagogical model employed, thereby validating the effectiveness of the proposed educational framework within the RDE.

While there was a notable improvement in students' competencies, particularly in time management, organization, and adaptability to unpredictability, the data confirm that the pedagogical framework is still evolving and requires further refinement. The findings provide insights into potential methods for more concrete monitoring and mentoring, particularly in assessing both the acquired competencies and the critical and responsible approaches developed by students.

Moreover, the analysis identified the strengths of such events in managing transdisciplinary relationships among the academic, public, and private sectors. Innovative approaches emerging from this study suggest promising avenues for research aimed at fostering stronger empathetic relationships with stakeholders and increasing awareness of the social, economic, and environmental impacts of design projects. These elements are crucial for helping young designers consolidate their values and create a cohesive team-building environment among educators, tutors, students, and stakeholders.

While the academic literature extensively documents the efficacy of design sprints within industryuniversity partnerships, their impact

on innovation projects and the public sector remains relatively underexplored. Therefore, the RDE presents a promising case for further study and pedagogical improvement. The implementation of collaborative learning experiences within the RDE demonstrated potential for mitigating hierarchical influences; however, the results indicate that educational models like RDE require robust coordination and time management strategies to ensure the inclusive participation of all students and stakeholders. This calls for further investigation into the role of educators and tutors as facilitators of the learning environment. Additionally, interviews highlighted the need to enhance the continuous evaluation and monitoring of the entire academic community's engagement (including faculty) to more accurately assess the efficacy of these educational experiences across all competencies, not just those of the students.

The authors propose the integration of this educational model into lifelong learning contexts within design education. This approach outlines research pathways for the co-design of new pedagogical and organizational methods aimed at enhancing the critical capacities of students and educators, and improving cooperation between design schools and local communities. These educational efforts aim to amplify the social impact of design through collaborations and servicelearning initiatives, which can lead to a greater understanding and appreciation of designers' actions by local actors and stakeholders across various fields and sectors.

Discussions in focus groups with stakeholders highlighted the success of event-based education in providing new perspectives and structuring educational processes towards innovation, focusing more on relationships (both social and professional) rather than strictly on entrepreneurship. The feedback underscores the need to optimize programming by balancing time dedicated to teambuilding with educational activities and stakeholder interactions, thus improving the overall experience of future iterations of the event.

Indeed, the results from various research methods suggest the need for measurement approaches that link social outcomes, unlock shared value among educators, stakeholders, and students, and develop scalable solutions in social and public contexts. Design pedagogy should adopt approaches that promote empathy and impact awareness, particularly within social ecology projects, to achieve changes at the individual, interpersonal, organizational, and societal levels. Empathy plays a crucial role in enhancing communication and understanding between individuals, strengthening community ties, stimulating cooperation and social collaboration, and promoting equity and social justice.

In the Rome Design Experience (RDE), fostering empathetic relationships with stakeholders and increasing students' awareness of the impact of their projects are achieved through several key methods. First,

collaborative design sprints allow students to engage directly with stakeholders in iterative, hands-on processes that prioritize frequent feedback and alignment with real-world needs. Second, stakeholder co-creation workshops encourage mutual understanding by involving stakeholders in the early stages of problem definition and ideation, ensuring that students consider their perspectives from the outset. Additionally, structured reflective practices guide students in critically assessing the social, economic, and environmental impacts of their work through individual and group sessions, facilitated by professors and tutors. The RDE also incorporates real-world scenarios and challenges, where students work on concrete problems provided by stakeholders, enabling them to understand the tangible impact their designs can have on local communities, PA and industries. Finally, ongoing stakeholder feedback throughout the event ensures that students remain responsive to stakeholder needs, fostering deeper empathy and refining the relevance and impact of their projects. These methods are integral to the RDE's pedagogical approach and ensure students are equipped to create designs that are both empathetic and impactful (Figure 5).

These methods are fundamental to the RDE's pedagogical approach and guarantee that students are equipped to create designs that are both empathetic and impactful. IHowever, it It is essential to explore how these practices can be applied in other educational settings. Event-based education, as demonstrated by the RDE, should be applied in various institutions and fields to promote greater impact awareness and empathy. Design schools in other countries should adopt similar methodologies to encourage a deeper connection between students and local communities. Similarly, universities in non-creative fields must use similar approaches to make their courses more oriented toward social and environmental impact.

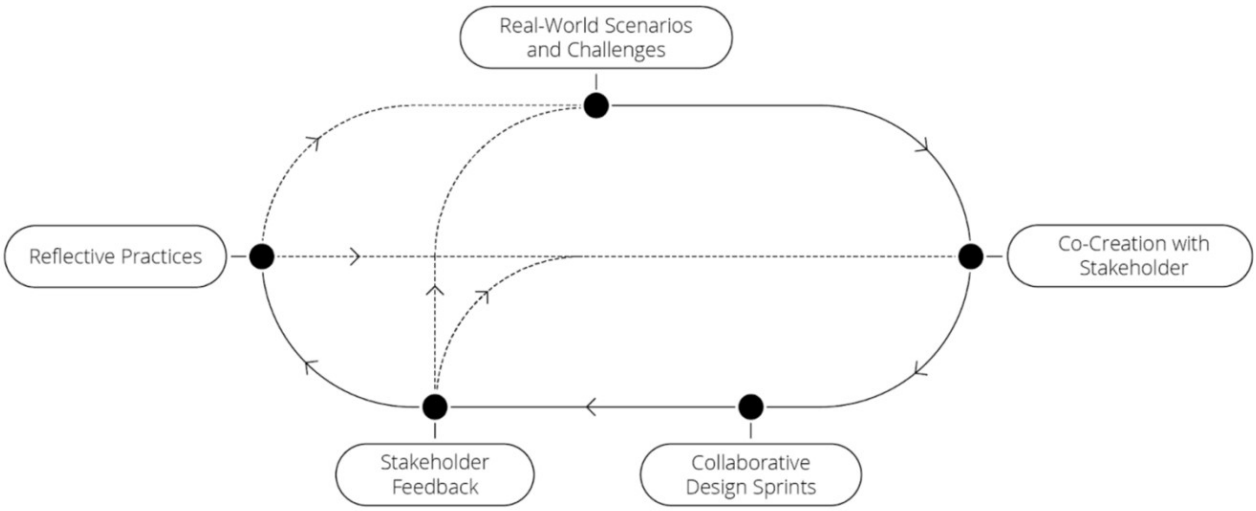


Figure 5. Rome Design Experience education model.

The RDE approach can be adapted to different educational settings by customising design sprints and workshops based on the specific needs and characteristics of various stakeholder groups. Furthermore, reflective practices and continuous feedback must be implemented in various academic programmes to enhance students' critical awareness and engagement with the impacts of their actions. Event-based education is a versatile and adaptable model that can and should be expanded to contribute to a more robust and responsible educational preparation across various fields and sectors.

In this context, event-based education appears to be a promising model for helping students develop personalized pathways based on impact awareness and empathy, even when these pathways diverge from traditional curricula and qualification frameworks. In today's rapidly changing social landscape, the role and responsibilities of higher education in creative fields are undergoing significant evolution.

Systemic design approach provides students with the tools to advance sustainable development goals through interaction, community building, and knowledge sharing. The relationship between design and society is both profound and multifaceted: design influences how individuals interact with their environment, fosters emotional connections, and promotes positive social change. Such understanding can be applied in a variety of educational contexts to foster global positive change.(Massari, 2024).

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EMPOWERING DESIGN: A FRAMEWORK FOR STIGMA-FREE DESIGN AND HUMAN AUGMENTATION.

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ABSTRACT | Designing assistive devices extends beyond clinical and technical considerations to include emotional aspects such as social stress, stigma, and shame, which are often neglected. Users of these devices frequently encounter subtle biases due to cultural stereotypes, challenging their self-reliance. This paper explores Product-Related Stigma (PRS) and how design can mitigate stigma, transforming perceptions from disability to extra-ability and human augmentation. We investigate the social constructs of warmth and competence, essential in social cognition and interpersonal perceptions, as defined by Fiske et al. Our proposed framework aids in creating stigma-free, human-augmenting products, featuring two design tools: the Product Intervention Model for Stigma (PIMS) and the Design Method for Human Augmentation (DMHA). PIMS includes 14 stigma-reducing design cards that inspire positive solutions by emphasizing warmth, fostering feelings of friendliness and approachability. The DMHA introduces designers to human augmentation, encouraging innovation in enhancing human capabilities and effectiveness, garnering respect and admiration while considering ethical implications. This dual-method approach, validated over five years in educational settings, has shown positive effects. By addressing both warmth and competence, these tools help promote empathy among design students, showcasing concepts that strengthen userproduct attachment, empower users, and enhance collective well-being.

KEYWORDS | INCLUSIVE DESIGN, STIGMA, HUMAN AUGMENTATION, DESIGN ETHICS

1. Introduction

A product-related stigma occurs when the product is the causal factor of social rejection or stigma. Due to their appearance and reinforced by existing stereotypes, people can link a product's appearance or certain visual features to an existing social stigma, resulting in a stigma-eliciting product (Vaes, 2014). When a product with specific visual features has the potential to elicit stigma, it is not the stigma that is present in the product itself, but only the capacity to elicit stigma. The immediate situation and the culture in which the interaction occurs greatly affect the actual eliciting of this stigma potential and the force of its impact. As such, product-related stigma is confined to a product's meaning and significance. Product-related stigma can initiate a stigmatization process in which people (bystanders in various contexts) externalize these stigma meanings, so they can be observed and experienced by the product user or wearer.

Some assistive, protective, or medical products carry a long history of 'rejection,' while others become questionable or unaccepted as soon as they move out of their intended context. People who use or wear assistive, protective, or medical devices are often confronted with subtle, clearly visible, or even invisible reactions of bystanders or passers-by (Vaes et al. 2010, 2013). As such, an encounter with a person and their stigma-eliciting product is an impactful experience that results from the aesthetic and functional aspects of the artifact itself, the individual experiencing the stigma, the observing bystanders, and the cultural context in which the situation is set.

Stigma-free design is an approach to creating products that aims to counteract such negative attention to a user's condition. Additionally, design for human augmentation aims to improve human abilities not only for people with a temporary or permanent impairment but also for healthy individuals looking to improve their current capabilities. At its core, human augmentation is about empowerment. Hence, products designed with this concept in mind should not only make users feel stronger and more capable but also reinforce their personalities by providing intrinsic value and meaning.

The framework presented in this paper comprises two toolkits that aim to inspire user empowerment and extra-ability, instead of social stigma and disability.

2. Universal dimensions of social cognition: warmth and Competence

To understand Product-Related Stigma (PRS), we examine the social constructs of warmth and competence (see Figure 1). These dimensions, delineated by Fiske et al. (2007), are reliable across stimuli, cultures, and time and are essential in social cognition, addressing competition, status, and interpersonal perceptions. Fiske et al. state that individuals perceived as warm and competent elicit uniformly positive emotions and behaviour. In contrast, stigmatized groups are often negatively stereotyped on competence and/or warmth across cultures. These dimensions reflect answers to two basic survival questions: first, does the other intend to harm or help me (warmth)? Second, does the other have the ability to enact those intentions (competence)? Distinct types of discrimination result from each warmth-by-competence combination. The warmth dimension pertains to perceived friendliness, trustworthiness, and goodwill, with warm individuals eliciting positive emotions and being perceived as approachable. As the primary dimension, warmth predicts active behaviours: active facilitation (helping) versus active harming (attacking). Conversely, the competence dimension concerns perceived capability, intelligence, and effectiveness, with competent individuals garnering respect and admiration. As the secondary dimension, competence predicts passive behaviours: passive facilitation (association) and passive harm (neglect). These dimensions, universally applicable across various stimuli, cultures, and temporal contexts, offer insights into how bystanders perceive a product user and their stigma-sensitive product. Depending on the target group and demographic, designers can enhance social image by emphasizing warmth (friendliness), competence (capability), or ideally, both.

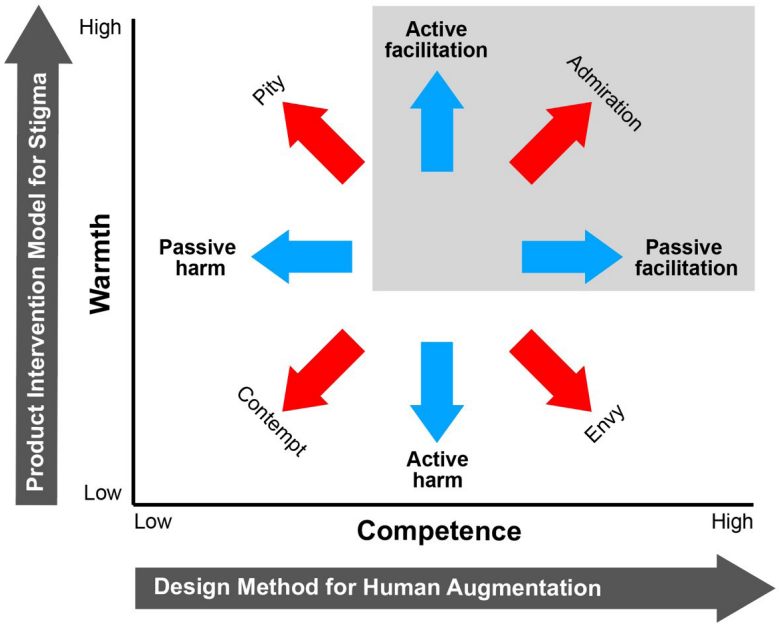

Figure 1. Behaviours from intergroup affect and stereotypes (BIAS) map (Fiske et al. 2007).

In Fiske et al.'s theory on the universal dimensions of social cognition, the four behaviours - contempt, pity, envy, and admiration - are positioned based on combinations of perceived warmth and competence. Applying these behaviours to the design of assistive devices can provide insights into user reactions and how to address them effectively.

Contempt: Low Warmth, Low Competence
Contempt arises when a person or entity is perceived as neither warm nor competent. This behaviour involves feelings of disdain or disrespect. Bystanders may view a user and their assistive device with contempt if it is seen as poorly designed (low competence) and lacks empathic communication (low warmth). Users might avoid using the device, spread negative word-of-mouth, and express frustration.

Pity: High Warmth, Low Competence
Pity occurs when a person or entity is perceived as warm but not competent. This behaviour involves feelings of sympathy or condescension. Bystanders may pity a user and their assistive device if it appears to have good intentions but fails to perform effectively. Product users might use the device out of necessity but with low expectations, possibly seeking alternatives.

Envy: Low Warmth, High Competence
Envy arises when a person or entity is perceived as competent but not warm. This behaviour involves feelings of jealousy or resentment. Bystanders may envy a user and their assistive device if it is highly effective but lacks user-friendliness or empathy. Users might rely on the device for its capabilities but feel disconnected or frustrated by its lack of warmth. Integrating more personalized and empathetic interactions and make the device more approachable and supportive.

Admiration: High Warmth, High Competence
Admiration occurs when a person or entity is perceived as both warm and competent. This behaviour involves feelings of respect, approval, and admiration. Bystanders admire a user and their assistive device that is both highly effective and user-friendly, radiating empathetic communication. Users are likely to have a positive experience, feel satisfied, and recommend the device to others.

Understanding these behaviours allows designers to strategically position their devices within the high warmth and high competence quadrant, fostering admiration and positive user engagement

3. The Framework for Empowering Desing

To battle product-related stigma and strive towards admiration (High Warmth, High Competence), the framework for empowering design operates along the two dimensions described above and preferably in a segmented approach.

We first apply the **Stigma-free design method (PAMS & PIMS)**. The implementation of both PAMS and PIMS can positively impact

the warmth dimension, helping to reduce negative perceptions associated with certain products. By emphasizing warmth, designers can create products that evoke feelings of friendliness and approachability.

In a second step, we apply the **Design Method for Human Augmentation (DMHA)**. Human augmentation refers to device-based technology designed to improve human abilities as an extension or integration of the human body. It can replicate, supplement, or exceed the user's physical, sensory, cognitive, and social capabilities, delivering true intrinsic value and meaning. Primarily applied in product design and engineering, human augmentation aims to transcend conventional design principles for (dis)ability (De Boeck, 2024). The DMHA introduces product designers to the field of human augmentation, encouraging exploration and idea generation for future advancements in human capabilities and prompting reflection on the ethical considerations of their conceptual designs. As such, the DMHA impacts the competence dimension, enhancing human capabilities and effectiveness, garnering respect and admiration while considering ethical implications. Competent products can be perceived as effective, innovative and reliable, advancing human capabilities beyond traditional disability-focused design solutions. Adding human augmentation elements assists in developing tools for users to cope with stigma. The user not only identifies with the product but feels empowered by it. When properly integrated, human augmentation can turn a user from a passive victim into an active challenger of stigma.

We will now elaborate on both tools of the framework.

3.1 Stigma-free design method (PAMS & PIMS)

3.1.1 PAMS – the Products Appraisal Model for Stigma

The best way to gather input on assistive devices is through actual immersion, by observing and questioning the user. Establish an empathic understanding with the user, observe and ask questions, and challenge your own assumptions. Immersive workshops in which designers and developers get to try and use these devices themselves are ideal to challenge one's own assumptions. Additionally, and prior to any design task, it can be useful to 'theoretically' delve into the context of the specific stigma-eliciting product, identifying the primary sensitivities for the product itself, the user, individuals they interact with, and society at large. To facilitate this exploration, we propose a checklist of 27 questions known as PAMS (Vaes, 2019) to uncover stigma pitfalls and social conflicts associated with the product.

The PAMS presents a systematic way of recording these insights. The PAMS questions are organised into three sets of nine, following a three-step sequence, from sensing (product perception), through

acting (product use), to meaning (reflection on product use). Within each set of nine questions, the standards, attitudes, and goals of three stakeholders involved in the human-product interaction are evaluated: the user, the bystanders, and the cultural context. The social pitfalls, conflicts, and challenges that emerge from the PAMS can be useful to pinpoint shortcomings of an existing product solution or they can be considered prior to the design of a new product solution. However, failure in addressing the important issues brought up by the PAMS could lead to product rejection by the stakeholders.

PAMS Matrix 1: Questions assessing appraisals related to product perception.
In this matrix, we assess how stakeholders perceive a user of an assistive device through all their senses. Completing this matrix will reveal tensions between the sensory product appreciations and the concerns of the three stakeholders. The designer needs to consider all sensory incongruities that might upset others or cultural norms and values. Products can be more than just sensory repellent to their users; they can represent sensory discomfort to their surroundings and can even go against cultural tastes. Additionally, the perception of a product and its user might conflict with the goals of bystanders, potentially distracting or influencing their behaviour. The sensory qualities of products may conflict with the stakeholders' values and standards, which can express personal or cultural value or significance and are variable in time and place. When assessing the goal appraisal, one should also reflect on how the sensory aspects of a product can motivate its user to wear or use the product. Obligatory product use or dependence on a product has never been a rewarding motivation for product use.

PAMS Matrix 2: Questions assessing appraisals related to product use
This matrix evaluates stakeholders' intentions regarding physical interaction with the product and examines how this interaction aligns or conflicts with their standards, goals, and attitudes. It addresses usability aspects, the distinction between obligatory and desired use, and the impact of use on various stakeholders. When users assess whether a product meets their standards during use, they consider any uncomfortable episodes and how these episodes make them feel. Additionally, to achieve certain goals, the product might require additional functionalities, such as being waterproof, dustproof, or adjustable.

From the perspective of bystanders, this matrix reveals whether the product in use is likely to negatively stereotype its user or hinder the bystanders from achieving their goals. What is comfortable and efficient for the product user might obstruct the goals or freedom of the bystanders. On a cultural scale, product use can indicate undesirable social behaviour and conflict with societal norms regarding decent behaviour.

PAMS Matrix 3: Questions assessing appraisals related to consequences of product use. This matrix represents the cognitive interpretation area where stakeholders evaluate their expectations of product and user behaviour, and assess whether these meet their standards, goals, and attitudes. These nine questions relate to stakeholders' perceptions of the product and its user, and the 'meaning' of these interactions.

Reflecting on the interaction, users can determine whether the product met their goals and whether they tolerated the interaction out of necessity or enjoyed certain aspects. On a higher level, we question whether the interaction conflicts with the user's expectations and beliefs. How do bystanders perceive our user after the interaction, and does this affect them mentally? These perceptions can extend to the cultural level, where users may be stereotyped by cultural values, even when they are not engaged with the product.

It is important to note that not all questions in the PAMS need to be answered. Depending on the product and context, some questions might even be irrelevant. The questions intentionally overlap and present slightly different perspectives, so it is not crucial which specific questions reveal the necessary insights. What matters is that all questions are considered and that the necessary stigma sensitivities are addressed. Some users of the PAMS have reported this overlapping nature as an important quality of the model, stating that it challenges them to delve deeply and report even the slightest variations in human behaviour.

The stigma specific sensitivities, conflicts, and challenges that are revealed through the PAMS can serve as input for the next design tool, the PIMS (Product Intervention Model for Stigma), which proposes stigma-reducing design interventions that seek to 'heal' the product of its stigma content. In this publication, we do not elaborate on the PAMS tool.

3.1.2 PIMS – The Product Intervention Model for Stigma

In a second step, we provide 14 inspirational stigma-reducing design cards shown in Figures 2 and 3 (Vaes, 2019). The purpose of these cards is to inspire designers to develop concepts that not only address the defined stigma challenges, but can also enhance user-product attachment, user empowerment, and collective wellbeing.

Re-shaping the meaning of the product
The context that is best understood by designers is the appearance of the product. Aspects such as shape, material qualities, and other sensory aspects all belong to the physical product context.



Figure 2. PIMS - Ten design interventions that aim to re-shape product meaning.

- Intervention 1: Camouflage or disguise stigma-sensitive product features. Use translucent or skin-coloured materials to hide obtrusive design features, potentially rendering a product invisible. This can signal product undesirability and increase user vulnerability, potentially reducing assertiveness in social settings.
- Intervention 2: Divert attention from stigma-sensitive features. Redirect attention to more appealing or eye-catching features to detract from stigma-sensitive aspects.
- Intervention 3: Strengthen the product's individual identity. Communicate individuality or personality through design aesthetics, allowing users to incorporate their own 'creative mark' via mass customization or personalization.
- Intervention 4: Strengthen the product's group or institutional identity. Design products to evoke feelings of belonging to a social group or subculture, providing emotional support, social validation, and a sense of community.
- Intervention 5: Strengthen the Product's Brand Identity. Reflect the identity of a positively perceived brand in the product, disconnecting from any negative brand affiliations to enhance user experience.
- Intervention 6: Eliminate confronting moments in product use. Adapt the product's functionality or usage rituals to avoid physically or mentally confronting moments.
- Intervention 7: Integrate additional benefits and experiences. Incorporate experiential benefits that pleasantly surprise the user during product operation, beyond practical or functional aspects.

- Intervention 8: Manage the frequency and intensity of product use. Reduce the frequency or intensity of product use to limit social exposure, providing mental alleviation or physical freedom.
- Intervention 9: Advances in material and technology. Utilize new materials and technologies to transform the product, making it lighter, stronger, more ecological, cheaper, and more accessible.
- Intervention 10: Aim for semantic and meaningful cooperation with other products. Design products to interact cooperatively with other products, combining positive traits to improve acceptance. Products can mimic the shape of accepted objects or complement each other's typology for strong design outcomes.

Empowering the user against product stigma

- Intervention 11: Endow the product user with extra-abilities. Instead of adding disabilities, enhance the user's abilities beyond those of 'abled' users. This intervention should inspire users to engage in meaningful and stigma-challenging activities, further expanded in the DMHA.
- Intervention 12: Boost the user's social skills. Encourage users to compensate for stigma by enhancing their social skills, becoming visually or verbally more assertive to overcome product-related stigma challenges.

Reshaping the social and cultural context

- Intervention 13: Reshape the product's cultural meaning. Challenge designers to reshape the product's cultural meaning through campaigns or interventions that educate or change public views. Consider design interventions in public spaces to promote interaction or appropriate behaviour.
- Intervention 14: Increase positive social visibility and product endorsement. Reshape the product's cultural meaning by increasing its positive social visibility. Endorsement by influential figures can significantly impact acceptance.



Figure 3. PIMS - design interventions that aim to empowering the user against product stigma and aim to reshape the social and cultural context.

It is important to mention that the interventions aim to inspire designers and suggest a general design direction. Applying the appropriate intervention is a creative and generative process that requires both expertise and practical experience. A properly designed stigma-free product is often the result of several and often overlapping interventions that create positive impact on bystanders, user-product attachment, and collective well-being.

3.2 Design Method for Human Augmentation (DMHA)

Human augmentation aims to transcend conventional design principles for (dis)ability. Primarily and increasingly applied in product design and engineering, a new design method has been developed to address the unique challenges and opportunities involved in enhancing human capabilities. Accordingly, the DMHA enhances the competence dimension by improving human capabilities and effectiveness, earning respect and admiration while addressing ethical considerations.

The DMHA was developed to introduce product designers to the emerging field of human augmentation, aiming to stimulate innovation while ensuring the ethical development of future design concepts for the augmented human. This design method was translated into a functional tool to enable validation through workshops. Figure 4 shows the structure of the human augmentation tool, which is subdivided in three educational learning goals or levels: an exploration, an ideation, and a reflection level.

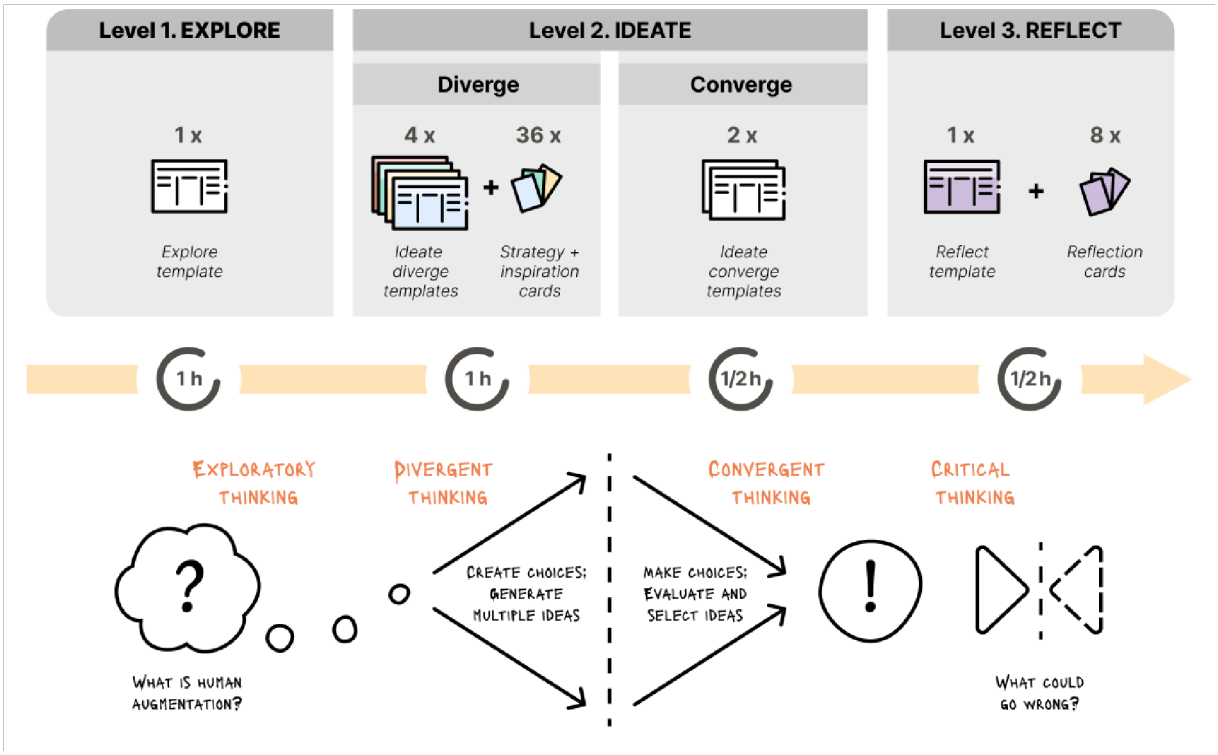

Figure 4. Structural model of the human augmentation tool

The human augmentation tool aims to facilitate various approaches to designing for the future human. Accordingly, the first level focuses on igniting exploratory thinking and introduces a framework that expounds the categorical and dimensional classifications of human augmentation identified in the literature. As depicted in Figure 5, human augmentation consists of three different dimensions i.e., replicating, supplementing, and exceeding a human ability, and four different categories i.e., physical, sensory, cognitive, and social augmentation. The framework was developed to help product designers better understand and characterize the type of human augmentation product they are designing by identifying its location(s) in the framework. As such, participants start by selecting an existing body-near product, providing a clear description of all its functions and locating them within the framework. As an initial exploration, they are then encouraged to consider the other categories and dimensions, brainstorming about additional possibilities and innovative features that could improve their initial product.

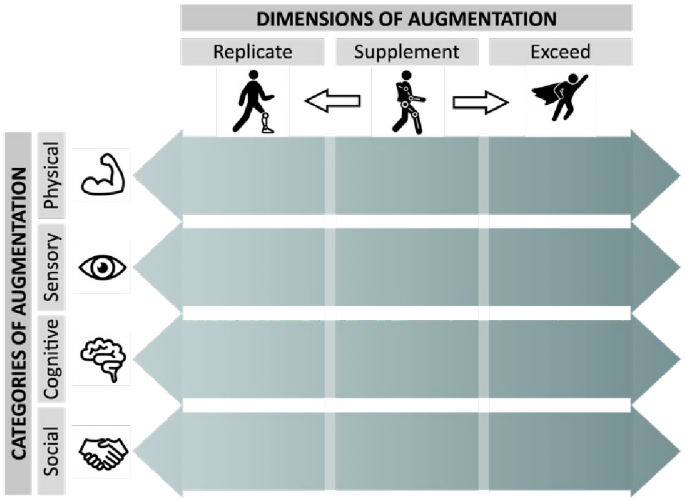

Figure 5. Human augmentation framework, presented in the first level of the tool.

The second level consists of two subparts. Within the first subpart, participants are encouraged to engage in divergent thinking using design strategy card sets, which are designed to prompt the generation of new ideas. Each set of cards corresponds to one of the four categories, with the back of each card providing an example to guide participants. The tool comprises a total of twenty-three strategy cards that were identified through a systematic analysis of 123 student projects (De Boeck & Vaes, 2024). These include seven for physical, four for sensory, six for cognitive, and seven for social augmentation. Additionally, a few extra inspiration cards are included to further stimulate creativity. The sets of cards are visually represented by an exemplary card in Figure 6. The second subpart involves convergent thinking, where the generated ideas are discussed, evaluated, and refined to create cohesive and innovative concepts. This process involves identifying creative product proposals as a team, highlighting the importance of solution identification, decision-making, and teamwork in the development of human augmentation products.



Figure 6. Design strategy cards and inspiration cards, presented in the second level of the tool.

Finally, the third level challenges participants to reflect on potential ethical issues that could arise from their newly developed concepts. Using eight reflection cards, participants are guided to consider worst-case scenarios, helping them identify how seemingly promising future concepts might encounter ethical concerns. The themes on the cards (listed in Figure 7) are drawn from literature, where many academics have discussed ethical issues related to human augmentation (Caon et al., 2016; Forlano, 2017; Naughton & Daly, 2020; Oertelt, 2017; Record et al., 2013). Again, the back of each card provides an example to further clarify the issues to the participants.

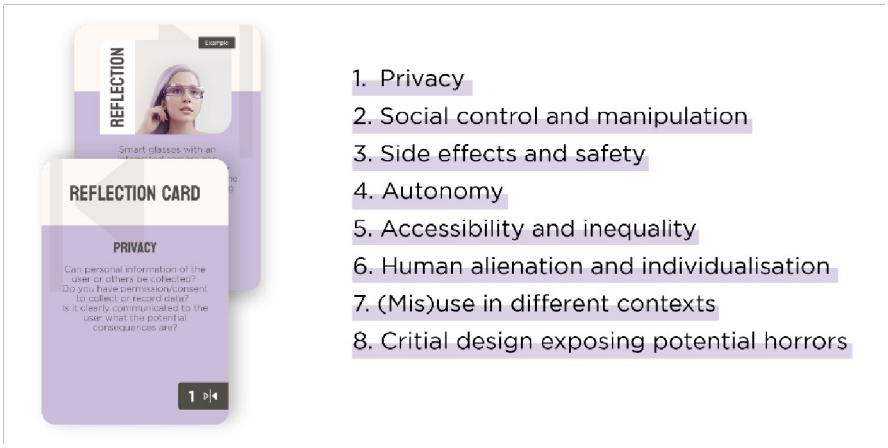

Figure 7. Reflection cards, presented in the third level of the tool.

4. Conclusions

The presented 'design for empowerment' framework challenges designers to break stereotypes and think beyond better ergonomics, pure functionality, and legal and technical restrictions. Properly integrating this framework can boost user involvement and enhance abilities, surpassing those who do not use the product. The framework applies to a wide range of products and services

aimed at improving the lives of individuals with situational impairments, those who are differently or temporarily abled, and anyone needing care through an assistive product or service. Ultimately, this framework may become universally applicable, as everyone will experience some form of impairment or need for care at some point in their lives.

Over the past five years, the Stigma-Free Design Toolkit has demonstrated its value in educational settings and as part of research and validation projects in the field of Inclusive Design. Initially perceived as complex, the PAMS model prompted 59% of students and users to engage in high levels of abstract thinking. By displacing designers into the context of the user, PAMS allows them to systematically uncover the challenges and realities faced by people with disabilities and their assistive devices. Thus, PAMS should complement personal immersion, observation, or empathic understanding, synthesizing and structuring insights derived from actual user contact and real-life challenges.

Both students and design teams have noted that the PIMS intervention cards assist designers in reducing negative perceptions associated with certain products. Reducing product-related stigma positively impacts the perceived warmth of the product user, evoking feelings of friendliness and approachability. A properly designed stigma-free product typically results from several overlapping interventions.

Instead of focusing on de-identification interventions that may increase users' mental vulnerabilities and conflict with the need for a strong social presence, it is more beneficial to invest in interventions that foster social confidence, optimism, and competence in social contexts. Aligning product identity with individual preferences and broader group, institutional, or brand identities can enhance product attachment and evoke feelings of pride, joy, status, and belonging. While effective, identification interventions that add ego-enhancing features provide extrinsic benefits and may not inherently strengthen users, potentially increasing their vulnerability in the absence of these features.

Interventions aimed at reshaping product use should focus on eliminating physically and mentally confronting moments to make product use more enjoyable. Designers can enhance this experience by adding benefits or managing social exposure through the frequency and intensity of product use. Considering new materials and technologies is essential, as they can lead to significant advancements, making products lighter, stronger, more ecological, and more capable. These innovations enable the exploration of design solutions that enhance the body's abilities, allowing users to transcend disabilities. The final product intervention, where less accepted products incorporate elements from more celebrated ones, has inspired many designers and students, showing promise in acceptance and innovation.

The PIMS model also emphasizes user-focused interventions aimed at empowering users, transforming them from passive recipients to active challengers. Enhancing users' abilities and social skills can protect and boost self-esteem, enabling them to overcome negative societal reactions. This empowerment extends beyond individual users, benefiting others with similar stigmatizations. Additionally, efforts to change cultural attitudes towards disability and assistive devices, such as campaigns and structural interventions, are crucial in supporting these design endeavors. In conclusion, we trust that, in the hands of a trained designer, the Stigma-Free Design Toolkit has the potential to alleviate the effects of stigma surrounding assistive devices and increase both user-product attachment and collective well-being.

In addition, the human augmentation tool has been conceived through the analysis of 123 student projects and was implemented in an academic context for two consecutive years for validation. Student feedback on this tool, gathered through an online questionnaire, highlighted several key aspects of its usefulness. In perfect alignment with our goals, one student stated that human augmentation "can leverage someone's impairment to a higher level, transforming it into an asset." Another student described the tool as "an efficient way to quickly generate high-quality concepts," emphasizing its ability to produce valuable ideas in a short time. It was also credited with "broadening their scope," suggesting that the tool expanded their field of creative thinking. Moreover, praised as "a complete set that taps into creativity," the tool provides comprehensive support for idea development. Students found it helpful for "finding their way in chaos," indicating its utility in navigating complex creative processes. Furthermore, they appreciated the "strong foundation at the start of the design," making it highly "deployable in a team." The tool strikes a "perfect combination between realistic thinking and more imaginative idea generation," blending practicality with creativity to enhance the design process.

As human augmentation can be made for anyone, including users who may or may not face an impairment, it pursues to go beyond stigma-free design by focusing on empowerment and making any user feel more capable (De Boeck & Vaes, 2024). With the rapid advancement of technology, there has been a growing interest in not only restoring but also surpassing human abilities. The growing importance of human augmentation technologies, the novelty of the proposed research field, and the significant practical and ethical considerations involved, have contributed to the drive of this study and the development of the human augmentation tool. By providing a tool that enhances capabilities, product designers can empower individuals and positively impact their self-perception. When individuals feel more capable, they are likely to project this confidence in social

interactions, which can influence how others perceive their competence. Overall, as human augmentation has the potential to significantly influence perceptions of competence by enabling individuals to exceed typical human limitations, it can reshape how society views capability and (dis)ability.

Within previous research, we also discovered that social augmentation has not been as thoroughly studied as the other categories, despite its significant potential value for empowerment. Social augmentation aims to improve social skills by supporting collaboration, communication means, and interaction, which can positively influence how individuals are perceived in terms of their competence. During the implementation of our tool in academic settings, we observed that student product designers frequently overlooked the aspect of social augmentation. By also broadening this perspective, the human augmentation tool has the potential to significantly contribute to social empowerment, which in turn can improve perceived competence.

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DESIGNING A PARTICIPATORY PROCESS TO IMPLEMENT TECHNOLOGY-BASED PROJECTS IN VULNERABLE COMMUNITIES.

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ABSTRACT | The state of Chihuahua is characterised by being a mainly arid ecosystem, where the effects of climate change are contributing to create new conditions of extreme vulnerabilities (Janssen 2006; Ribot 2011). This aspect, together with the rapid socio-environmental changes, brings to the need to understand how design could evolve to face the new challenges in the vulnerable communities of this region (Brown 2017; Giorgi 2022; Wen 2020). Contrary to the vision that considers technological development and community approaches as antithetical themes, the main research question that addresses this paper is: how design can facilitate community appropriation of interventions based on accessible technological resources, in order to improve the built environment, quality of life, and climate change? The research project is an ongoing project and the outcomes here presented have been developed between 2022-2024. The project which is based on a strong connection between researchers and communities' members, were developed following these methodological stages of participation (Winter 2019; Groat 2013): (1) semi-structured interviews; (2) walks; (3) co-mapping; (4) definition of indicators; (5) project reflection; (6) definition of technological resources. By implementing a process of participation with communities' members, six projects were defined whose objectives are to generate, through accessible technological resources, a change in the local community towards sustainable, socially and financially viable models. The six projects developed can be summarised as follows: PASO DEL NORTE – Mobility HUB: Implementation of an electric bicycle network to improve accessibility to urban services in the neighbourhood, with a focus on training residents to transform traditional bicycles into electric bicycles and promoting entrepreneurial activities. PASO DEL NORTE – Technology HUB: Transformation of a kiosk into a technology center equipped with solar energy, Wi-Fi, projector, tablets, aimed at improving educational activities and reducing the digital divide in the community.

NUEVAS DELICIAS – Agri HUB: Installation of smart greenhouses and water and solar energy collection systems to experiment with new forms of sustainable agriculture and address the water deficit in the region.

JULIMES - Water HUB: Implementation of water filters to remove arsenic and fluoride from wells, along with awareness activities to improve the quality of life of residents.
BASASEACHIC – Environmental HUB: Environmental awareness through the installation of greenhouses, solar panels and biodigesters in a secondary school, as well as the distribution of air quality meters to monitor, with community science processes, pollution in homes in the region.
BASASEACHIC – Tourism HUB: Development of a tourism project focused on promoting night tourism for stargazing, through training students in the use of telescopes and drones. Based on the framework above described, this paper introduces results by: (1) introducing design responses that resulted from the process described in each of the six categories, (2) explaining how the design of these spaces has been embedded with the communities' members, (3) providing details about construction process, level of community engagement, use, and budget, (4) based on previous experience developed by the authors in China, Italy and Mexico, this paper provides explanation and comparisons on how this methodology can be applied in other cities.

KEYWORDS | URBAN VULNERABILITIES, VULNERABLE COMMUNITIES, TECHNOLOGY-BASED PROJECTS, RESEARCH BY DESIGN, DESIGN FOR VULNERABLES

1. Introduction

In a society that sees increasingly frequent and disruptive radial changes, urban-architectural design cannot remain outside the discussion on what its role should be in the present. If we consider "vulnerability" as that condition in which a factor external to a system can put the wellbeing of the system itself at risk, it is clear that these current changes more easily put vulnerable realities into crisis, and it is precisely in these conditions that deeper reflections must be made in terms of the role and responsibility of design (Jonas, 1985). Considering, moreover, that these conditions of vulnerability depend on the political, economic and technological power that the realities possess, it is interesting to analyze in particular how it is precisely the "new" technological sphere that can activate important thoughts in terms of new vulnerabilities, unexplored potentials and processes of technological acceptance in vulnerable communities (Aftergood, 2016; Anders, 1980; Galimberti, 2012).

In this context, the research project "Design for Vulnerables" is developed, which aims to define a design methodology capable of facilitating the acceptance of accessible technological resources in vulnerable communities to reduce the very conditions of vulnerability and the digital divide. This methodology is based on citizen participation processes that, although very fashionable in recent years, remain a topic of debate in terms of methodologies, objectives and even definition (Groat, 2013). In particular, if the concept of "participation" sounds attractive to government or philanthropic entities that carry out interventions in communities, participation is often limited to listening to problems or expectations. The research project presented here combines the challenges related to the acceptance of technological resources to eradicate conditions of vulnerability and the challenges related to participatory processes (Brown, 2017; Janssen, 2006). The study of these challenges is carried out in contexts of vulnerability in a semiarid region of Mexico.

1.1 Challenges, Vulnerabilities and the semiarid region

The "Design for Vulnerables – Technology Challenge" research project is currently being conducted in four distinct communities situated in the state of Chihuahua, Mexico (see Fig.1). These communities were selected due to several compelling factors: (1) their residents are facing local vulnerabilities stemming from both human-made and natural challenges; (2) each community possesses untapped potential for sustainable and regenerative development; (3) these communities are dealing with significant impacts from climatic and environmental changes prevalent (Ribot, 2011) in a semi-arid region such as Chihuahua; and (4) each community represents a unique setting —urban, peri-urban, rural, and forested— which serve as models for other regions exhibiting similar contexts.

1.2 Paso del Norte (Chihuahua, Chihuahua) — Urban Community

Paso del Norte (28°67'41.77" N, 106°06'90.05" W) is a semi-formal urban community situated within the municipality of Chihuahua. Established in the 1970s, as a solution for families migrating from rural areas seeking housing in the city. The main characteristic of Paso del Norte is its geographical setting: it is perched on the slopes of a mountain range that restricts urban expansion and is divided from the formal urban area by an urban highway and the Sacramento River. This geographical isolation poses challenges for residents, contributing to feelings of exclusion and insufficient access to essential services. Accionética, a local association led by Virginia Aceves, has dedicated the past seven years to work within the community, focusing primarily on organizing recreational and educational initiatives for children and youth. Through comprehensive analysis and mapping of community assets and challenges, two prominent issues have been identified by residents: (1) improving accessibility to and from the community, and (2) enhancing access to technological resources that facilitate learning activities promoted by Accionética.

1.3 Nuevas Delicias (Chihuahua, Chihuahua) — Peri-Urban Community

Nuevas Delicias (29°07'19.96" N, 106°25'16.02" W) is a peri-urban town within the municipality of Chihuahua, founded after the Mexican Revolution (circa 1910-1920) to redistribute land from wealthy landowners to poorer populations. The Union Agrícola y Ganadera of Nuevas Delicias primarily oversees the management of communal resources and production sites. Moreover, this community is very important in the region since it is home to several educational institutions that attracts students from surrounding agricultural region, encompassing an elementary school with 300 students, a secondary school with 250 students, and a high school with 100 students. Moreover, organizations like the "Club del Abuelo" actively collaborates on various initiatives within the community. However, climate change and the mismanagement

of water resources, pose serious threats to the sustainability of agricultural practices in Nuevas Delicias. During community workshops, participants highlighted the urgent need to address these environmental challenges and water consumption sensibility.

1.4 La Regina (Julimes, Chihuahua) — Rural Community

La Regina (28°24’45.1” N 105°27’05.3” W) is a rural community located within the small municipality of Julimes, with a strong agricultural focus thanks to the relative abundance of water sourced from the Conchos River. Despite this availability of water, the community faces severe contamination issues—particularly with arsenic and fluoride levels—which jeopardize the health of its residents. Although both state and municipal public authorities, alongside private sector interventions, have made tremendous advances to mitigate water quality issues, some problems persist and the current methodologies to make water drinkable, such as reverse osmosis systems, lack effectiveness. Although numerous socio-economic emergencies exist, predominantly linked to extreme poverty, community members unanimously identify water quality as the paramount issue needing immediate and comprehensive attention.

1.5 Basaseachic (Ocampo, Chihuahua) — Forest Community

The community of Basaseachic (28°12’14.1” N 108°12’34.5” W) is nestled in the municipality of Ocampo, located in the western Sierra Madre, commonly referred to as the Sierra Tarahumara.

The region’s natural resources and scenic landscapes render the Sierra Tarahumara one of Mexico’s premier tourist destinations, with Basaseachic renowned for hosting the highest continuous waterfall in the Americas. Despite its natural allure, the local tourism industry suffers from a lack of visitor retention. Moreover, the community’s ecological and social frameworks are under threat from excavating operations, combined with the negative impacts of climate change and a general apathy towards environmental conservation. During community workshops, two critical themes surfaced, indicating the residents’ desire to engage actively on these issues: (1) fostering greater environmental awareness among the population, and (2) developing innovative and sustainable tourism offerings within the municipality.

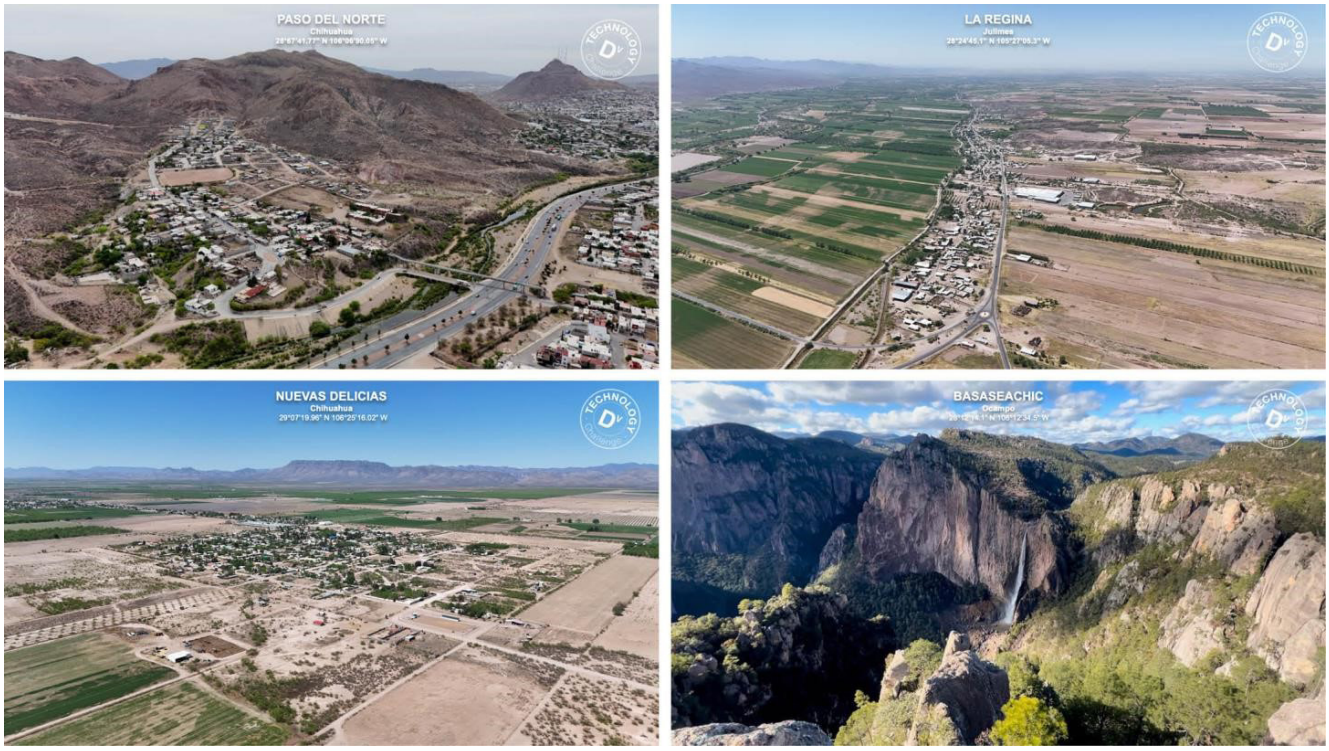

Figure 1. The four locations of the research project: Paso del Norte (urban), Nuevas Delicias (periurban), La Regina (rural) and Basaseachic (forestry).

2. A six-step participative process

To optimize the results of community participation, the work was structured according to six main phases of collaboration with the community, preceded by two phases for preparing the environment to the implementation of the six-steps. The following six steps have been:

1. Activity 1. Semi-structured interviews (Screening)
2. Activity 2. Walk around the neighborhood (Screening)
3. Activity 3. Mapping
4. Activity 4. Definition of indicators and vulnerabilities
5. Activity 5. Development of shared strategy / HUB
6. Activity 6. Definition of tech-based project

2.1 Preparing the process

As first activity, to prepare the process, a phase of knowledge of the contexts by the research group took place: in this pre-workshop, field visits were carried out and videos were recorded to document the territorial context of the four communities. In addition, the objectives of the

"Design for Vulnerables" (Dv) project and the structure of future methodological activities were presented to the stakeholders. Field visits were carried out in the communities, during which each expert conducted non-participatory observations, collecting video material on the socioenvironmental contexts of each area. The videos produced were shared among the team of experts to better define and understand the vulnerability of each community.

The second activity regarded the involvement of the main actors active in the context: the purpose of the "Design for Vulnerables" project was explained to the stakeholders along with the structure of future methodological activities, confirming the interest of the community. Prior to this activity, stakeholders expressed their willingness to voluntarily participate in the formulation, presentation and implementation of the "Design for Vulnerables" project.

2.2 Activity 1. Semi-structured interviews (Screening)

With the main actors, that is, those actors who first joined the project, semi-structured interviews were conducted to allow (1) to gain a deeper understanding of the context, analyzing those aspects that emerged in the initial approach to the community; (2) to begin to establish a relationship between researchers and residents that is deeper than those that are created in activities with many people. Without a doubt, this first activity allows for a very important awareness of the main themes to be studied.

2.3 Activity 2. Walk around the neighborhood (Screening)

In order to create an even deeper bond between the research team and the residents, as well as to have a deeper knowledge of the context, several field visits were organized with interviews and informal meetings between the main actors. The main objective of this activity remains the possibility that, by walking through the context, the residents could better express the concerns and hopes that characterize their normality.

2.4 Activity 3. Mapping

Participatory cartography workshops were held in each community for mapping and prioritization, lasting approximately two hours. The process was documented through photographic and video recordings, both with prior verbal approval by the participants. The activity consisted mainly of community mapping of vulnerabilities, potential for change, and factors that influence access to technology using a satellite image (map) of each territory printed in large format. Each community located social, environmental, and/or territorial problems on it. The identification, choice of symbology, and location of these problems was carried out through dialogue among participants and

with the guidance of technical facilitators (interdisciplinary experts). Colored labels, markers, and colored pencils were used for the symbology.

2.5 Activity 4. Definition of indicators and vulnerabilities

The fourth activity represents the last activity of this first "analysis" session and is about the community prioritization of vulnerability indicators in each community (Valderrey et al., 2023). A printed questionnaire was used containing the 50 ecological and social indicators proposed by the academy that are related to the six dimensions of vulnerability analyzed in the Project. The participants used a three-point Likert scale (0-not at all important; 1-somewhat important, and 2-very important) to assess their importance. Without a doubt, the main objective of this activity is to reflect, starting from a scheme of vulnerabilities defined by the academy, on the most relevant needs of the context with the results of (1) raising awareness about situations of vulnerabilities and (2) opening the reflection to the generation of ideas and proposals for the strategies to be implemented.

2.6 Activity 5. Development of shared strategy / HUB

Thanks to the list of vulnerability conditions developed in the previous activity and the reflection that the list generation produced, this review of the intervention strategies proposed by each community was developed. Then the team of experts structured the strategic lines of technological intervention based on the contextual characteristics of each community. These strategies have undoubtedly been the result of an imaginative process that wanted to propose a vision of radical change in the communities, without considering the specificity of each intervention or the technical aspects.

2.7 Activity 6. Definition of tech-based projects

Based on the definitions of the strategies, the projects to be implemented and the technological approaches that each of these should have began to be defined in joint work between multidisciplinary experts and community actors. Thanks to the support of experts in different disciplines and experts in technological resources, six projects were defined that contribute to the realization of the visions defined above. All the projects (Fig. 2) have an important technological component that facilitates the realization of activities that contribute to the objectives of each project.

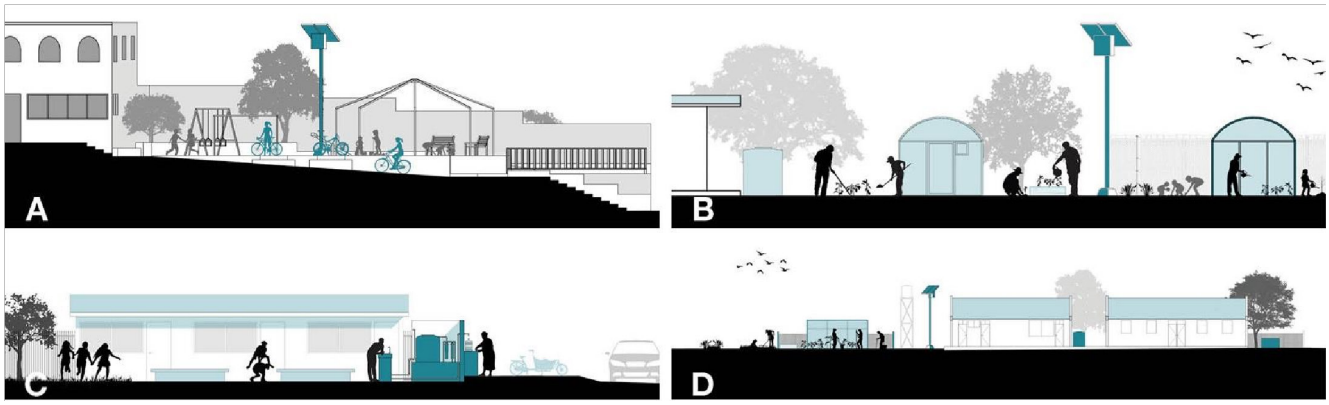

Figure 2. The designed interventions for the four communities (more drawings and pictures on the webpage www.designforvulnerables.com).

3. The six projects

During a period of 6 months (September 2023 to March 2024) the six projects planned with the communities have been implemented and the first activities supported by these projects took place. Here, we present the six projects and in the following section of “results” the main common characteristics will be underlined, so to present some final conclusions, which are the answers to the main question of this research.

Together with the communities, we decided to call all these projects as “hub” with the assumption that these interventions could be a first step where to generate and think about following steps toward a common shared vision of local sustainable development (Fig.3).

3.1 Paso del Norte – Mobility Hub

To facilitate the connection between the community and the formal city, an electric bicycle system that facilitates access to the community and urban services is being implemented. The initial phase of the project involved some public activities to make people “fall in love” with the technology. Then, according to the willing and the levels of participation, four bikes have been assigned to some families. At the same time, a workshop to modify traditional bikes to electric bikes has been organized, led by a professor in mechanical engineering. So, other four bikes have been assigned to other families which created their own electric bike. The main goal of theses phases was to introduce the technology in the community, showing the benefits and the facility to create it.

The second phase involves the installation GPS to other electric bicycles with the aim to leave them freely in the community and create a connection from the main square of the community to the Tecnologico de Monterrey campus, where the main transportation lines of the city pass.

The last phase (hopefully) is to support the community's entrepreneurial initiative for the generation of an electric bicycle service in other vulnerable communities.

3.2 Paso del Norte — Technology Hub

To facilitate the activities of the association and limit school dropout, an existing kiosk has been transformed into a high-tech public element: (1) a wifi router brings Internet to the community; (2) a projector, a screen and speakers allows residents to organize shared cinema activities; (3) tablets and 3D viewers allows Accionética to organize educational activities, together with experts or by themselves, for children, youths and women of the communities. All these electronic devices are supported by a solar panel that has been installed in the main square and which supports also the recharge of the electric bikes.

3.3 Nuevas Delicias — Agricultral Hub

In order to raise awareness about the importance of sustainability in agriculture and to promote new forms of agricultural production, the following projects have been implemented: (1) two "intelligent" greenhouses for the production of vegetables (high school) and flowers for sale (club del abuelo) have been installed together with a solar panel to make the sensors, computers and pumps work; (2) cactus cultivation for new techniques of fodder for livestock (in the secondary, a cactus garden was already been planted); (3) drip irrigation systems, with solar panels to sensibilize about water saving and humidity; (4) composting system for recycling food waste (in the primary school); (5) a drone system to supervise the maintenance of water resources and the surveillance of livestock, saving time, fuel and water. The five systems work in a circuit, so that the compost products are used for the greenhouses and gardens that feed the school canteens.

3.4 La Regina — Water Hub

To allow residents to access water supplies without having to resort to contaminating reverse osmosis systems and to avoid high energy consumption, five slow filtration filters have been installed in public spaces: one in the main public square and four within primary and secondary schools, with faucet installed inside and outside the schools' fences. These filters, developed by a local company, can remove significant amounts of arsenic and fluoride (all of them have been approved by the public authorities and are under periodical controls by the local health system). Moreover, to create understanding about the importance of filtering the water, some educational activities have been implemented with the schools and water quality testers have been distributed within the community.

3.5 Basaseachic — Environmental Hub

To raise awareness of the importance of caring for the environment and the social opportunities associated with environmental activities, the Basaseachic Secondary School and CONANP (National Commission for Natural Protected Areas) work together

with the “Environmental HUB”: (1) biodigester to recycle food waste from the canteen and heat classrooms with gas instead of firewood; (2) intelligent greenhouse to produce vegetables for local consumption and mushrooms for selling; (3) a scientific laboratory on air and water quality.

3.6 Basaseachic – Tourism Hub

To think about new possibilities for tourism and to offer a new digital image of Basaseachic (as a natural area with many tourism opportunities) a project with the high school and hoteliers has been implemented. In particular, the project works in the direction to promote a new offer for touristic activities in Basaseachic: taking advantage by the fact that this are of Sierra Tarahumara is one with the best region in Mexico to observe the starry sky, the high school proposes activities focused during night time, giving the opportunity to promote one-night stays in the local hotels.



Figure 3. The six projects developed within the project: (A) electric bike network in Paso del Norte; (B) technological gazebo for educational purposes in Paso del Norte; (C) agricultural hub in Nuevas Delicias; (D) public filters for potable water in La Regina (Julimes); (E) the environmental hub in the secondary school of Basaseachic; (F) the tourism hub, with the high school of Basaseachic.

4. Results

4-1 Design responses

A first result to highlight is related to the ability to involve the local community. Objectively, to date, it has not been possible to involve all the actors of interest for the participatory process: the public sector remains almost completely excluded from the urban project of Paso del Norte and the participation of society does not exactly reflect the population of the colony. This second fact can be related to the important role played by Accionética which focuses its work on the youngest segment of the population and on women's groups.

On the contrary, in the projects of Nuevas Delicias, Julimes and Basaseachic, there has been a strong participation of the educational sector (all levels of basic education) and an important participation of the local public administrative sector (Unión Agricola in Nuevas Delicias; the municipality, the Civil Protection and the State Health Secretariat; the municipality in Basaseachic). Objectively, the participation of the schools has made it possible to plan the projects, carry out the interventions and manage them.

It should be noted again that the lack of educational services in Paso del Norte does not allow a school to be involved as easily as in other contexts.

4.2 Design of spaces has been embedded with the communities' members

The implementation of the projects had important implications both in the physical spaces of the communities that were modified to allow the projects to be executed, and in the ephemeral organizations of the communities.

The changes in the spatial sphere are already distinguishable in section 2 "A six-step participative process" (Fig.2), where we see how: (1) the public square of Paso del Norte had to undergo modifications to install the solar panel, the technological kiosk and facilitate the use of bicycles; (2) the external spaces of the schools of Nuevas Delicias had to be rethought to accommodate the vegetable garden, the greenhouse, the rainwater collection tanks and the solar panel; (3) the spaces of the schools of La Regina had to internally accommodate water filters and the fences saw the emergence of these points of sharing with the external community; (4) the secondary school of Basaseachic made a significant modification of the land to better accommodate the greenhouse, all the connected systems and create the vegetable garden.

Beyond the new activities that associations and schools carry out thanks to the interventions, the changes in the ephemeral sphere mainly concern the changes that schools have made in their educational

programs: in Nuevas Delicias, the primary and secondary schools have made changes in the educational program to introduce the use of technological resources in teaching activities. The secondary school of Basaseachic has done the same, with very interesting results, by introducing an ecological laboratory in the various levels of teaching and the bachillerato has introduced a sustainable tourism class.

4.3 Applications of this methodology in other cities

In the years in which the "Design for Vulnerables" research project has been carried out (2021 – today), one consideration always appears very clear and indisputable: the conditions of vulnerability are contextual (Wen, 2020; Winter, 2019). For this reason, it would be unthinkable to propose these same solutions a priori in any other community, even if it were a community 5 kilometers from those currently involved. This fact sheds an important light on the role that the methodological process plays in tackling a design path together with a community of residents. As explained previously, even in a single project like this, the spectrum of participants is not uniform in the four communities due to different characteristics of the social fabric. Therefore, it is even less uniform in radically different social and cultural contexts. Therefore, the ability to observe and map – in the first instance – who are the main actors in a context, and try to be able to count on a balance of participation, without losing the presence of the main actors and without forgetting the less impactful ones, becomes an extremely relevant aspect. Which these are (whether public, educational, administrative, private, academic, associative, etc.) cannot be defined without knowing the context.

Secondly, an important aspect that emerged from the implementation of the six-step methodology concerns the importance of sensitivity, typical of the architectural discipline, to be able to read and interpret together with the community, the characteristics of a territory thanks to different means of communication and reflection. Now, since vulnerabilities are contextual, there is nothing more important than these processes of participatory reflection, which allow us to highlight the peculiarities of a territory, allowing, at the same time: (1) to bring the design group closer to the context, (2) to facilitate dialogue with the community, (3) to document a process rich in ideas that can prove important when introducing new actors, and (4) to reflect together with the community on the potential and vulnerabilities of the context, facilitating the emergence of visions that go beyond the normalization of reality and the rise of phenomena of awareness.

5. Conclusions

The process presented and developed during this project highlights that design has a fundamental role in the ability to create awareness. That is, it has always been

highlighted how the participatory collaboration between the research group and the community allowed communities to reflect on some issues specific to local vulnerabilities and that residents often know, but do not associate with conditions of potential and vulnerability. This consideration opens an interesting area of possible development linked to how the design process can be first and foremost - in certain contexts and needs - a promoter of awareness.

A further consideration is linked to the importance of being able to count on economic resources to be able to carry out the projects planned with the communities: a research on participatory processes that ultimately did not lead to the realization of some project would raise important concerns, beyond the ethical sphere, of continuity and depth of analysis: it would not be possible to thoroughly analyze the impact of participatory design, as we plan to do in this project, starting in the next few months.

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Author 1 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE] [_P/RoD Author Bio and Acknowledgements]

Author 2 add an author bio that describes research interests and main achievements in a maximum of 40 words. [LEAVE BLANK UNTIL FINAL ACCEPTANCE]

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ARCHITECTURE OF DEGROWTH: A SPECTRUM

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ABSTRACT | Urban development projects are determined by current neoliberal economic policy values, the trajectory of growth, and these values are reflected in our public spaces. As a result, the value systems behind sustainable plans are often overridden. The reason, as asserted by scientific works focusing on the spatial aspects of degrowth (Kallis and Vansintjan, 2017; Lehtinen, 2018; Nelson and Schneider, 2019; Xue, 2022), is that these models originated within the paradigm of growth. Therefore, there is a need for a new theoretical foundation surpassing the scope of sustainable development, one that capitalism is unable to assimilate and that lies beyond the logic of growth imperative. Although there is not yet an all-encompassing, consensus-driven architectural, urbanistic, and design strategy, numerous studies outlining operational conditions and methodologies demonstrate that science generates the established knowledge necessary for degrowth to become tangible for practicing designers (De Castro Mazarro, Kaliaden, Wende, Egermann, 2023, p. 2). This study aims to modestly contribute to this process by (i) presenting the Architecture of degrowth as an interpretative spectrum and (ii) by comparing the Urban Sustainable Development Goals (USDGs) and the degrowth objectives. In the (i) section "The Spectrum of Architecture of Degrowth", the paper is situating Architecture of degrowth within the field of Architecture without Building (Yona Friedman, 1958), Architecture without Architects (Bernard Rudovsky, 1964), and Speculative Architecture (Liam Young, 2017) - at the same time distinguishing it from them. As the crisis of civilization and ecology have since taken even more extreme directions, these conceptual projects serve as real reference points for examining the spatial aspects of degrowth. The focus of the analysis is not the historical context but the compatibility of these early avant-garde examples with the current principles of degrowth. The investigated authors and studios do not reject architecture itself, but rather reject the conditions of their time. In this respect, these works align almost entirely with the contemporary principles of the Architecture of

degrowth. In section (ii) this paper proposes seven criteria that categorize and compare sustainable urban development and urban degrowth strategies, concluding that there are more commonalities than differences between the two strategies. Continued growth remains the one paradigm that represents the most significant impediment to sustainable and degrowth initiatives. From the perspective of urban development, a significant difference is that the USDG model increases the density of globally growing (by population), but shrinking (in available space) cities to enhance energy efficiency and accessibility. The objectives of degrowth are exactly the opposite: degrowth considers proportionate, human-scale, and liveable cities desirable. To conclude, the study offers an overview of the status of the Architecture of degrowth in Hungary, delving into a few significant publications (Lányi, 2020; Schneller, 2015) and highlighting some poetically beautiful realized works and plans (Baló, 2020; GUBAHÁMORI, 2022, AUW, 2022).

KEYWORDS | DEGROWTH, URBAN DESIGN, CRITIQUE OF SDGS, CLIMATE CREDIBILITY

1. Introduction To The Sence of Enough

The slogan, movement, and scientific literature of degrowth all stem from a new societal proposition born from the critique of growth, aiming to increase human well-being and improve environmental conditions by reducing production and consumption (Schneider, Kallis, Martinez- Alier, 2010). While its goals exhibit a kinship with the concept of sustainable development, degrowth envisions a fundamentally different trajectory toward the equitable distribution of resources or the enhancement of community self-determination in the realms of economics, the humanities, and the arts. This study primarily focuses on the architectural—particularly urbanistic—aspects of degrowth. The development of the theory of degrowth has already begun in various scientific fields, and although we are far from having a coherent model or dominant paradigm, representatives of the movement agree that degrowth—or a similar setup—is inevitable (Dombi and Málovics, 2015, p. 217). The concept of degrowth (décroissance) can be approached from three interpretive frameworks—slogan, movement, scientific theory— which, although not independent of each other (Kuslits, 2012), this study primarily deals with the scientific approach.

The theory, originating from the French movement, traces its roots back to Nicolas L. S. Carnot[1], who formulated the second law of thermodynamics (Latouche, 2011, p. 17). However, scientific research tends to place the antecedents of the theory in the fields of environmental economics and ecological economics, particularly emphasizing the works of John Stuart Mill, Karl Polanyi and Herman Daly. The forebear of green economists Mill, argued in his 1871 book, Principals of Political Economy, that the stationary state of capital would not imply stationary state of human improvement but on the contrary, if minds are no longer engrossed by the pursuit of economic gain, there would be a much greater likelihood of advancing the art of living and even the industrial arts (Mill, 1871). Ecological economics reject the existing of an economic necessity independent from social connections. To disprove the anthropological bases of this approach Polányi emphasises in his work The Great Transformation (Polányi, 1944/1975) that profit-based market exchange does not arise from unchanging human nature and is not the cause but the effect of capital-based economy. He proves that the two most important conditions of production, human work capacity and natural resources, are not capable of following the fluctuations of supply and demand, because they exist not for the purpose of sale but according to the order of life – the order of nature. Since then, his nightmare of market mechanisms being the sole director of the fate of human being and their natural environment causing social exposure, defiled

1 “In nature, most processes proceed in one direction and do not spontaneously reverse (although external influences can reverse the process). Such processes are termed irreversible.” The ecological sciences frequently reference this principle in relation to the tipping point of ecosystems. Environmental processes can be simulated only up to a certain point; however, beyond a specific global average temperature (calculations vary) or a natural event (such as the cessation of the North Atlantic current), these processes become irreversible and unpredictable.

landscapes, and polluted rivers has become reality. The market rates do not reflect the multitude of species and habitats destroyed by the economically completely reasonable and wonderfully profitable exploitation. This is not due to prices but to the fact that nature is incapable of behaving like a product (Lányi, 2022, p. 45). Critics of growth have highlighted since the early 1970s that the finiteness of resources makes continuous economic growth unsustainable (Meadows et al., 1972). Moreover, in the long term, it incurs greater costs than benefits, as the relentless pursuit of monetary gain results in profound social inequalities and significant environmental degradation. Herman Daly who was the first to develop an economic model capable of ensuring increasing wellbeing without the growth of economic throughput (energy and material) (Dombi and Málovics, 2015, p. 202), and argued that the increased traffic of materials does not produce an increase in wellbeing, security or satisfaction (Daly 1973, 1996). "The more, the better" only applies to the economics of profit, while economics of subsistence seeks right measure: what is just enough. Since the turn of the millennium, contemporary critics of capitalism and growth have extensively examined the economic possibilities of degrowth (Kallis, 2018; Hickel, 2020). One theory of degrowth economic policy, the modern monetary theory, citing John Maynard Keynes, asserts that "What we can actually do, we can afford" (quoted by Pogátsa, 2023, p. 202), meaning the state can create money for public goods and services without the threat of inflation. Critiques of the theory highlight that actors of the market continue to produce even when resources are depleting – why would they choose to make the right decisions when the monetary resources are almost infinite?

The core principle of degrowth, likely borrowed from environmental ethics, can be summarized as follows: the need to halt growth is not only necessary (for environmental reasons) but also desirable (for social reasons). The tangible experience of destruction wrought by industrial and technological societies gave birth to ecological ethics. While early treatises on animal suffering have existed, it was the 20th century's recognition that human-induced environmental degradation threatens human existence that brought this issue to the forefront. "The time of history has met the time of evolution in our age." (Lányi, 2020, p. 161) Thus, ethics could no longer avoid making statements about the relationship between humans and nature. The animal liberation movement expanded species boundaries, paving the way for pathocentric (Ryder, 1996) and bioegalitarian (Taylor, 1981) views. Amongst others, Aldo Leopold, Arne Naess, and Holmes Rolston has put down the bases of ecological ethics. By introducing Land Ethics (Leopold, 1949) Leopold states that it is not the individual living beings but the living communities and the entire biotic community that hold moral value. Leslie Paul Thiele's most important conclusion is that neither the biocentric

approach, which attributes rights to nature and thereby limits the freedom of human civilization, nor the sociocentric approach, which strives to extend the freedom of human reason and personality beyond the human world, contributes to solving the environmental crisis (Varga, 2001, p. 100). Humans are just one among many species on Earth and only equal to them. Moreover, the Deep Ecology movement (Naess, 1989) states that moral consciousness implies the obligation to care, not privilege. From a designer's perspective, perhaps the most crucial guideline is that the intrinsic value of nature should compel us to treat the living world carefully, in accordance with our intellectual abilities, regardless of whether this is painful or comprehensible to them (Hale, 2011) in order to be "the shepherd of being" (Heidegger, 1985).

2. The Spectrum of Architecture of Degrowth

2.1 Precursors in History: Mixed Scale

According to Kallis (2011), Architecture of degrowth can be understood as an umbrella term that encompasses the critique of architectural philosophy and education, the institutional critique of the construction industry, moral objectives of architecture, and concrete proposals for feasibility. The development of these facets requires a multidisciplinary, and even transdisciplinary, approach, as it involves social inclusion and activism. This study argues that the Architecture of degrowth is not synonymous with the concept of "non-building" prevalent in professional jargon, but rather represents an interpretive spectrum that includes its architectural precursors as well as the exploratory models found in the latest scholarly literature (Fig. 1).

In the mid-20th century, system-critical groups, anti-war protests, the sexual revolution, and civil rights and feminist movements began to influence the arts, including architecture. The plight of the masses migrating to cities gained increasing public visibility, highlighting the chasm between high-end architecture and social needs (Frampton, 2009, p. 378). Some designers responded to phenomena such as value erosion, the threat of nuclear war, the space age, and rampant production and consumption with radical theoretical works. Given the increasing extremity of the ecological and civilizational crises, these conceptual projects serve as real reference points for examining the spatial aspects of degrowth. The following section compares the work of prominent figures in radical, avant-garde architecture and theory with the criteria of Architecture of degrowth (Table 1). The examination focuses not on the historical context but on the applicability of degrowth principles.

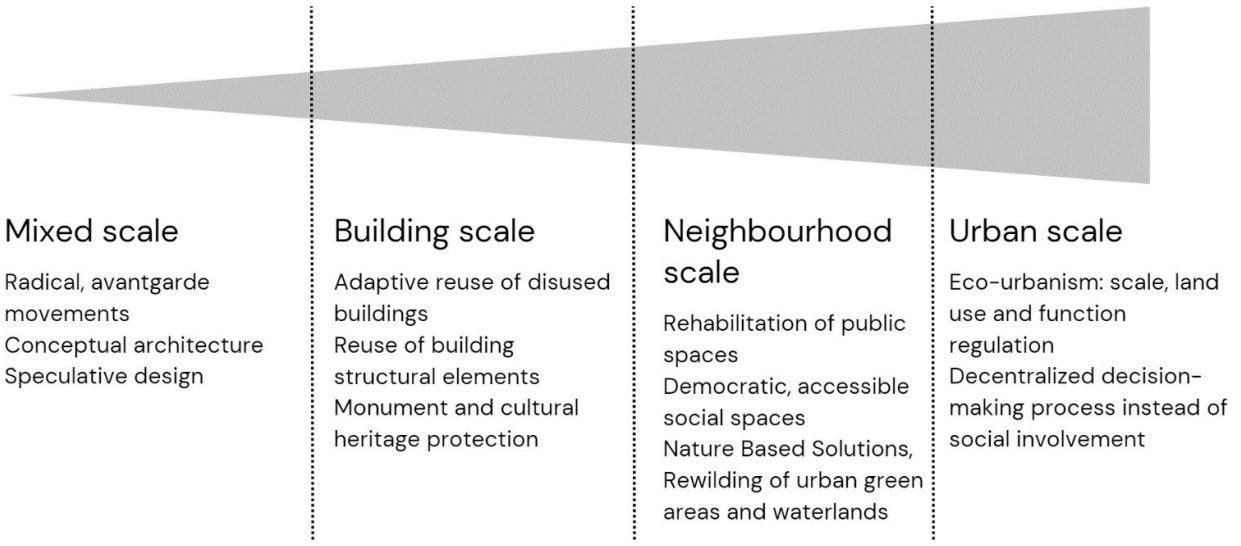


Fig. 1. The Spectrum of Architecture of Degrowth. Source: De Castro Mazzaro et al. (2023), Kallis and Vansintjan (2017), Lehtinen (2018), Nelson and Schneider (2019). Created by the author.

R. Buckminster Fuller created the first version of the Dymaxion house in 1927, designed from accessible materials and continually improved over decades. He extended the concept to the Dymaxion car, intended as an affordable alternative for transportation. In 1932, in response to the economic crisis, he proposed converting the vacant offices of skyscrapers into emergency housing (Frampton, 2009, 316). This idea holds particular relevance today in light of the ongoing construction of high-rise buildings in the U.S., which remain unoccupied due to real estate speculation, and the concurrent housing crisis (Schmied, 2021). In his 1969 book Operating Manual for Spaceship Earth, Fuller offers solutions to unemployment caused by automation, criticizes the continuous extraction of non-renewable resources, and questions whether material wealth metrics truly reflect human well-being.

Similarly, Yona Friedman proposed different solutions in his 1956 manifesto L'Architecture mobile, which envisions a flexible and mobile infrastructure accommodating an ever-changing lifestyle. This framework allows for free home creation, extending the right to build to the broadest societal strata. In his Spatial City plan, buildings minimally touch the ground, and residential units are freely modifiable and movable, responding to changing needs. According to Friedman, the supporting structure is neither definitive nor predetermined (Friedman, 1958). In 2011, a retrospective exhibition of Friedman's work, "Yona Friedman: Architecture without building," was held at the Ludwig Museum in Budapest. The museum quoted Friedman:

"We are building too much. We have overbuilt the Earth without providing suitable shelter for everyone. This overbuilding (like overdesigning and excessive agricultural cultivation) leads to environmental catastrophe. This is not a professional error of architects but partly

due to a misinterpretation of architecture. Architecture is not merely the art of building: it is the art of organizing space." (Friedman, Ludwig Museum, 2012)

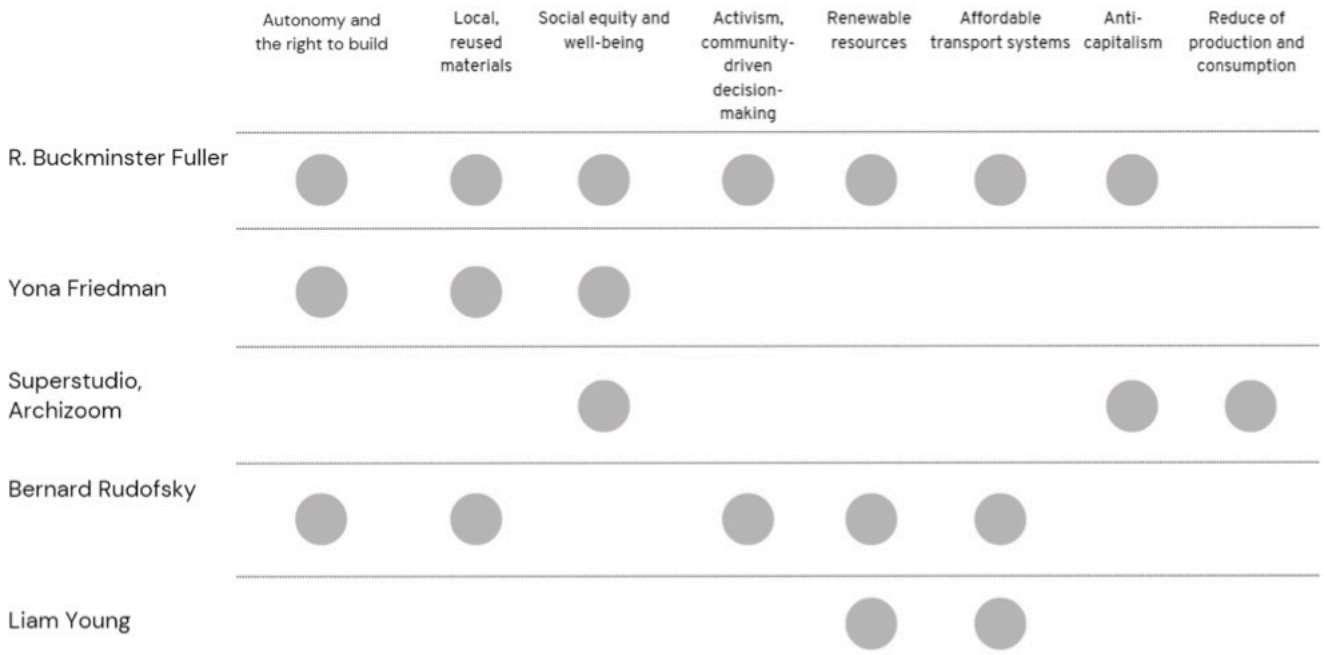
The exhibition likely contributed to the identification of Architecture of degrowth with the concept of non-building. However, as the quotation and his entire oeuvre suggest, non-building (or even anti-architecture) does not imply zero action. On the contrary, organizing space remains a necessary task.

Techno-optimistic yet anti-futurist and peaceful utopias were also envisioned by the Italian Superstudio group. They imagined a world without products and waste, where there is no need for architecture, only the manifestation of spirit (Frampton, 2009, p. 378). In 1971, founding member Adolfo Natalini wrote that "as long as design remains another reason for consumption, architecture merely legalizes ownership, and urban planning manifests social injustice, there is no need for design or architecture—whose task should be to satisfy real needs" (Didero, 2017, p. 290). Superstudio's radical anti-architecture thus rejects not the act of building itself but the conditions of its time, aligning almost perfectly with the contemporary principles of Architecture of degrowth (Fig. 2). The group often exhibited alongside other conceptual architects, including Peter Eisenman, Archigram, and Archizoom. While Archizoom advocated for radical democratization of architecture, rejecting even image creation, Archigram had concrete visions for the future world. Although essential in avant-garde architecture, Archigram's techno- optimistic, flexible architecture, while ideologically aligned with Fuller and Friedman's plans, led to the creation of resource-intensive, complex systems that produced dehumanizing spaces, making no statements about well-being or humanity's relationship with nature (Frampton, 2009, p. 368-371).

A significant reference point for the Architecture of degrowth is Bernard Rudofsky's book Architecture Without Architects (1969), which discusses anonymous, traditional architectural forms and techniques developed independently of formal architectural education and institutions. The book emphasizes the richness of vernacular architecture and its sustainable, practical solutions across various climatic and cultural contexts. Rudofsky's approach aligns with the principles of degrowth, which recognize and draw upon indigenous knowledge.
Although not a historical precedent, the speculative architecture and design fiction represented by Australian architect and filmmaker Liam Young can be seen as a consequence of conceptual architecture. His films explore the complexity and consequences of technological development and urban futures, critically reflecting on social, environmental, and ethical issues. Often using utopian or dystopian narratives, his works highlight future challenges of human-machine interactions, sustainability, and urban living. Despite its dystopian and techno-optimistic tone, his short film The

Great Endeavor presents a positive vision where the world's nations implement planetary-scale carbon-capturing machines justly, emphasizing social equality and traditional values.

Table 1. The Intersection of Architecture of Degrowth and Its Historical Precursors. Source: Fuller (1969); Friedman and Orazi (2015); Didero, M. C. (2017); Rudofsky (1969); Frampton (2009), De Castro Mazarro et al. (2023); Liegey and Nelson (2020). Created by the author.



2.2 Contemporary Explorations: Urban Scale

While ecological economics, social sciences, and other disciplines have been advancing the theory and feasibility of degrowth for over two decades, this concept represents a relatively recent development within the field of urbanism. A Routledge study on housing relations within degrowth was published in 2019 (Nelson, Schneider, 2019), and a 2022 study outlining the goals, principles, and tools of degrowth-based urban planning refers to the topic as a missing debate, identifying at least three areas requiring further elaboration (Xue, Keblowsky, 2022, p. 397). Based on published studies and case studies, we gain a more detailed picture of the spectrum and conditions of Architecture of degrowth. It remains unresolved whether universally applicable principles are necessary or whether the strength of degrowth lies in its heterogeneity and locality. The volume, through international case studies and theoretical works, aims to delineate an interpretive field that includes tangible solutions for urban planning practitioners while inviting detailed debate among professionals.

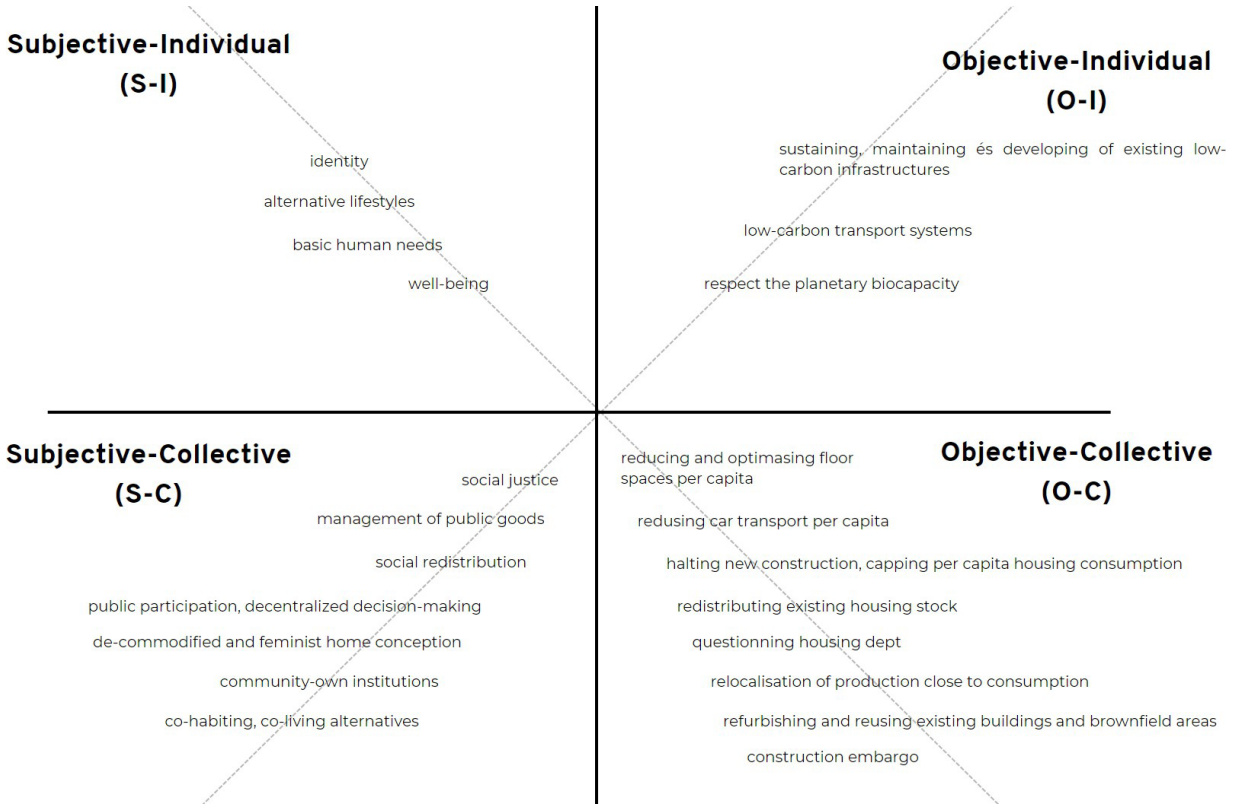


Fig. 2. Integral Perspective Diagram of the Spatial Aspects of Degrowth. Sources: Xue (2022); Brenner, N., P. Marcuse, and M. Mayer (2012); Chertkovskaya, E., and A. Paulsson (2022); Ferreira, A., and K. C. von Schönfeld (2020); Lehtinen, A. A. (2018); Martinez-Alier (2010); Cattaneo and Gavaldà (2010); Kallis (2011); Wilber (2009). Created by the author.

Based on the integral map's systematic diagram (Wilber, 2009), authors within the degrowth paradigm articulate claims in urban contexts regarding individual well-being (S-I), the relationship with nature (O-I), social justice (S-C), and public policy-economic systems (O-C). In urban contexts, the Architecture of degrowth emphasizes individual wellbeing (I-S) and meeting real human needs, which, in addition to the basic necessities for subsistence, includes the criteria for a dignified life, such as freedom, meaningful work (where skills can be practiced), and recognition and acceptance by the social group. The spatial representations of the process reclaiming the right to a normal life, referred to by Lányi (2020, p. 33) as environmental ethics, involve convivial tools (Illich, 1973) that promote social and cultural integration beyond economic rationality. Chertkovskaya and Paulsson introduce the factor of "identity," arguing for the importance of the continuity of urban landscapes that are "dear" to their inhabitants (2022, p. 444). Emphasizing the role of place in identity formation resonates with the concepts of place attachment in environmental psychology (Dúll, 2006) and oikophilia in green philosophy (Scruton, 2018, P. 208). The social quadrant (S-C) includes the collective values corresponding to the above, such as establishing democratic and inclusive public spaces and institutions, community forms free from market logic, like alternative housing solutions

or the feminist home concept (Martínez Alonso, 2022; Cucca and Friesenecker, 2022). Regarding the relationship with nature (O-I), degrowth urban authors primarily propose solutions that support the maintenance and reparability of low or zero carbon-emission construction and transportation systems—within the planet's carrying capacity. This emphasis is crucial as sustainable urban development strategy sets nearly identical objectives but places much greater importance on market-driven technological development on the path to achieving them, as will be seen in the next chapter. One of the most radical concepts in the administrative and economic quadrant (O-C) is reducing the per capita built-up area (Xue, 2022) and implementing construction embargoes. Several cities experiment with partial embargoes based on areas (e.g., city centers) or types (e.g., shopping centers), yet investor logic often overrides these efforts, as seen in Budapest. Degrowth authors emphasize that the housing crisis should and can be addressed not by building new areas but by renovating and redistributing the existing housing stock—even if this requires greater financial investment from the state. This is closely related to questioning housing loans.

2.3 What is the difference?

Various urban development projects are determined and planned by the value system of current economic policy, which is reflected in our public spaces. The iceberg model, used in systems thinking (Senge, 1990), shows that the main drivers of visible events are the underlying network of values. If the tip of the iceberg represents our visible world, what do our public spaces reveal about our society, shared values, and relationship with the natural world? What mindset lies beneath the iceberg whose tip is marked by a European capital's newest, tallest building belonging to an oil company (Budapest) or lithium mines opened on cemeteries (Serbia)? The answer, of course, lies in the neoliberal economic system, where the compulsion for growth inevitably dictates urban development, capable of overriding the values underlying sustainable plans. The concept of sustainable development (Brundtland, 1987), tautological as it is, has faced numerous criticisms even before its inception (Meadows, 1972; Illich, 1977; Lányi, 2010). Nevertheless, the UN based its 17 goals (SDGs: Sustainable Development Goals) and the resulting urban sustainable development framework (USDG: Urban Sustainable Development Goals) on this concept. While the sixteen SDGs reflect a considered, morally grounded systemic perspective, the mentioned influence is still apparent (8th SDG: Decent Work and Economic Growth), or as Latouche puts it, "growth disguised under the mask of sustainability" (2011, p. 107).

Proponents of degrowth oppose the sustainable development system, pointing out that despite numerous international conferences (COP 1-27), agreements (Stockholm 1972, Rio 1992, Kyoto 1997, Paris 2015), and institutions (IPCC 1988), real carbon dioxide reductions were only observed temporarily during the 2008 global financial crisis (Kallis, 2011) and the COVID-19 lockdowns. In other words, the idea of sustainable development (and green growth) has failed. However, there are more commonalities than differences between the goals of degrowth and sustainable development. When categorizing and comparing urban development strategies by seven criteria (Table 2), it becomes clear that reducing consumption, supporting local producers, using renewable resources instead of hydrocarbons, transitioning to a circular economy, and increasing inclusive, equitable social spaces are shared goals, albeit with different emphases.

There is partial overlap in the issue of local autonomy: while the USDGs highlight civil participation in urban decision-making processes, the principle of degrowth advocates for the decentralization of decision-making, suggesting community-driven public space planning. The growth paradigm is, of course, the most defining difference. The USDGs aim for economic growth realized in parallel with ecological and built environmental sustainability. Authors advocating for degrowth emphasize the physical impossibility (Meadows et al., 1972; Bailey et al., 2010; Jackson, 2016) and even cynicism of this (Lehtinen, 2018, p. 10). From an urban development perspective, a significant difference is that the USDG model aims to increase the density of globally growing (but shrinking) cities to enhance energy efficiency and accessibility, while degrowth's objectives are precisely the opposite: aiming for proportionate, human-scale, and livable cities. Despite goals concerning the support of local communities and social equality, the sustainable development vision for rural areas is limited to supplying cities, although supporting rural communities, the circular economy.

Table 2. The growth-based urban development model, the Urban Sustainable Development Goals (USDGs), and the goals outlined in the Degrowth Manifesto, highlighting the comparative analysis of the latter two in terms of compatibility. Sources: Daly (1996); UN SDGs (2015); UN- Habitat (2013, 2023); GEO-6 (2019); De Castro Mazarro et al. (2023); Liegey, Nelson (2020). Created by the author.

Categories	Capitalist urban development	Urban Sustainable Development Goals (USDGs)	Degrowth Principals of Urban Development	Allignement Y (yes) P (partial) N (no)
Growth paradigm	Prioritizes economic growth, infrastructure expansion, and population increase	Achieving economic growth while ensuring environmental sustainability and social inclusion	Prioritize sustainability, well-being, and quality of life over continual expansion	N
Scale and density	Focus on increasing density to accommodate a growing population efficiently	Enhance urban density to improve resource efficiency and accessibility	Questions high-density models and propose right-sizing cities to create more sustainable and livable urban environments	N
Consumption and production	Promotes consumption-oriented lifestyles and expansive infrastructure	Include measures to reduce resource consumption and promote eco-friendly practices	Reducing material consumption, promoting local production, and fostering resilient communities	I
Community Well-being	Enhance community well-being through improved amenities and social services	Improve the well-being of urban communities through better infrastructure, services, and social inclusion	Importance of community well-being, suggesting that smaller-scale, locally-oriented developments can contribute to stronger and more connected communities	I
Resource usage	Not explicitly address resource depletion concerns	Emphasizes sustainable resource use and reducing the ecological footprint of cities	Reevaluating resource use, favoring sustainable practices and circular economies	I
Local autonomy	Focus on local empowerment but may still be embedded in a growth-oriented framework	Include elements of local empowerment and participation in urban planning processes	Advocates for greater local autonomy, decentralization of decision-making, and community-driven urban planning	R
Social equity	Often include objectives related to reducing social inequalities within cities	Aiming to address urban inequalities	Underscores the importance of social justice, addresses and rectify existing urban inequalities	I

3. Spatial Literacy

Our visible world, encompassing both the built and natural environments, is shaped by principles, values, beliefs, and fears. The deeply rooted convictions of a given era's society—often its narrowest elite—underlie the construction of temples, the regulation of rivers, the clearing of forests and reeds, as well as the development of inclusive public institutions and climate-adaptive cities. Various associations within society reflect this, with their physical manifestations (or events) occurring in public spaces. Society is not merely a collection of individuals but a system, characterized by relationships among its components that serve specific purposes (Meadows, 2008). This ever-changing web of relationships dictates its functioning. Thus, a city is not merely a collection of buildings; it is defined by the public spaces (connections) that exist between these buildings.

The necessity for accessibility has created intersections and squares, transforming this infrastructural network into social spaces. Certain sections and nodes have become prominent, requiring careful planning. Traditionally, public space is the negative space between buildings, reflecting a society's values, economic status, and possibilities in all directions. Muddy medieval streets at some point transitioned to paved surfaces, particularly around temples and town halls. Protection, enclosure, and communal use characterized these spaces, with public institutions forming dominant parts of the space's boundaries. The irregular spatial forms offered varied vistas, which remain appealing today. The old towns are the most beloved tourist destinations in European cities due to their human scale and the dynamic nature of the space boundaries, encouraging exploration and interaction. In contrast, Renaissance spaces are composed, serene, often square-shaped, and although not naturally formed through use, they are highly functional. Thanks to 18th-19th century urban planning, European cities have geometrically designed classical squares. These squares are larger, with open corners, airy, adorned with centrally placed monuments and statues that embellish the city. Early 20th- century urban developments were abruptly halted by world wars, and socialist realism did not continue this tradition (Szövényi, 2021, p. 15-18). Postmodernism recognized the value of returning to 19th-century public spaces, where one could stroll, see, and be seen, but consumer culture demanded the construction of shopping malls. Malls created artificial promenades and plazas, providing only consumption and services among the myriad functions offered by urban spaces. Early shopping centers (based on U. S. models) featured ice-skating rinks as their central plazas, but in newer malls, these have been replaced by kiosks, and in suburban outlets, by parking lots.

At the peak of the previously mentioned Iceberg Model (Senge, 1990) are visible events. Below these are the patterns and trends shaped by the behavior and functioning of systems. However, it is not the system that is the starting point, despite the frequent mention of "well or malfunctioning systems," but rather the underlying mental models. The search for origins can, of course, continue indefinitely. Sometimes, the tip of the iceberg influences the deeper layers, as seen with significant events like wars and natural disasters impacting multiple generations' thinking. Systems thinking research seeks the causes of observable phenomena in the deeply embedded network of mental models. Systems do not "malfunction"; they operate according to the value-based conditions established for them. The advantage of systems thinking is its neutral evaluation of cause-and-effect relationships. For example, if a city prioritizes automobile infrastructure for ninety years, it will see a radical increase in heat island effects and air pollution. These are not side effects but probable outcomes, alongside frequent bus services, thousands of annual injuries, rapid emergency services, and the exponentially increasing number of private vehicles. The system functions perfectly, even if we did not

anticipate or want some consequences. If different results are desired, systems thinking recommends interventions at high-leverage points (Meadows, 2008, p. 145).

Such an intervention is design focused on the Architecture of degrowth. Contrary to analysis, design involves the designer setting goals according to their and the client's values. To set these goals, we must understand the changes in social space in relation to human-nature and city- ecology dynamics. Designer responsibility means morally acceptable goal-setting, a commitment to uncovering the connections between causes and consequences, while being aware that the complexity of systems prevents full knowledge of all outcomes, necessitating the utmost caution.

Capitalism colonizes sustainable models and corrupts decision-making processes. The institutionalized certification systems of greenwashing (LEED, BREEAM) provide shameful evidence of this, issuing sustainability certificates for building complexes constructed through environmental degradation and with life cycles of less than twenty years. For instance, the MOL (Hungarian Oil Company) Campus in Budapest, inaugurated in 2022, unsurprisingly holds both certifications, achieved through solar panels, rainwater recycling, 160 bicycle storage spaces for 2500 employees, and bird feeders (MOL Campus, 2022). Despite the sad comedy of this list, it is undeniable that the building operates energy-efficiently. However, the flag of sustainability obscures important environmental and wellbeing issues. Specifically, why was the building constructed at all? What was and could have been on its site? Whom does it serve, and what are the impacts of its construction and operation? Which building regulations had to be altered, and why did this happen? What message does it convey to the city's residents who will see it from every point of the city?

This last question is particularly significant as it dissolves the usual distinction between private and public investments. The city silhouette, the visual aspect, is part of both the public and social space. Thus, any significant change to the city's appearance is a public matter. The all- seeing and omnipresent yet "introverted skyscraper" (Gehl, 2014, p. 5) alters the city silhouette, aiming to insert monumental grandeur into everyday environments without creating genuine urban centers. "It disrupts the traditional values of the city without creating new urban quality" (Schneller, 2015, p. 119). Regarding spatial perception, Szövényi notes that while the upper boundary of an urban space is perceived as twice the height of the tallest building forming the space boundary, in the case of skyscrapers, this upper limit can be perceived as multiples of the tall building's height (Szövényi, 2021, p. 12). The cityscape is also significantly influenced by suburban areas, new parcels, and residential parks—all raising similar questions. However, the greatest current threat to Budapest and all the metropolises of the world lies in the government and—occasionally—city-supported developments that irreversibly change the capital's face, causing unforeseen environmental damage while exacerbating social inequalities.

4. The Context of Degrowth in Hungary

The first international degrowth conference was held in Paris, followed by events in several major cities across Europe and overseas, and in Budapest in 2016. In addition to Serge Latouche's seminal works, the book Prosperity Without Economic Growth (Liegey, 2013) was translated into Hungarian. One of its co-authors, Vincent Liegey, a prominent figure in the degrowth movement and spokesperson for the French Degrowth Party, resides in Budapest and is the founder-coordinator of Cargomania. Numerous Hungarian researchers address the economic aspects of degrowth, either directly or indirectly. These include Alexandra Köves (Köves et al. 2023), Zoltán Pogátsa (Pogátsa 2023), András Takáts-Sánta (2000), and Zoltán Bajmócy and Judit Gébert (Bajmócy and Gébert, 2014a). In the humanities, András Lányi's contributions are particularly notable, with several books dedicated to critiquing unsustainable sustainability.

4.2 The State of Architecture of Degrowth in Hungary

In Hungary, theoretical works on Architecture of degrowth can trace their lineage to István Schneller's collection of essays and studies titled The Qualitative Dimension of Architectural Space (2005) and selected chapters from Ákos Moravánszky and Katalin M. György's study collection (2007). Although these authors do not explicitly advocate for degrowth, they belong to a generation of creators who were active before the Great Acceleration and attribute the devaluation experienced in the 2000s and the rise of real estate speculation to globalization and the compulsion for growth. The topic is partially addressed by the projects of the Contemporary Architecture Centre (KÉK), the book The Power of Civic Ecosystems by Levente Polyák and Sophie Bod (2021), and the study Mapping Architectural Practices Associated with the Economic Program of Degrowth, published under the auspices of the BME Doctoral School, which presents the 2019 Oslo Architectural Triennial focusing on degrowth (Horváth-Farkas 2020).

While the practical architectural profession includes a niche segment whose works reflect the principals of degrowth, these endeavors remain partial, with only specific projects, rather than entire portfolios. Besides a few realized projects, most contributions are ephemeral, consisting of installations or conceptual works. This study highlights a few notable examples.

Dániel Baló captures the essence of degrowth through transformation as a design act (Fig. 3-4.). He views the challenging legacy of the Hungarian countryside, including the uniform cubes and other heterogeneously constructed buildings, as opportunities, with his executed works demonstrating energy optimization and a sound moral foundation.

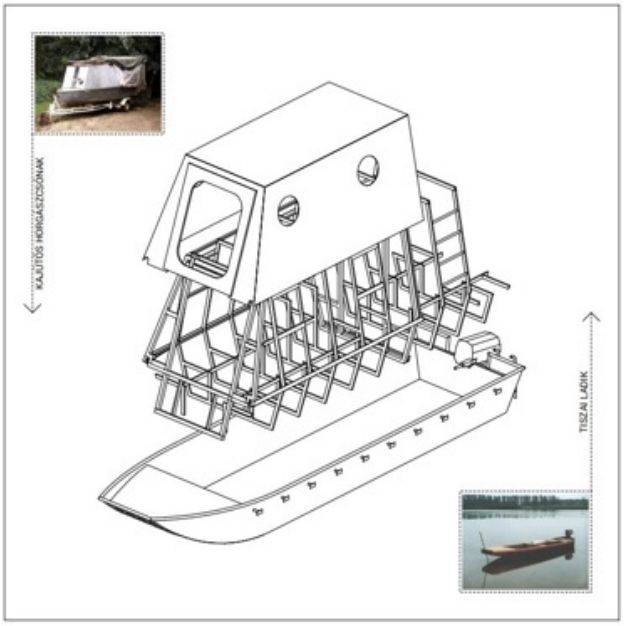




Figures 3-4. Dániel Baló: Long Cube House 2020. Photo: Dániel Baló.

Tamás Bene's Bait houseboat blends the aesthetics of a cabin fishing boat and a skiff typical at River Tisza (Fig. 5-6). This modest and gentle "holiday home" is a result of sophisticated design. Bait's passengers do not forgo distant shores but instead discover the hidden nature of their homeland, offering opportunities for connection.





Figures 5-6. Tamás Bene: Bait. Boat on River Tisza. Photo and axonometry: Tamás Bene.

The Architecture Uncomfortable Workshop (Lukács Szederkényi, Dénes Emil Ghyczy) was one of the exhibitors at the aforementioned Oslo Architectural Triennial. They presented the House of the Spring Wind, which they have erected every spring since 2013. The House of the North Wind, similar to its Hungarian counterpart, was constructed through a ritualistic process (Fig. 7). The large canvas mounted on the archetypal house-shaped frames is shaped and completed by the wind, also functioning as a gate that visitors pass through to interact with nature.



Figure 7. AU Workshop: House of the North Wind 2019. Photo: AU Workshop.

In Hungary, cube houses situated on valuable plots are typically demolished, but this family chose a different approach. The expansion of the existing cube house was shaped by the constraints imposed by new building regulations. For AUW, however, these limitations acted as a catalyst for creativity. As a result, HouseLove (Fig. 8-9), an innovative addition was developed that not only functions effectively but also optimizes the use of financial resources, materials, and energy for the owners.



Figure 8-9. AU Workshop: HouseLove 2021. Photo: AU Workshop.

Nest box designed by BIVAK is a gentle yet effective intervention serving the nesting of birds (Fig. 10). In Hungary it is common to perforate utility poles in order to reduce their weight. Human intervention often appears on the mass erosion. Regularly the holes in reachable height can be used as trashcan, shelf or billboard. The nestbox placed in 2 meters height is an intervention which allows nature to connect with an infrastructural element, giving it a new function. Inserting the box causes no harm in the utility pole and does not change its condition or function. It can be taken out and cleaned easily by twisting the leg. The surface of the durable material (acacia) is treated with oil to sustain the weather conditions. 3 prototypes were placed in Budapest waiting for the nesting season.

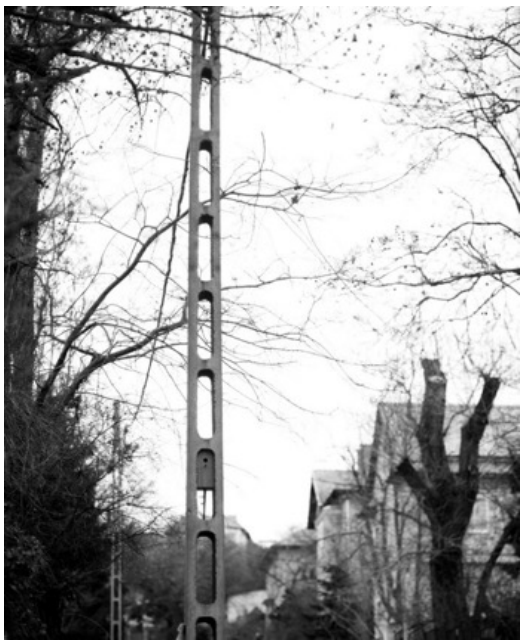


Figure 10. BIVAK: Nest box 2019. Photo: BIVAK

Sándor Guba and Péter Hámori's project proposal aims to suggest a transformation of human needs along the shores of Lake Balaton. According to the plan, the large grassy, paved beach with its service facilities will be removed, and instead, a network of internal lakes and meadow- like areas, featuring reed beds and both dry and wet grasslands, will be reconstructed. The few service pavilions will be constructed from the materials of the demolished buildings and slide structures, thus reducing construction waste. The railway side facing Lake Balaton will be transformed into a car-free zone to minimize noise and air pollution impacting the natural environment. Access to this zone will be permitted only with micromobility vehicles. Due to the reduced human presence and sound effects, it is expected that the characteristic animal species of the area will return, similar to what was observed during the quarantine periods of the COVID-19 pandemic.

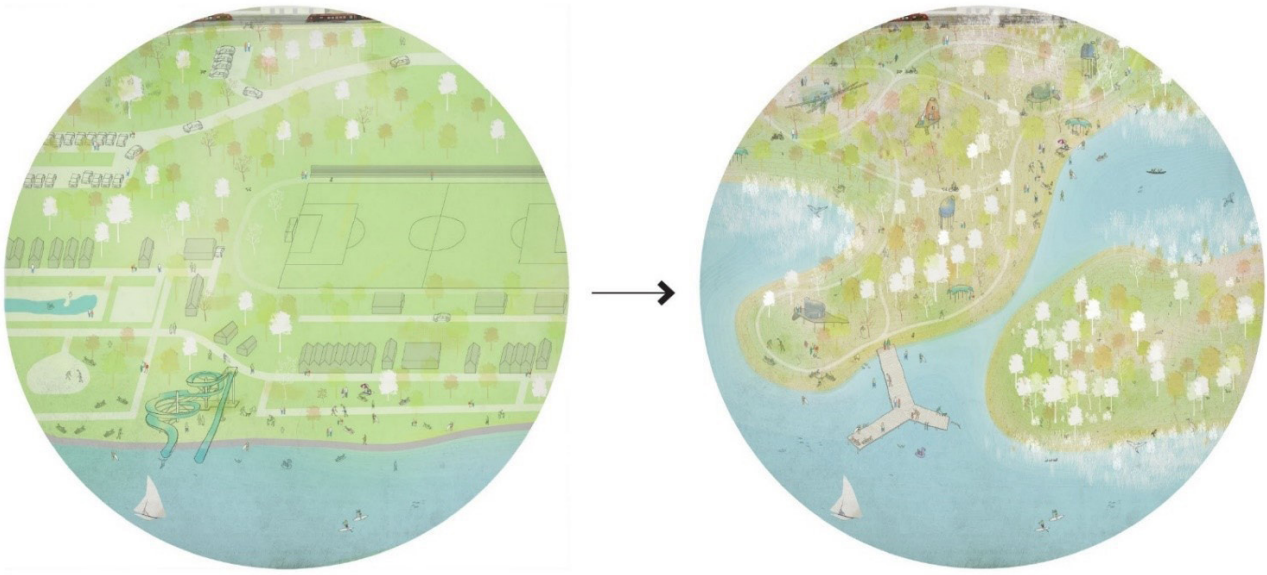


Figure 11. GUBAHÁMORI: Waterfront Development at Lake Balaton 2020.

5. Conclusion

Proponents of degrowth concur in rejecting the hegemonic paradigm of economic growth, opposing the instrumental valuation of living and non-living entities, and challenging individualism and globalism. They strive for a society that operates within ecological limits, in a just and democratic manner, prioritizing human wellbeing. Despite the shared goals, the origins of degrowth are complex and transdisciplinary, encompassing various visions and social movements (Xue, 2022). Although the foundational principles of a steady-state economy were articulated by early precursors in the 19th century, it is only in the last two decades that various academic disciplines have begun to rigorously explore the framework and feasibility of such

an economy. In the fields of architecture and urban planning, there is an ongoing process of conceptual clarification and practical implementation, which necessitates the informed engagement of policymakers and urban populations. Policymakers need to be convinced through economic and environmental rationality—recognizing that change is inevitable—yet more crucial is the cultivation of urban citizens' awareness regarding the desirability of this change. This endeavor requires a redefinition of the concept of a good life, emphasizing the recognition that fundamental human needs have remained unchanged over the past twenty thousand years, encompassing not just basic sustenance, but also a life imbued with meaning and a sense of belonging within an accepting community. The dogmas of belief in progress have led to the degradation of knowledge into mere utility (diminishing our capacity to understand others and ourselves), the reduction of freedom to consumption, and the conflation of creation and work with production. The means have become the ends. In fact, we do not find our lives to be authentic and fulfilling when technological services relieve us of intellectual and physical effort, but rather when we have the opportunity to exercise our abilities and achieve excellence in doing so. (Lányi, 2022, p. 23). The concept of degrowth, therefore, is not primarily about environmental or animal protection, economic and technological innovation, or feminist or children's rights movements, but rather an all-encompassing and insatiable desire to recreate the conditions for a life worthy of Homo sapiens, the wise human being. Network biologist Ferenc Jordán reassures his readers with a profound observation:

"Pension systems, capitalism, Roman law, the network of international relations, or even democracy itself are extraordinarily complex systems, but each is vastly simpler than, say, a cell." (Jordán, 2023, p. 237.)

This remark encourages us that human-made systems can indeed be altered by humans.

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Figure 11. GUBAHÁMORI: Waterfront Development at Lake Balaton 2020.
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THE FUTURE EVOLUTION OF DESIGN-ORIENTED PRACTICES IN THE CONTEXT OF HUMAN AND NON-HUMAN COLLABORATION

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ABSTRACT | The complexity of the social, environmental and institutional challenges facing by contemporary culture needs collaborative, multidisciplinary and intercultural actions to foster a changing process towards a more sustainable and collective future. With the acceleration of technology, the proliferation of data, approaches and digital tools has revealed multiple characteristics of relation with technical field, finding also several criticisms from a social and environmental point of view. In this context, the design space is evolving into a multi-agent and mixed-initiative system where human and non-human agents collaborate and co-perform shaping multidisciplinary and multimodal creative processes, offering practices beyond human-centric cooperation to identify more democratic and inclusive scenarios. Collaborative practices become interaction methods capable of overcoming critical issues and limitations highlighted by technological systems, with a focus in artificial intelligence models and virtual environments topics. The research aims to introduce an analysis of the collaborative aspects which allow this hybrid relationship and the definition of methods in which this cooperation can take place. These conceptual aspects will be applied to the analysis design-driven approaches developed in a series of university projects, in which the human-non-human practices contribute in observing the transformation of hybrid processes and the figure of the designer himself, who acquires the features of the transitional designer.

KEYWORDS | HUMAN NON-HUMAN COLLABORATION, DESIGN-DRIVEN APPROACH TO TECHNOLOGY, ARTIFICIAL INTELLIGENCE, EXTENDED

1. Design-driven technology approach

1.1 Introduction

The complexity which characterizes those global challenges defined as 'wicked problems' by Hornst Rittel and Melvin Webber in 1973 has become an observable aspect of today's society. The specificity of these challenges is multi-scalar, multi-causal and interdependent (Formia et al., 2021) and are represented by complex social dynamics involving different types of actors and acquiring different forms and characteristics depending on the spatial, cultural context within which they are embedded.

Together with these aspects, another fundamental issue emerges in the analysis and representation of the current social system: the influence and application of digital technologies and tools has acquired a social value and represents a vector of change in modes of relations, habits, flows, approaches to production and consumption, generating new forms of knowledge and cultural processes (Beer, 2017).

These tools turn into socio-technical agents, i.e. complex systems that have a relevant impact in the political, ethical and environmental fields and interact with human agents (Vermaas, 2011) in a hybrid, heterogeneous and collective relationship (Latour, 1987).

The concept of the 'Technosphere', coined by Peter Haff, fits within this research framework and emphasizes the speed with which the relationship between human agents and non-human agents, i.e. technological and environmental elements, has developed: the 'Technosphere' is the physical representation that encompasses the enormous extension of technological and digital networks. This term is also intended to represent aspects of how anthropic occupation also proceeds through progressive infrastructural colonization (Antonelli et al., 2019). The representation of this artificial layer (Haff, 2014) represents the impact that the development and acceleration in technological production is having on social, cultural and environmental transformations. In this context, a heterogeneity of human actors, such as individuals from civil society, public administration, businesses and

researchers, find themselves interacting and collaborating daily with technological tools and systems that have rapidly acquired a relevant role in everyday activities.

Currently, several human actions are mediated by interaction with tools that allow interaction with non-human technological agents. A hybrid multi-agent relationship is established, where the concept of an agent represents an entity capable of perceiving its environment (Cattabriga, 2022) and is classified according to several aspects related to autonomy and the cognitive approach (Burgin & Dodig-Crnkovic, 2009).

Interfaces, media and digital tools not only shape the way we relate and think, but also the way we interact with our bodies (Clark, 2008) and our approach to design complexity (Giaccardi & Redström, 2020). Within this context, it is fundamental to identify what limits multidisciplinary approaches and design cultures can overcome to identify new hybrid spaces where technology represents a support, not only instrumental but also collaborative, to human, cognitive and operational capacities (Monari & Baraldi, 2020), becoming a resource for actions of public interest and the innovation of operational and design processes (Hoc, 2000).

A shared and systemic vision of design practices makes it possible to identify practices that can be applied in different fields, such as the production system, which refers to consolidated processes based on the substantial consumption of energy, raw materials and human capital, or such as social and relational practices, where technologies can become a tool and an approach to the construction of collective scenarios, if designed according to an inclusive, accessible and democratic approach. Connected and collaborative actions overcoming the concept of design, cultural and natural limits allow us to imagine an integrated design between tools and actors that can foster positive change and transformation towards a future that truly considers eco-systemic and sustainable aspects (European Commission, 2019).

The objective of this contribution is to represent the experimental activities carried out in the context of a university research group to create multi-agent systems and environments where the collaboration and design-driven approach allows for the creation of methods and paradigms useful to optimize the processes in which these systems are embedded, in terms of sustainability, and at the same time can present implementation approaches to current technological development methods to make this framework more democratic and accessible.

2. Research Methodology Framework

2.1 Research framework

The presented paper finds its inspiration within the extended research of the working group of which the authors are

part. The research unit is characterized by an interdisciplinary approach resulting in the development and in-depth study of different design themes intersecting with each other. In order to better understand the design-oriented methods considered in the development of the discussions and projects described in the following paragraph, it is useful to briefly introduce the different areas of research, which mainly concern the design of services and systems for the city and the people who live in it, reactivating places and communities through inclusive and accessible processes, the transformation of models and processes within creative cultures as a system of human and social value generation, responsible innovation practices within design systems (Formia et al, 2023) and design-oriented disciplines that deal with how human beings transform themselves in dynamic and complex ways depending on the context.

These different fields of research are characterized by more defined project areas resulting from the project contamination; an example of this is the theoretical and applied field of research in Human Body Interaction and Design Driven Open Innovation in which the experimentation subsequently presented find their contextualization.

The project space is characterized by a transversal methodology and a systemic approach linked to the concept of anticipation (Celi, 2015; Formia, 2017; Iñiguez Flores et al., 2019) and future studies based on collaborative practices and collective intelligence (Celaschi, Celi & Formia, 2014) that drive transformation. Through a mapping and verticalization of data and information collected in the research phase, futures and possible scenarios are generated (Celaschi et al., 2019) conditioned by environmental and social factors that can respond to the complexity of the present and the changing context.

Anticipation represents the point of view through which the different research field are interpreted, and which are translated into project actions for the creation of multi-agent systems in different contexts and environments.

2.2 Experimental framework

As previously mentioned, the current condition in which our society finds itself differs from its predecessors due to the continuous changes, the acceleration in technological production and consumption, and the increase in social distinctions that induce the need for rapid and planned actions that can respond reactively to the criticalities that emerge. In this sense, design action and above all anticipatory action acquire importance, suggesting how in the technological sphere, issues related to sustainability (Bettiol, 2024), accessibility and the democratization of digital practices are necessary, are interconnected and fundamental for designing future scenarios of interaction with a more inclusive, conscious technology and as a tool for activating collective knowledge.

Within this academic environment, two research paths are in progress that focus on identifying new ways of interaction between people and technological tools, considering external factors and how they influence each other. Respectively, the two researches focus on the definition of new paradigms of collaboration with artificial intelligence and virtual environments; they are distinguished by their different technical backgrounds, by the use of different tools and approaches, while they are linked by a transversal method involving multiple disciplinary fields and an approach linked to experimental activities, user research and testing, iteration and validation, which are useful to form knowledge and skills that are not only theoretical and transversal, but also specific and linked to know-how (Jarmon, 2009).

The applicative nature of the two research makes them suitable for implementing the progressive results obtained within projects carried out by the research unit into national and international programs. In fact, the group's involvement in a national project running for a total of three years with the aim of developing digital tools to support design sustainability has created the context for experimenting with practices of relating people, artificial intelligence and the virtual environment.

2.3 Artificial intelligence-related fields of action

The research stream analyzing the relationship between people, artificial intelligence and the design environment has resulted in the opportunity to identify new models and paradigms of interaction which could create a more transparent (Wang et al., 2022) and accessible relationship between human and non-human agents (Wang et al., 2022).

The field of research related to artificial intelligence encompasses technical fields of study on the analysis of intelligent computational agents (Poole & Makworth, 2018) and finds a relationship with design cultures in the interdisciplinary design of modes of communication, relationship and interaction (Yang et al, 2020; Zdanowska & Taylor, 2022) that can manage and interpret the complexity of AI systems (Cattabriga, 2022).

Design-driven disciplines represent a useful tool for the definition of more democratic ways of using technologies (Qahha & Ahmed, 2021) through approaches that involve human agents, understood as end-users, and non-human agents in the design of new ways of using AI-based systems, creating processes of knowledge diffusion between people and their environment, including technologies, for the definition of a conscious user experience.

Through an analysis of the current state of the art on design actions to develop technological systems and related interaction tools that can respond to more accessible, intersectional and sustainable design methodologies, it is possible to identify new practices of relating to artificial intelligence that do not replicate the social structures mediated by the vision of the dominant design culture (O'Neal, 2016; Eubank, 2018) and that allow for an informed and aware user experience as opposed to the elusive logic of some algorithmic flows (Card, 2021).

By designing new technological tools and their implications in processes according to a collaborative approach, it is possible to imagine new scenarios in which it is possible to introduce technological support to optimize the working method and consequently bring about improvements in terms of the capital investment used. If this approach is applied in the production environment, it is possible to experiment with operating settings where collaboration and communication between people and technological agents can represent an outline that enhances the sustainability conditions of the entire system.

2.4 Extended reality-related fields of action

The research area regarding extended reality stems from the consideration of how affordance and perception change in fully virtual or real scenes with virtual augmentation (Shin, 2017). The first aim of this work is to structure and optimize digitized learning and training procedures in industrial contexts. With this intention, in the light of investigations and mapping of state of the art in the various fundamental areas, e.g. that of instrumentation, modelling software and usable applications and experiences, shortcomings in the literature were identified, which were attempted to be addressed by means of several experiments. The first specifically concerns the ability and comprehensibility of conveying written information, through its transposition into experiences of dematerialized immersive procedures (Van Campenhout, 2020).

The other raises the challenge of exploiting virtual scenes not only to foster learning on the part of the end users, but also to facilitate the creation of content, specifically textual notes and interactive videos, that simplify and make the instruction work carried out by trainers more efficient. The analysis of the data collected during the execution of these first experiential tests shows that, despite the rapid and important developments in the field of virtual and mixed reality, the element of presence is still critical and particularly complex to fully pursue.

Therefore, the analysis and in-depth study of a further field, that of haptics, was added, with the aim of investigating the impact generated by the addition of a component to the experience capable of determining greater cognitive involvement, through the creation of experiences that exploit multimodal stimuli (Gallace, 2012). In this framing, the multi-agent component is

understood, on the one hand, as a design approach that sees the introduction of digital techniques not only as an executive tool, but as a collaborator in support of design, while on the other, it is precisely the multi-sensory character that entails a change of perspective in the design of virtual experiences that are no longer driven by the sense of sight as the unique source of input and contribute to the construction of more usable and comprehensible experiences.

There is much room for improvement in this field as well, but from the combination of programmes and software already known, it was possible to realise a pilot project stressing this sector to understand its potential and limitations. A new experiment was born that focuses on textiles and aims at the convergence of perception between the touch of real materials and the touch of virtual materials reproduced through visual and tactile rendering by vibration.

3. Multi-agent design-driven experiments

3.1 General process flow

The application of the two research within the framework of the pathway financed by the National Recovery and Resilience Plan through the creation of extended partnerships between universities, research centers and enterprises made it possible to develop a series of experiments aimed at defining the characteristics and approach useful for the creation of multi-agent contexts and spaces.

Two parallel projects were started up involving multidisciplinary teams composed of human agents and non-human agents represented by artificial intelligence and extended reality.

They specifically concern the development of advanced tools for digital acquisition and visual/aptic XR interaction for the textile industry and the definition of new paradigms of proactive relationships between people and machines for continuous transformative production and robotic systems. A retrospective reconstruction of the design process allowed us to identify an approach with several features in common and some design patterns of difference. The following is a description of the general flow of the applied design-driven method, without focusing on the different declinations of the two experimental activities. In this way, it will be possible to identify the shared aspects, patterns and recurring design actions of the process of defining a multi-agent environment, underlining the transformation of the design space (Giaccardi & Redström, 2020) and the overcoming of traditional human-centred practices.

The analysis and systemic representation of these two paths is useful to define what are the results obtained from the experiments carried out up to the current state of progress of the project, which represent what are the characteristics which a multi-agent design process should take into consideration in order to favour the development of transparent and aware contexts and interactions, fostering the development of

sustainable solutions in the technological sphere. The design approach acquired in the two technological experiments (Figure 1) can be summarised in three macro-phases that define the activities already carried out and future actions for the characteristics definition of multi-agent space in which design processes are optimized. As may be noted, the actvities are divided into actions that are performed by human agents alone, non-human agents alone, or multi-agent collaboration.

The start consists of the macro-activity "Context framework phase" of defining the context and research framework; this phase, which can be analyzed as a pre-project step, represents the action through which the human multidisciplinary groups are created based on the skills and tools available. These teams define at this stage what are the common objectives to be considered in the development and structure of the project line to be followed, also examining the different nature of the skills and disciplines introduced according to which an interdisciplinary process can be developed.

The second action is the "Research phase" where the individual themes involved are defined and the mapping of the state of the art, of the various relevant topics in the project, is initiated. This analysis makes it possible to identify and collect good practices concerning both the state of the art of bibliographic research and the identification of case studies and the collection of computational tools useful for the development of the project, such as hardware and software.

This first state of research results in the definition of certain insights that will represent the starting point for user research activities and the development of design concepts. At the same time, the analysis of the human and artificial users involved, and the collection of the actors' needs make it possible to reformulate and implement the results collected, also identifying useful strategies for the development of project proposals that can respond to the research question and the needs that have emerged.

Consequently, in the 'Design phase', the process of defining the design output through the integration between the parties is designed, paying particular attention to the development aspects, and the collection of feedback that is fundamental for the correct interpretation of the dialogue between human and non-human agents with the aim of optimizing the designed experience. In this step, design- and technology-driven experimentation took place, which enabled, through an iterative process, the acquisition of a mode of knowledge mediation, information selection and interactive representation of the processes activated in the interaction with complex information systems. Two-way communication between agents (Chen et al., 2018) takes the form of a design tool where design mediates between shared feedback. The analysis, construction and testing of born design prototypes allows the process to be concluded.

The final output of the workflow takes

the form of a so-called post-design phase that represents the systematization of the main characteristics and aspects related to the construction of a multi-agent space, collected through the development of the process. This concluding activity allows the work to flow into a practical application that enhances and finalizes the collaborative process between human agent and computational agent in the execution and facilitation of new design behaviors.

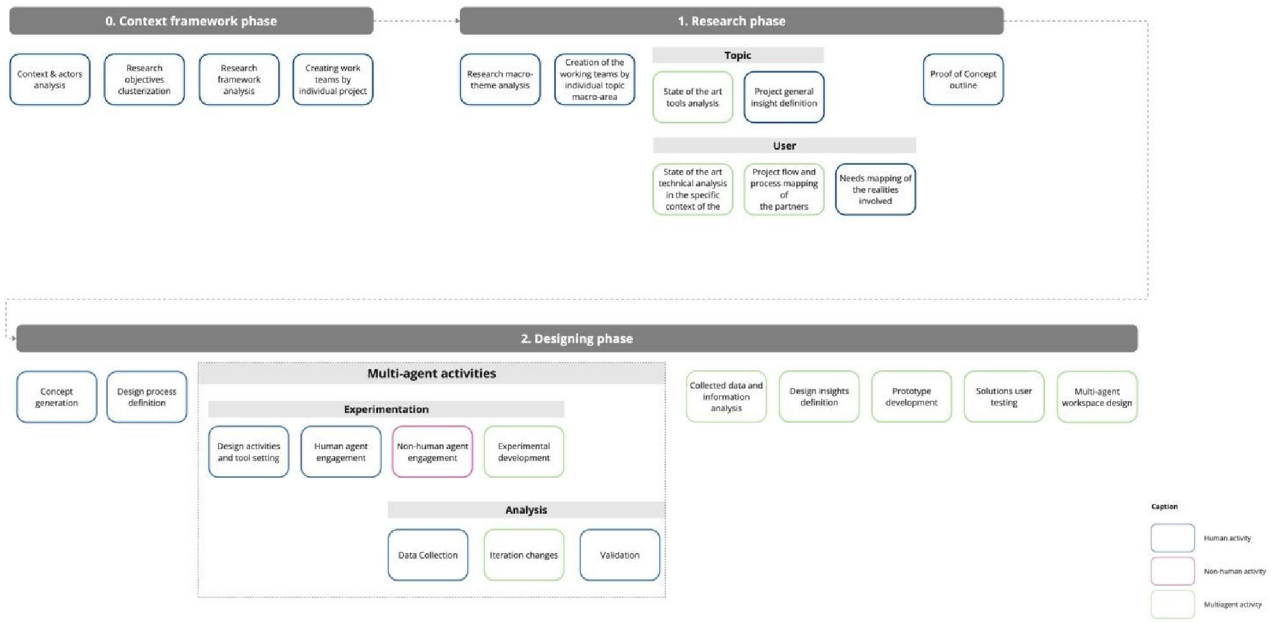

Figure 1: General workflow process

3.2 Artificial intelligence-based experimentation

The identification of new practices of multi-agent relationships makes it possible to imagine new scenarios in which this interaction can take place. In fact, by designing and testing hybrid design spaces, it is possible to scale them to different scenarios involving different domains, such as the educational domain or the industrial production domain.

The creation of a collaborative multi-agent environment between people and machine allows overcoming the concept of unidirectional interaction, identifying the potential of human and artificial capabilities, promoting diversity, empowerment (Ionescu, 2022) and testing more sustainable industrial processes.

The objective of the experimentation on the development of new paradigms of proactive relationship between people and machines for continuous transformative production and robotic systems described below, introduces the issue of cooperation between industrial operators and artificial intelligence to be able to create communication and feedback exchange systems that can make the process more iterative and sustainable. In this sense, it is crucial to analyze ways of proactive communication that enables shared decision making (Allen, Guinn and Horvtz 1999; Chen and Barnes 2014), through the definition of a flow and related interaction tools that can interact with existing established HMI systems.

The process (Figure 2) is begun through an initial definition of the issues and figures involved: the different cores of the project are represented by some fields of engineering involving the analysis of a vertical reconfigurable cable-driven system, collaborative robots powered by AI, AI-based HMI, virtual prototype and Industrial co-orchestration of network and application software.

From these aspects, the group is configured through the collaboration of different figures such as researchers in the engineering field, for the development of technical aspects, operators who directly relate to the workspace taken under analysis, and designers, who enable the design of the most optimal mode of communication for the context. At this stage, the non-human agents involved are represented by tools and figures based on artificial intelligence systems that participate in the production actions and enter the process as real operators and designers.

Following the definition of the design framework and mapping of the state of the art, the analysis of the communication needs of the human and non-human actors involved define the design insights for optimizing the interaction and identify the key aspects of the current interface used to manage the machines.

The design phase, as described earlier, is characterized by the experimental activities; in this process, this activity is characterized by three main aspects: the definition of the quantity and quality of information, in order to put the agents in a position to understand it quickly (Billsus et al., 2005), the choice of a graphical language, and the prototyping of an interface, understood as a conceptual space of action and colloquial interaction (Sheridan & Verplank, 1978; Anceschi, 1993).

By first identifying the graphic components related to the digital experience through a series of collaborative activities, it is possible to develop a series of prototype proposals tested with operators and AI systems.

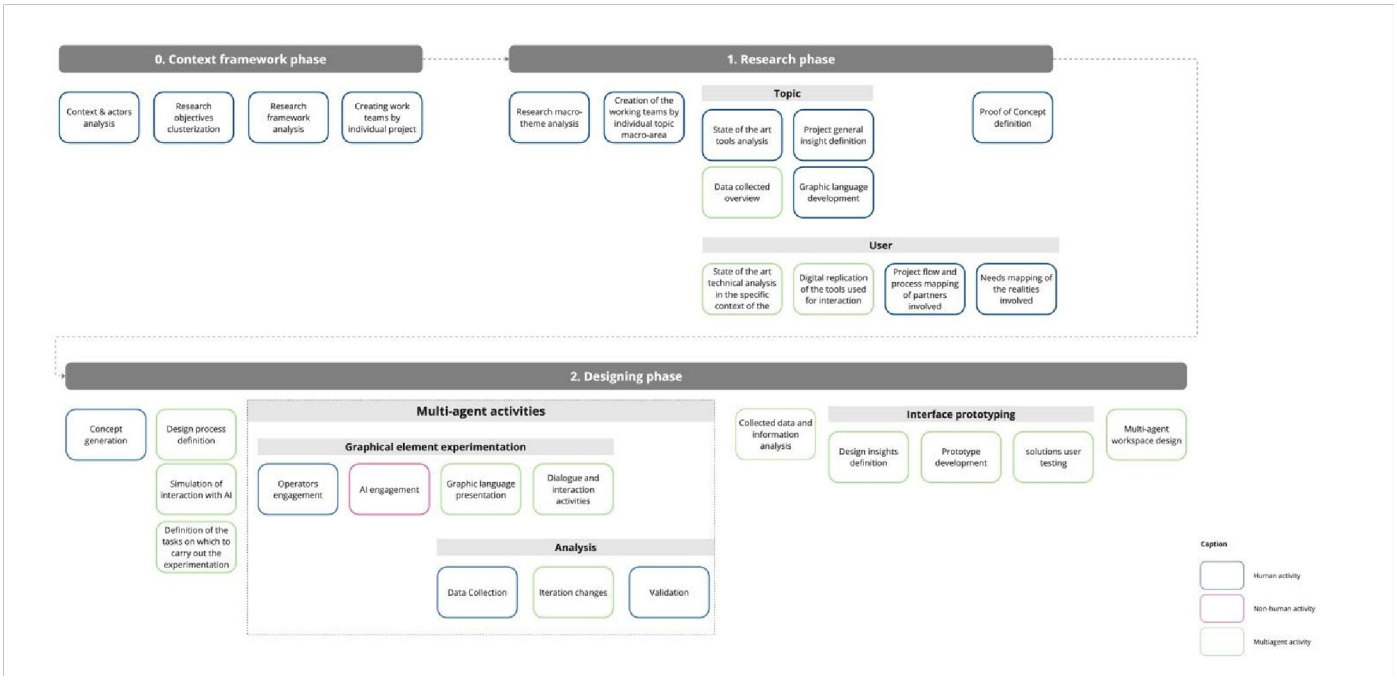

Figure 2: Artificial intelligence-based experimentation

3.3 Extended reality-based experimentation

In the context of extended reality, the thesis on which the experiments are based can be summarized in the application of the multi-agent model as an approach that, in the face of increased complexity inherent in the pre-design and design phases, positively affects the impacts of the resulting virtual experiences by enhancing the interactions between human and non-human components, multiplying the feedback produced by both parties. The common goal of the constructed digital scenes, is to shape virtual environments in which collaboration between two or more individuals is fostered by non-human factors, aligning their perceptions and stimulating their creativity in response. The result is experiences that differ in output, which it sees changing as the scope and goals for which it is being developed change but retain a structure that can be traced back to the working method in use by the research team.

The most relevant project is a pilot born out of the need to delve into the branch of haptics to understand its potential and limitations. The experience relates to remote shared design in textiles with ambivalent spillover to the fashion and furniture sectors, through the creation of a virtual environment that allows immersive interaction of designers with tissues and prototypes that do not require physical counterparts during the early operational phases; this approach can bring benefits in the optimization of concept generation and material use. The development process is articulated, and for this reason only the stages related to the proposed multi-agent approach are reported in this section.

With a view to maintaining a multidisciplinary approach, the preliminary phase (Figure 3) requires the careful structuring of a group composed of figures from different fields who share common interests and goals. Following the identification of a working outline follows the involvement of professionals and researchers whose expertise covers a broad area of knowledge. Since this is an experience related to the generation of an archive of digitized textile samples, profiles from the field of representation were needed, in charge of managing the workflow of acquisition and visual restitution; mathematicians, in charge of identifying algorithms useful for the transformation of acquired images into three-dimensional virtual geometry and figures competent in programming; and designers, dedicated to the study and creation of virtual scenes and the design of interactions, with particular attention toward haptic restitution.

Following the research phase, during the design development phase, study of the experience architecture takes place, the outcome of which is the creation of the multi-agent collaborative session being experimented on. At this juncture, activities are directed toward designing the dynamics of agent involvement and interaction, both human components (users of the experience who enter input into the system) and of the non-human components (in this case the virtual simulation environment, which inherits input and responds through feedback). What has been described needs to be evaluated through a testing process to gather data and insights useful in defining the collaborative environment. At the end of the design phase, the multi-agent collaborative sessions carried out with the aim of systematizing the dialogue between the human and non-human components, to identify the convergence between what is returned as feedback and what is perceived by the user and vice versa. This last phase is particularly significant because the totality of the non-human component's ability to express meaningful and interoperable feedback that actively stimulates the creativity and connectedness of the designers involved depends on it.

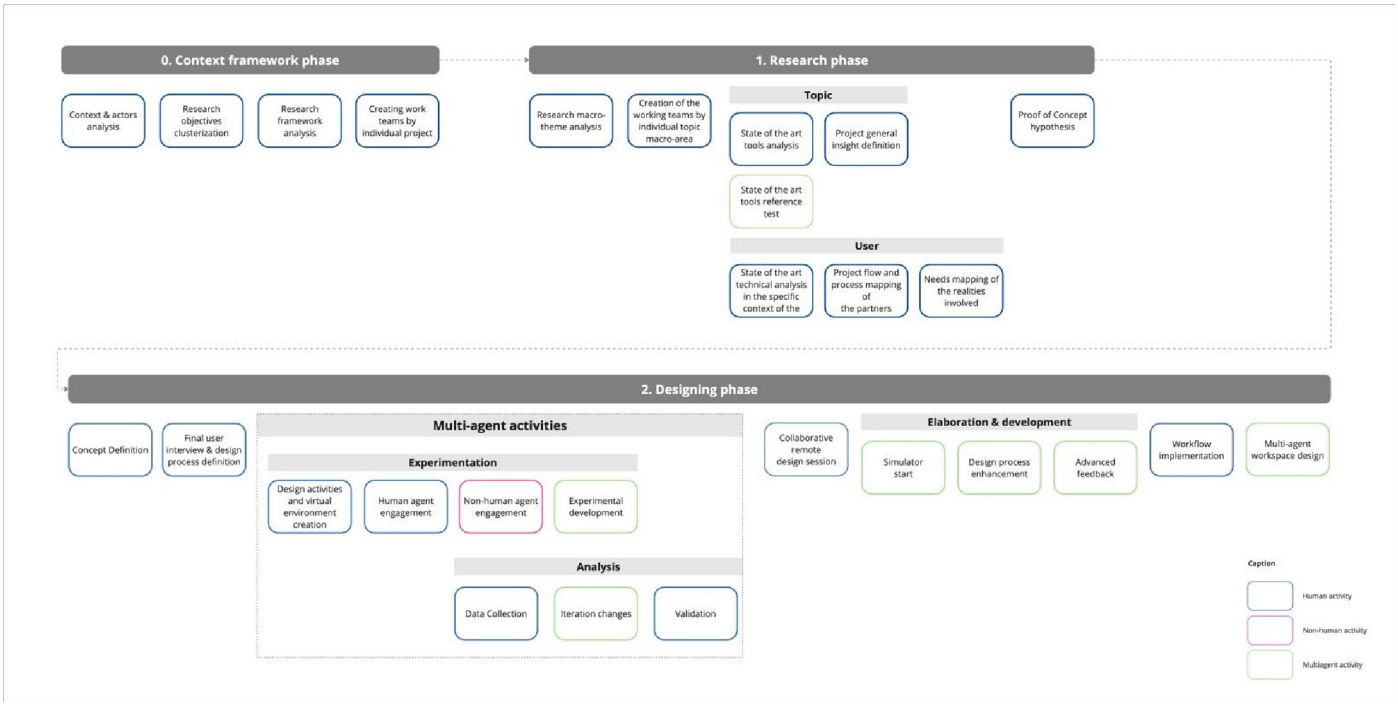

Figure 3: Extended reality-based experimentation process

4. Conceptual and methodological synthesis

The results of the research activities carried out up to now are shaped in the preliminary definition of what are the main characteristics the achieved multi-agent space should have to be a tool for overcoming design practices offering methodologies beyond human-centric cooperation to identify more democratic and inclusive scenarios.

The main features outlined can be summarized as follows:

· Interdisciplinary collaborative approach: first, it emerges the need to create a working team and design process that includes the final agents of the project in the design. In this way, the results obtained can be modified and implemented based on feedback and key aspects for putting into practice and utilization of the obtained output. Systemic analysis of the entire process allows consideration of the context within which the process is developed, gaining attention and care for environmental, human, and social issues.

· Systemic Complexity Analysis: The whole-process view allows consideration of the context within which the process is developed, acquiring attention and care for environmental, human and social issues. In this context, multi-agent systems can

range from simple interactions between a few agents to highly complex ecosystems involving numerous components with different roles and interactions.

· Agent heterogeneity: this aspect refers to the characterization of the agents involved according to different capabilities, goals and decision-making processes, from autonomy and responsiveness to the environment (Russell & Norvig, 2009; Wooldridge & Jennings 1995). Human agents may provide cognitive capabilities, social intelligence and systems approaches while non-human agents may contribute specialized knowledge, efficiency in certain tasks or automation capabilities.

· Adaptation and learning: Agents in a multi-agent design space often exhibit adaptive behavior, learning from their interactions and experiences over time. This can lead to improved performance, refinement of strategy, or better alignment with human goals.

· Ethical and social implications: The presence of human and non-human agents raises ethical considerations related to accountability, reliability, fairness, and impact on society. Collaborative design allows development processes to be defined where human and nonhuman agents can work together to modify aspects of the process and functionality to make such systems more inclusive.

5. Conclusions

From the synthesis of the analyzed processes, the need to identify new paradigms of relationship with technology emerges; in particular, the interaction with computational tools is no longer characterized only by an instrumental function but also by a hybrid dialectical exchange where nonhuman agents are collaborators of designers and researchers to develop virtuous and conscious experiences.

This approach underlines the potential of design-driven collaborative processes applied in multiagent environments (Margarido et al., 2022) fostering the possibility of interpretation of complex systems and environments by non-technical and specialized users and creating processes of increased technological awareness, accessibility, and technological democratization (Stumpf et al., 2021). In addition, the skills to simulate environments, procedures, and behaviors, makes it possible to optimize the necessary resources, including those turned into computation, producing a positive impact in making processes more sustainable.

The research activities carried out so far have made it possible to define preliminary results that can be encapsulated in 3 thematic macro-categories.

The first aspect concerns the role of non-human agents within the process: in fact, the need emerges to consider non-human - or

ultrahuman - components as technological tools no longer as at the service of designers, but on a par with any other co-participating and collaborative figure with the goal of improving the ideational and creative process behind development processes.

Second, the aspect related to the application of research in multi-agent experiments takes the form of the formulation and subsequent preparation of collaborative design activities through the definition of a shared language that allows all agents involved to be able to interact and create a hybrid dialectical relationship of information exchange. The definition and codification of a shared language makes it possible for the shared interpretation, according to their own specificities, of input data and to be able to process consistent and interoperable outputs.

Finally, the role that the designer takes on within this approach emerges: this figure assumes the function of a dragging vehicle (Irwin, 2015) to evolve traditional systems into multi-agent enabling spaces, where he or she is involved in the interpretation, transmission and facilitation of interaction and dialogue between human and non-human agents. The discipline of design again acquires the function of mediation and transmission of knowledge (Celaschi, 2015) in a context where the type of knowledge shared is human and artificial.

Moreover, the figure of the designer is required to learn and practice vertical skills that can enable design that can foster the creation of virtuous systems that can lead to open and accountable innovations (Blok & Lemmens, 2015), in addition to the traditional cross-cutting and interdisciplinary skills. The work described within the paper represents a still evolving process that will be deepened and reformulated through the planning of new project activities and actions. The goal is, in fact, to expand the field of experimentation by involving other computational agents and human agents not yet included in the study, such as generative modeling systems, to expand, but at the same time to obtain validation or useful information to the updating of the model hypothesis presented in this contribution. Through this approach, it will also be possible to identify new contexts and realities within which to scale and test the formulated approach.

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DESIGNING FOR DURABILITY: HOW FASHION BRANDS ARE ENCOURAGING LONGER GARMENT LIFE THROUGH CONSUMER BEHAVIOUR CHANGE

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ABSTRACT

The fashion system is confronted with a complex range of challenges, one of the most pressing of which is the unsustainable impact of the industry, that is responsible for a significant portion of world's pollution and textile waste. The fashion industry's linear model is environmentally destructive, as it relies on the extraction of excessive resources. In response to the linear models that have been prevalent in the fashion industry, alternative forms of collaborative retailing have emerged in the context of the Circular Economy, seeking novel solutions to promote more conscious and sustainable consumption. In this context, a growing number of fashion brands are taking proactive measures to educate consumers about the importance of garment care and durability, thus focusing on the final phases ('use' and 'post-use') as an integral asset of the transformation into a more sustainable fashion paradigm. The strategies adopted include maintenance and repair services; take-back schemes; awareness and marketing campaigns and collaborative business models. In this context, which is predominantly discussed from a managerial and marketing perspective, it is crucial to contribute to the discourse from a Design standpoint and identify its potential as an agent of change. This paper employs a qualitative approach, supported by a literature review and case study analysis, to examine the strategies employed by brands and platforms to raise consumer awareness about extending the life of clothing, thereby facilitating a shift in consumer behavior towards fashion circularity services and actions. In particular, the analysis considers the macro strategies of Care, Recommerce and Reverse Logistics services and practices, exploring how these are implemented to sensitize the consumer to a more sustainable consumption habit.

KEYWORDS | CIRCULAR ECONOMY, SUSTAINABLE FASHION, DESIGN FOR SUSTAINABILITY, RESPONSIBLE CONSUMPTION

1. Introduction

The fashion industry is a significant contributor to global pollution, responsible for considerable greenhouse gas emissions, excessive consumption of water and harmful chemicals, as well as generating a large amount of textile waste. The textile industry, in particular in developing countries, is characterised by precarious working conditions, including low wages, long working hours and exposure to dangerous chemicals (Battisti & Spennato, 2024). Furthermore, a considerable quantity of clothing is discarded annually, frequently before it has even been worn, due to the rapid obsolescence of fashion, the low quality of products and the lack of incentives for reuse and repair. The issue in question is linked to the linear business models that are typically employed by many fashion market participants. The linear economy correspond to a system in which resources are extracted to create products that ultimately become waste and are discarded. This approach, based on the principles of mass production, a focus on efficiency, a one-way business model and end-of-line disposal, has the potential to generate several negative impacts such as damage to ecosystems, a reduction in the useful life of the product and a mismatch with the demand for responsible products (Bick et al., 2018; Brewer, 2019; Fletcher & Grose, 2012).

In contrast to the linear system, Circular Fashion (CF) has emerged as a promising alternative for the fashion industry. The objective of this approach is to reimagine the system as a continuous cycle, where resources are used efficiently and products are designed to last, being recyclable or reused (Dan et al., 2023; D'Itria & Aus, 2023). The collaboration of brands, manufacturers, retailers and policymakers is highly important to create a more sustainable fashion system based on circular business models (Poldner et al., 2022). However, another crucial factor in effecting a paradigm shift is the consumption habits (Koszewska, 2019). At this point in time, brands and companies are attempting to raise consumer awareness through a variety of strategies within the concept of CF, thus concentrating part of their efforts on the last stages of the fashion chain (retailing and consumption). These strategies include: maintenance and repair services (clear and accessible instructions on how

to wash, dry, iron and store each garment; online and offline customisation workshops, professional repair services, DIY repair kits); take-back programmes (collecting the products either directly from consumers or by setting up take-back points); awareness and marketing campaigns (content highlighting the importance of conscious consumption and durable fashion, clear information on the origin of materials, production processes and environmental impact of garments); collaborative business models (recommence, rental and subscription platforms).

Within this context, this paper adopts a qualitative approach, supported by a literature review and case study analysis, to examine the macro-strategies and parallel processes employed by brands and platforms to raise consumer awareness about extending the life of clothing. The objective is to facilitate a shift in consumer behaviour towards fashion circularity services and actions. In particular, the analysis considers the macro strategies of Care, Recommerce and Reverse Logistics, exploring how these are implemented in order to sensitise the consumer to a more sustainable consumption habit.

2. Conceptual Background

2.1 Circular Fashion: How the fashion industry is moving towards a more sustainable model

The fashion market is gradually responding to the growing demand for sustainability, and the concept of CF, which promotes a more responsible approach to the production and consumption of clothing, is gaining ground. However, the dichotomy between the traditional fashion system and sustainability principles remains a complex challenge. The concept of the Circular Economy (CE) within the fashion system (Hina et al., 2023; Koszewska, 2019; Vecchi, 2020) challenges the conventional linear production system for clothing, footwear and accessories. Instead of being discarded, these products are reintroduced into the production process after use, thereby inverting the traditional logic of linear production applied into the fast fashion market. The initiative replaces the dynamics of consuming finite resources, increases the useful life of materials, reduces industrial waste and promotes the sustainable development of the sector. In practice, companies that adhere to the principles of CF utilize fewer materials to create individual items, work to eliminate non-recyclable and polluting items from the supply chain, attracting new suppliers and sustainable inputs. Furthermore, they recapture all materials that leave their factories, from garments to packaging, for reuse. They also seek to reuse inputs as much as possible, promoting the collection and renewal of materials.

The dominance of fast fashion in the market over recent decades has been a significant factor in the transition to CF, which is a complex and gradual process. Fast fashion brands have an important role to play in this

transition, but they must overcome a number of challenges to adapt to a new business model. These challenges affect not only fast fashion but the entire fashion system - from high-end to luxury - which appears to be better equipped and ready for change at the moment and, therefore, able to drive the transition. Although the responsibility for change is not limited to brands, consumers, governments, and civil society also have a crucial role to play.

In the light of this, the Ecodesign for Sustainable Products Regulation (ESPR) represents a significant transformation in the landscape of European product regulation. The regulation, which came into force in July 2024, imposes rigorous environmental criteria on all products placed on the EU market, from the design phase to the end of their useful life. By prioritizing the possibility of repair, reuse and recycling, the ESPR facilitates the transition towards a circular economy and reduces waste. This regulation serves to protect the environment while simultaneously stimulating innovation and competitiveness within the EU, thereby establishing sustainable products as the new norm. Furthermore, the ESPR is set to transform the fashion industry, challenging the dominant fast fashion model. The regulation places an emphasis on durability, repairability and recycling, compelling fashion brands to prioritize quality over quantity, transition to sustainable materials and investigate circular business models such as rental, repair and resale. While it necessitates substantial adaptation, the ESPR offers prospects for innovation and leadership, proposing a more environmentally responsible fashion landscape.

2.2 Design for Longevity: Making long-lasting clothing

Design for Longevity represents a comprehensive methodology for product development, with a particular emphasis on extending the lifespan of the product in question. The objective is to create items that are not only durable and functional, but also resilient to changing conditions and user needs. By evaluating factors such as material selection, construction methods, and user experience, designers can develop products that retain their value and utility over time, thereby reducing waste and environmental impact (Carlsson et al., 2021). Such an approach frequently incorporates strategies such as modular design, repairability and adaptability, with the objective of ensuring that the product remains relevant and desirable throughout its lifecycle.

Particularly within the fashion system, this can be achieved through the implementation of strategies such as the creation of long-lasting clothing utilizing high-quality materials, the incorporation of durable construction, the provision of proper fit, and the incorporation of clear care instructions. Furthermore, fostering an emotional connection between the wearer and the garment, as well as exploring business models that prolong the active life of clothing, contribute to the creation of value and the extension of the product's lifecycle.

Within this context, the initial phases of the fashion supply chain (conceptualization, sourcing and assembling) is of particular importance with regard to the role of Design. At this stage, the choice of materials is of great consequence, as is the development of the patterns, it should ensure that the garments are not disposed of prematurely due to rapid wear and tear or an imperfect fit. Moreover, during the modelling and sewing phase, it is essential to adopt an approach that contrasts with that of low-level production. This entails considering the social implications of the production process and re-evaluating the working conditions of those responsible for assembling the items. By doing so, it is possible to promote transparency in production processes, thereby fostering an emotional connection with consumers who choose to adopt a more sustainable lifestyle. Nevertheless, the role of Design is not limited to the initial stages of the fashion supply chain. The final phases (retailing and consumption) are being examined from a sustainable perspective due to the growing recognition of the importance of 'use' and 'post-use' as integral and crucial aspects for transformation of the fashion system into a more sustainable paradigm (Spagnoli & Iannilli, 2023).

Some fashion companies, for instance, are undertaking a process of business model redesign based on the concept of Collaborative Fashion Consumption (CFC). These business models are based on the provision of resale, rental, leasing, sharing, gifting and swapping services (Arrigo, 2021; Becker-Leifhold & Iran, 2018). The services most frequently offered by fashion brands and companies have been resale and rental (Fabro Cardoso, 2024). In theory, by being reused and shared, clothes last longer, reducing the need for constant production. However, the rationale behind consumers' decision to utilize this type of service remains inconclusive, with motivations oscillating between a sustainable positioning and an economic choice (Khalek & Chakraborty, 2023). This is because, when resold or rented, the products price is reduced. In Europe, there is a significant presence of resale services (including Vestiaire Colletive, Vinted, DePop), while the United States is also open to exploring sustainable solutions through rental and subscription services (including Rent the Runaway, Nuuly, Cocoon).

Other post-usage service that is being explored by fashion brands and retailers are the Takeback schemes, these programmes are implemented with the objective of collecting used clothing (Kant Hvass & Pedersen, 2019). The objective is to minimize the disposal of garments in landfill sites and to encourage the concept of circular fashion. By recovering the garments, companies have the option of recycling them, transforming them into new products, or even selling them on resale platforms. Such practices can offer a number of advantages, including a reduction in environmental impact, the creation of a more sustainable image for brands, and the promotion of more conscious consumption on the part of consumers. Nevertheless, the implementation of these programmes

necessitates meticulous planning and the overcoming of challenges, including those pertaining to collection logistics and the quality of returned items. Among the brands that have adopted these programmes are H&M, Levi's, Eileen Fisher Patagonia and The North Face.

Furthermore, some brands are creating dedicated areas in their stores where customers can take their parts to be repaired by qualified professionals. Another alternative is to provide repair kits so that customers can carry out small repairs at home. This option allows consumers to be more independent and to carry out small repairs quickly. Other brands and platforms are partnering with local seamstresses to provide repair services to their customers. This strategy not only facilitates access to the service, but also contributes to local economic development by strengthening local trade. Repair and reuse are fundamental pillars of the 'Care' concept in the fashion industry. By offering repair services and promoting the reuse of clothing, brands are contributing to a more sustainable and circular future. Veja, Nudie Jeans and RE;CODE are companies involved in this concept.

In this context, Product-Service Systems (PSS) Design is an emerging as that provide valuable tools in the redesign of fashion services (Afief et al., 2021; Johnson & Plepys, 2021; Lang & Armstrong, 2018; Pal, 2016). PSSs in the fashion industry represent a paradigm shift in the way clothing is sold and used, moving beyond the traditional model of a one-time purchase. By offering services such as rental, subscription, repair, customization and take-back schemes, PSSs provide consumers with access to a wider variety of items, thereby extending the life cycle of clothing and reducing waste (Vezzoli et al., 2022). This business model has the potential to promote sustainability, personalization and customer satisfaction, transforming the fashion industry into a more circular and conscious model. In contrast to the linear model of production, consumption and disposal, PSSs can possibly promote reuse, recycling and the creation of value from existing products (Tukker, 2015).

Fashion brands, companies and retailers are not limiting themselves to a single strategy or process when responding to sustainable demands. Instead, they seek to integrate a variety of practices and processes to engage consumers, as will be discussed in further detail in this paper.

3. Methodology

The aim of this paper is to identify and discuss the strategies that the fashion system is currently pursuing to transition towards a more sustainable system, with a particular focus on how it is encouraging longer garment life through consumer behavior change. Moreover, the regulatory proposals put forth by the EU, which aim to enhance the circularity, energy performance, and environmental sustainability of products sold within the EU market (known as the Ecodesign for Sustainable Products Regulation, or ESPR), serve as a further catalyst for this study.

Methodologically, this article is structured in two parts. Initially, a conceptual background is presented, based on a literature review, followed by an analysis of case studies. The selection of the cases was made through secondary research methods, resulting in the identification of six case studies. The following criteria were employed in the selection of the cases: (1) Commitment to sustainability: all the selected cases adhere to principles based on circular and sustainable fashion as their guiding philosophy; (2) Diversity/Relevance in consumer awareness initiatives: variety and/or relevance of initiatives to raise consumer awareness of the durability of clothing's life cycle; (3) The cases are approached from two distinct perspectives: In one approach, half of the cases are developed by established fashion brands, while the other half concern businesses that act as support and consultancy for fashion companies.

The cases were primarily framed into three macro strategies: (1) Care, exemplified by the cases RE;CODE and The Seam; (2) Recommerce, exemplified by the cases of Pangaia Rewear and Vestiaire Collective; and (3) Reverse Logistics, exemplified by the Ellen Fischer and SuperCycle cases.

Within those macro strategies, the processes explored are: (1) Maintenance and repair services: clear and accessible instructions on how to wash, dry, iron and store each garment; online and offline customisation workshops, professional repair services, DIY repair kits; (2) Take back programmes: collecting the products either directly from consumers or by setting up take-back points; (3) Awareness and marketing campaigns: content highlighting the importance of conscious consumption and durable fashion, clear information on the origin of materials, production processes and environmental impact of garments; (4) Collaborative business models: resale, rental and subscription platforms.

Taking these factors into account, the analysis aims to investigate the strategies adopted by the fashion industry to prolong the lifespan of clothing items by fostering consumer awareness. Furthermore, the objective is also to identify which processes are addressed in parallel with the macro strategy.

4. Case Studies Analysis

4.1 CARE

This section will analyse two case studies in relation to the 'Care' macro-strategy. The first case study considers RE;CODE, and the second case study considers The Seam.

RE;CODE is a South Korean sustainable fashion brand that has as primary focus the upcycling, specialized in transforming surplus materials and discarded textiles into garments, reducing waste and promoting an eco-friendlier fashion cycle. The incorporation of recycled and organic materials into their collections serves to minimize the environmental footprint, allowing the brand to create unique pieces or limited collections. In this context, the service called MOL 1 RE;CODE offered by the brand is dedicated

to the upcycling and transformation of pre-owned clothing. The service provides a means of transforming existing garments into new and stylish items through the application of alterations, enabling the wearer to refresh their wardrobe and give new life to items that are no longer worn. The customer selects a garment that they wish to have reworked, RE;CODE tailors and upcycles the piece based on the customer's preferences and their design expertise. The customer then receives their renewed garment.

Furthermore, the brand offers a movement called RE;TABLE, an activity where individuals can gather with friends and family at the table and practice fun upcycling together. Until today, 20,824 people participated of the initiative, which also aims to empower single mothers financially and to sustain their economic activity. The promotion of upcycling and sewing education is offered to single mothers who experience difficulties in balancing childcare and economic activity. They are trained to become professional instructors through this initiative, and those who successfully complete the educational programme are subsequently employed as skilled upcycling workshop instructors, guaranteeing a stable standard of living through continued economic activity. In addition, RE;CODE keeps its sustainable impact numbers up to date on its website (number of revived stock garments; number of repair/ remodeling requests; number of designers who have partnered with them, number of socially responsible people together; number of participants in the workshop RE;TABLE).

Moreover, RE;CODE's BOX ATELIER represents an expansion of the company's commitment to sustainable fashion practices through the incorporation of a resale service, facilitating the circularity of garments by enabling customers to extend the life cycle of their pre-owned RE;CODE clothing. To do so, individuals may present unwanted items to the BOX ATELIER, where a potential consultation may assess the condition of the garment and establish a fair resale value. Subsequently, RE;CODE oversees the listing and sales process, thereby enabling the clothing to be repurposed and reducing textile waste. Conversely, the resale section enables customers to become active participants in sustainable fashion by offering a curated selection of pre-owned garments at potentially reduced prices.

Still concerning Care strategies, the platform The Seam has established itself as a crucial service provider within the fashion industry, with a particular focus on the UK market. The organization's fundamental objective is to encourage the adoption of sustainable practices through the provision of clothing repair and alteration services. This approach directly addresses the environmental consequences of fast fashion by extending the lifespan of existing garments, thereby reducing textile waste and the necessity for continual new clothing purchases. The Seam offers a comprehensive range of services, encompassing repairs that address minor imperfections such as ripped seams, as well as more intricate alterations such as zipper replacements. Furthermore, they offer

garment tailoring services with the objective of achieving an optimal fit, including operations such as suit tailoring, hem adjustments, and dress alterations. Additionally, select locations offer cleaning services for garments, thereby providing a comprehensive approach to clothing care. This dedication to sustainability is not limited to the longevity of garments, The Seam actively fosters the revival of skilled craftsmanship within local communities. By forming partnerships with local tailors and seamstresses, they are able to guarantee the provision of high-quality alterations and repairs, while simultaneously supporting the growth of small businesses.

The Seam also places a premium on customer convenience. Their website offers a user-friendly interface for online appointment booking and service selection. This includes the option of studio visits, whereby customers can bring their garments to a designated Seam location. For an additional fee, they offer the convenience of at-home visits by skilled tailors.

4.2 RECOMMERCE

This section will present an analysis of two cases pertaining to the 'Recommerce' macro strategy. The first case study is that of Pangaia Rewear, and the second is that of Vestiaire Collective.

The PANGAIA Rewear initiative, projected by the sustainable clothing brand PANGAIA, is a peerto-peer resale platform dedicated to the sale of pre-owned PANGAIA clothing items, aiming to extend the life of their garments by encouraging consumers to resell them when they are no longer fit for purpose. From an environmental perspective, this process has the benefit of reducing the amount of clothing waste and the necessity for new PANGAIA clothing production.

The use of Quick Response (QR) codes on care labels facilitates the listing of items. PANGAIA Rewear is conceived as a nexus for their circular fashion mission, with the potential for the integration of rental, repair, and take-back schemes in the future. In addition, PANGAIA has a page dedicated solely to the care of its articles. Entitled 'PANGAIA Aftercare', the use of natural fibers and dyes in their products, requires an extra care to keep them in good condition.

Other incentive of the brand regards the Pangaia's Inner Circle, a complimentary loyalty programme. The registration process can be completed by creating an account on their website, and for each purchase made, customers are awarded points, which can subsequently be redeemed for discounts and vouchers on future purchases. In addition, members of the Inner Circle have exclusive benefits, including the opportunity to gain early access to new product launches and sales. As one ascends through the tiers, which are unlocked by accumulating more points, one may gain access to special events or experiences that align with PANGAIA's sustainability mission. One may also select a welcome gift at the time of joining, such as a discount or a donation to environmental causes.

The brand goes beyond, offering a B2B service named 'Powered by PANGAIA', a platform that makes its apparel and accessories available to corporate clients who are inspired by and aligned with the platform's mission. From the provision of merchandise to major corporations for the benefit of their employees and for corporate gifting, to the formation of bespoke artist partnerships with cultural institutions, to the enhancement of company uniforms for employees, as well as to larger innovation-driven projects such as the recycling of old garments into new materials, 'Powered by PANGAIA' ensures that other business solutions achieve the same high quality and responsible standards as their own brand.

The second case studied in this section regards the global online marketplace Vestiaire Collective, where users can purchase and sell pre-owned designer clothing and accessories. The company's focus is on luxury, with a particular emphasis on top brands and vintage items, as opposed to fast fashion. The platform employs a multi-faceted approach to act against the phenomenon of fast fashion. The promotion of CF is a key aspect of the company's business model, predicated on the repurposing of garments and accessories, thereby curbing the demand for mass-produced fast fashion items. In 2022, the company initiated a policy of banning fast fashion brands from its platform, making it increasingly challenging for users to locate these items on the site. Vestiaire Collective also educates consumers about the negative impacts of fast fashion, such as textile waste and pollution, and demonstrates the lower cost per use of second-hand clothes, which is typically less than that of fast fashion items. The company has also formed sustainable partnerships with organizations such as The OR Foundation to address the issue of clothing waste in developing countries.

With Sojo, a UK-based enterprise specializing in the repair and alteration of garments, Vestiaire Collective has established a strategic alliance. The objective of this collaboration is to address two significant challenges within the pre-owned fashion market: achieving an optimal fit and ensuring the longevity of garments. By incorporating Sojo's services into their platform, customers can now purchase pre-owned luxury items with greater assurance of size and fit. The capacity to tailor these garments ensure a precise fit, thereby reducing the risk of disappointment due to sizing issues and fostering a more favorable perception of pre-owned fashion.

Finally, in response to the growing demand from our eco-conscious consumption, Gucci has collaborated with Vestiaire Collective to launch a new take-back programme. The proprietor of a handbag from one of their signature lines can exchange it for store credit. This may be done either through an elevated in-person experience in selected Gucci boutiques or online, the extension of the lifespan of a Gucci product is in alignment with the House's vision of a circular future for fashion.

4.3 REVERSE LOGISTICS

The section will analyze two cases in relation to the 'Reverse Logistic' macro-strategy. The initial case study is that of Ellen Fisher Renew and Supercicle Platform.

The Eileen Fisher Renew platform was developed with the objective of promoting sustainability in the fashion industry, where pre-owned Eileen Fisher clothing to be given a second life. The programme is a recycling initiative whereby used Eileen Fisher clothing is collected and returned to the company, it encourages the practice of responsible consumption and the reduction of textile waste. Clothing produced by Eileen Fisher may be returned regardless of its condition, whether it is gently used, damaged, or in any other way unsuitable for sale. For the consumer there is a reward in the form of a Renew Rewards Card for each returned item. From an environmental perspective, this process extends the lifespan of garments and reduces the necessity for new clothing production.

Launched in 2018, Eileen Fisher's Waste No More initiative extends the life of clothing and resources by transforming pre-consumer and post-consumer textile waste, specifically unwanted Eileen Fisher garments, into unique and artisanal textiles. Through the Eileen Fisher Renew programme, customers can return used clothing in any condition. Waste No More then meticulously sorts, cleans and repairs these garments whenever possible. Using a felting technique (process of matting and condensing wool fibers together using heat, moisture, and agitation), they give new life into the used materials, creating one-of-a-kind sustainable textiles. These transformed textiles are then used to make products such as cushions, wall hangings and decorative objects. Waste No More not only combats textile waste destined for landfill, but also offers customers the opportunity to participate in a more environmentally conscious fashion cycle. Furthermore, although the brand doesn't focus on marketing campaigns, it does have a section called 'the journal' on its website, dedicated to providing information on repair and resale techniques, on the certificates the brand has earned, such as the B Corp, and on materials and how to extend their useful life.

Supercircle is a comprehensive technology platform designed to assist retail brands in the implementation of circular practices, with a particular focus on the textile industry. The platform's primary objective is to facilitate the transition towards a more circular economy. Aiming to reduce textile waste by establishing a closed-loop system for the collection, processing, and reuse of clothing, footwear, and other textiles. This is accomplished through the provision of a range of services for brands. Through the Turnkey Trade-In Programmes, Supercircle assists brands in implementing consumer-facing programs that facilitate

the return of unwanted items and provide customers with credit towards future purchases. This encourages the practice of responsible consumption and facilitates the reintroduction of used items into the supply chain. The platform also offers solutions for excess inventory overseeing the management of a brand's surplus inventory, which may include damaged goods, samples, or excess stock. Supercircle assumes responsibility for the collection, transportation, and potential resale or recycling of these items.

In terms of data and reporting, Supercircle furnishes brands with exhaustive data and reports on the performance of their programmes. This enables brands to monitor the environmental impact and customer response to their circular initiatives. Brand partners of Supercircle include Reformation, ALC and Uniqlo US.

5. Discussion and Conclusion

The aim of this paper was to contribute to the field of Design by illustrating 6 of the best practices in the fashion system in relation to consumer awareness through strategies and processes related mainly to the use and post-use of clothing (Figure 1).

The first finding of this study concerns the encouragement that a fashion brands and platforms are providing for its consumers towards a more sustainable fashion system. The construction of a macro-strategy (Care/Recommerce /Reverse Logistics) supported by parallel processes, can lead to positive socio-environmental effects. The cases presented illustrate two distinct paths. The first is exemplified by fashion brands (RE;CODE, PANGAIA and Eilen Fisher) that demonstrate diversity in their processes and services, irrespective of their macro-level strategies. The second is represented by platforms that have the fashion system as their target customer base (The Seam, Vestiaire Collective, Supercicle). In this case, processes and services tend to be more specialized. The analysis demonstrates the interrelationship between services and processes, given that in the majority of cases, brands and platforms offer a combination of them.

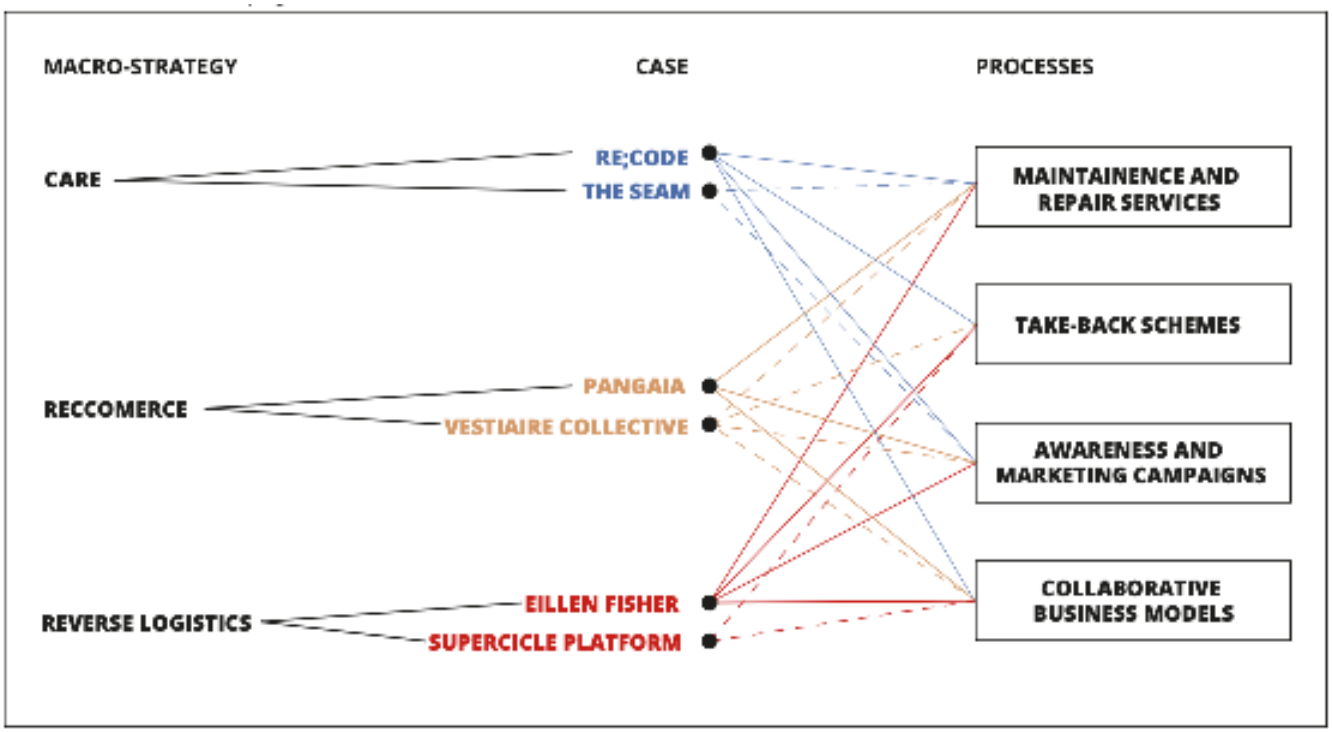

Figure 1. Connection among macro-strategies and processes gained from fashion best practices in relation to consumer awareness related mainly to the use and post-use of clothing.

Having as a macro-strategy the concept of 'Care', RE;CODE transforms surplus materials and discarded textiles into unique garments, offering services like custom upcycling and resale. Beyond environmental sustainability, the brand empowers single mothers through upcycling education and employment opportunities. By tracking its sustainable impact and offering a platform for community engagement through RE;TABLE, RE;CODE is leading the way in creating a circular and socially responsible fashion industry. The Seam instead, by offering a wide range of clothing repair and alteration services, extend the life of garments, reduce waste and promote ethical fashion. Their commitment to local craftsmanship ensures high quality repairs while supporting the community. The Seam also prioritizes customer convenience with online booking, in-store services, home visits and mail-in options.

From the 'Recommerce' macro-strategy point of view, the PANGAIA Rewear platform facilitates the resale of pre-owned PANGAIA items, extending the life of garments and reducing waste. But the brand also supports the consumer through other processes, for example the Inner Circle loyalty programme, where customers are rewarded for their sustainable choices and receive exclusive benefits. To extend its impact, Powered by PANGAIA offers B2B solutions for businesses in line with the brand's sustainable mission. With a focus on aftercare and material transparency, PANGAIA aims to create a long-term relationship with its customers and the environment. Always

under the same macro strategy, Vestiaire Collective, through the promotion of circular fashion and the banning of fast fashion brands, addresses the adverse effects of the industry. Collaborations with organizations such as The OR Foundation and Sojo further enhance the sustainability efforts of the platform. Additionally, the partnership between Vestiaire Collective and Gucci highlights the growing significance of resale and circularity in the luxury fashion sector.

Furthermore, Eileen Fisher Renew programme, based on 'Reverse Logistics' macro-strategy, encourages customers to return used clothing in exchange for rewards. Meanwhile, Waste No More transforms unwanted garments into new products. Through education and transparency, Eileen Fisher empowers consumers to make informed choices. The Supercircle platform instead offers a technology platform to support brands in implementing similar circular initiatives. This provides tools for trade-in programmes, inventory management, and data analysis. Collectively, these initiatives promote a circular fashion economy and reduce textile waste.

The second key finding of this study highlights that the transformation of the fashion system does not depend solely on the actions of individual consumers despite the relevance of their role. Indeed, the role of consumers is crucial in shaping market trends, production decisions and the overall value chain of the fashion industry. Consumer demand, which moves towards greater sustainability and circularity, is increasingly recognized as a driving force in encouraging more responsible corporate behaviour (Musova et al., 2021). Consumer and industry responsibilities are distinct but interdependent aspects of promoting responsible consumption (Cavender, Lee & Wesley, 2021). While research has traditionally focused on the lack of circularity in the textile supply chain or on consumer habits regarding the use and disposal of garments, the involvement of the fashion industry in the post-retail phase is a more recent development. The connection between consumer and industry responsibility is particularly evident in the increasing recognition of the fashion industry's role in the circular economy and the growing consumer awareness of sustainability. However, this awareness, widespread especially among the younger generations, does not always translate into behavioural changes. Therefore, fostering consumer attitudes towards sustainability, together with a sense of responsibility, is essential to promote meaningful change (Luchs, Phipps & Hill, 2015).

In response, companies, brands, retailers, and platforms can contribute through a range of strategies, engaging the consumer in the process. Design, in its diverse forms, represents a potential avenue for impact. In addition to influencing the initial stages of the fashion supply chain (conceptualization, sourcing and assembling), the efficacy of Design on the final stages of the fashion supply chain such as distribution, retail,

and consumption is important to guide the consumer into a more conscious use and post-use of the garments. In this sense and within the concept of Design for Longevity, the relationship between Use and Post-Use Services (such as Fashion Resale/Repair Platforms and Take Back schemes) and Product Service Systems (PSSs) Design is becoming increasingly close and strategic, with the objective of developing a circular and sustainable business model in the fashion industry. These approaches ultimately converge towards the extension of product lifespan and reduction of waste.

PSSs are embedded in a fashion system with the objective of minimizing resource use, waste, emissions and energy losses through the implementation of strategies that seek to slow down, close and narrow material and energy cycles. This can be achieved by extending the lifespan of products, improving efficiency in product use and operation, and recovering materials that could be exploited at the end of their lifespan. Therefore, PSSs must be intentionally developed for the purpose of the circular economy, although it is still challenging to see full results, since a fashion company can adopt circular economy principles of closing the loop and still be unsustainable, for example, if its employees work in poor working conditions.

In conclusion, the study shows that design processes, which will soon be further encouraged in light of the recently introduced EU ESPR regulations, have become a challenging undertaking. This is due to the necessity of developing a system comprising products and services in an integrated manner, in accordance with the new guidelines that have yet to be considered in the conventional linear development approaches employed by numerous companies within the fashion industry.

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PROTOTYPING A MIGRATING VIRTUAL RE- CEPTIONIST USING PHYSICAL AND VIRTUAL REALITY TOOLS: IMPLICATIONS FOR DESIGN COMPETENCY AND TOOL DEVELOPMENT.

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ABSTRACT | This paper presents an examination of the design process and tools for adaptable Intelligent Virtual Agents (IVAs) in both physical and virtual proto- types, using a Research through Design (RtD) approach and prototyping. The study focuses on the design of a migrating virtual receptionist for a computer science department, transitioning from a screen at the entrance, to a phone for mobile interaction, and ultimately to a robot in the coffee area. The research ex- plores the educational implications of designing such virtual agents, raising significant questions about the competencies required and the tools necessary for future designers. The study also investigates design tools equipped with pre- configured agents, identifying and discussing the adjustable parameters within these tools. The prototypes were evaluated with 23 participants who interacted with the virtual receptionist in both a virtual reality (VR) and a physical environ- ment, with the evaluation results indicating a high level of usability in both envi- ronments. The research contributes to the field of design research, particularly in the context of designing IVAs, by furthering understanding and application of the design process and tools, exemplifying the integration of physical and virtual realities in prototyping, and suggesting improvements for design tools and meth- ods to facilitate this process.

KEYWORDS | MIGRATING AGENT, VIRTUAL RECEPTIONIST, INTELLIGENT VIRTUAL AGENTS, DESIGN, SKILLS, COMPETENCIES, PROTOTYPING, RESEARCH THROUGH DESIGN, USER- CENTRED DESIGN COMPETENCY MODEL

1. Introduction

An agent is commonly defined as a software or computer system that is situated in an environment and capable of autonomous action in this environment to meet its design objectives (Wooldridge & Jennings, 1995). Intelligence is, in this context, demonstrated through flexible autonomous actions, that is, how the agent per- ceives its environment, how it reacts to the environment, and its social interac- tion capabilities (Wooldridge & Jennings, 1995).

Intelligent virtual agents (IVAs) are defined as interactive digital characters that are characterised by human-like modalities and flexible autonomous actions by means of real-time perception, cognition, emotion and action. (Lugrin, 2021). Related, Embodied Conversational Agents (ECAs) demonstrate interaction abili- ties similar to face-to-face human conversations. This includes the ability to pro- duce and respond to verbal and nonverbal communication (Cassell, 2000; Lugrin, 2021). The physical presence and visual representations of ECAs aim to enhance engagement and user experience (UX). The nonverbal cues and facial expressions of the embodied conversational agents can be used to convey meaning and emotions (Cassell, 2000).

A virtual receptionist is an IVA or ECA that uses verbal and nonverbal input such as “the user’s voice [...] and contextual information to provide assistance by an- swering questions in natural language, making recommendations and perform- ing actions” (Cowan et al., 2017). Such agents should be able to engage in face- to-face conversations with visitors to a place, demonstrating many of the same communicative behaviours as humans do in service situations.

Different agent embodiments provide varying opportunities for interaction while imposing different limitations. Robots compared to screen-based ECAs have a greater physical presence (Li, 2015), but can suffer from mobility problems and power limitations (Kriegel et al., 2011). Digital characters convey emotions more effectively but do not move in physical space as they are confined to a screeen. Characters on handheld devices can accompany their users but their size is a limitation, and they also have limited interaction modalities (Aylett et al., 2013).

The design of these interactive technologies necessitates specialised expertise and knowledge from various fields or domains, making it crucial for these diverse disciplines to have effective methodologies (Kautonen & Nieminen, 2016). Com- petency models offer a structured approach to organising and evaluating the knowledge, skills, abilities, personal characteristics, or a combination of these attributes necessary for effective performance (Kautonen & Nieminen, 2016). Nieminen (Nieminen, 2015) developed a User-Centred Design (UCD) competency model comprising 12 fundamental competencies (see Table 1). These competen- cies are categorised into four groups: User Strengths or Designer Strengths depending on the participant's role, Soft Skills and Hard Skills, based on whether the com- petency is innate or acquired (Nieminen, 2015). We have created prototypes of an IVA that migrates between three embodiments. This can be thought of as a'soul-shell'approach in which the IVA is characterised as the soul and the embodiments it inhabits as the shell and only one instance of the IVA is able to migrate between various shells (Koay et al., 2011). The main research centres on the design of a migrating virtual receptionist for a computer science department with questions on what competencies are required to design these IVAs, and how might we equip future designers with these skills?

Table 1: UCD Competency Model according to Nieminen (Kautonen & Nieminen, 2016)

User Strengths	Soft Skills	Designer Strengths	Hard Skills
Subject Domain Experience (SDE): (Tacit) knowledge, crafts and skills gained by (long) experience.	**Communication (C)**: Wellfunctioning and democratic communications are the most time consuming and critical part of design work.	**User Involvement (UI)**: Capabilities in selecting the right users and working with them effectively.	**Process and Methods (PM)**: Process, management and methodological excellence and the skills to adapt them.
Context Availability (CA): Access to real context of use, may be restricted or difficult to arrange.	**Multidisciplinarity and Collaboration (MC)**: Multiple points of view increase the eventual impact of design.	**Problem solving and Designerly ways (PSD)**: Attitude and determination towards designing a change for the better and having the means to realize it in a responsible manner.	**Technology and Market Potential (TMP)**: Awareness of advances in available technologies and relevant trends at target markets.
User Cultures, Social Networks and Practices (USP): Each user groups have their own language and culture that can be difficult to grasp and utilize in a design project.	**Motivation and Ambitions (MA)**: Intrinsic motivation, self-improvement, professional ambitions, competitive salary and manageable workload create solid design conditions.	**Conceptualization, Visualization and Validation (CVV)**: Skills in creating product concepts, prototyping and testing.	**Subject Domain Knowledge (SDK)**: Knowledge and skills gained by education and certification.

In this paper, we describe the proposed design and its embodiments in two pro- totypes, which have been tested with 23 users. Data on perceived usability, prod- uct reactions, and strengths and weaknesses in the user experience were col- lected. As different prototypes filter a design space and manifest design ideas differently (Lim et al., 2008), the two prototypes effectively work as data source triangulation (Thurmond, 2001) to increase confidence in the research findings.

The structure of the paper is as follows: Section 2 provides a background on the migrating virtual receptionist and the study's tools and methods. Section 3 out- lines the methods

employed in the study, while Section 4 details the results of the evaluation of the two prototypes. In Section 5, a discussion of the study and its findings is presented, and Section 6 contains the conclusions.

2 Migrating Receptionist Prototypes

The prototypes of the migrating receptionist are based on the findings of a previous study on the conceptual designing of a virtual receptionist (Author, 2021). Three concepts were generated and the concept of a migrating virtual reception- ist was selected after a PMI (plus, minus, interesting) chart evaluation process.

The prototypes were designed for three places of interaction: the entrance, the corridor and the coffee area of the department. The receptionist migrated to a different embodiment at each place. The users were to interact with the receptionists on a large screen by the entrance, on a mobile phone used while walking in the corridor and embodied in a robot in the coffee area. The interaction with the receptionist on the screens was based on a form of text-to speech (TTS). The user selected among text alternatives whilst the receptionist responded using speech. Two prototype versions were developed: one in VR and one in physical space.

2.1 Virtual Reality Prototype

The migrating receptionist in VR was developed and run in Unreal Engine [1]. Unreal Engine is a 3D game engine made by Epic Games used to create video games, VR experiences, and other interactive content for various platforms. Unreal Engine was selected due to its graphics qualities in VR and good support for VR, which facilitated making the VR environment realistic in relation to the physical prototype. The environment (3D layout of one floor of the department) was developed using Blender [2] which is a software used for creating 3D models, animations, visual effects, etc.

The 3D model of the VR environment is a representation of the three places of interaction (the entrance, the corridor, and the coffee area). The VR controllers represented the user's hands, and a 3D model of a mobile phone appeared in one hand. Communication between the user and the receptionist was that the user selected among text alternatives, and the receptionists responded using speech. Communication with the robot in the coffee area was in text-based dialogue format. The user selected text alternatives and the robot responded with both audio and text. Orange text represented the user's text and green text was the robot's response.

2.2 Physical Prototype

The physical prototype was developed using a static website for the agent on the entrance and the mobile device screens. The robot

1Unreal Engine
2 Blender

used in the coffee area was a Furhat robot [3]. Furhat is a social robot that communicates with users in human–like face–to–face human conversations by speaking, listening, showing emotions, and maintaining eye contact (Al Moubayed et al., 2012). A touch pro- jector screen [4] by the entrance was used for the initial interaction with the receptionist. Each participant was then accompanied by the agent after it migrated to their personal mobile phone. The migration to the phone happened after the user scanned a QR code provided by the receptionist on the entrance screen. In- teraction on the phone was performed using the the touch screen. Communica- tion with the Furhat robot was a face–to–face human-like conversation.

3 Method

The data collection of the migrating virtual receptionist study was carried out with a number of tools and methods. Video recording of the touch interaction with the screens in the physical prototype, as well as the interactions in VR was performed. Audio was recorded during the product reaction card words session (described below). The study procedures and the data analysis methods are pre- sented in this section as well.

3.1 Instruments

Product reaction cards were used to collect product desirability, and the system usability scale (SUS) was used to collect the usability data of the prototypes. An age and gender questionnaire was used to collect demographic data.

Product Reaction Cards

Benedeck and Miner (Benedek & Miner, 2002) developed product reaction cards at Microsoft as part of the desirability toolkit (also known as the Microsoft Reac- tion Card Method). The toolkit was created to understand the intangible emo- tional responses like desirability and fun resulting from a user's experience with a product (Barnum, 2021). The method introduces a controlled vocabulary for participants (Moran, 2016). The toolkit consists of 118 words, the intention is to cover a wide variety of possible reactions. The word list can be modified in terms of the kind and number of words. The selection process of which words to use depends on design objectives, that is desirable UX qualities, and the type of study (Arvola, 2010; Arvola & Holmlid, 2015).

The words selected for the migrating receptionist study were based on the following design objectives:

- Immersion and engagement.
- User-friendly interfaces.
- Seamless (continuous/fluent) transition between interfaces and embodiments.
- Awareness: the user should feel accompanied by the same agent between embodiments.
- Similarities in interactions between the two

3 Furhat Robotics

4 Sony Xperia Touch

prototypes, i.e., both prototypes should represent the same interaction design.

The words used in the reaction cards included 15 positive words and 11 antonyms of the positive words. The use of antonyms was done to allow for expansive vocabulary – to give participants more options to express themselves. The reaction card method recommends including at least 40% of negative words, and some neutral words (Moran, 2016). The words used were selected from the 118 words of the Microsoft desirability toolkit. Although not in the toolkit's 118 words, the words indifferent and Ok were included for the expansive vocabulary.

System Usability Scale (SUS)

The SUS, developed by Brooke (Brooke, 1996), is a standardised questionnaire used for the assessment of perceived usability (Bangor et al., 2008; Lewis, 2018). The SUS is a relatively quick and easy-to-use tool to be used when doing usability evaluations. It is adaptable to various interface technologies due to its technology-neutral approach, allowing it to provide a comprehensive assessment (Bangor et al., 2008). The SUS is stated to be robust even with a relatively small number of participants (8–12 users) (Tullis & Albert, 2013)

We used the original SUS questionnaire questions, with the word system repre- senting the migrating receptionist prototype as that does not affect the results (Bangor et al., 2008; Brooke, 2013). One questionnaire was used for each environment (VR and physical prototype) of the study.

Positive	**Negative**	**Neutral**
Easy to use	Negative	Familiar
Engaging	Complex	Indifferent
Seamless	Disconnected	Ok
Relevant	Irrelevant	Exceptional[5]
Immersive	Disengaged	
Inspiring	Impersonal	
Stimulating	inconsistent	
Effective	Difficult	
Personal	Overwhelming	
Exciting	Confusing	
Novel	Intimidating	
Approachable	Annoying	
Consistent		
Motivating		
Appealing		

3.2 Participants

5 Exceptional: Depending on the context of use, the word can have either positive or negative connotations.

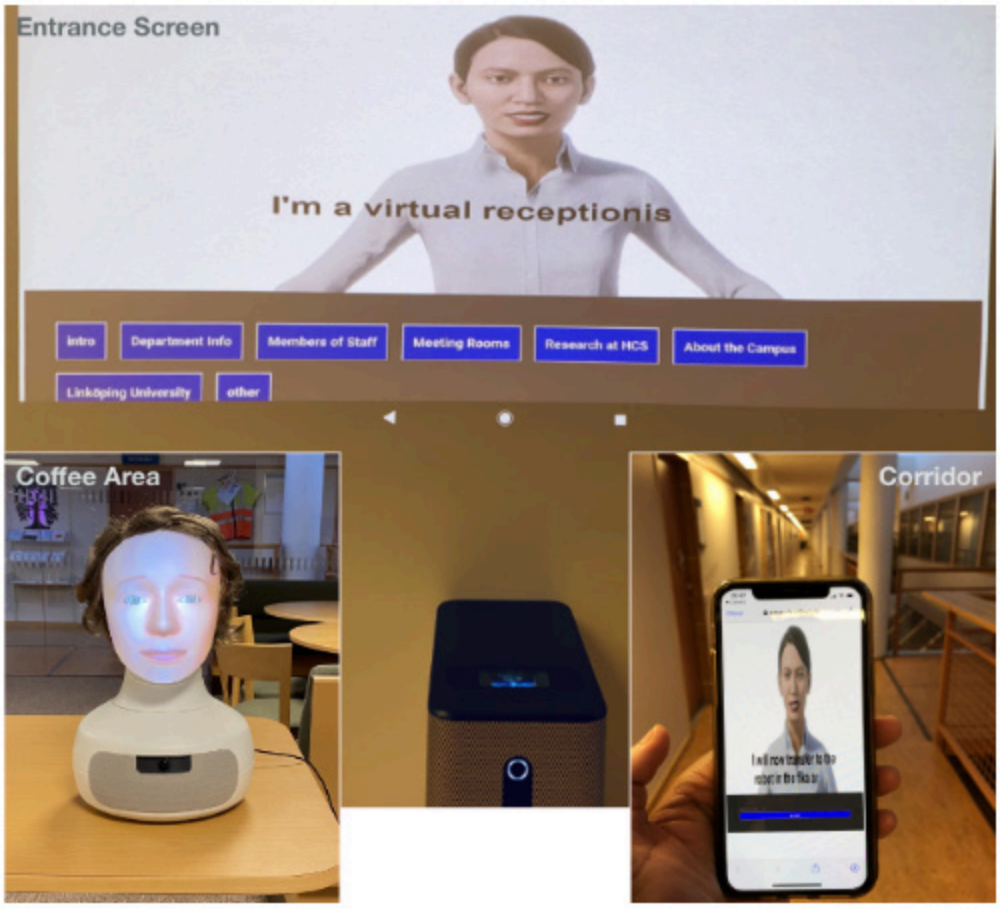
The study consisted of 23 participants, 12 members of staff, 6 female and 6 male (age range: 21–59). 11 student participants, 6 female and 5 male (age range: 18– 49). The mode (10) of participants was within the age range of 21–29. 80% of these participants belonged to the student group. The member–of–staff group was evenly distributed across three age ranges. Four participants were between the ages of 30–39, four between 40–49, and another four between 50–59. Six of the member–of–staff participants were researchers and the other six were not.

Following The European Code of Conduct for Research Integrity (All European Academies, 2017), prior to participating in the study, all participants were required to provide their consent. They were briefed on the data collection methods and tools, as well as the intended use of the data. The consent form covered specific areas, such as conferences, teaching, presentations, and workshops. Information regarding data storage and management was also included in the form. Additionally, in accordance with the research code of conduct, no personal data of the participants was to be presented in any of the defined areas (conferences, teaching, presentations and workshops).

3.3 Procedure

Participants were first presented with the age and gender questionnaire. Then a scenario was given describing that they were unfamiliar with the department building and were to find the office of a named member of staff. Participants first interacted with the receptionist at the entrance screen. Once they found the E.Chilufya, M.Arvola, T.Ziemke part of the building to go to, the agent then migrated to the mobile phone, giving real–time directions to the office as they walked in the corridor. Participants were then informed that the member of staff was in a meeting ending in 10 minutes and were asked to wait in the coffee area. The participant was then given direc- tions to the coffee area and informed that the receptionist would migrate to the robot in the coffee area. These interactions are illustrated in Figure 1 and 2. The physical screen and VR interactions were video-recorded during each session.

Figure 1: Migrating receptionist in physical prototypes.



This was followed by the product reaction card session. The user was asked to select which words they associated their interactions with the receptionist in the 3 embodiments. The participants were to explain why they selected each word. The explanations were audio recorded. The last part of each session was for the participant to fill out a SUS questionnaire.

Changes were made to the VR experience as the design had to be adapted to the prototyping technology used. The HTC Vive Pro [5] was used. As the HTC Vive Pro requires a cable (from the PC) to be attached to the Head–Mounted Display (HMD), the cable limits the navigation space. We used the VR teleport function to overcome the limitation. The participants first had a trial session to get familiar with teleportation, having the HMD on, and using the VR controllers for interac- tion. The participants practised interacting with the robot in the coffee area during the trial sessions as well. This had the participants familiarise themselves with the robot, which responded through speech and text. The participant used the trigger function on the VR controller for all interactions in the VR environment.

The order in which a participant experienced a prototype was balanced. If a participant's first interaction with the virtual receptionist was in the physical prototype, the next participant would

5 HTC Vive Pro

start with the VR prototype. This was done with the purpose of reducing learning and order effects.



Figure 2: Migr

3.4 Data analysis

Analysis of the SUS data was done using the SUS grading ranking, whilst the reac- tion cards data was analysed using Burke's pentad with the WWWWWH (5WH).

SUS Grade Ranking

Bangor et al. (Bangor et al., 2009) incorporated a grade ranking system into the SUS, inspired by the letter grades used by many universities as a recognisable and easy–to–understand point of reference. This entails that a score of 80.3 or higher corresponds to an A, a score between 74 and 80.3 equates to a B, a score between 64 and 71 corresponds to a C, a score between 51 and 62 is equivalent to a D, and any score below 51 results in an F.

Burke's Pentad and

Mediated Action is an approach to studying cognition by analysing people's ac- tions with physical and psychological mediating means (tools) (Rowe & Bachman, 2012). Wertsch (Wertsch, 1997) uses Burke's Pentad of human actions and mo- tives in his own framework of thinking as mediated action. He states that the pentad involves focusing on agents and their cultural tools or mediational means.

Burke Pentad is Burke's approach to human action. It uses five terms as gen- erating principles of investigation: Act, Scene, Agent, Agency, Purpose (Burke, 1969). As the pentad can also be used for the analysis of the design problem as described in the WWWWWH (5WH) method (Van Boeijen et al., 2020), we com- bine the two (agent/who, act/what, scene/when–where, agency/ how, and pur- pose/why) to present the emotional valence of the words selected during the product reaction cards session.

4 Results

The data collection methods combine both quantitative and qualitative approaches. This section presents the SUS score with Bangor et al.'s (Bangor et al., 2009) grade ranking, as well as the product reaction cards results and their relation to Burke's Pentad and the 5WH method.

4.1 SUS Results

The SUS results of both prototypes showed more positive results with a mean of 83.9 for the physical and 78.3 for the VR as shown in table 2. A SUS score ranges from 0 to 100, with higher scores indicating better usability. A score above 70 is considered good, while a score above 85 is excellent.

Table 2: The mean, standard deviation and mini of the SUS score for the VR and physical prototype

	Physical prototype	VR
Mean:	83.9	78.3
Std Dev:	10.7	13.2
Min:	60	47.5

Using Bangor et al.'s (Bangor), the major- ity of the SUS scores for both the physical and VR prototypes fall under the ad- jective best imaginable (scores between 84 and 100), with the highest count of A grades by the participants. This is followed by a B grade (adjective excellent) of 6 for the physical and 8 for the VR prototype. The next range is under the adjective Ok, D grade, with 2 for the physical and 4 for the VR prototype. The lowest SUS score of 47.5 is under the adjective poor. This was a single result from the VR prototype.

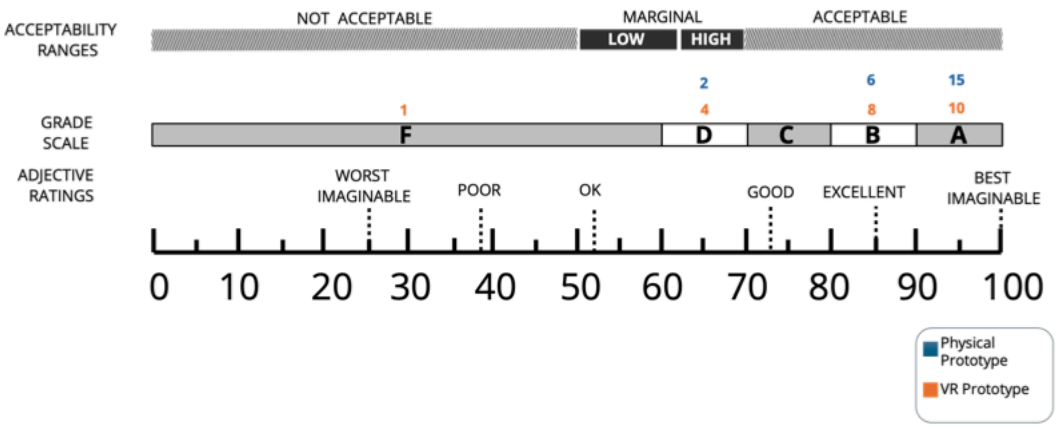


Figure 3: SI

4.2 Product Reaction Cards Results

The results of the product reaction cards session are shown in Figure 4. The word easy–to–use has the highest count in both the VR (15) and the physical prototype (20). The words not selected by any of the participants (with zero count) are: dis- connected and disengaged. The top 5 positive words in both prototypes are easy to use, effective (23), engaging, seamless and novel (all selected 20 times). The neg- ative words are confusing (9), impersonal (6), complex (5), intimidating (5) and overwhelming (4). The most selected neutral words are familiar (10) and ok (8).

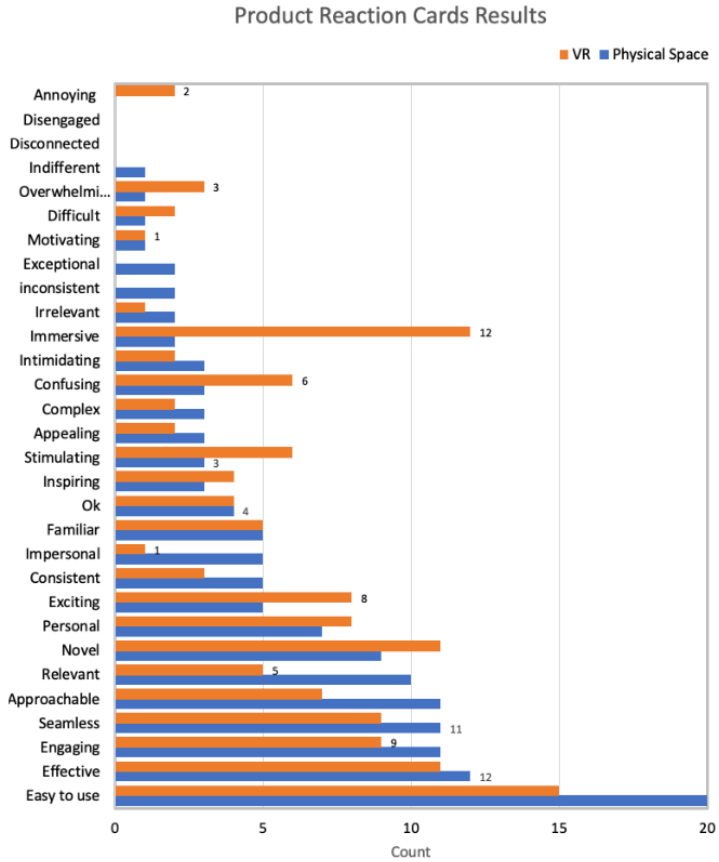


Figure 4: PRC selected w

The top positive, nega the following Burke's Pentad and the SWH as follows:

- Easy to use relates to how/agency. Participants selected the word to refer to the experience of interacting with the migrating receptionist.
- Effective relates to why/purpose, Participants found the idea of having a migrating virtual receptionist effective.
- Engaging relates to who/agent and how/agency. Some participants selected the word engaging to refer to having the same agent accompanying them. Other participants referred to interactions with the different interfaces (agency) as engaging.
- Seamless relates to when/scene and how/agency. Participants used the word seamless to refer to the VR environment and the interaction with a migrat- ing receptionist (agency).
- Novel relates to why/purpose and how/agency. The idea of interacting with a migrating virtual receptionist was novel to most participants. The form of using VR for the purpose of interaction with the agent was novel to a num- ber of participants as well.
- Confusing relates to how/agency. This referred to the interactions in VR.
- Impersonal relates to who/agent: Participants used the word impersonal to refer to the interaction with the Furhat robot, it felt disconnected from the screen embodiments.
- Complex relates to what/act and how/agency. Participants used the word complex to refer to actions in VR such as teleportation. Others used the complex to refer to the technology/programming used to build the prototype.
- Intimidating relates to how/agency and who/agent. Participants not familiar with VR found it intimidating. Other Participants used the word intimidating to refer to the Furhat robot.
- Overwhelming relates to the how/agency and who/agent. Though categorised as negative, one participant used the word overwhelming for a positive ref- erence during the VR experience. Others used the word to refer to a nega- tive inference to the VR experience and interaction with the receptionist.
- Familiar relates to where/scene and how/agency. Participants used the word to refer to the familiarity of the VR environment as it felt like the physical environment. Familiar was also used to refer to the technology used before; such as QR coding, interactive touch screens and the Furhat robot.
- Ok relates to why/purpose. Participants selected the word to refer to the experience with the migrating receptionist.

Relations of the rest of the words to Burke pentad and the 5WH method:

- Why/purpose: Relevant, Inspiring, Stimulating, Motivating, Irrelevant. • What/Act: Exciting and difficult.
- How/Agency: Consistent, disconnected and inconsistent.
- Who/Agent: Approachable, personal,

appealing, disengaged and annoying.

- When–where/Scene: Immersive.

Two participants added 2 words that were not included in the collection of words provided. Unapproachable was used to refer to the initial interaction with the Furhat robot by one participant. The other word is natural, which was used to refer to a meaning connecting the words seamless and effective. The participant used natural to refer to the manner in which the migrating agent took the initia- tive to make itself known to the user once it migrated to another embodiment.

Table 3: Burke's Pentad with the 5WH association to the words selected by the users.

Why?/ Purpose	Novel, Relevant, Inspiring, Stimulating, Motivating, Effective, Ok, Irrelevant.	+ + + + + + +/- 0 - (mdn= +, mode= +)
What?/ Act	Exciting, Complex, Difficult	+ - - (mdn= -, mode= -)
How?/ Agency	Easy to use, Engaging, Seamless, Consistent, Novel, natural, Overwhelming, Familiar, Confusing, Complex, Intimidating, disconnected, Inconsistent	+ + + + + + (+/-) 0 - - - - - (mdn= +/-, mode= +)
Who?/ Agent	Engaging, Approachable, Personal, Appealing, Intimidating, Impersonal, Disengaged, Annoying, Unapproachable	+ + + + - - - - - - (mdn= -, mode= -)
When? Where?/ Scene	Seamless, Immersive, Familiar	+ + 0 (mdn= +, mode= +)
Valence: + Positive, - Negative, 0 Neutral		

Table 3 shows the valence of the words selected by the participants and the association to Burke's Pentad and the 5WH. The words associated with the why/purpose relate to the users' interpretation of the purpose of the migrating receptionist.

The purpose has a median and mode of positive valence. The what/act words relate to how the users perceive the actions taken in interacting with the agent in the different embodiments. the Act has a mode of negative valence and the median is negative.
The how/agency words relate to how the users perceived the interaction with the receptionist in

the 3 embodiments (interfaces). Agency has a median of +/- (the word 'effect' was used to refer to negative and positive valence). The mode of the agency is positive. Who/agent, in this case, is the virtual receptionist. Agent has a median and mode of negative valence. The words associated with When/where/scene refer to the space in which users interact with the receptionist.

5 Discussion

The purpose of this study is to explore how to design a migrating virtual receptionist for a computer science department, to contribute to a discussion about the competencies required to design IVAs for public spaces, and how future designers can be equipped with such competencies.

The paper describes two prototypes of the same agent that filter the design space and manifest design ideas differently (Lim et al., 2008). This and the use of quan- titative and qualitative data collection effectively work as data source triangula- tion (Thurmond, 2001) to increase confidence in the research findings.

Although differently filtered design spaces, the results of both prototypes were similar. Initially, it was that the VR prototype would be less accepted by users due to limitations in mobility and the use of VR equipment. However, this was not supported by the results, which showed similar levels of acceptance between the VR and physical prototypes. The physical prototype exhibits slightly better results in terms of the SUS results. The VR equipment affected some responses on immersion, seamlessness, novelty, complexity, overwhelming and familiarity. The SUS score grading places both prototypes primarily within the categories of best– imaginable, excellent, and good (figure 3).

The results from the product reaction cards indicate a higher count of positive words compared to the negative and neutral words. However, there are slight differences between the two, with the physical prototype having a higher count in areas such as ease of use, approachable, and relevance. The overall trend, how- ever, remains similar for both prototypes. The VR prototype scores higher in words such as immersive (exceedingly), exciting and stimulating. Some of the negative words that stand out for the physical prototype are impersonal, complex and in- timidating (with reference to the Furhat robot). The VR prototype has confusing, overwhelming (though used as a positive word by some users), and annoying. The neutral words familiar and Ok score the same for both prototypes.

Burke's pentad and the 5WH analysis of the top positive, negative, and neutral valence focus on the interaction of the user with the migrating receptionists. With the most prominent being the ease of use and seamlessness of the embodiments. This includes the complexity and intimidation of some of the mediums of interac- tion. Some of the words apply to more than one term

of the pentad and 5WH. Complexity relates to the act as well as the agency. The neutral word familiar looks at the familiarity of the environment and some of the technologies used for the prototypes. The word Ok refers to how the ideas of the prototypes being passive (Bangor et al., 2008).

5.1 Competencies and Skills

Nieminen (Nieminen, 2015, p. 22) refers to "competency (pl. competencies) to describe the characteristics, abilities, and necessary resources to complete a de- sired task in an excellent manner". We use Nieminen's UCD competency model (Table 1) to outline the design competencies and skills required by designers of IVAs. This identifies and clarifies the necessary skills, knowledge, and character- istics (Nieminen, 2015, p. 22) to design the IVAs. We selected the competencies essential/ relevant to the study findings.

User Strengths

The user Strengths competencies are characterised by items, actors, and con- cepts belonging to the users' immediate surroundings (Nieminen, 2015). These include experiential knowledge acquired through work tasks or prolonged use, the context of use as a design resource, and ingrained user cultures, networks, and practices (Nieminen, 2015). The study is conducted with students and members of staff who frequent and work at the department. This includes the use of the three areas of interaction (entrance, corridor and coffee area) with the receptionist. The **user domain experience** can range from low:i.e. visitors to the department, medium:i.e. students and members of staff who have been in the department for less than 3 years and high:i.e. graduate students and members of staff who have been in the department for more than 5 years (Nieminen, 2015, p. 67).

Context of use (**context availability**) is often associated with situatedness, encompassing time, location, and other factors surrounding the actual use (Niem- inen, 2015, p. 68). The design of the IVA physical prototype must consider the location of the interaction, as well as when and how the agent can be accessed. In the case study, the agent is accessed via the large screen by the entrance, the mobile screen as the user walks through the corridor, and the physical robot in the coffee areas. The design of an IVA in VR must account for the scale of the available physical space users use to manoeuvre, and alternatives such as teleportation if the space is limited, with teleportation methods varying based on the user's past experiences. Other contextual factors include the presence of other users in the areas of interaction and the levels of access to those areas - e.g. high for members of staff as they can access most parts of the building, medium for students and low for visitors.

User cultures, social networks, and practices refer to the common practices

(Subject domain terminology) and cultural interpretations of future users of the product or service (Nieminen, 2015, p. 70). The virtual receptionist study primar- ily involved Swedish speakers, with a few participants from other countries, including one native English speaker. Although participants were proficient in En- glish, a few words required further explanation or translation during sessions with a few of the participants. An important factor in this context is the use/ display of written text during digital (screen or VR) interactions.

Soft Skills

Soft Skills competencies encompass design and teamwork traits that are influenced by personal aptitudes, such as communication and collaboration skills, a multidisciplinary attitude, and motivation (Nieminen, 2015, p. 72). While these skills can certainly be refined through training, they are primarily rooted in intrin- sic abilities (Nieminen, 2015, p. 70).

Prototypes facilitate and encourage a shared understanding between users and designers. They provide means to identify relationships between users' tasks and system functionality that can guide how to order functions and contents tempo- rally as well as spatially (Hakim & Spitzer, 2000). The study involved participants from the same department, which allowed for a high level of communication. All parties had the same vocabulary, which enabled easy dialogue with the de- signer. Communication in the design of IVAs should be high for effective team-work and design outcomes (Nieminen, 2015).

The conceptual phase of the study involved participants with expertise in multiple fields, including design, computer science, and cognitive science. A multidisciplinary approach facilitates a more comprehensive understanding of the human aspects of complex design tasks that necessitate expertise from several disciplines (Nieminen, 2015, p. 73). This design approach is required for IVAs oper- ating within social interactive spaces, which are expected to interact with diverse users with varying levels of experience.

Designer Strengths

These competencies focus on the core values of UCD: user involvement, designerly ways of solving design problems, and professional skills in defining, visualising, and testing new solutions' (Nieminen, 2015, p. 77). Designers of IVAs need to integrate these codes to generate relevant and useful designs.
User involvement pertains to identifying and engaging suitable users at the correct time, and incorporating suitable interaction methods to stimulate their participation and creativity (Nieminen, 2015).

The design phase dictates selecting suitable users (Nieminen, 2015). In the case of the virtual receptionist, user involvement began from the concept generation phase, which included students and researchers from design, computer science and cognitive science. The prototype evaluation phase involved students from various programmes

within the department, administrative staff members, and researchers.

The interaction methods were chosen based on a mixed-method approach (triangulation), adhering to UCD principles as UCD aim to understand users and pro- pose new solutions to improve their lives (Nieminen, 2015, p. 79). “Design as a practice is characterised by an attitude and a determination to introduce change for the better, and have the necessary means to realise it, in a responsible manner” (Nieminen, 2015).

New designs must be defined, have a concrete form and be evaluated to determine a suitable solution (Nieminen, 2015, p. 81). Ideas and features must be refined into **concepts** that describe the scope of the design. The forms and contents of these concepts are explored using various **visualisation** techniques (low to high fidelity) (Nieminen, 2015). Artefacts are then used to test the design (**validation**) using a plurality of usability or user experience (UX) evaluation methods (Nieminen, 2015).

The generation of ideas and features for the virtual receptionist was achieved using a combination of methods. These included a remote bodystorming (Porfirio et al., 2019) with the staff researcher and a *desktop walkthrough* (Blomkvist et al., 2016; Stickdorn et al., 2018) with the student participants. During these sessions, participants discussed each of the three areas of interaction and proposed potential ideas and features. This was followed by a *brainstorming* session with the participants after each method, which served to refine the identified ideas and features. The findings from both sessions were then analysed using a combination of *morphological* chart (Smith et al., 2012) with *Burke’s pentad*, resulting in three concepts. The *Plus, Minus, and Interesting* (PMI) (Sharma & Priyamvada, 2020) method was used to select the final concept: the migrating virtual receptionist. The final concept was then developed into VR and physical prototypes, which were evaluated using usability and UX methods.

Hard Skills

Training and education serve as the foundation for acquiring these competencies. These competencies contain the capability to choose and apply appropriate procedures and methods, comprehension of the potential of available technologies and the market, and a segment of knowledge that forms part of the subject domain expertise (Nieminen, 2015, p. 84).

The training and education required for prototyping IVAs can vary significantly, depending on the intended context, the prospective user, and the current knowledge and skills of the designer or developer. For instance, the physical prototype of the virtual receptionist study required programming skills in HTML, CSS, and Javascript for the agent displayed on the screens. The Furhat robot, on the other hand, requires

programming skills in Kotlin or graphics. The VR prototype de- mands proficiency in 3D modelling, animation, and C++ and/or node-based pro- gramming. This highlights the diverse skill set required in the field of IVA design and development.

The type of equipment required to develop an IVA for a social interactive space is context-dependent as well. For example, in the case where the agent migrates between three embodiments, interactions by the entrance happened via a touch projector screen [6]. Participants used personal mobile phones for interactions in the corridor. The Furhat robot was used to conduct interactions in the coffee area.

The *Effectiveness* and *efficiency* of developing an IVA are influenced by the context and the designer or developer's knowledge and learning skills. Using the development process for the virtual receptionist serves as an example. With a large learning curve, the VR prototype took approximately six months to develop. This included a four-month period of gaining a comprehensive understanding of the tools and equipment, followed by two months of development of the VR environment. In contrast, the physical prototype took approximately two weeks to develop, with the majority of the time spent on learning and developing the dia- logue in Kotlin for the Furhat robot. The other platforms (screen-based agents) did not require much time due to the developer's prior proficiency in the development tools.

5.2 Limitations

The longer development time of the VR prototype can be attributed to the extensive feature set and complex toolset of the platform. Building the features for the three embodiments required the integration of multiple external plugins, which added to the learning time and complexity. The development time could have been reduced by building the environment from scratch, eliminating the need to learn and customise the dialogue plugin. Similarly, utilising tools like MetaHuman Animator [7] could streamline the animation generation process and further optimise development time.

The notion of developing the physical space prototype using two different platforms (web development stack and Furhat SDK) goes against the significance of utilising a single platform for developing the agent across all embodiments. This approach ensures seamless integration and connection between the different embodiments, enhancing the overall cohesiveness and functionality of the prototype.

It is important to acknowledge that the findings may not be generalisable. Instead, it is more appropriate to consider the transferability of the results on a case-by-case basis, allowing readers to assess the applicability to their specific design contexts or challenges. This approach recognises the

6 Sony Xperia Touch

7 MetaHuman Animator

unique characteristics of each design situation and the influence these can have on the outcomes of the research

While case studies in industry contexts are common in design research, we opted to create our own project within the department. This decision was made to ensure better control over the experiment and to explore innovative methods without the constraints of business risks. However, it is important to note that this approach may result in reduced ecological validity, as the findings may not directly represent real-world industry scenarios. Nonetheless, it provided us with the opportunity to experiment and test new ideas in a controlled environment.

6 Conclusions

This paper has presented a study of the prototyping and evaluation of a migrating virtual receptionist in virtual reality (VR) and in physical prototypes. The two prototypes were used to filter a design space and manifest design ideas differently. The prototypes effectively function as data source triangulation to increase confidence in the research findings. While the generalisability of the findings to the comprehensive design of migrating embodied agents for public spaces may be limited, specific aspects of the findings can still be effectively employed in the field of design research. These aspects further understanding and application of the design process and tools, exemplify the integration of physical and virtual realities in modern design practices and suggest improvements for design tools and methods to facilitate this process.

The idea of applying design ideas from this study to the design of agents in other public spaces is interesting for further research.

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DESIGNING HYBRID WELFARE SPACES AND SERVICES: EXPLORING THE INTERSECTION OF PHYSICAL AND DIGITAL DIMENSIONS FOR SOCIAL INCLUSION IN URBAN CONTEXTS AND PERIPHERIES

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ABSTRACT | This paper presents the preliminary findings of a multidisciplinary study exploring how physical and digital spaces contribute to social inclusion within welfare systems. Conducted by a team of sociologists, urban planners, and designers, the study focuses on the exploratory mapping phase, which encompasses two main areas of investigation: 1) the impact of digital dimensions on socio-spatial inequalities in welfare access in contemporary cities and 2) the role of physical spaces in promoting social inclusion in the peripheral areas of Milan, with a specific focus on youth, the elderly, and migrants. To address these questions, the study utilizes a specialized triple mapping tool: 1) the Context Tool, which places spaces within their broader neighbourhood context; 2) the Detailed Space/Service Tool, which evaluates the internal layout and technological infrastructure of these spaces; and 3) the Activities and Digital Service Tool, which identifies and assesses digital welfare services. The findings from this phase are compiled into a dossier that aggregates data and provides a foundational framework for analyzing and designing future welfare spaces. This preliminary research underscores the potential of hybrid spaces—integrating multiple functions and stakeholders—to enhance digital competencies and improve access to welfare services for vulnerable populations. Ultimately, this paper aims to set the stage for further research and policy development in welfare design, highlighting the designer's role in creating analytical tools and innovative solutions.

EYWORDS | E-WELFARE, DIGITAL WELFARE, SPATIAL AND SERVICE DESIGN, SOCIAL INCLUSION

1. Introduction

This paper presents the initial phase of a multidisciplinary research project conducted by sociologists, urban planners, and designers from Department of Architecture and Urban Studies (DAStU) and the Design Department at Politecnico di Milano.

The paper illustrates the preliminary results of the ongoing research "E-Welfare in the city. Physical and digital spaces for social inclusion in the metropolitan area of Milan" conducted by this interdisciplinary group, which operates within the "MUSA - Multilayer Urban Sustainability Action" ecosystem, funded under the National Recovery and Resilience Plan (NRRP) by the European Union - NextGenerationEU.

MUSA - Multilayer Urban Sustainability Action aims to transform the Milan Metropolitan Area into an innovation ecosystem for urban regeneration, encompassing all levels of intervention, from social to technological. The goal is to scale this model at regional and national levels and eventually to serve as a European benchmark. This objective will be achieved through a set of actions addressing various dimensions of an innovation ecosystem, defined as "an evolving set of actors, activities, and artefacts, and the institutions and relations, including complementary and substitute relations, that are important for the innovative performance of an actor or a population of actors" (Granstrand & Holgersson, 2020). The ecosystem is designed to thrive on the synergy between academia, industry, local government entities, and civil society. It is a collaborative effort involving Università di MilanoBicocca (the lead entity), Politecnico di Milano, Università Bocconi, Università Statale di Milano, the Municipality of Milan, and the Lombardy Region.

The project's intervention areas, referred to as "spokes," include various domains. The Department of Design and the Department of Architecture and Urban Studies (DAStU), to which the research group belongs, are engaged in multiple aspects of the project, from social to technological scales. The research focuses on:

- Immersive digital platforms for communication, visualization, and interaction with territorial data related to urban contexts to guide sustainable urban regeneration processes.
- Sustainable fashion, luxury, and design to steer key economic sectors towards an eco-digital transition, contributing to low-impact production and distribution processes.
- Innovation for sustainable and inclusive societies, aiming to strengthen social inclusiveness by tackling inequalities, promoting public engagement, enhancing social sustainability, and advancing technological tools for individual and social wellbeing [Spoke 6].

Within Work Package (WP) 3 "Innovative Models against Social Inequalities", the project addresses existing obstacles to social inclusion, focusing on the most vulnerable individuals and groups. It develops innovative welfare services, supports stakeholders and policymakers in measuring social inclusion impact, and identifies inclusion indices to suggest and develop technological strategies to reinforce the presence of marginalized groups. Specifically, Task 3.3 focuses on Territorial Welfare, promoting interventions towards social inclusiveness, recognizing and including marginalized and precarious populations within local welfare services and policies, shaping local policies to improve work-life balance, and promoting integrated access to social and healthcare services, particularly for vulnerable individuals.

The research "E-Welfare in the City" and this paper contribute to the ongoing debate regarding the relationship between digital tools and welfare provision, exploring the implications when digitalization intersects with territorial welfare systems. It specifically highlights the significance of **physical spaces in shaping the modes of digitalization**. Contrary to the assumption that digitalization eliminates the need for physical spaces, it redefines their role in facilitating access to welfare. These spaces serve as crucial intermediaries, bridging specific subsets of the population with welfare services. This renewed function underscores the importance of physical locations in ensuring that digital welfare services are accessible and effectively meet community needs. **By examining these dynamics, the research aims to provide a deeper understanding of how digitalization and physical spaces can coexist and complement each other in providing welfare services**.

2. The Digital Divide as a trigger element in Design for Welfare

Recent technological advancements, driven by platforms supported by terrestrial and space-based infrastructures, induce systemic changes in urban environments with implications that are largely unknown. Traditional concepts such as the "smart city" have proven inadequate in addressing these complex challenges and may even exacerbate socio-spatial inequalities. The smart city narrative often emphasizes

technocratic governance through data and surveillance while neglecting the role of citizens and the existing vulnerabilities within urban populations (Angelidou, 2015; Kitchin, 2014; Aurigi & Odendaal, 2020). Without addressing underlying systemic and structural inequalities, the uncritical adoption of digital technologies risks marginalizing those unable to meet the imposed digital standards (Datta & Odendaal, 2019). This research critiques the simplistic application of smart city concepts. It underscores the necessity of understanding the nuanced impacts of digital transformation in local contexts, particularly regarding the digital divides affecting access to rights and welfare services.

Digital divides refer to the boundaries that separate inclusion and exclusion in societies that depend on digital platforms, and they can serve as avenues for expressing ongoing social tensions. The emergence of digital platforms has resulted in substantial social and cultural transformations. Consequently, the discussion around digital innovation has become widespread and is largely regarded favorably (Selva, 2020).

In the realm of digital technology, there are many noticeable and distinguishable uses. Participatory uses of digital media enhance recreational activities by allowing individuals to utilise digital tools for economic and social participation. This includes using digital media for work, education, political engagement, and interacting with public administrations and governments through e-government and open government platforms (De Blasio, 2018).

Digital capital is derived from the expansion of possible applications of digital media. Digital capital enhances and supplements other types of economic, social, and cultural capital. It refers to the effects and societal implications that arise from the diverse ways in which different groups of people utilise digital media (Ragnedda & Ruiu, 2017). The digital divide is the conceptual disparity between persons who possess access to and are fully integrated into the digital society and those who lack such access and integration. This division signifies the discrepancy in terms of inclusivity and exclusivity, the inequitable allocation of resources, and the segregation among various groups (Selva, 2020). Over the years, scientists and policymakers have adopted many understandings of the digital divide. The concept is typically seen as a compilation of multiple divisions, known as digital divides, rather than a singular separation. The digital gap refers to the unequal access and use of digital media among individuals, with some having access and utilising it while others do not (van Dijk, 2020, p. 1).

As digitalization progresses, **three primary levels of the digital divide become evident**:

1. **Access Divide**: This level concerns access to digital infrastructure, including connectivity, devices, and software. It highlights disparities in the availability of and access to essential technological resources.
2. **Skills Divide**: This level focuses on digital literacy and skills, including using

devices and software effectively and understanding the implications of digital interactions, such as data privacy.

3. **Structural Divide**: This level addresses how digital divides intersect with existing socio-economic inequalities, such as those based on gender, age, economic status, and citizenship. It reflects how these divides exacerbate pre-existing disparities in access to resources and opportunities.

Even with social protection measures in place, welfare systems may not guarantee equitable access due to the ongoing digital transition affecting organizations and administrations. Barriers to access can arise from disparities in information and relational resources, limiting awareness of rights and the ability to formalize requests and institutional design limitations. In this evolving digital landscape, digitalization plays a crucial role in welfare distribution by transforming access methods through online tools and platforms, altering resource distribution, and changing intervention approaches, such as remote learning (DAD) and telemedicine. Moreover, digitalization redefines social needs, including social isolation and educational poverty, and influences support programs, such as IT training courses and youth engagement initiatives.

By examining these dynamics, the research aims to identify insights into whether and how digital and physical spaces can collaboratively contribute to the delivery of effective welfare services and highlight the need for integrated approaches to address the evolving challenges of digitization.

3. E-Welfare in the City Research Project Objectives and Roadmap

The study focuses on two main areas of investigation. First, it aims to analyze the digital dimension's role in reproducing or mitigating socio-spatial inequalities in accessing welfare in contemporary cities. Second, it explores the role of physical spaces in fostering social inclusion in peripheral areas of the metropolitan city of Milan, focusing on youth, older people, and people with migrant backgrounds. The research spans three years, and this paper focuses on the initial phase, specifically the field research. The activities and spaces examined for field exploration of the impact of digitalization on welfare at the metropolitan scale include the WeMi Spaces of the Municipality of Milan and Polimi Off Campus Nolo and Polimi Off Campus San Siro. The interest in WeMi started with the "Welfare di tutti" project. This initiative, active in the Milan metropolitan area since 2015, was developed by the Municipality of Milan in collaboration with 16 partners, including Politecnico di Milano, and funded by Fondazione Cariplo. This project provides a valuable case study for assessing an ongoing initiative, analyzing its strengths and weaknesses years after implementation, and offers insights into a model of welfare access that integrates digital tools while remaining embedded in local communities.

The "Welfare per Tutti" project consists of two main components:

1. **Digital Platform**: A public platform that serves as a showcase for aggregating welfare services. This digital platform allows users to identify the services offered and the providers, supporting associations, and the nearest locations to access these services.
2. **Territorial Physical Spaces**: These are physical locations, known as WeMi Spaces, where citizens can receive assistance and guidance towards welfare services. These spaces, managed by local authorities and supported by foundations, associations, and cooperatives, aim to address the potential limitations of accessing services solely through digital means (Bricocoli & Sabatinelli, 2017).

In addition to WeMi Spaces, the Off Campus initiatives of the Politecnico di Milano were also selected for field research in the Milan area.

The Off Campus program is an initiative promoted by Politecnico di Milno to strengthen Politecnico's presence in Milan and foster a more responsible university that is attentive to social challenges and open and connected to local territories and communities.

Launched in 2018, the Polimi Off Campus initiative saw the opening of the first Off Campus space in the San Siro neighbourhood in April 2019, followed by three other spaces: in the Nolo neighbourhood (September 2020), at the F. Di Cataldo Prison/San Vittore Prison (October 2022), and Cascina Nosedo, at the entrance of the Parco Agricolo Sud (December 2022).

Within the Polimi Off Campus spaces, faculty, researchers, and students engage in the following activities: innovative teaching, focused on working in real-world contexts as a means to develop new skills; responsible research, attentive to the inclusivity of knowledge production processes; co-design with local entities, to implement interventions that have a positive impact on the community. Additionally, services are provided to the territory and neighbourhoods, and a cultural and educational offer is promoted for local actors and communities.

The research focused on nine of twenty WeMi Spaces and two of four Polimi Off Campus Spaces across Milan. These cases were selected to ensure variability in location (central and peripheral areas), management type (foundations, associations, and cooperatives), services provided (range and nature of shared services), and spatial attributes (size, visibility, and accessibility).

3.1 The Exploratory Dimensions

These methods were analyzed along three interpretative axes, referred to in the research as Exploratory Dimensions.

1. **Service**: The service encompasses the activities and functions related to the case's welfare. It dictates the requirements to which the space adapts. Beyond activities in terms of actions and policies, the service also includes digital aspects such as the platform and access.

2. **Space**: The Space can be defined as "long-term physical assets in the social sectors that enable goods and services to be provided" (Fransen et al., 2018, p. 14), this dimension explore the spatial configuration and characteristics of the case's spaces. Space overlaps with the service and is shaped, modified, and adapted according to it. At the same time, the space includes both technological (computers, printers, illuminated banners, screens) and analogue (furniture) equipment.
3. **Digital**: The digital infrastructure and its relationship with access, skills, and awareness among users and operators. This can refer to both the platform, which showcases the services and highlights the capabilities of the service space, and the technological-digital equipment, such as computers and printers.

The integration of these axes aimed to understand the organization's mission, the services provided in the WeMi and Polimi Off Campus contexts, digital services and challenges, and the specific characteristics of the space and neighbourhood.

3.2 The Exploratory Mapping Tool

The exploratory mapping tool comprises three main elements:

1. **Context Tool**: Identifies the reference context in which the space/service is situated, including the neighbourhood and nearby services.

The selected WeMi and Polimi Off Campus spaces are always located in urban contexts characterized by a strong social fabric, often on the city's outskirts, and they work closely with neighbourhood dynamics.

It is important to note that some cases are set in unconventional contexts. For example, Polimi Off Campus Nolo is situated in a location that might not traditionally be associated with welfare services. The Polimi Off Campus Nolo is located within the municipal market on Viale Monza in Milan, a covered space with various commercial stalls. Similarly, WeMi San Gottardo is located inside RAB, a bar where people can have breakfast, study, meet friends, and more. This placement ensures exposure to a broader audience, who may learn about the service while engaging in daily activities, thereby better integrating with the neighbourhood. The Context Tool helps map the space's surroundings to understand the proximity relationships with different local entities, providing quantitative and qualitative data on the primary users likely to engage with the service.

2. **Detailed Space/Service Tool**: Details the internal division of the space its location (within other activities or associations) and identifies all physical and digital touchpoints and technological infrastructure.

Through the space/service tool, the internal and external layout can be diagrammatically mapped to track the number of rooms and spaces and the types of activities conducted there. For instance, WeMi spaces typically include an area called "Chiocciola," designed for digital literacy, though it often serves multiple functions as needed. This tool also identifies technological devices, workflows, entrances, square footage, touchpoints (between users and service providers), furnishings, and more intangible elements like accessibility, recognizability, and the type of access (direct, indirect, or semidirect).

3. **Activities and Digital Service Tool**: Identifies the digital service functions and activities related to welfare, including organizers and users, as well as access and competencies.

This tool is essential for briefly describing each activity, detailing the timing, actors involved, and levels of digitalization or digital technologies used. Concerning the first level of the digital divide, it notes the percentage of digital access and the specific services accessed. Regarding the second level of the digital divide, it assesses the competencies acquired and their specifics. However, this tool presented challenges, particularly in organizing information gathered during interviews and site visits. Therefore, it was reconsidered and more effectively utilized during the debriefing phase, with extended time for reworking and interview transcriptions.

3.3 Results of the Exploratory Mapping Activity

The main results from this exploration indicate that the services' characteristics and recognition are strongly influenced by the history and activities of the managing entity (association, cooperative, or academic institution). In some contexts, the space is better known and serves as a reference point for other local entities/organizations engaged in services rather than individual citizens.

From a digital perspective, those who approach the help desk primarily struggle with the bureaucracy of accessing welfare, which is exacerbated by digital barriers. This makes it increasingly more challenging to access services with digital skills and with the mediation of these entities. The connection between "analogue and digital" is essential and manifests in various forms, relying on the mediation of the operator (an "analogue" element), who must increasingly possess digital skills in addition to their relational and social worker competencies. This enables them to navigate and manage the network to support measures and meet the emerging needs of the target populations of these spaces.

Regarding the physical space, its configuration and location matter. Direct street presence facilitates access, visibility, and circulation, while intermediary spaces within the facility help accommodate diverse activities.

Among the cross-cutting results, it is notable that the local network of participation, services, and associations plays a key role in the operation of the examined spaces.

Identified potentials include a social mix in spaces and services and welfare spaces as a physical/digital continuum. The "physical space defined as "the material world that surrounds and is perceived by bodies, measurable and with clear boundaries" (Mütterlein, Fuchs 2019), where welfare services, projects, and programs circulate and the "digital space" (defined as "the digitally open world where technologies and devices blur the boundaries between physical places, such as markets or squares, and virtual places, such as Facebook, where users interact virtually, for example through user profiles," ibid. 2019) are increasingly interacting and continuous.

Despite variable configurations and intermediary transitions that act as "doors," sometimes closed, sometimes open, these transitions are mediated by devices and, always essentially, by the social worker (or their proxy).

3.4 Future Developments on the Tools

The mapped spaces were used to construct a dossier, which is not merely a document binding all mapped spaces but an extrapolation of descriptive elements that enable the creation of a framework for analyzing future spaces and, more importantly, understanding how to design future welfare spaces, creating meta-design guidelines to generate new valuable solutions.

The dossier facilitated the development of a "reading grid," which provides guidelines for future design, a toolkit comprising various instruments with a focus on spaces and services to continue mapping other locations. This extends the analysis beyond the Milan Urban Area, reaching into the broader metropolitan area of Milan.

These design tools will be helpful in the upcoming development and co-design of new spaces/services, as well as in the development and co-creation of new spaces/services for mediating access to welfare.

4. Conclusion

This research on "Designing Hybrid Welfare Spaces and Services" underscores the significance of integrating physical and digital dimensions to foster social inclusion in urban and peripheral contexts. By exploring the intricate dynamics between these dimensions, the study highlights how they can mitigate socio-spatial inequalities and enhance access to welfare services.

The exploratory mapping phase revealed that the effectiveness of welfare spaces is heavily influenced by the history and activities of their managing entities. Additionally, the study found that digital barriers often complicate access to welfare services, emphasizing the

need for digital literacy and the mediation of skilled operators. Integrating physical and digital elements in welfare spaces is crucial, as physical configurations and locations significantly impact accessibility and usability.

The findings are compiled into a comprehensive dossier that documents the current landscape and provides a framework for future analysis and design of welfare spaces. This framework and a toolkit of design instruments will guide the creation of new spaces and services, extending the research beyond the Milan Urban Area to the broader metropolitan region.

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“ALLES RICHTIG IST NICHT RICHTIGES FÜR ALLE”.

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ABSTRACT | Design (intended in the broader way, as the Italian tradition and definition) has always been a decisive player in the realm of the disciplines connected to the project, shaping and defining spaces and voids, roles and opportunities. At the same time, the natural making of choices, willy-nilly, generates stereotypes and oppression. The constant, pervasive and horizontal presence of the multiple aspects of the discipline and its applications in people’s lives brings with it an inevitable social mandate. The responsibilities and social awareness of future designers must be built and stimulated during the training phase: in this direction, a critical evaluation, a posteriori, must encompass the changes in society and the futuristic changes in design approaches. We wish to introduce in this paper a crucial disciplinary debate, as imperative as an eleventh principle, added to the ten of Dieter Rams. Could there ever exist a genderless design? Trying to answer, coping with the issue of gender and sustainability we are offering our reflections about an unanswered question. According to our theoretical observation and discourse, through references and reflections - from two generations and two professional points of view – we state that going from a genderless design to a gender-sensitive one is socially more sustainable and reasonable for the future. Among designers’ responsibilities, the ability to comprehend and handle the multiplicity of aspects linked to the mutability of society is a clue point: an aspect that – yesterday, today and tomorrow – never stops influencing people’s lives with close interconnection.

KEYWORDS | DESIGN HISTORY, CONTEMPORARY DESIGN CULTURE, GENDER STUDIES, SUSTAINABILITY, RESPONSIBILITY

1. Introduction: what our time brings to us

It seems there is not an exact date on which to address the birth of Dieter Rams's ten principles; what is sure is they come after the indisputable experience of Rams in Braun and influenced, inspiring, generations of designers, not only in product design realm but in all the design's world, because of their sensitivity and forward-looking wiseness. Stating the importance of innovation, usefulness, aesthetics, functionality, honesty, duration, environmental consciousness, Rams bridges from the product design field to the entire design discipline a mean of opportunity and appropriateness. But when it comes to unobtrusiveness and essentiality, we might feel the distance between the German cultural context in which the principle were born and the over-exposed position that design nowadays, willy-nilly, takes in the global contemporaneity. As Sudjic states:

...«Many people believe that objects are the indisputable facts of everyday life. Dieter Rams, who for two decades was head of design at Braun, the German consumer electronics company, certainly believed this. He described Braun razors and kitchen mixers as if they were English butlers, discreetly invisible when not needed, but always ready to serve effortlessly when called upon. In reality, this description no longer suffices.» (Sudjic, 2015, VI-VII)

It is only related to the German consistency or it is instead somehow connected to the inextricable bond that design, objects and society have? Georg Simmel expresses that: «Individualism, adopting what suits the individual, has very different roots than in Germany» (Simmel, 2015, 27). Written in the early XX century, this concept was addressed to fashion (and trends) but in some ways it is impossible not to encompass fashion and trends within the realm of design. They are eventually part of it, due to dealing with two key aspects: society's evolution and self-expression.

In the contemporary panorama, in fact, design is positioned as a widely recognized discipline, an object of constant research and evolution, increasingly enriched by the experiences that contribute to defining it as a fundamental subject for the growth of society.

(Walker, 1989, 31-2) For decades scholars have debated which the definition of design must be the right one and even if is possible to come up with (only) one. Walker in the past, but also Lorusso in closer days, quoting Victor Papanek kind of contradict and confirm his statement about everyone being designer and mostly all human actions being design(ed) ones. (Walker, 1989, 31; Lorusso, 2023, 15-6)

Among the many definition presented, offered and debated within the years of existence of the subject, from the ICSID one of 1961 to nowadays, we will assume design is a discipline, «used to give form to perceptions, with which we comprehend objects.» Having many facets of resonance, design is also a pleasure by itself. Actually, it is not so important to state what, but why, because design «is a language that evolves and changes its meanings as quickly as any other language. [...] It is the key that allows us to understand the world made by man.» (Sudjic, 2015, 37)

Therefore, having a constant memory of the complexities that characterize this discipline in relation to society, is mandatory: between society - intended not only as but also as economic comportments in consumption, but even choices, behaviours and trends – and design exists a strong bond and this inevitably confronts, contaminates, shapes and is shaped. (Margolin and Margolin, 2002, 24-30).

«The overuse of the word designer has erased its previous meanings. [...] However, the design of objects can offer a formidable means of seeing the world. [...] Our relationship with what we own is never linear. It is a complicated mixture of awareness and innocence.» (Sudjic, 2015, VIII)

Design, for sure not only meant as objects but encompassing communication, events and fashion within, forms and defines roles and opportunities: at the same time - in the natural operation of choices, willingly or not - it generates stereotypes and oppressions.

The constant, pervasive and horizontal presence of the multiple aspects of the discipline and its applications in people's lives, brings with it an ineluctable social mandate. Maldonado expresses how impossible is not to contemplate this aspect (Maldonado, pp. 133-5), which in the European panorama is debated and questioned over and over again but never denied (Walker, 1989, p. 52-3).

Therefore, identifying, clearly what the responsibilities and consequences of disciplinary applications are is crucial, so much so that in the theoretical literature of design we speak of ontological design: it is asserted that design itself projects and influences our lives (Willis, 2006, p. 70).

From the chaos of a messed "starter pack" (Lorusso, 2023, 21-2) to the symmetric wise disposition of Rams's principle, design suits in the middle «looking at how designers have to negotiate between management and execution, technics and humanities, autonomy and dependence, power and subjugation, bureaucracy and innovation, things and self.»

2. Design changing through society's lens changing

2.1 Of design, trends, culture and other amenities

«When Gertrud Arndt quit her job in an architect's office in 1923 to take up a scholarship at an art and design school whose prospectus promised to welcome " any person of good repute, without regard to age or sex," she had high hopes of studying architecture. Instead, she was urged to join the weaving workshop, as were most of the other women who enrolled as students at the Bauhaus. Those who refused were encouraged to choose book binding on the grounds that it too was suitably "feminine."» (Rawsthorn, 2022, 79)

Leaving apart pretenses and hypocrisy and going straightforward to the point, being a woman and a designer nowadays will assure going through a tough time, probably a bit less in respect of Arndt's time but still tough enough. If you are not grasping and feeling it, probably you are a man. More than one hundred years passed and yet, women have to demonstrate more, work more, harder and better, being rarely acknowledged for their contribution. (Rawsthorn, 2022, 83-4)

On the other side, the consumers' one, rarely women are taken primarily into account, or are addressed as first users, unless it is a "feminine" product: in this latter case, what will be evoked immediately is either a stereotyped senses of motherhood/caring or a sensual consciousness. In the fashion realm, always the differences between men and women attitude has existed and been exhibited because, due to the differences imposed by societies on one hand and of bodies on the other, it was however an opportunity to express oneself choices. (Simmel, 2015, 11).

This, nevertheless, finds an answer in Sudjic saying : «the question is not so much whether fashion is truly design but what fashion has done to design.» Continuing farther on: «Fashion has the ability to control all the control buttons of contemporary life. (However, editor's note) [...] With a few exceptions, including Adolf Loos, fashion has never been taken seriously.» (Sudjic, 2015, 111)

Since the First Industrial Revolution, in fact, due to some behaviours that from the fashion world spread to the design one, more and more increasingly temporariness and selfexpression have brought design to be the chaos Papanek, Lorusso, and Rawsthorn critically refer to, undoubtedly deeply far from Rams's conception of it.

How to change the attitude if the society is not ready? And why has design to deal with fashion when debating about gender and gender sensitivity. The second answer lies in the fact that, at this very moment, dealing with gender and gender issues is a trend: this might occur as a detriment instead of a benefit. Fashion design has been the first dealing with the topic, but as said rarely it is taken seriously, so the first fashion designers "playing" with gender issue has been considered as performing an exercise.

This was, indeed, the anticipation of what would become in short time a cogent issue, to be considered in the design world. About the first question instead, the responsibilities and social awareness of future designers must be built and stimulated, during their training, and in this direction a critical evaluation a posteriori can be of great help, identifying the biases and shortcomings. Such responsibilities include, among other things, the ability to include different aspects linked to the changeability of society and its needs: aspects that influence each other with close interconnection, evolve in a symbiotic way, to allow the discipline of design to move easily in a succession of increasingly rapid transformations. In this sense, excellent results are demonstrated by the intersectional approach to the discipline.

Lorusso quotes Maldonado, dealing with institutions, education and schools highlight the double nature of design, «[...] Maldonado offered a compelling definition: the designer is a technical intellectual. This way, he attempted to abolish the false dichotomy that opposes humanistic culture to scientific culture.» (Lorusso, 2023, 274)

This concept, applicable in a professional context, is equally identifiable in academic classrooms and in education: what is shared in university courses of study responds to a matrix built on archaic models - now obsolete (Walker, 1989, p.200) - dictated by a social reality far removed from what defines contemporaneity today. It requires a revision, appropriately preceded by a careful and precise preliminary discussion. Design, as an open discipline in constant change and self-definition, must lay its foundations on the composite nature of its own cultural space. What should leave us speechless and ashamedly asking for a change is the consideration of what could be being a non-cisgender or a transgender designer today. But the future might be better. «Given [...] the growing acceptance of the design process as a possible solution to an increasingly expansive range of socioeconomic and environmental challenge more new discipline should surface in the future.» (Rawsthorn, 2022, 86)

Women have the natural power to adapt, comprehend, consider and evolve, but « queer and trans designer should gain too. They stand to become prime beneficiaries of the new opportunities offered by attitudinal design.» (Rawsthorn, 2022, 86)

Sanctimoniousness is still part of the design world because it's part of our society. And it is very harsh not to convey with Rawsthorn asking:

«Why has design remained a "man's world" for so long? And how much longer will the gender politics of a discipline that should in theory be open and eclectic, remain so archaic given the surge of interest in feminism, transgenderism and gender fluidity?» (Rawsthorn, 2022, 81)

2.2 The role of gender identity in social constructs

As is well known, society undergoes continuous evolution and renewal, constantly changing its nature and essence (Bauman, 2000). It adapts to the needs of its actors, absorbing the everdifferentiating characteristics that mark the evolution of the cultural landscape it inhabits. Indeed, each society has its own nature, development, and construction, perfectly fitting into the environmental and cultural context in which it is generated (Scott, 2017). This opens up very different scenarios, which are comparable and sometimes overlapping, but certainly defined by specific peculiarities that determine their uniqueness. This aspect forms the basis of the theme investigated in this contribution, offering a preliminary viewpoint on what is to be researched in the field of design and its interaction with social sciences.

As mentioned, there are various aspects that define a society and, in particular, its actors, shaped in response to certain socially recognized, accepted, and proposed dictates over the years and historical epochs. However, it is also well known that the parameters validated by society are in constant flux. Each individual is defined by various aspects that contribute to shaping their identity, such as ethnicity, religious belief, gender, spoken language, physical abilities or disabilities, and much more. This approach, aimed at understanding and intertwining the different aspects that define each person as an individual, creating particular forms of discrimination, is known as intersectionality (Angelucci, 2015, 268-274).

This term, first introduced in the scientific panorama by Kimberlé Crenshaw in 1989, leads to the intersectionality theory, theorizing the phenomenon of multi-layered discrimination, highlighting how human experiences undergo and reflect the complexities of the society which they refer. Here is how Crenshaw – reported by Angelucci - describes the origin of her thoughts on Intersectionality Theory:

«It originated from the attempt to conceptualize the way in which the law responded to problems involving both racial and gender discrimination. What was happening was like an accident, a collision. Intersectionality comes from the idea that if you are on the trajectory of two forms of discrimination, it is likely that you will be hit by both. These women are injured, but when the 'ambulance' of race and the 'ambulance' of gender arrive at the scene of the accident, they find them at the intersection and say: Well, we cannot determine whether this is gender or racial discrimination and until they tell us which one it is, we cannot help them. » (Angelucci, 2015, 269).

The described theory, very complex and rich in reflections, provides a broad and articulated vision. Specifically, in the ongoing research, we focus on investigating one of these aspects, namely gender identity. Gender identity is one of the aspects that most significantly contributes to the identification

of every human being, regulating various social and cultural aspects. The significance of this aspect in social construction defines roles and opportunities for each individual, leading to confining stereotypes. It is in this specific aspect that the designer is involved, capable of shaping and directing society and its users, creating artifacts that can break the rigid dictates imposed by models from past realities that are now outdated. Therefore, following the evolution of society and activating a critique of design and the designer's role, it is natural to ask whether and how the dimension of gender enters into the project, evaluating its impact on users. This contribution aims to address this aspect, which is undoubtedly central to multiple areas of contemporary research, necessarily entering the debate of design disciplines. Hence, the aspects that define identity – in the various sectors that are the domain of design – are investigated through a fundamental question: can there be a genderless design? There are various viewpoints on this reflection, derived unequivocally from the perspective through which the intersection between the two disciplines in question, design and gender studies, is observed, often finding differing positions.

3. Design, gender, sustainability: an open issue

As mentioned, gender stereotypes can be defined as a rather rigid set of culturally shared beliefs. These beliefs dictate many aspects of users' lives, such as physical and psychological characteristics and activities typically attributed to male or female figures (Eagly & Wood, 2012). Each stereotype, contributing to the definition of opportunities and limitations, is shaped through both individual and collective processes of categorization or simplification of the social reality in which social dynamics are embedded (Wagner, Holtz, Kashima, 2009). By actively participating in the structuring of social realities, design plays a fundamental role in perpetuating these stereotypes.

In the research presented here, we aim to investigate all aspects that contribute to the gender definition of design artifacts, addressing the central question of this reflection regarding the necessity of having a gender-neutral design. To answer this question, it will be necessary to proceed on several levels: delving into the topic through literature review and analysing exemplary case studies. Concerning the literature aspect, this research is clearly structured on multidisciplinary foundations, drawing on what parallel disciplines—such as sociology, anthropology, psychology, and pedagogy—can offer. Although the debate on the intersection between design and gender studies is becoming increasingly frequent, within the project discipline it remains an aspect still under exploration, primarily deepened in the field of communication design and less so in other project areas (Almeida, Balaam, Comber, 2020). However, being a hybrid discipline between technique and theory, leveraging humanistic content can certainly foster the ongoing debate.

In this regard, as quoted by Lotti in his publication, Flaviano Celaschi states:

«The design we study today appears to us as a knowledge of relation among other knowledges. A discipline that seems to consolidate around the sensitivity of not producing an autonomous type of knowledge (or at least not having succeeded yet) in competition with the analytical capacity and knowledge of the other diverse and historical disciplinary lines of modern science; rather, by respecting the statutes and analytical knowledge synthesized by other disciplines, it appropriates them as project inputs, as a basis for developing organized transformation actions of the world of goods that surround us.» (Lotti, 2016, 32).

3.1 Case studies and insights from fashion to digital devices

It is true that some fields of design have already understood how to develop and reflect on concepts that keep the gender dimension at the core of their design activities; among these, fashion design stands out (Fallan, 2010). This branch of design has always absorbed social influences, incorporating the unique, often temporary characteristics that define the contemporary landscape into its production. Throughout fashion history, various evolutions, rich in suggestions, have often become manifestos of what the socio-cultural context was experiencing at a given time.

One of the most disruptive examples of the last decade is undoubtedly the work of Alessandro Michele, former art director of the fashion house Gucci. Through his contributions, several social themes—including gender equality, social justice, disability, environmental sustainability, and circular economy—were brought to light and showcased through collections, events, and installations (Paulicelli, 2021). This not only repositioned the brand in the market under a new guise but, more importantly, opened a debate on globally significant issues, offering more contemporary perspectives capable of raising user awareness. Frequently, this was achieved in a provocative manner, presenting images that had a broad impact, thereby initiating widespread debate.

The Florentine Maison, under Michele's direction since 2015, had already demonstrated a commitment to addressing fundamental social issues for the future by founding Chime for Change, a campaign launched in 2013 by Gucci along with co-founders Salma Hayek Pinault and Beyoncé Knowles-Carter. The association has carried out many initiatives, including a short film exploring the concept of gender fluidity titled "The Future is Fluid," directed by Jade Jackman, produced by Irregular Labs, and presented at the Sundance Film Festival in 2019.

This production gathers the testimonies, voices, and experiences of 13 individuals from around the world, aged 15 to 25, hailing from Brazil, Canada, India, Italy, the United

Arab Emirates, the United Kingdom, the United States, Singapore, and South Africa. These narratives reflect the stories of the next generation that is redefining our world through a prism of fluidity.

Another branch of design that has long been sensitive to the gender dimension is graphic design. Through choices in colour, form, text, and more, it has the power to divide as well as unite aspects that contribute to gender categorization. Communication design, understood as a tool for inclusion, has the potential to counter disparities, stereotypes, and gender binarism, working to dismantle the rigidity of roles and dominant hierarchies (Lupton, Tobias, 2021). The process of ensuring communication that is attentive and respectful of all users' needs is indeed complex, involving various aspects that characterize each individual's identity. This requires particular attention to multiple factors that contribute to creating socially ethical and sustainable communication (Ting-Toomey, Dorjee, 2018). For instance, ensuring that image selection fairly depicts both women and men to better guarantee the quantitative representation of both female and male subjects, and avoiding the use of the masculine generic form. This latter aspect pertains to languages that distinguish gender in speech.

Other focal points include non-discriminatory representation of roles, promoting representations that do not imply gender-based hierarchies, avoiding depictions that reinforce the status quo, and promoting the use of diverse and non-stereotypical colour palettes. As is well-known, the distinctive elements mentioned here are only a few of the visual tools that contribute to gender categorization and stereotyping, thereby reinforcing social constructs that do not reflect contemporary cultural evolutions. (Milestone, Meyer, 2020)

A case that sparked significant discussion was the Immuni application, released in 2020 by the Milan-based company Bendign Spoons to track Covid-19 infections. The public outcry upon the app's release centred on the highly stereotyped representations of users. Upon opening the digital platform, users were required to register through a simple procedure, but what disturbed many was the mandatory selection of a gender, limited to male and female, and the chosen representations of these genders: the woman dressed in various shades of pink, cradling a baby, while the man was depicted in a blue work suit, behind a laptop.

Unsurprisingly, users quickly voiced their dissatisfaction with these formal and chromatic choices, as they perpetuated a narrative that no longer aligns with the diverse familial and personal structures of contemporary society. The company promptly revised the images to better represent the population, using neutral colours such as green and orange and reversing the occupations previously assigned to the subjects. The path toward stereotype-free visual representation is certainly long and complex, but some cases demonstrate the fundamental importance of staying connected with the social context and its needs.

Even in the fields of product and interior design, considerations regarding the gender dimension and how it can be a distinctive element in defining roles and opportunities for users have been addressed. When considering spaces and their organization, an interesting example is the London toy store Hamleys, which in 2011 decided to break gender stereotypes. Among its seven floors of toys, one was dedicated to those labelled as feminine and another to those labelled as masculine. The entire department was painted in pink and blue hues, from the signage to the shelving, creating a monochromatic world inaccessible to the opposite gender. The store redefined these divisions, preferring a categorization based on themes and/or age groups, thus opening each department and its contents to all young customers. Following this trend, a few years later, Selfridges in London challenged gender stereotypes with a pop-up store. Through a collaboration with English designer Faye Toogood, a space was created that broke gender binarism and transcended predefined social norms: titled Agender, the concept store went beyond androgyny and unisex, questioning the common practices that still support gendered, sectorized, and categorized clothing. The space aligned with the social theme through its neutrality of forms and colours, as well as the arrangement of the items for sale. The area, freely traversable in its entirety, did not impose distinctions or divisions indicating which space was designated for whom, thus ensuring a neutral experience open to all possibilities.

In the realm of inclusion and awareness, facilitating user accessibility, projects of various natures also become relevant to the research presented here. If the liveability of spaces is central to our daily lives, the digital device sector plays a fundamental role regardless of users' gender, age, ethnicity, abilities, and other identifiers. Today, most actions we perform are mediated by our relationship with digital tools, often highly advanced in their employed technologies. One such tool is the voice assistant, an artificial intelligence instrument that has become part of many people's personal and professional lives, facilitating various daily tasks.

Well-known examples, familiar to a broad audience, include Alexa, Siri, and Google Assistant. Despite the significant technological advancements achieved, some aspects remain limiting. Through the lens of gender studies, it is evident that these tools are still rooted in outdated, binary gender stereotypes. Specifically, the chosen vocal attributes and names assigned to these tools often define their gender and role: stereotypically, the female voice assumes a nurturing, compliant, and always-present role.

Thus, it is clear that the design of voice assistants needs to be more conscious and equitable. Although the latest versions allow users to personalize their voice assistants with their preferred vocal attributes, the default setting remains a female voice.

Not surprisingly, voices assigned to machinery or industrial equipment in professional contexts are always male. This stark contrast results from socially accepted norms constructed on a model of society quite different from the contemporary one.

Sound designer Nis Norgaard addressed this design issue by creating "Q", a gender-neutral synthetic voice, positioning it as a political act in the contemporary debate (Prochner, 2023). In this project, the designer involved individuals identifying across different genders, collecting vocal recordings which were then overlapped and manipulated to achieve various sound alterations.

These outputs were evaluated by a sample of 4600 people on a scale from 1 to 5, where 1 corresponded to masculine and 5 to feminine. This process identified a range in which the voice is perceived as neutral, specifically at 153Hz. "Q"'s vocal timbre falls between 145 and 175 hertz, creating a sound range perceived as neutral by users, thus varying in perception by different individuals.

3.2 Toward inclusive design practice

The relationship between design and gender studies is an evolving field that reflects the social and cultural dynamics of each era. Historically, design has often contributed to the perpetuation of gender stereotypes (Eagly & Wood, 2012). Through rigid categorizations, design has defined and limited the opportunities and roles available to individuals based on gender. However, the design discipline, owing to its hybrid nature of both technical and theoretical aspects, holds the potential to challenge and transform these narratives.

Looking ahead, the prospects for design in relation to gender studies are both promising and complex. One of the primary challenges will be to continue developing design practices that not only recognize but also valorise gender fluidity and the diversity of identities. As evident from the extensive body of research preceding us, it is crucial to foster a dialogue between design and the humanities and social sciences to enrich the discourse and develop a design practice that is ethical and sustainable. Parallel disciplines such as sociology, anthropology, psychology, and pedagogy offer tools capable of deconstructing what has been learned and disseminated thus far, thereby enriching the design process from a social sustainability perspective. To achieve these goals, a rethinking of the academic training of future designers is necessary. Design programs should include courses that explore issues of gender, diversity, and inclusivity, as well as the social impact of design. Students should be encouraged to develop a critical understanding of the social and cultural implications of their design choices and consider how these can affect various user groups. Collaboration with experts from other disciplines, with a view to interdisciplinarity, can further enrich designers' education. Through a critical reflection of its models

and principles, design can truly contribute to achieving a more equitable and just society. This requires an academic education that promotes a broad and integrated view of design, preparing future designers to become agents of social and cultural change.

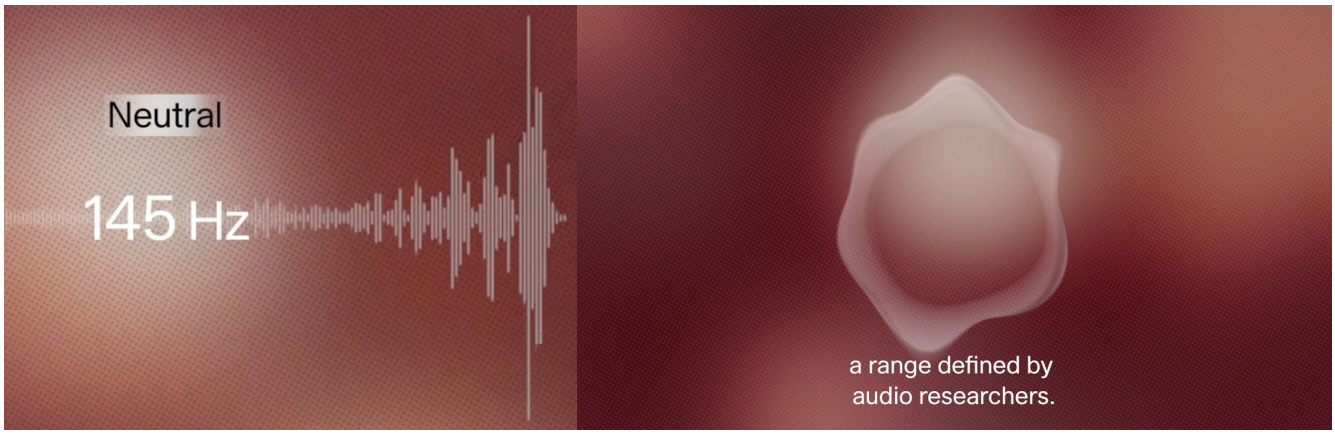

Figure 1. Q, the first neutral voice assistant, by sound designer Nis Nørgaard.

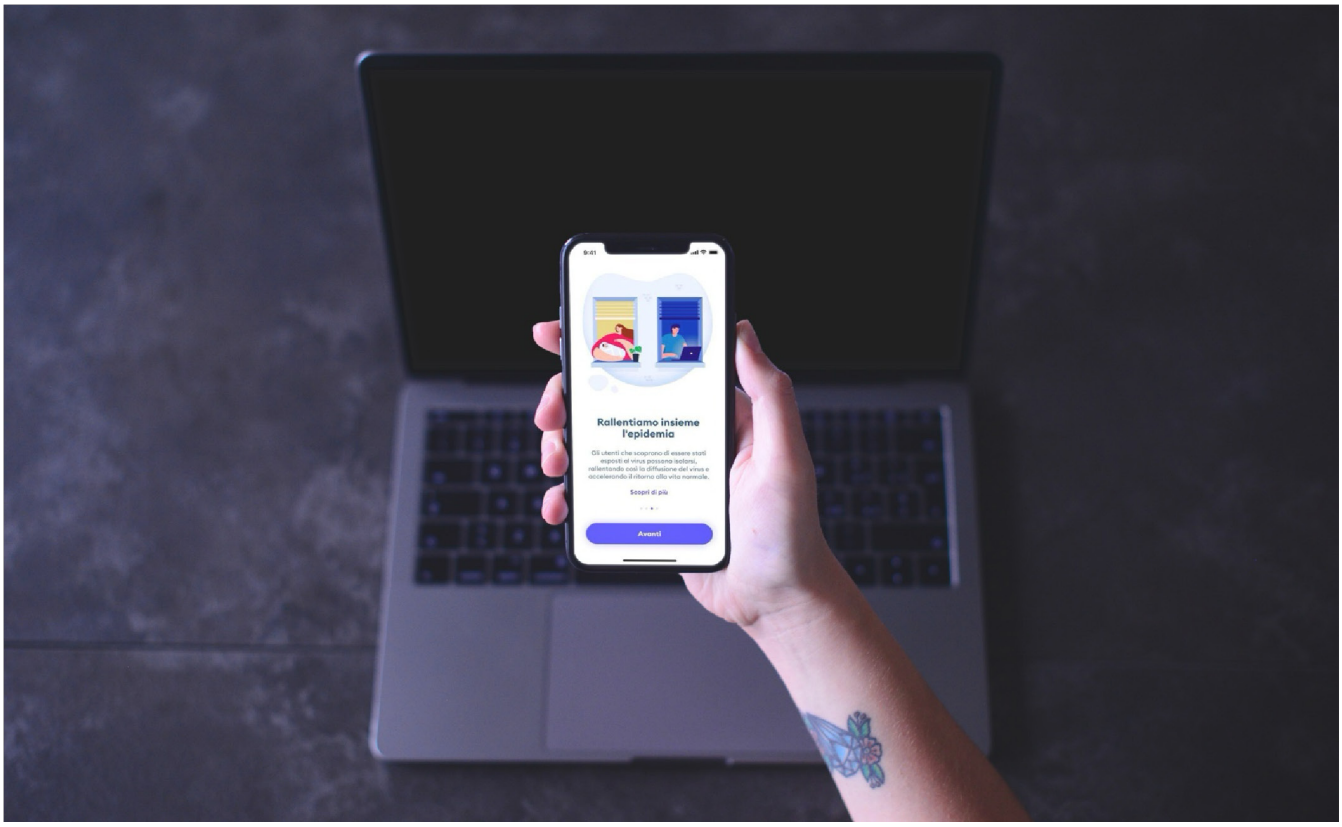

Figure 2. Immuni app interface before redesign.

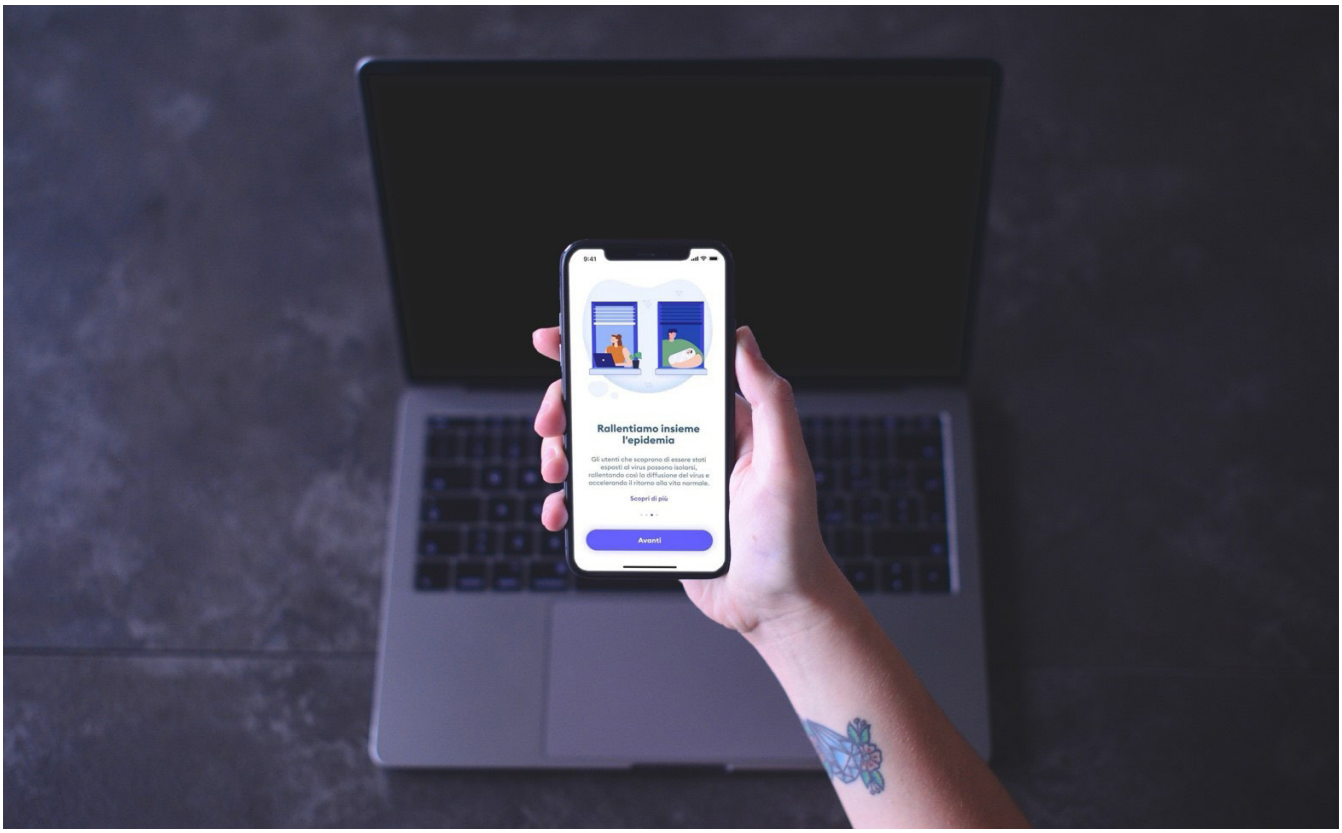

Figure 3. Immuni app interface after redesign.

4. Conclusion: only the future knows

In 1885, the Englishman John Kemp Starley created the first real bicycle, which he called the Rover Safety Bicycle (Morteo, 2019, 36): it was equipped with all those features that made it, unlike the previous bicycles, safer and more comfortable: wheels of the same diameter, thanks to a chain to transmit movement to the rear wheel, a freewheel pedalling system (a mechanism that allows the wheel to continue turning even when the pedals are stationary), a sprocket fixed to the hub of the rear wheel and a sprocket keyed to the pedal axle, a frame in Mannesmann tubes and tires along with a braking system. In some additional years, it will become a hobby and a way to keep in shape.

What now we consider something part of our everyday life, something to which everyone of us is trained for since being a child, was for a long time a simple (and not so safe) vehicle, alternative to horses and carriages. Innovation brought a huge change in its time: it changed society's habits, although having appeared exactly for answering to another society need.

In 1986 a law introduced in Italy the mandatory use of helmets when riding or being passenger on a motorcycle and a scooter, for all younger than eighteen. In 2000 it became mandatory for all ages and all two-wheels vehicles. The use of helmets increased from 15% to 97%: from the design

point of view, this was the chance to develop incredible products, fashionable yet based on safeness, elegant icons connected to any generation (necessarily).

Reaching the interest of bespoke historical brands, a law changed how society appears: in this direction the collaboration for the 2024 collection of Nolan and Borsalino, two bespoke brands, self-defying ambassadors of Italian heritage.

Understanding and evaluating properly in advance which will be the spark leading to innovation, the one that will draw new futures, answering to expressed and unexpressed need is almost impossible.

What design can do is try to give a reasonable answer to the changes, looking at them with the right criticism, thanks and due to the right instruments: the best of this instrument is knowledge, and it perfectly pairs sensitivity.

At this moment the 'issue' of gender impacts design realm in our everyday life with a spread of "her/his/they" indications at the bottoms of our emails: despite of being maybe interested, possibly aware of what is the current debate about this, not many of us have thought about the reasons and the consequences these pivotal changes would have.

We think of design as a discipline capable of universally dialoguing in the same way, a shared and universal language: this is unreal and utopian. It would mean aspiring to a flattened reality, devoid of cultural diversity and nuances.

The clue is that an oriented (man-cis-white-young-healthy) approach for too long has affected the design discipline, which shapes and diriges our lives. This affects everyone's life and this is a problem. Rawsthorn, quoting Criado Perez, highlights how the "one-size-fits-all" is a lie, as well as is a untruth. (Rawsthorn, 2022, 81)

We might add that, even if this would likely to solve some problems and issues related to consumption and production, sustainability and environmentalism, a genderless design, wouldn't be a solution. It would not leave space for expression, behavioural statements, nuances to which nowadays we are all used.

«As a binary definitions of cis male and cis female appear increasingly outdated, it is even more important for us to all able to decide how to express the nuances of our personal identities in our design choices, rather than leaving it to the cis male establishment that has sustained the "man's world" of design for so long.» (Rawsthorn, 2022, 87)

What, so far, could be the answer? The educational context is the place where - using the words of the feminist educator and writer Bell Hooks - freedom can be trained.

In the recognition and consideration of the multiplicity, the incredible varieties within cultural expression, behavioural dispositions,

personal conditions in this world there is not a single answer, and there could never be. We struggle so much for preserving and enhancing natural biodiversity: considering of an answer in design discipline and process that fits all would always leave someone out of the range. Designer must be trained to be aware of it, conscious they would need and will be asked for choosing which question they are addressing their efforts. Because, even if following straightly and exactly the perfect Dieter Rams' s ten principles still one seems to look great along for the contemporary era, when coming to largely intended design: everything right is not right for everyone.

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CO-DESIGNING WITH HUMANS.

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ABSTRACT | Incorporating artificial intelligent agents into the design process has been an important challenge during the past decade. From neural networks to generative adversarial networks, to modern large language models and latent diffusion models, there has been a large advancement, not only in terms of technology, models and methodologies, but conceptually in terms of how creative professionals, specifically designers engage with machine learning and artificial intelligent agents, this study presents and documents the advancements, process, methodology and results of a set of projects derived into a course designed to introduce designers to machine learning and artificial intelligence, from the perspective of Co-Design. Encouraging designers to envision artificial agents as active contributors of the design process, either as agents or as factual users in a co-design or cocreation process.

KEYWORDS | ARTIFICIAL INTELLIGENCE, CO-DESIGN, MACHINE LEARNING, DESIGN PROCESS

1. Introduction

The integration of artificial intelligence (AI) into design processes has dramatically transformed the way we approach creative problem-solving and innovation over the past decade (Chen, Z., & Ye, R. 2021). From neural networks and generative adversarial networks (GANs) to modern large language models and latent diffusion models, there has been substantial advancement in technology, models, methodologies, and conceptual frameworks for how designers engage with AI allowing them to explore unprecedented creative possibilities.
AI's capabilities in data analysis, image generation, and decision-making have introduced new dimensions to design thinking and practice, enabling designers to overcome limitations related to scale, scope, and complexity.This publication aims to review the development, implementation, and outcomes of the "Co-Design with AI" course in Japan. The course is structured to introduce design students to AI and machine learning concepts, emphasizing co-design principles where AI agents are considered active contributors to the design process. By reviewing the methodologies, projects, and educational strategies employed in the course, this paper provides insights into the educational approach and the potential of AI in design education.

The relevance of integrating AI into design education cannot be overstated. As AI technologies continue to evolve, their application in design processes becomes increasingly critical for fostering innovation and efficiency. Educating designers to work with AI agents as stakeholders of the design process not only enhances their creative capabilities but also prepares them for the future of the design industry, where AI is expected to play a significant role.
This course at Chiba University represents a pioneering effort to bridge the gap between traditional design practices and emerging AI technologies, promoting a collaborative and interdisciplinary approach to design education. Therefore, the course focuses on teaching machine learning (ML)

techniques that are essential to develop a full understanding of the design process in the context of today's data-driven world. As design increasingly integrates AI, understanding how ML works enables designers to create adaptive, and user-centered solutions. ML techniques, such as supervised learning (learning from labeled data), unsupervised learning (learning from unlabeled data), semi-supervised learning (using both labeled and unlabeled data), and reinforcement learning (learning through interaction with environments), offer powerful tools for generating insights, automating tasks, and optimizing design decisions (Mohammed, M., et al, 2016). This course focuses on learning these techniques through a hands-on approach, such as practical classes, intensive workshops, all of them based on projectbased learning. Students benefit most when they are tasked with building functional prototypes, applying ML algorithms to real-world design problems. Additionally, collaborative learning environments and interdisciplinary projects are effective educational techniques in the AI and design field, allowing students to explore the creative possibilities of ML while developing technical expertise.

This paper reviews and documents the advancements, processes, methodologies, and results of a fourth year course designed to introduce designers to AI and machine learning from a co- design perspective. The goal is to encourage designers to view AI agents as active contributors to the design process, either as agents or as factual users in a co-design or co-creation process.

2. Designing with AI: Course Development and Implementation

2.1.First Iteration / Tool Generation & Generative Adversarial Networks

In 2020, the initial iteration of the course was developed to integrate artificial intelligence into a design curriculum within the System Planning Laboratory at Chiba University in Japan, driven by the increasing prominence of AI models as design tools (Chacón, J. C, 2021) . Previous reference projects such as Deepwear (Kato N.,2018) and the ChAIr Project (Schmitt, 2018), have utilized GANs to generate images for fashion and furniture design, respectively and showed great possibilities for the use of these technologies in design. Despite this, many students lacked the technical expertise to fully utilize AI in their design processes, and at that time, there were fewer open platforms for interacting with these models compared to the accessibility available today. During this iteration, the necessity to teach fundamental machine learning concepts while enabling students to interact with generative AI models and create different outputs using this technology motivated us to develop the GANSta platform (Figure 1) (Juan Carlos Chacon Quintero, & Hisa Martinez Nimi 2020), a Python-based tool with a graphical

user interface that facilitates the design and training of Generative Adversarial Networks (GANs), and its application in various stages of the design process. This node-based interface, familiar to designers from tools like TouchDesigner and Grasshopper, allowed users to design and train GANs without prior programming knowledge. While other graphical tools for machine learning exist, GANSta was uniquely developed to meet the needs identified during design-led projects. It facilitated an understanding of GAN concepts through the distribution of Nodes (Table 1) and allowed designers to develop and train their models. However, limitations such as the cost of computer equipment, GPU requirements, and training time may hinder widespread adoption. Despite these challenges, the success of that initiative indicates that AI will likely become an integral part of the design process in the near future.

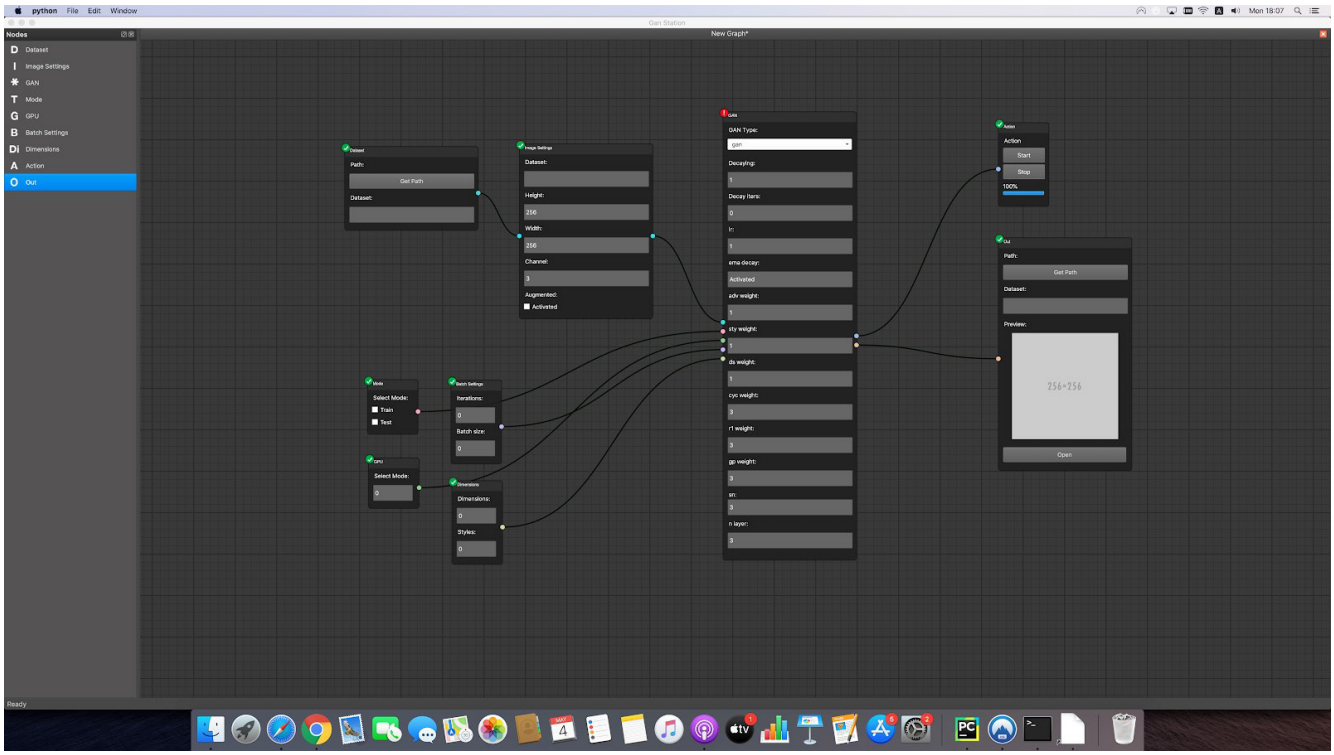

Figure 1. GANsta: A Graphical user interface that facilitates the design and training of Generative Adversarial Networks (GANs)

Table 1. GANsta platform Nodes and functions.

Dataset Node	Selects and verifies the dataset path.
Image Node	Defines image parameters and applies transformations.
Mode Node	Chooses between training and testing.
GPU Node	Optionally selects GPU usage.
Batch Node	Determines batches and epochs for training.
GAN Node	Sets parameters for the generator and discriminator.
Output Node	Defines output path and format.
Action Node	Initiates training and testing, displaying progress.

Participants from Chiba University engaged in several projects as a result of the implementation of this platform. Some of the remarkable projects include iconographic branding generation and typographic font design projects to explore the potential of GANs in design. The results demonstrated that prior knowledge in programming or machine learning is not required for designers to benefit from this technology; however, some basic fundamental knowledge will definitely impact the quality of the results.

2.2.Second Iteration / AI as a co-creation Partner

After the first iteration of incorporating AI as a tool in the design process, we explored the potential of utilizing this technology not merely as an auxiliary tool but as an active co-creation partner. This realization highlighted AI's ability to participate in creative decision-making and generate innovative design solutions collaboratively with designers. The success of this approach opened up new opportunities for the next iteration of the course and projects, encouraging a deeper exploration of AI's role in the design process and fostering a more integrated and synergistic relationship between human creativity and artificial intelligence. This stage delves into the concept of AI as a co-creation partner, focusing on the collaborative dynamics between designers and AI in the context of imagebased design projects using Generative Adversarial Networks (GANs).

To explore the collaborative potential of AI, a workshop was conducted at Chiba University's System Planning Laboratory. The workshop aimed to provide practical machine learning knowledge to design students and integrate AI as an active participant in the design process. The workshop was structured into five stages: project selection, dataset creation, dataset testing, results evaluation, and documentation. Also, in this iteration, our internal tool GAN Station (GANSta) was used to include designers without prior programming knowledge.

The workshop brought together a diverse group of design students from various creative fields, including graphic design, industrial design, product design, and interactive design. These participants were organized into five teams based on their individual skills and interests. The topics chosen for this iteration of the workshop included Japanese kanji design, font design, emotions applied in character design, character animation, and icon generation. During the workshop, students had the autonomy to select their topics and methods for developing their projects, leveraging their personal interests as a catalyst for learning. This approach, inspired by Seeley Brown and Adler's (2018) concept of passion-based learning, encouraged students to delve deeply into their subjects, applying and practicing their knowledge through productive and peer-based learning. This method allows students to learn new techniques by observing their peers, defending their work, and engaging in community discussions about emerging challenges. The use of passion-based projects proved advantageous, as students, already familiar with their chosen topics and related processes, were able to incorporate the intelligent assistant or tool effectively, despite limited prior knowledge of deep learning, generative design, or engineering processes. Throughout the workshop, a variety of methods and tools from other disciplines were integrated into each team's creative process. Design thinking, persona profiling, and other design methods complemented the process, facilitating student interaction with the tool in their own unique ways. Management, evaluation of result quality, and the number of process iterations were determined by the participants, based on their preferences and experiences.

Each team tailored their dataset to meet the specific requirements of their project. From a generative design perspective, the characteristics of the selected dataset were used as parameters to create new domains or "designs" by mixing characteristics between dataset components. After the model training, the introduction of new domains and parameters enabled the transfer of dataset characteristics to new domains, generating new design variants beyond the initial dataset parameters.Upon completing the training process and verifying its functionality, the learning evaluation continued by generating images from transversal latent walks within the same model, without using other images as input or guiding parameters. This evaluation further extended through the generation of images derived from the mixture of characteristics and parameters deemed relevant during the visual assessment of the initial results (Figure 2). At the conclusion of the evaluation, students proposed potential uses or applications for the resulting models, aiming to develop future services or tools. They also conducted a personal evaluation of the knowledge acquired and the methodology followed throughout the project. This reflective process led to observations and recommendations on how to simplify and improve the workflow for future iterations of the workshop.

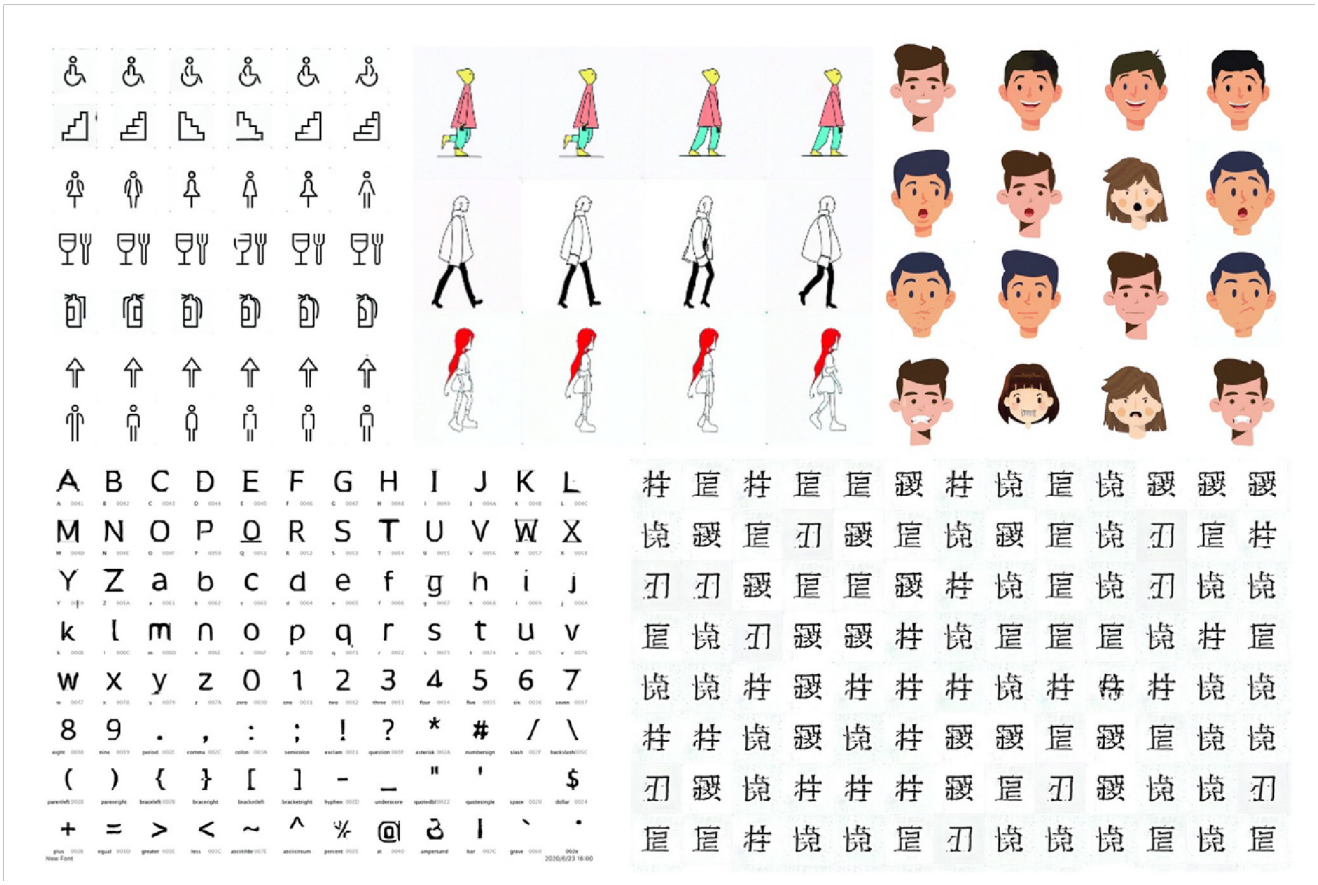

Figure 2. Student Outputs from the ‘AI as a Co-Creation Partner’ Workshop

2.3.Third Iteration / Co-designing with the Machine

Following the second stage of integrating AI as a co-creation partner, where AI was utilized to augment the creative process, we discovered its profound potential not only as an assistant but as an equal collaborator in design (Carlos, C.Q.J., Hisa, M.N. 2024). This realization led us to envision a more integrated approach where AI is embedded deeply within the co-design framework. This shift opened new avenues for the next iteration of the course and projects, emphasizing collaborative creation with AI at every stage of the design process. At this stage, the “Co-Designing with AI ” became a class inside the Industrial Design curricula of Chiba University. This course was designed to introduce design students to Generative Design and Machine Learning tools while adopting a unique perspective by positioning AI as an active agent (Huang, Y. 2024) in a co-design process. Through a combination of regular classes and intensive workshops, the course enables students to collaborate with AI agents, fostering a deep understanding of AI and enhancing their practical skills. This chapter reviews the course structure, methodologies, and student projects, highlighting the immense creative potential of AI in diverse design contexts.

The concept of co-designing with AI agents emphases the collaboration between human designers and AI models throughout the design process. At this stage, a shift was made from co-creation to a co-design approach. For this case, we refer to co-creation as a process that involves collaborative creativity enacted by a group (Sanders, E. B. et al. 2008), while with co- design we refer to a collaborative creative process applied throughout the design cycle (Flores, R. L., et al. 2015). In the context of this course, co-designing with AI entails human designers and AI agents working together from idea generation to evaluation and refinement. This approach aligns with the distributed creativity framework, which views creativity as a collective phenomenon involving multiple actors, artifacts, and environments.

The course is structured into four key stages: introduction to machine learning concepts, project conceptualization, development, and evaluation. Students work closely with researchers to refine models, understand technical implications, and reflect on their experiences. The course is offered in two formats: a traditional seven-session classroom course and an intensive 5-7 N. Surname, N. Surname (LEAVE BLANK) [STYLE: _P/RoD RUNNING HEAD Even] session workshop, conducted in collaboration with various institutions. Students from diverse academic levels and backgrounds collaborate on projects, enhancing their proficiency in technical areas and problem-solving skills. The co-design framework underscores the importance of usercentered design and collaborative problem-solving.

The following results demonstrate the utilization of various artificial agents across different stages of the design process.

Lamp Project: Conceptualizing a Product with GANs

In this project the AI Agent was involved in the conceptualization stage. The focus of this proposal is on designing lighting fixtures inspired by sea creatures (Figure 3). Using generative adversarial networks (GANs), students designed AI agents capable of proposing conceptual sketches for lamp designs, including colors and illuminations. The collaborative process involved interpreting AIgenerated proposals and developing three-dimensional representations from the human side, demonstrating AI's role in the conceptualization phase.



Figure 3. Student Outputs from the 'AI as a Co-Creation Partner' Workshop

Envisioning Future Scenarios: AI Sneak Peek Project

In this project the AI Agent was involved in the prototyping, voice recognition, and image generation stages. Students created a diffusion-based image generation model that translated real-time conversations into images depicting potential romantic futures for participants (Figure 4). This interactive experience demonstrated AI's ability to impact users' perspectives and communication.

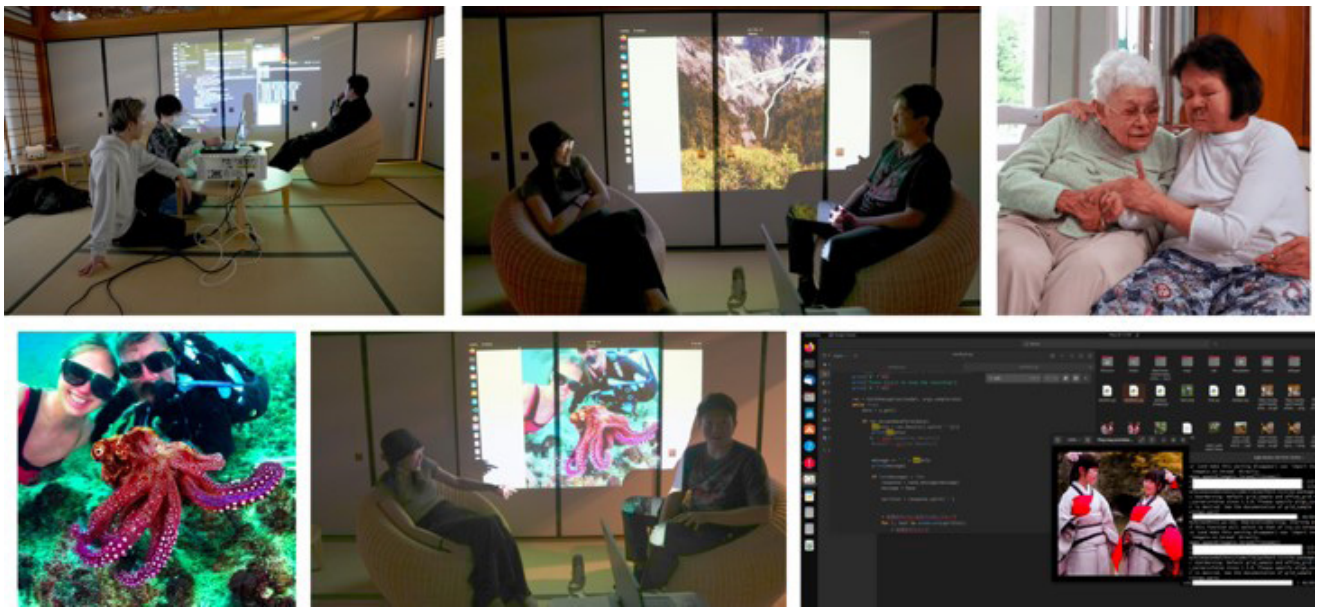

Figure 4. Prototype testing of the AI agent that translates conversations into images depicting potential future scenarios for the participants.

Real-Time Co-Design with AI: Shadow Master Project

This project explored new ways of interacting with generative AI agents through lighting and shadow identification. The project allowed users to create graphic representations of animals through body movements, even without prior knowledge of the generative process (Figure 5)..

This playful co-design approach has significant potential for visual communication in cross-cultural environments and for representing complex concepts and storytelling. The project highlighted the use of AI models in the design stage, analyzing user shadow images and generating final illustrations, fostering inclusive and innovative visual communication strategies.



Figure 5. AI agent interacting in real time with the users through the detection of shadows and lighting.

Incorporating AI agents into the design process has been a transformative educational experience. The “Co-Designing with the Machine” course highlights the potential of AI in education, demonstrating a multidisciplinary approach that provides a stimulating learning environment. By engaging with AI as team members, students harness the potential of collaborative AI to enhance their creative abilities and develop problem-solving loops for training AI models. This educational experience emphasizes the importance of collaboration and co-design, showcasing how diverse roles and skills can work together effectively. Adopting this perspective enriches designers’ abilities to navigate the evolving landscape of human-machine collaboration, paving the way for groundbreaking design innovations. These examples inspire further exploration and innovation in this rapidly evolving field.

2.4.Fourth Iteration / Co-designing with Humans

The “Co-Designing with AI” course at Chiba University has progressively evolved through four distinct stages: AI as a tool, AI as a co-worker partner, co-designing with the machine, and,

most recently, codesigning with humans. This chapter delves into the fourth stage of this course, where AI agents undertake the majority of the design process autonomously, while human participants engage as stakeholders, providing input and feedback without being fully aware of the underlying design mechanisms. In this stage, the role of the designer shifts from direct involvement in the design process to creating and managing interactive loops (Verganti, R., 2020) between AI agents and human stakeholders. The course components are structured to reflect this dynamic interaction. AI agents are tasked with conducting comprehensive design activities autonomously to generate innovative solutions. Human participants, acting as stakeholders, engage in periodic reviews, offer contextual insights, and make strategic decisions without needing to grasp the technical intricacies of the AI processes. However, designers play a crucial role in creating interactive loops that facilitate ongoing collaboration between AI agents and human stakeholders, ensuring continuous improvement and adaptation of the designs. This framework not only enhances the learning experience but also simulates real-world scenarios where AI and human collaboration is pivotal.

During this session, designers were responsible for Creating Interactive Loops: Designing systems that enable seamless collaboration between AI agents and human stakeholders, ensuring that both parties can contribute effectively to the design process. Designing their tailored AI agents: For this session, designers are not only in charge of designing the loop in which the user and the machine intervene but must also be able to design their own intelligent agents and train them combining several models and other techniques. *Facilitating Stakeholder Engagement*: Ensuring that human participants can provide valuable input and feedback at strategic points, enhancing the overall design outcome. *Monitoring and Improving Processes:* Continuously evaluating the performance of AI agents and making necessary adjustments to improve their effectiveness.

Collective emotions project

The design project tasked designers with creating a system where AI agents engage with a group of students in drawing images related to their emotions. By aggregating these individual drawings, the AI then was able to generate a collective visualization of the group's emotional perspective. Following this, the AI agent creates a 3D visualization of the collective emotions, preparing the results for physical manifestation. The students utilized resin printing to transform the AI-generated visualizations into tangible exhibits, allowing the group to physically display and reflect on their shared emotional landscape. This exercise not only demonstrated the potential of AI in synthesizing collective human experiences but also provided a tangible means for participants to engage with and exhibit their collective emotional expressions. In this project, the designers played a pivotal

role in both the technical and logistical aspects of the process. Initially, the designers focused on developing the AI agents, programming them to engage with humans by asking them to draw images related to their emotions. This involved creating algorithms capable of interpreting emotional input and translating it into visual data. Once the AI agents were operational, the designers managed the logistics of the project, coordinating the various stages to ensure smooth execution. They organized sessions where students were asked to draw their emotional responses, providing the necessary materials and guidance. After the drawings were completed, the designers facilitated the scanning process, ensuring that the physical images were accurately digitized and input into the AI system. Following the digitization, the designers feed the AI agent with the collective emotional visualization, to translate these visualizations into 3D models. They then managed the printing process, using resin printing technology to create physical representations of the collective emotional landscape. By meticulously coordinating these steps, the designers ensured that the project not only harnessed the technical capabilities of AI but also effectively engaged human participants, resulting in a meaningful and tangible exhibition of collective emotions.

The fourth stage of the course represents a significant advancement in the integration of AI in design. By positioning AI agents as the primary drivers of the design process and engaging humans as stakeholders, this stage highlights the transformative potential of AI in creative fields. The experiences and insights gained from this educational initiative provide valuable lessons for the future of design education, emphasizing the importance of collaboration, trust, and ethical considerations in the evolving landscape of AI-driven design. However, the transition to a predominantly AI-driven design process presents several challenges and insights. Firstly, technical limitations pose a significant hurdle; ensuring the accuracy and creativity of AI-generated designs necessitates robust datasets and multimodels. Any deficiencies in these areas can compromise the quality of the output. Secondly, building human trust and acceptance is crucial. Demonstrating the efficacy and creativity of AI solutions is essential for gaining stakeholder confidence and fostering a collaborative environment. Thirdly, the autonomy of AI in the design process raises ethical considerations regarding authorship, creativity, and potential biases. Addressing these concerns is vital for the responsible integration of AI in design. For future iterations, this fourth stage of the “Co-Designing with the Machine” course opens new avenues for design education and practice. Enhanced collaboration can be explored in future iterations, with AI handling complex design tasks while humans provide strategic oversight. Additionally, a continued focus on developing AI models that prioritize inclusivity, fairness, and transparency will be paramount as AI becomes more integrated into creative processes.

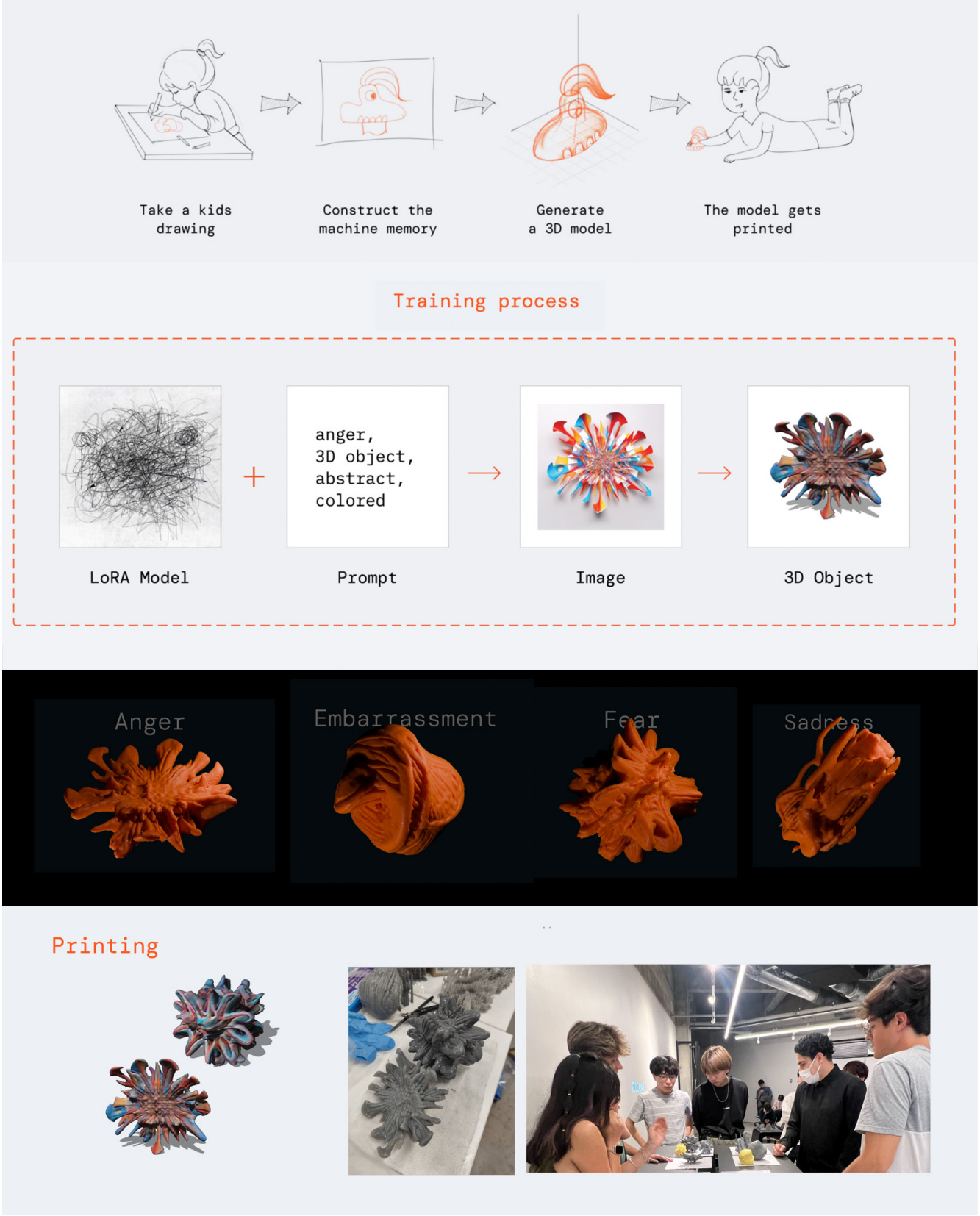

Figure 6. Process and results of the collective emotions project during the fourth iteration of the course.

3. Conclusion

The “Co-Designing with AI” course at Chiba University has provided a comprehensive exploration into the integration of AI within the design process, evolving through four distinct stages: AI as a tool, AI as a co-worker, co-designing with the machine, and co-designing with humans. This study has documented the progression of these stages and the methodologies employed to leverage AI as both a collaborative partner and a primary driver of the design process. The course has showcased the transformative potential of AI in creative fields, emphasizing the role of AI as an active contributor rather than a mere tool. In the initial stages, AI was used to automate repetitive tasks and enhance efficiency, helping designers to streamline their workflows. The second stage shifted AI’s role to that of a co-worker, actively participating in creative decision-making and generating innovative design solutions collaboratively with human designers. The third stage, co-designing with the machine, highlighted the seamless integration of AI into the co-design framework, promoting collaborative creation at every stage of the design process. The fourth stage, co-designing with humans, represents a significant advancement where AI agents undertake the majority of the design process autonomously, while human participants act as stakeholders. This stage underscores the importance of designers creating and managing interactive loops between AI agents and human stakeholders to ensure continuous improvement and adaptation of designs. The educational framework immerses students in the role of stakeholders, allowing AI agents to drive the design process while human participants provide strategic oversight. Despite the advancements, the transition to a predominantly AI-driven design process presents several challenges and insights. Technical limitations, such as ensuring the accuracy and creativity of AI-generated designs, require robust datasets and multimodels. Building human trust and acceptance remains crucial, as does addressing ethical considerations regarding sustainability and potential biases. Enhanced collaboration between AI and human stakeholders can be explored. The experiences and insights gained from this educational initiative emphasize the importance of collaboration in the evolving landscape of AI-driven design. These lessons will undoubtedly inspire further exploration and innovation in this rapidly evolving field, paving the way for groundbreaking design innovations and a more inclusive future in design education and practice.

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ECONOMIC GENERATION PROJECT FOR INDIGENOUS WOMEN IN NORTHERN CAUCA

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ABSTRACT | This project, developed in Colombia, contributes to improving the living conditions of 200 indigenous women in northern Cauca by creating sustainable economic generation options. This population is considered high-risk due to the presence of armed groups that violate the community's rights. In this context, the project represents an opportunity to promote the economic and political empowerment of women and reduce inequities.

Three main components were proposed: first, to train and obtain the official hand-weaving seal from the Colombian government, as well as to train in adapting design and production processes to meet the specific demands of the slow fashion market. Second, to implement a commercial strategy to establish agreements with previously identified actors in the tourism and slow fashion sectors. Third, to strengthen internal business management processes by adopting basic practices that govern product design, production, quality control, as well as supplies and sales.

The importance of economic development from the natural and social sustainability of the territory is highlighted. Therefore, in the different processes, priority was given to strengthening their ancestral practices, which involved the use of native raw materials and an integrative product design approach, respectful of the indigenous cultural identity and their relationship with the land. Equally important was promoting women's empowerment through autonomy in decision-making and economic independence.

KEYWORDS | HAND-WEAVING, INDIGENOUS WOMEN, SUSTAINABLE ECONOMIC, WOMEN'S EMPOWERMENT.

1. Introduction

This article explores the challenges faced by design in communication [among and for multicultural audiences] from a social and territorial perspective, focusing on the traditional practices and knowledge of Latin American Indigenous communities. These dynamics were analyzed from the results obtained in the development of the international cooperation project called "Integral Program of Commercial, Productive, and Business Management Transfer for the Promotion of Access to Slow Fashion Markets for Indigenous Women in the Department of Cauca, Colombia"[1].

The project was funded by the CHANEL Foundation and implemented by the CODESPA Foundation, Colombia delegation, between 2018 and 2021. CODESPA is a Spanish non-profit development cooperation organization that focuses on strengthening the enforceability of social and economic rights, promoting productive activities for the revitalization of local economies, and facilitating income-generating opportunities for displaced families in urban and rural areas. The main objective of the project was to improve the living conditions of 200 Indigenous women in the northern part of the Department of Cauca, specifically in the municipalities of Caldono, Corinto, Jambaló, Caloto, and Toribío. To this end, sustainable economic generation options were created that promote the economic and political empowerment of women in situations of inequality (Codespa America Foundation, 2019).

This was achieved with the mediation of some cabildos[2] of Indigenous reserves[3] and the collaboration of key allies, such as governmental institutions, including the National Learning Service (SENA). Territorial

[1] Cooperation Agreement between the CHANEL Foundation and the CODESPA America Foundation named CHANEL PE-1826.
[2] The Cabildo is defined as the local authority and coexists with the central and regional government of the country.
[3] The indigenous reservation constitutes the basic unit of territorial and socio-political organization from which the life of the indigenous peoples is developed (Donato et al., 2007).

liaisons from the Governor's Office of the Department of Cauca also participated, including the Cooperation Office, the Departmental Secretariat for Women, and the Secretariat for Education and Culture. In addition, the project team had a diverse professional composition, including political scientists, business administrators, industrial designers, and artisan technicians specializing in weaving techniques.

As indicated by Andrés Rodolfo Trujillo (2023), representative of the CODESPA Foundation, Colombia delegation, the methodological approach was developed in three key stages. First, participants were trained in adapting design and production processes to meet the specific demands of the slow fashion market. Second, a commercial strategy was implemented to establish agreements with previously identified actors to access stable and sustainable markets. Finally, internal business management processes were strengthened by adopting basic practices that govern product design, production, quality control, supply, and sales processes.

The results of the design process adaptation[4] component reveal the challenges faced by the discipline of industrial design, from the perspective of the [communicative object], that is, "the relationship between language and object" (Cid Jurado, 2002). In this case, the development of [*Indigenous objects*] of [*everyday and non-ritual use*], elaborated from artisanal production processes, was addressed. According to Ballestas Rincón (2019), these categories of utility are deeply rooted in the "meaning assigned or codified by the community" (p.17), while the geographical context determines the material and intellectual links with their territory, thus generating a construct of symbols that define their physical and cultural world (Quiñones Aguilar, 2003,p. 1).

This article proposes to follow the following route of analysis: first, to contextualize the territory around the handicraft activity; second, to describe the handicraft and gender approach from the living conditions of the beneficiaries; and third, to understand the dynamics around their knowledge and ancestral practices based on the [*Indigenous object*]. Finally, the methodological approach and the results obtained are presented, offering a comprehensive view of the challenges and achievements of the project.

1.1 Contextualization of the Territory

The Department of Cauca, known for its ethnic, cultural, and environmental plurality, is the department with the second largest indigenous population in Colombia. It is in the southwest of the country in flat areas and areas of medium and high mountains ranging from 1,600 to 2,800 meters above sea level. It is made up of 39 municipalities, 29 of which are inhabited by seven Indigenous

[4] Activities were carried out as part of the technical assistance and training component by design professionals for the "Association of Artisans and Craftsmen of Cauca Enredarte con identidad", legally established during project execution.

peoples: Nasa, Guambiano, Yanacona, Totoró, Coconuco, Eperara Siapidara and Inga. Of these, only five have preserved their native languages (Donato et al., 2007,p. 60).

Despite this cultural heritage, the socioeconomic context of artisans in Cauca is complex. According to the Statistical Information System of Artisan Activity - SIEAA (2014 -2020), out of a total of 32,187 artisans registered in 29 departments of Colombia, the 13th place is occupied by the Department of Cauca with approximately 1,404 artisans, where 35.8% inhabit rural areas, 32.6% indigenous reservations, 31.1% municipal capitals and only 0.5% peasant reserve zones (National Administrative Department of Statistics - DANE, 2022).

However, most of the artisanal production systems present in these territories respond to subsistence economies, where it is the families living in the villages or peripheral areas who develop the artisanal trade. A total of 69.5% of the artisans belong to vulnerable populations, while 30.5% do not recognize themselves as such. The context of vulnerability may be determined by several factors, such as being the only person responsible for the household, belonging to an ethnic group, being in a situation of poverty, and being a victim of armed conflict and displacement, among others. These aspects make artisans be perceived as agents in a condition of vulnerability. This situation is intensified due to the strong influence of illegal economies present in the area, which displaces labor towards activities such as coca leaf cultivation, illegal mining, and even sex trade, activities that predominate in the young population between 17 and 35 years old (Codespa America Foundation, 2019).

Given this reality, community associations and enterprises emerge as a crucial field of action for the construction of autonomy (Donato et al., 2007,p.54). From this perspective, the initiative arose to consolidate a network of artisan workshops as a social enterprise with a focus on the valuation and recovery of the cultural identity of the indigenous and peasant communities of the territory. This network of workshops was named “Association of Artisans of Cauca Enredarte con identidad” and made up of six artisan workshops. Its purpose is to promote quality work to improve the social and economic conditions of women through handicraft weaving.

The importance of these workshops lies not only in their economic contribution but also in their role as guardians of community traditions. The family weaving workshops are the base where these traditions rest, transmitting their knowledge from generation to generation, either through technical instruction in the field or orally (Campi, 2021). Therefore, promoting the creation of networks and relationships among artisans is fundamental for the subsistence of the workshops (Pérez, 2023, p.208). In the context of the project, the network of artisan associations of the “Enredarte con identidad” was formed with the traditional knowledge and know-how of the artisans of: SEK DXI from the municipality of Jambaló, WAKAT

KIWE NASA from Toribío, KUMBIAXCA from Corinto, Kwesxksxawnxi from Caloto and UMA from Tacueyó.

In summary, the dynamics generated by the artisan workshops not only allow for economic subsistence but also act as a vehicle for cultural preservation, essential for the continuity of the traditions and identity of the Cauca communities. The network of artisan associations made up of workshops from different localities, demonstrates that collaboration and the exchange of knowledge are fundamental for facing the challenges that affect these communities, ensuring the survival of their cultural legacy.

1.2 Gender and craft

The panorama of the handicraft sector in Colombia reveals that weaving is the most common craft, classified into two types: textiles and basketry. Both use different techniques to weave threads and fibers, using materials such as wool, cotton, and vegetable fibers. The regions with the greatest presence of artisan weavers are the Caribbean, Pacific, Coffee Belt, Central East, and South.

Weaving stands out as a predominantly female activity; 72% of artisans are women and 28% are men. This female predominance is also reflected in the project, which was executed with the participation of 200 women, 74% of whom belong to the Nasa people and 26% of whom are mestizos. These women artisans, who live in the northeastern part of the Department of Cauca, in the municipalities of Caldono, Corinto, Jambaló, Caloto, and Toribío, face various educational and labor constraints.

Only 36% of these women attended elementary school more than 30 years ago, and 70% do not have a paid job, dedicating themselves mainly to household chores, such as cleaning, cooking, caring for children, and weaving. Although weaving is a deep-rooted tradition, for 71.5% of them it does not represent their main source of income, benefiting economically only 28.5% of the participating population. The ages of the women who made up the six artisan workshops associated with the project can be seen in Table 1, where 68% of the artisans are between 26 and 50 years old, 16% are under 25 years old, 14% are between 56 and 70 years old and only 2% are over 70 years old.

Table 1. Beneficiary group by age.

Age group	Percentage participation
18 -25 years	16%
26 – 40 years	48%
41 -51 years	20%
56 -70 years	14%
Over 71 years old	2%

Nota. Table data reproduced from "Fostering Access to Slow Fashion Textile Markets for Indigenous Women in Cauca, Colombia" (p.9), All rights reserved 2019 by NGO CODESPA Foundation. Reproduced by permission of the author

The transmission of traditional knowledge is a key aspect of the practice of weaving. According to Donato (2007), traditional knowledge could be defined as "the collective memory, past, present and future of the different indigenous peoples and local communities" (p.232). In many communities, traditional Indigenous knowledge is transmitted by women who are mothers or grandmothers over 71 years of age and are called "mayoras". They are largely in charge of transmitting their knowledge to the following generations, as Campi (2021), quoting Solanilla in her records, concludes:

"Being a weaver in Central and South America has always been a job that is carried in the DNA, passed down from grandmothers to mothers and daughters, and is a basic pillar of their economy. In the weavings, we will have to see and "read" their ways of thinking and believing" (p.38).

In fact, data on the artisan panorama in Colombia confirm that the transmission of the craft is mainly hereditary: 43.6% of artisans obtained their apprenticeship through a family member, 23.6% are self-taught, 12.7% learned from other artisans, 10.5% were trained in an institution, 5.6% learned in private workshops and 2.8% did so through other options (Artesanias de Colombia, 2020). Within the framework of the project, this knowledge is shared among the artisans through the practice of manual work, where weaving becomes "a repository of feelings, knowledge, and craft; it is, at the same time, creation and imitation of nature" (Reyes, 2021, p.7).

1.3 Indigenous Object

Changes in social contexts, generated by forced displacement and the scarcity of raw materials, have caused the loss of traditional practices and knowledge in indigenous communities. This process not only alters manufacturing techniques but

also transforms over time the symbolic and cultural meanings of the objects that these communities create in their territories. Many of these objects have become mass-produced [*handcrafted objects*], decontextualized, and stripped of their symbolic or ritual charges and traditional uses. These objects, due to their high demand in the handicraft sector, become susceptible to being replicated, redefined, and commercialized by industries that do not recognize patrimonial, moral, and creative rights (Reyes, 2021, pp. 13,41).

As Cid Jurado (2015) points out, objects are an accumulation of interpretations that generate diverse meanings determined by the context. Thus, [*Indigenous crafts*] are approached as a tangible manifestation of the culture of ethnic communities, determined by the physical and social environment, which originates useful, ritual, and aesthetic objects (Quiñones Aguilar, 2003). This approach implies considering not only the techniques and raw materials used for their manufacture but also the cultural imaginaries that determine their form and symbolic load.

In this sense, it is essential to analyze the [indigenous object] of [daily and non-ritual use], from its symbolic dimension, which refers to the metaphorical concept concerning its meaning (Cid Jurado, 2002). Although the symbolism present in the textiles woven by the Nasa indigenous people is not generalized throughout the community, some basic shapes predominate, such as rhombuses, triangles, rectangles, and squares. Through these geometric figures, they abstract forms associated with nature, spirituality, cosmovision, and experiences.

The artisans of the different ethnic groups of the Department of Cauca, such as the Nasa-Paéz, preserve the traditional technique of finger weaving, one of the oldest inherited from their elders[2]. Using sheep wool, thread or cabuya, the Nasa make cuetanderas and jigras, objects that the elders use to transport food from the marketplace to their homes or to carry the coca leaf they chew while working. This craft practice not only keeps a technique alive, but also reinforces the symbolic and cultural connection with their environment and traditions.

Finally, the analysis of the information gathered on the transformation of the indigenous object from an everyday, non-ritual use to a handicraft object reveals the importance of considering both material and intellectual aspects, influenced by the geographical context. This analysis made it possible to identify various signs and symbols that a group of craftswomen from the Nasa-Paéz community have constructed over time.

[5] "elders" name assigned to grandmothers and grandfathers as a synonym of wisdom.

2. Materials and Methods

This research is part of the project "Integral Program of Commercial, Productive, and Business Management Transfer to Promote Access to Slow Fashion Markets for Indigenous Women in the Department of Cauca, Colombia". Executed by the NGO CODESPA Foundation, Colombia delegation. Its purpose was to create sustainable economic generation options that promote the economic and political empowerment of women in situations of inequality.

The project was implemented through the "Association of Artisans and Craftsmen of Cauca Enredarte con identidad", a network of six artisan workshops. These workshops developed handicraft products for everyday use using traditional weaving techniques, such as vertical loom, crochet, and finger weaving, using natural raw materials. This article is the result of the technical assistance and training component of the design adaptation process. Figure 1 shows the general methodology developed in the project.

2.1 General Methodology

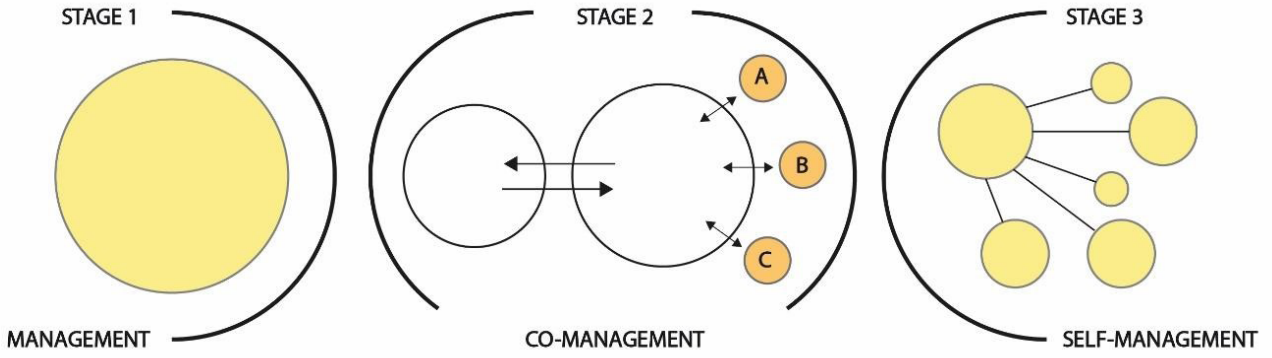

Figure 1. General methodology. *Note.* Adapted from Project Intervention Methodology. All rights reserved 2019 by NGO CODESPA Foundation. Reproduced by permission of the author.

CODESPA Foundation's methodological intervention approach aims to guarantee the operational and financial sustainability of the project, for which it develops three stages:

1. Management stage: Organizational conditions are generated and strategies, priorities, and responsibilities are defined by the communities. This phase implies a permanent accompaniment.
2. Co-management stage: Functions and responsibilities are gradually transferred between CODESPA and the "Association of Artisans and Craftsmen of Cauca Enredarte with Identity". The objective is that the organization can continue autonomously improving their living conditions and participation with economic and social impact. This stage involves periodic monitoring.

3. Self-management stage: The transfer of functions and responsibilities to the organizations is completed, with specific support in aspects that are still deficient for a defined time. Subsequently, the organizations continue to carry out their activities autonomously, with advisory support.

2.2 Co-management Stage

In the methodological stage of co-management, a large part of the component of adaptation of the design processes for the elaboration of indigenous handicraft products for daily use was developed. This phase required training and technical assistance from design professionals, in collaboration with artisan weaving technicians. The development of this component made possible the implementation of commercial strategies, which were later consolidated to strengthen the association's internal processes. Figure 2 shows the components that articulate the co-management stage.

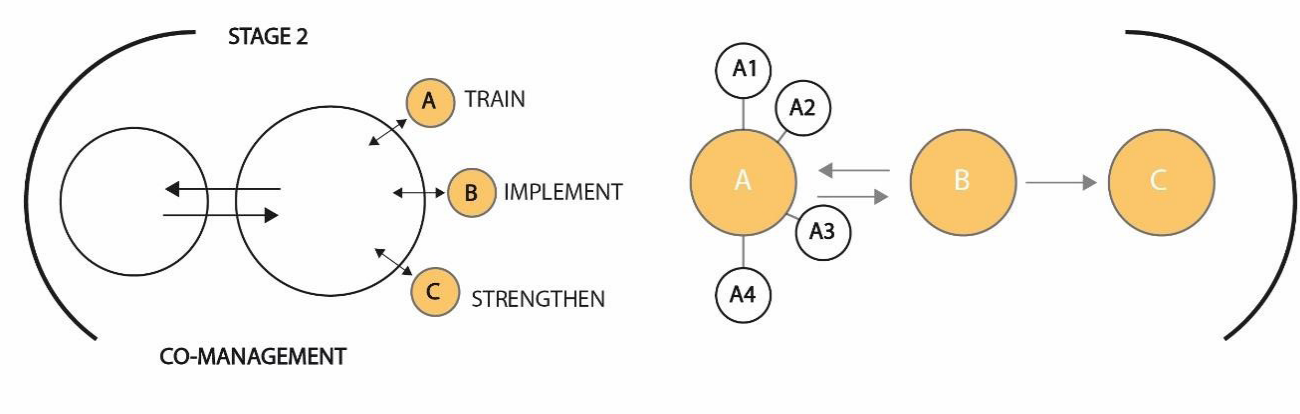

Figure 2. Stage no. 2 Co-management: Components. *Note.* Own construction from the implementation of the Project Intervention Methodology.

The co-management stage addresses the following three components:

a. Training in adapting design and production processes to meet the specific demands of the slow fashion market.

b. Implementation of a commercial strategy for the establishment of commercial agreements with stable and sustainable markets.

c. Strengthening internal business management processes

2.3 Adaptation Component of Design Processes.

The training component for the adaptation of design processes was developed in four major phases: exploratory, conceptual development, detailed design, and manufacturing. During these phases, both qualitative and quantitative methods of data capture and analysis were used, through field visits, participant observation, semi-structured interviews, and multidisciplinary working groups. Cycles between phases were iterative, allowing for analysis and adjustment of actions as needed. Each phase of the process was developed collaboratively with members of the partnership, ensuring knowledge transfer. Figure 3 highlights the phases of the adaptation component of the design process.

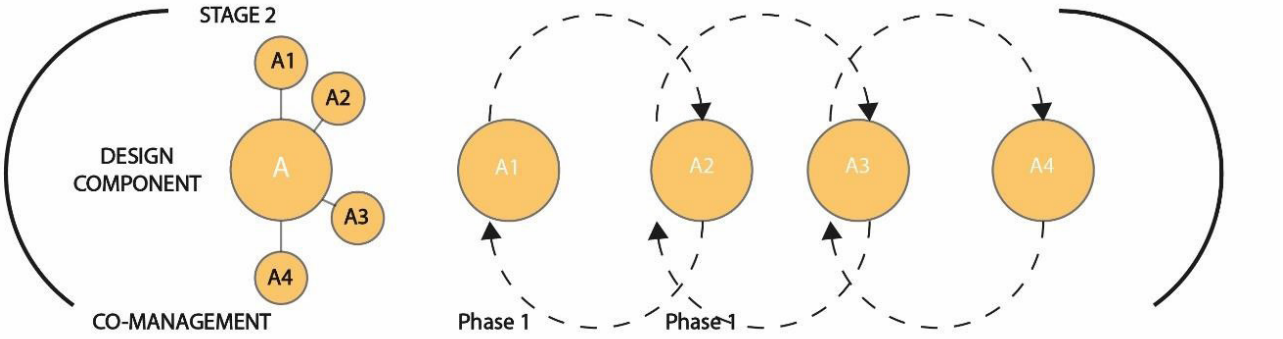

Figure 3. Stage no. 2 Co-management: Phases of the design adaptation process.
Note. Own construction from the implementation of the Project Intervention Methodology.

The adaptation component of the design addresses four phases:

A.1 Exploratory phase:
In this phase, the internal and external variables of each workshop associated with the network are identified. Factors such as dialect, ways, and forms of relating and communicating in the artisan community are determining elements for their characterization. Also considered are the technical skills of the artisans, the type of products manufactured, the raw materials used, the territorial characteristics that include road access to the workshops, and their digital connectivity, among others.

A.2 Conceptual and design phase:
This phase maps the associations between the collective meaning generated by the associations and the representations of forms of their physical and natural environment on the woven objects. It also analyzes knowledge in terms of extraction, transformation, and conservation of natural raw materials traditionally used in the manufacture of handicrafts.

A.3 Detailed design phase:
In this phase, product specifications are constructed based on the analysis of the data collected. In addition, preliminary actions are implemented to improve the technical execution of the product through training in vertical loom and crochet weaving techniques. The objective is to achieve certification of labor competencies for the 200 artisans associated with the network.

A.4 Production phase:
In this phase, the manufacture of products by each artisan workshop begins. The production capacity, availability of raw materials and tools, and production costs are constantly evaluated. In addition, the process is fed back to consumers' perceptions to outline the target market.

3. Results

The information obtained in the development of the four phases of the design adaptation component was analyzed in terms of the transition from the indigenous object of daily and non-ritual use to the artisan object, considering the material and intellectual variables that are determined by the geographic context. This analysis made it possible to identify some of the signs and symbols that a group of craftswomen from the Nasa - Paéz community have constructed over time.

To reflect the scope of the results obtained in the adaptation process, it is important to highlight that the development of the handicraft objects was carried out through a process of co-creation. This process involved constant interaction and experimentation, where the traditional knowledge of each of the participating artisan workshops was integrated.



Figure 4. Co-creation workshop: Design adaptation process. Note: The image corresponds to the activities of the detailed design phase executed in the artisan workshop in the municipality of Vitoyó. All rights reserved 2019 by NGO CODESPA Foundation. Reproduced by permission of the author.

The following sections focus, first, on the characterization of the indigenous object, exploring the dynamics related to their ancestral knowledge and practices. Secondly, the development of the indigenous handicraft object is addressed, integrating the characteristics of signs and symbols, specifically applied to the typology of the traditional backpack, which allows evidence of the transition from [indigenous object] to [handicraft object] from the four phases of design adaptation proposed in the methodology.

3.1 Characterization of the Indigenous object

The baseline of the design adaptation component was built from the identification of internal and external variables of each workshop associated to the network. Among the factors considered were geographic location, dialect, owned and adopted craft techniques, type of objects manufactured, and traditional and substitute raw materials.

The characterization process, before the intervention, showed that most of the artisans live in the high and medium mountain zones. Although the predominant language is Spanish, Nasa Yuwe is their native language, used mainly by long-lived artisans. The

most common techniques are crochet for weaving backpacks and the vertical loom, used as a complementary technique in the manufacture of parts of both the cuetandera and the backpack. Some artisans still use the ancient technique of finger weaving, one of the oldest in the territory,

To weave their textiles, they use sheep's wool, thread, or cabuya, although synthetic fibers currently predominate, which function as substitutes for the traditional raw materials of plant and animal origin. The typologies of objects common among the six artisan workshops were:

Mochila, Cuetandera, Jigra, Chumbe, Ruana, and Capisayo. Table 2 groups the information obtained in the characterization of the six artisan workshops.

Tabl2 2. Characterization of artisan workshops

Artisan workshop	No. Artisans	Native language	Weaving technique	Raw materials	Indigenous object typology
SEK DXI Municipality of Jambaló High mountain zone	55	Nasa Yuwe Spanish	Finger-knotting Vertical loom Crochet	Sheep wool Fique Polyester	a. Mochila b. Cuetandera c. Chumbe d. Jigra e. Ruana f. Capisayo
VITOYÓ Municipality of Jambaló High mountain zone	30	Nasa Yuwe Spanish	Vertical loom Crochet	Fique Polyester	a. Mochila c. Chumbe
WAKAT KIWE NASA Municipality of Toribío Mid-mountain zone	33	Nasa Yuwe Spanish	Finger-knotting Vertical loom Crochet	Sheep wool Fique Polyester	a. Mochila b. Cuetandera c. Chumbe
UMA Municipality of Tacueyo Mid-mountain zone	28	Spanish	Vertical loom Crochet	Sheep wool Polyester	a. Mochila c. Chumbe e. Ruana
Kwesxksxawnxi Municipality of Caloto Flat zone	30	Spanish	Vertical loom Crochet	Fique Polyester	a.Mochila c. Chumbe
KUMBIAXCA Municipality of Corinto Flat zone	24	Spanish	Vertical loom Crochet	Polyester	a.Mochila c. Chumbe

Table 3 a,b1,b2,c,d,e,f below shows the typologies of objects identified and relates the common and ritual uses assigned to them by the Nasa-Paez community.



Indigenous object	Traditional use
a. Mochila	It is an object with which the girls acquire identity as women by learning to weave it, measuring their capacity and knowledge. The first two knitted backpacks are kept according to tradition so that their energies and skills accompany them. Later, they learn to weave the ruana and the anaco.
b1. Cuetandera	Woven in synthetic fiber, it is a medium-sized backpack for daily use by the thë wala also called traditional doctor.
b2. Cuetandera	A small backpack specially woven in natural wool, it allows the thë wala to carry dry coca leaves to then mambear while performing rituals of refreshment, its use is occasional.
d.Jigra	Expandable body backpack is woven in fique and allows the transport to their homes of food grown in the Tul or those purchased in the marketplace.
c. Chumbe	A woven ribbon that allows newborns to be strapped to their mothers' backs, it is also part of the clothing and is sometimes knotted to the baton of the members of the cabildo.
e.Ruana	It is part of their daily attire, especially those made of natural dark brown sheep wool.
f.Capisayo	Garment in the form of a sackcloth or anaco used in special ceremonies.

The characterization process also included the identification of the methods of extraction, transformation and conservation of raw materials. It was identified that, traditionally, fibers of vegetable origin, such as fique, and of animal origin, such as sheep's wool, are used. However, in many cases these fibers are substituted by synthetic fibers since they do not require prior transformation and shorten the traditional manufacturing process.

The transformation of sheep's wool into yarn involves several steps: cutting the wool from an adult sheep, washing it, untangling it, cleaning it, and spinning it. If it is desired to modify its color, plants that provide the required shade are selected, and the fiber is cooked with the plants and then washed and dried. This whole process is guided by the lunar calendar.

Fique, a natural fiber of vegetable origin, also requires intense transformation processes before being woven. Its main advantage is that the region is one of the largest producers at the national level, which makes it easy to obtain. It is a resistant fiber that must be harvested in the shade. The process begins with the cutting of the maguey leaves, which are then manually scraped to extract the fiber. Subsequently, it is washed with water until a white color is obtained, and then it is dried in the shade. Finally, it is braided manually to achieve greater elasticity and obtain the thread. If it is desired to add color, the same steps of wool dyeing are followed, after the scraping phase.

Although fique and wool are materials that contribute to the natural sustainability of the territory, synthetic fiber is the second most used material for the manufacture of products. It is used to expand or complement the color ranges that natural materials do not offer and does not require physical effort for its extraction and transformation. However, the logistics for its delivery in medium and high mountain territories raise the acquisition costs. Table 4 shows the steps for the transformation of traditional fibers into yarn and the woven objects derived from each process.



a1. b. a2.

Raw material	Transformation	Weaving technique	Woven object
Animal fiber a1) Hand-spun sheep's wool a2) Hand-spun sheep's wool, with dyeing process from traditional plants of the territory.	**1.** Cutting the sheep's wool **2.** Wash **3.** Untangle **4.** Clean **5.** Spinning Color modification: **6.** Select plants **7.** Cooking fiber and plants **8.** Wash **9.** Dry	Vertical loom: It is the technique of interweaving threads at right angles using a loom. This is composed of the warp (threads arranged lengthwise along the loom) and the weft (threads placed horizontally). weft (threads placed horizontally).	a. Mochila b. Cuetandera c. Chumbe e. Ruana f. Capisayo
Vegetal fiber. b) Fique (Cabuya), Without dyeing process.	**1.** Cutting of the maguey leaves **2.** Manual scraping of the fiber **3.** Wash **4.** Drying in the shade **5.** Manual braiding **6.** Spinning Color modification: **7.** Select plants **8.** Cooking fiber and plants **9.** Wash **10.** Dry	Crochet: It is a succession of loops of yarn, intertwined one inside the other, using a needle. Finger-knotting: A technique of interlacing or knotting yarns performed without the use of tools.	d. Jigras

3.2 Indigenous handicraft object

In the words of Ana Cielo Quiñones (2003), craftsmanship is conceived as:

"Those forms of production of material goods before the industrial revolution have existed and remain by a complex set of social, cultural, technological and economic realities different for each historical moment" (p.1).

This has led to changes in the dynamics of the territories, where artisanal production processes are tending towards the automation of manufacturing, increased energy consumption due to the replacement of low-impact tools and processes, and increased consumption of synthetic and non-renewable materials. This generates pressure on small and family organizations, which are the most predominant in the territories. These handicraft production systems are characterized by the fact that they respond to subsistence economies where families living in the peripheral areas of the municipalities are the ones who develop the traditional handicraft trade.

To understand the transition from the indigenous object of daily and non-ritual use to the artisanal object, we sought to identify and record the forms of representation of the signs and symbols woven into the backpacks, since this type of object presents the greatest variability in figures, sizes and materiality. This allows us to explore the relationship of these signs with the physical and cultural landscape of the territory.

To this end, meetings were held with long-lived artisans to inquire about the meanings of the various figures that have been woven for many years in their territory. This dynamic was repeated in each artisan workshop with the objective of consolidating a total of 170 records. Figure 7 shows the digitalization of 30 signs belonging to the SEK DXI artisan workshops in the municipality of Jambaló and WAKAT KIWE NASA in Toribio, and is complemented by Table 6, which describes and categorizes the meanings of each of the recorded signs.



Figure 5. Digitalization of signs.

Table 6. Categorization and symbolic description.

ORALITY AND KNOWLEDGE TRANSMISSION		
1.	THE CONVERSE	The orality is the main traditional tool. It is the way Indigenous can express themselves, their feelings and their thoughts.
2.	THE THOUGHT	The know-how exchange offers a learning experience when walking through orality labyrinths.
3.	STOVE	Place where everyone meets around the fire to share and exchange food; It is also the place where elders used to educate, discipline, solve, and transmit ancient norms and laws knowledge of the Misak authority to others.
4.	MORROCOY	Town´s mythology is contextualized in the territory reading and the relationship between oral tradition and cultural dynamics.
5.	PEOPLE	The tulle ritual, the Windom job, and the food awareness.
6.	THE MEETING	Caldono is the main fique producer in the Cauca region, this characteristic has allowed this natural fiber to become a meeting point.
7.	THE DRINK	Corn tradition, drink, and food are a fundamental part of people's lives as a collective town.
COSMOGONY AND SPIRITUALITY		
8.	COSMIC SPACE	This is the sun representation, the father "Tata Sek o Tay" who is the one in charge of giving life and protecting NASA people. It also symbolizes the solar calendar, "The Wala", the man, and the cosmic space, a place where spiritual beings live.
9.	ELF	Protective spirit of Tul, the territory spirituality is the reserve of the ancestral guidance of its seeds and knowledge.
10.	BEING NASA ORIGIN	According to the legend the star fell in love with the lagoon that quietly lived high in the mountains. It began to conquer it and over time they understood each other and there was a lot of harmony, so the star with one of its points penetrated the lagoon eye, giving rise to Nasa being.
11.	DOWNPOUR SPIRIT	This is the protector spirit that gives life and allows sharing with those who need it. It comes from the lower region, going straight towards the mountain with thunders by its side.
12.	SPIRIT OF PARAMO	It is the protection and balanced spirit. He gets angry and appears when strangers and invaders want to harm the territory or to counter the downpour spirit: he goes toward them in a horse form or as a spiral to deviate them from the path.
13.	OUR LANDS RECOVERY	The community's survival is sustained by its cosmogony strength and its windom abundance.
14.	OUR MEDICINE	The origin and essential purity return.
15.	MANTEY DXI PHANDENXI	This is the Path from good to bad. The belly patience, the seed path.

WEAVING AND CULTURAL REPRESENTATION	
16. OVERFLOW	The weaving process is a way of representing the territory and people's traditions, knowledge, and experiences, much of its iconography shows up while weaving.
17. MINGA	The weaving process is a way of representing the territory and people's traditions, knowledge, and experiences, much of its iconography shows up while weaving.
18. WEAVER HANDS	The ruana is more than an accessory, it is the protection expression and represents the weaving hand's strength
19. THE WEAVER	A complementary vision between children and weaver hands who give life to the territory.
20. NAMUY LUTE	The weaving knowledge is enclosed within the loom framework: tulle, house, knowledge transmission, and women's strength.
21. SEEDS	The contour of the tulle´s job shapes couples' unions and families' foundations.
22. TULLE	The three balance, seed, soil, and water.
GENDER ROLES AND LIFE CYCLE	
23. LIFE GIVER WOMAN	When a woman is germinating seeds, she must do the awakening seed ritual from the second month. The whole ritual comprises three rituals that must be completed at the ninth month, to obtain a good seed.
24. PEASANT	In the peasant culture, women play an important role, they are always taking care of the home and housework, and they also help their partner in the field's daily activities. Women are a silent actor in a macho environment, where some of them are single mothers.
25. WEAVER PATH	The Spiral represents the original people´s life cycle, the Tampalkuari is a reference of continuity and survival.
26. COFFEE GROWING	To facilitate coffee crops, the farmer seeds the plants in rows, leaving a space between row and row, this way the harvesters can move easily between the plants during the harvest process
27. COFFEE BEAN	Coffee crop is one of the main employment sources for mestizo-peasant families in northeastern Cauca, this activity involves men and women at all process stages to contribute to the family incomes.
MEDICINAL PLANTS AND NATURAL BALANCE	
28. MEDICAL SHEET	Marijuana is a medicinal plant that allows the body to relieve itself, it is a natural element.
29. OREJUELA	It works as an element to calm, appease, and balance negative or positive natural environment energies; the excessive use of this plant makes the person calm.
INSTRUMENTS AND COMMUNITY CELEBRATIONS	
30. DRUM	It is one of the must-have instruments in community celebrations such as mingas, weddings, house building, and harmonization rituals.

The above categories allow us to understand the interrelationships between the meanings of each sign around the transmission of knowledge, the indigenous cosmovision, weaving as a symbol of identity and territorial representation, the importance of the role of women, and the deep connection between people, nature and spirituality.

The systematization of the figures and their associations fed the conceptual phase of the design process, starting with the identification of the collective meaning generated by the associations and the representations of forms of their physical and natural environment. Subsequently, progress was made towards a detailed design phase, which made it possible to interrelate the data obtained in the characterization phase, such as geographic location, dialect, own and adopted craft techniques, typology of manufactured objects and traditional and substitute raw materials together with their various conceptual approaches.

The result of the detailed design phase is a digitized register of signs integrated to a measurement system adapted to the capabilities of the craftswomen, which allows a clear interpretation to control dimensionally and proportionally the handcrafted objects. To achieve this, proportion concepts were implemented, defining the points and turns necessary to reach the required dimensions.

This information is consolidated in a technical sheet that expands the chromatic offer of the handcrafted objects. This is because Indigenous objects, as they move towards the handicraft industry, determine their meaning, in many cases, based on the attribute of the material. As Baudrillard (1981) points out, “Color is loaded with psychological and moral allusions. ...tradition subjects color to meaning” (p.31). This strategy makes it possible to adjust the production process according to the chromatic variability of the raw material. Figure 6 shows the color variations on the data sheets and the results obtained.



Figure 6. Datasheet records with color variation.

4. Conclusions

The development of the “Integrated Program for Productive Trade Transfer and Business Management to Promote Access to Slow Fashion Markets” demonstrates a valuable integrative approach, combining the preservation of traditional knowledge with adaptation to global markets. The project not only facilitated the artisans’ access to new economic opportunities but also catalyzed the strengthening of their cultural identity.

One of the relevant advances was the consolidation of a handicraft production system that respects and enhances the signs and symbols of the Nasa-Paez community. The digitalization of these symbols allowed not only their preservation but also their adaptation to new marketing contexts, ensuring that the identity and meaning of the objects woven by this group of artisans remain intact, even when they are integrated into broader markets. The systematization and digitization process highlights the importance of recognizing the symbolic value of the [*Indigenous handicraft object*] as an expression of the physical, social and spiritual environment of Indigenous communities.

A key aspect of the project was the implementation of a training, evaluation, and certification program in labor competencies for the artisans, to promote and recognize the learning and expertise acquired throughout the artisan lives of 200 women. However, this process went beyond technical training, as it addressed the structural barriers faced by indigenous women, such as low levels of schooling and linguistic limitations. To ensure effective and equitable participation, evaluation methodologies were adjusted, including translations into Nasa Yuwe, in an inclusive approach that achieved a transformative impact.

The project emphasizes that the strengthening of the artisanal production chain must be deeply connected to the territory and its resources, contributing to economic development from a perspective of environmental and cultural sustainability. For this reason, priority was given to the use of local raw materials, such as fique and sheep’s wool, which reflect environmental diversity and their influence on ways of conceiving, appropriating, and relating to the territories. This not only reduces dependence on synthetic materials but also places local knowledge and natural cycles as essential components in handicraft production.

Finally, the project has contributed to greater visibility and recognition of the role of women artisans within the Indigenous community of Cauca, relying on collaborative structures that create support networks and ensure both the continuity of artisan practices in the long term and economic autonomy through the empowerment of women artisans. In this context, the handicraft object emerges as a vehicle for the transmission of knowledge and traditions

that reaffirm identity and strengthen the sense of belonging to the territory. The project has contributed to improving the living conditions of the indigenous women of Cauca and is presented as a model to be followed in future initiatives that seek to empower vulnerable communities without compromising their identity or their relationship with the environment.

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A MATERIALS DESIGN PRACTICE BETWEEN CRAFTS, CREATIVITY AND TECHNOLOGY

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ABSTRACT| Combining craft and design processes with technologies and digital tools creates a positive tension in which a hybrid approach emerges. This approach can be recognised by the fusion of analogue and digital perspectives. This combination has demonstrated great potential in design research with and for new materials. In the experimental process of materials design, where the final aim is to foster responsible design, this practice is becoming more popular. It is argued that combining material tinkering, crafts practices and digital tools can expand the possibilities of emerging materials design and future materials applications, fostering local materials' cultural and economic values. This argument is supported by the resulting pathways from an international collaborative workshop organised by the National Taiwan Craft and Development Institute (NTCRI). The results reveal the potential of this combined creative practice by using a local biobased material from fish scales and 3D printing as a manufacturing method. Two pathways' narratives describe how this hybrid practice can be unfolded, highlighting the use of local materials and a collaborative, explorative approach. To conclude, recommendations for this hybrid and collaborative practice of materials design are elaborated based on the reflections of the workshop.

KEYWORDS | HYBRID PRACTICE, MATERIALS DESIGN, 3D PRINTING, COLLABORATION, BIOBASED MATERIALS

1. Introduction

Integrating digital tools into crafts and design has significantly influenced contemporary design practices (Marion & Fixson, 2021). This fusion of analogue and digital methods has gained attention across various design disciplines. In the territory of materials design, an emerging field within industrial and product design (Pedgley et al., 2021; Rognoli & Levi, 2005), this hybrid approach has been essential in generating novel material concepts, applications, and experiences (Nimkulrat, 2021). The potential for materials design to expand creative horizons and explore the development of materials and products through practices such as Material Tinkering (Parisi et al., 2017) and the incorporation of digital tools (Rognoli & Ayala-Garcia, 2021) has also been theoretical and practical studied.

Explorations in materials design, for example, using bioplastics algae-based and 3D printing for creating objects by Atelier LUMA, Studio Klarenbeek & Dros[1], have highlighted the promise of combining crafts and design practices that involve working with emerging DIY-Materials (Rognoli et al., 2015) and digital fabrication. This combination accelerates the development of material prototypes and final artefacts, highlighting the potential of self-making tinkering with materials and digital tools while fostering materials' embodied knowledge (Groth, 2016). In addition, incorporating digital fabrication is a great advantage because of its accessibility and speed, in contrast to traditional manufacturing processes, making it a valuable tool for experimentation and improvement (Romani et al., 2021). In this scenario, hands-on and digital practices complement each other, and designers, craftspeople or makers can actively participate in the process while modifying analogue or digital elements and tinkering with them. Within this dynamic, combining the self-manufacturing of materials and integrating digital tools and technologies, such as 3D printing, becomes an exciting practice for these practitioners.

Due to its experimental nature, this hybrid practice allows considering alternative and

1 For more information visit: www.designtransfer.udk-berlin.de/en/projekt/english-studio-klarenbeek-dros/

local resources as raw materials, creating new aesthetics and designed languages. In addition, it enables the exploration of production processes different from the industrial ones to favour ondemand local production, fostering local economies and aiming at environmentally sustainable manufacturing, seeking to reduce the use of materials and energy resources (Romani et al., 2023b).

Through this hybrid practice that includes materials tinkering, crafting and digital tools, the emerging materials design and its future applications can be leveraged, and local materials, cultural and economic values can be fostered. This argument, as well as a further investigation of this approach, is hereinafter supported by analysing two pathways from an international workshop involving designers and researchers with rich backgrounds in materials, craft, design, and digital manufacturing. This workshop brought together international participants to explore a biobased material from discarded fish-scales developed by the National Taiwan Craft and Development Institute (NTCRI) and its potential applications through 3D printing. Its objectives included exploring the material possibilities and collaborating for speculative materials and product design applications suitable for the local market. The workshop also intended to bring physical outcomes to present an enhanced and meaningful materials experience, demonstrating a commitment to drive production towards new perspectives of local circularity and sustainability. Participants' and organisers' insights from the workshop were collected and transformed into narratives for qualitative analysis.

This paper aims to emphasise the possibilities of this hybrid analogue-digital practice for materials design and reflect on how it can foster local materials' cultural and economic values. It explores how tinkering and DIY-Materials empower this process and how designers and researchers can foster collaborative, interdisciplinary environments to work creatively with locally available resources. The structure of this paper is as follows. Section 2 provides the background of this work. Section 3 is the methodology. Section 4 delves into the workshop journey. Section 5 discusses the two pathways. Section 6 resumes the final considerations and recommendations, and section 7 presents the conclusions.

2. Perimeter and related background

2.1 Crafts, Design and Digital tools

Crafts and design have always been related and are complementary domains (Bettiol & Micelli, 2014). Nimkulrat (2012) states that thinking and knowledge are inseparable from making in crafts and design practices. These practices are deeply intertwined, although they are recognised for their differences in approaches and outcomes (Rissati, 2009).

According to some scholars (Nitsche & Zheng, 2018; Temeltas, 2017; Tung & Chen, 2013), there are general differences between crafts and design and the practitioners who carry out these activities. Principally, differences are in methods and actions and the production size and scalability of the artefacts they produce. Often, craftspeople are seen as specialists in particular materials, carrying experiential processes for creation and fostering skills that result in cultural products. Their production process is self-contained, from concept to creation, frequently blending traditional techniques with modern methods. In contrast, designers usually receive diverse, interdisciplinary training, using various materials to address multifaceted design challenges. They employ a division of tasks, professionalised procedures, machines, and automation for efficient and scalable production, usually favouring standardisation to meet broad public demand.

Crafts and design practices have often been differentiated because the latter incorporates new tools and techniques provided by technological advances, and the former is related to ancient procedures and methods passed down from generation to generation (Lin & Lin, 2022). However, thanks to the maker movement, craftspeople now have enhanced access to technologies that enable them to design objects digitally and produce them using computerised tools (Nimkulrat et al., 2019).

This evolution positions craftspeople to adeptly embrace new technologies and explore digital realms. As Nitsche et al. (2014) predicted a decade ago, traditional crafts skills are increasingly merging with digital capabilities. These integrations open new opportunities for traditional and digital approaches (Nimkulrat et al., 2019; Zoran, 2013; Zoran et al., 2015).

Concurrently, the design field has changed, merging with crafts and with the advances of the DIY movement (Kuznetsov & Paulos, 2010). A brunch of design adopted approaches related to small productions, merging with self-fabrication and encouraging crafting and making with digital fabrication technologies. This shift underscores a resurgence in crafts and design, where selfproduction and digital technologies converge (Rognoli et al., 2015).

The integration of crafts and design with analogue-digital methods is increasingly gaining popularity. This process is characterised by creating objects with the support of a computer and digital fabrication machines (Zoran & Buechley, 2013). Integrating these elements changes the conception and experience of the materials, the final artefacts, and the design process. The convergence of these approaches -crafts, design, and digital- is forging new creative frontiers, material exploration, and applications that have yet to be discovered.

The perimeter of this study emphasises the use of designed and crafted biobased materials from fish scales and 3D printing (as part of digital fabrication methods) for the development of speculative artefacts.

2.2 DIY-Materials and Tinkering in Materials Design

Materials Design has been recognised as a field and practice within industrial and product design for almost two decades (Rognoli & Levi, 2005). The field has evolved, and much of the progress has been driven by rudimentary experimentation inspired by arts and crafts techniques, such as the process of 'making' and the increasing interdisciplinary collaboration (Duarte Poblete et al., 2023). Hands-on approaches and studies about materials, expressions and experiences expanded this field (Ayala Garcia, 2019). Furthermore, the DIY movement encouraged designers interested in the material side of design, which drove the increasing phenomenon of DIY-Materials (Rognoli & Ayala-Garcia, 2021), updating the vision of materials design practices and practitioners, i.e., materials designers.

By exploring the convergence of crafts, design and digital, enabling a hybrid practice within materials design, DIY-Materials can be connected as facilitators of the creative process of materials and product design. This approach is based on the contemporary materials design practice based on experimentation and materials experience (Giaccardi & Karana, 2015; Karana et al., 2015; Rognoli et al., 2015).

The DIY-Materials approach (Rognoli et al. 2015) can be summarised as a procedure that involves the creation of materials and artefacts, starting from personal or collaborative self-production, frequently applying methods of crafting and experimentation by the designer or makers. This process includes making materials using non-conventional ingredients as building blocks or enhancing pre-existing materials through modifications. These methods are closely related to material tinkering (Parisi et al., 2017). Materials tinkering is conceived as an experimental, iterative, and systematic stage in which creative manipulation and fine-tuning are used to discover material qualities and forms. It is based on learning-by-doing and trial-and-error to create samples and demonstrators. Materials demonstrators (Rognoli & Parisi, 2021) represent advanced prototypes exploring the formal potential and feasibility of future processes, shapes, and techniques (Béland & Granberg, 2023; Rognoli & Ayala-Garcia, 2021).

DIY-Materials and tinkering are recognised practices in the materials design process. These approaches can leverage emerging materials creation and their applications. In addition, these approaches are becoming particularly interesting for integrating Traditional Craft Knowledge (TCK)[2] into product design and vice versa.

The intersection of physical and digital experimentation, focusing on materials, crafts, and design, has been theoretically and practically explored. This intersection is

2 European projects which focus on the potential of traditional craft knowledge (TCK) are exploring DIY-Materials to achieve an enhanced economic and societal valuation of crafts and design in line with a future-oriented approach of heritage in Europe. For more information visit https://tracks4crafts.eu

evident in numerous instances displayed in museums, exhibitions, and online, showcasing their vast potential. One notable example is the GCODE. Clay[3] series, where 3D-printed artefacts are made using traditional crafts and modern techniques. This series includes various formulations, such as recycled clays, and employs 3D printing in a novel way to produce controlled errors that lead to new expressions and applications. Another illustrative example can be seen in Figure 1, where the exploration of crafting DIY-Materials and products through 3D printing exploits waste by converting it into a material filament for 3D printing artefacts.

In both cases, tinkering works at a hybrid level, which means experimentally adjusting both the physical materials and the digital settings of technological tools to enhance materials and product design and their functionalities, aesthetics, and experiences.

Significant advances have been made in the integration of digital tools with craft practices and emerging materials design and its applications (Kretzer, 2021; Moyer et al., 2024; Romani et al., 2021; Sauerwein et al., 2020; Veen et al., 2019; Yogiaman et al., 2020). This study recognises such integrations and explores them through a different lens, an international workshop. Moreover, this work explores how this hybrid practice can be further enhanced, e.g., using local materials, discussing the cultural and economic values of the region, and fostering interdisciplinary collaboration across borders.

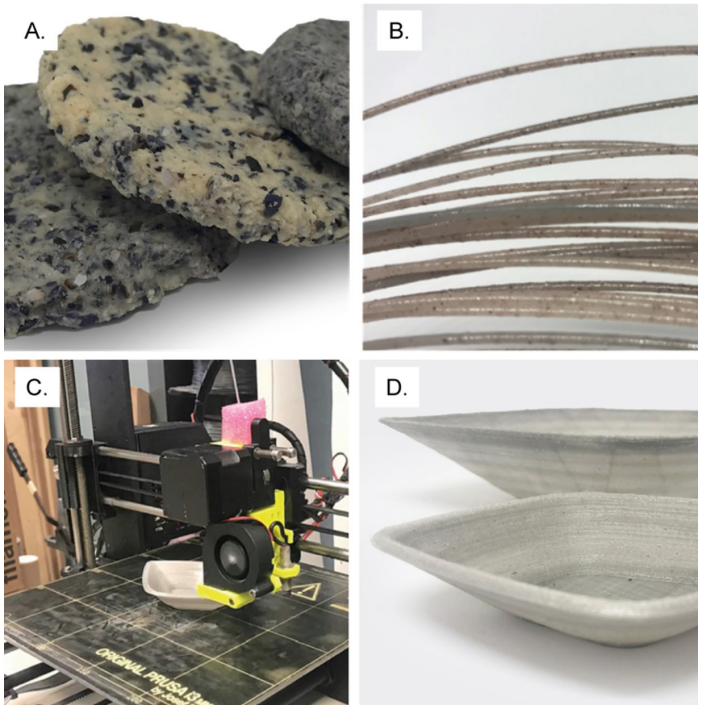

Figure 1 - Crafting local DIY-Materials and products based on mussel shells and a 3D printer. (a) crafted material by hand. (b)filament; (c) 3Dprinting process; (d) prototype. Credits: Chiara Stopponi (2018).

3 https://emergingobjects.com/project/gcode-clay

3. Methodological approach

To grasp the possibilities of hybrid analogue-digital practices in materials design, e.g., materials tinkering, crafting, and digital tools, and reflect on how these practices can foster local materials, cultural, and economic values, two pathways of design processes resulting from a materials design workshop are explored. The workshop functioned as a development platform where participants created new material applications and design processes, emphasising material design's practical and experiential aspects. At the same time, it served as a structured research approach to gather data and knowledge on hybrid analogue-digital practices (Ørngreen & Levinsen, 2017).

The workshop used hands-on experimentation as a research activity to delve into practical challenges and generate new theoretical insights (Reich, 2017; Schön, 2017). The workshop's agenda was defined to explore the potential of the materials design practice, venturing into speculative tinkering (Romani et al., 2023a) and maximising the value of fish-scale materials through the hybrid approach to advance these materials closer to market readiness.

A Material-driven Design (MDD) method was implemented to guide the participants. This method prioritises designing for Materials Experience (Giaccardi & Karana, 2015) and working with tinkering and DIY-Materials. This approach fosters the development of materials and their applications by treating the material itself as the starting point for exploration (Karana et al., 2015). Pragmatic exploration and direct engagement with materials were instrumental in transforming conceptual ideas into tangible outcomes (van Bezooyen, 2014).

To study this hybrid practice, the investigation is grounded in the principles of autoethnography. This qualitative research and analytical method integrate personal experience and self-reflection into both the research process and the analysis, providing deep insights into design inquiry (Forlano, 2021; Tomico et al., 2012). Autoethnography enables researchers to develop a personal and emotional connection to their research, which is crucial when engaging with materiality in design (Bochner, 2017). Such connections are essential for understanding the features, meanings, and experiences associated with materials (Rognoli, 2010). Among the authors of this paper, two attended as participants and two as organisers in the workshop, ensuring a diverse range of insights into both the design process and the workshop's creation.

4. "Re:Fish" workshop

The "RE:Fish" workshop belongs to the third phase of the "Fish Scale Project". It was launched in 2019 by NTCRI. This project aims to promote the development of contemporary crafts in Taiwan, with several instances of craft-based design interventions. In previous workshops, NTCRI collaborated with the

Materials Experience Lab to give fish scales waste a new appearance through art, crafts, and design. In the second phase, launched in 2021, NTCRI focused on transforming fish scales into a material that could be used in 3D printing, further studying such material, and developing equipment modifications to process it, such as custom extruders.

The third workshop was performed in 2023 through a collaborative development approach as a new phase of the Fish-Scale Project. It was designed to refine the material and propose product concepts for the local market. This paper focuses only on the third workshop and its outcomes.

4.1 Aims and objectives

Biobased materials, DIY-Materials, and other emerging materials derived from fish scales have been studied (Pasanaphong et al., 2024; Qin et al., 2022; Wu et al., 2021). However, the Re:Fish workshop had a specific focus. Its goal was not only to develop a new material or discover new applications for discarded fish scraps. Instead, the aim was to emphasise the possibilities of a hybrid analogue-digital practice for crafting materials and products and reflect on how it can foster local materials' cultural and economic values using a collaborative approach. Therefore, the workshop was necessary to examine the systemic aspect of the material and its stakeholders, as well as the significance of potential applications.

The workshop was structured as a "Research through Materials Design" (RtMD) initiative to improve the application of the already developed fish scale material, which could serve as an organic and locally sourced alternative to fossil-based resources. 3D printing technologies, crafts and design were leveraged. This workshop facilitated knowledge sharing among students and researchers from diverse geographic and academic backgrounds. Participants were encouraged to rethink the use of materials, promoting the transformation of waste into valuable creative resources and moving towards tangible applications. By considering the entire life cycle of the material, from collection to End-of-Life, this approach also aims to consider environmental sustainability. By raising awareness among local industries and potential stakeholders in developing this material and its applications, the workshop encouraged participants to think about design for economic and social sustainability and circularity.

4.2 Participants and teams

Thirteen were the participants of the workshop, creating a diverse group of students and researchers with expertise in crafts, design, materials, and digital fabrication. The selection was based existing collaborations with participants' home institutions, ensuring a rich but small mix of perspectives from Europe, Japan, and Taiwan to enhance cooperation and creativity. Participants were divided into three

interdisciplinary but heterogeneous teams—two consisting of four members each and one comprising five members—to maintain a focused and productive environment.

4.3 Support and Operations

Two organisers and five additional staff members from the organising institution supported the workshop. Operating in rotational teams, three staff members were present each day to assist with preparing materials, setting up machines, and purchasing necessary resources. This structured approach ensured continuous technical support and facilitated the participants' creative processes throughout the workshop.

The final, comprehensive analysis of the data, combined with the overall fish-scale project conducted by the organisers, falls outside the scope of this paper.

4.4 The format and agenda

Hosted by NTCRI, the workshop combined collaboration, fieldstrips, materials tinkering, crafting, and digital tools to explore meaningful materials design and applications, aligning with the spirit of the previous workshops and deepening interdisciplinary relationships. As shown in Figure 2, the workshop was structured into two basic phases with different activities, each designed to progressively build on the knowledge and skills from the previous steps. Each day of the workshop was programmed to last eight hours.

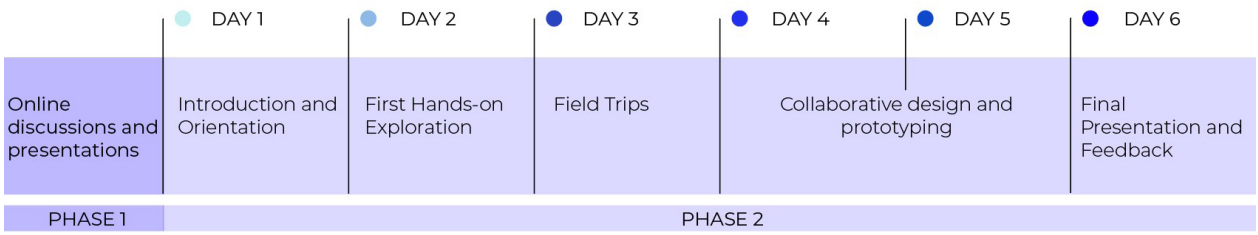

Figure 2 - Workshop timeline.

Phase 1. Preliminary phase

- Online meetings

The journey began with two preliminary online meetings of around one hour for presentation and short discussions with the organisers to provide participants with general information for the workshop. This stage set the foundation for the collaborative work that followed.

Phase 2. Physical workshop

- Introduction and orientation

On the first day, the workshop officially opened with a comprehensive introduction to the aims and objectives of the project. Participants shared their diverse academic and professional backgrounds, and the research centre's facilities were showcased. Working groups were mixed, combining expertise in crafts, design, and digital tools. This day was concluded with cultural exchanges, emphasising the importance of diverse perspectives and positionality in the research process (De Coen et al., 2023).

- First hands-on exploration

The second day marked the beginning of practical projects. Lab assistants introduced the formulas for DIY-Materials and provided training on the 3D printing tools. The developed paste biobased materials and custom-modified 3D printer tools were then showcased. Participants engaged in various activities: preparing and tinkering with materials, exploring digital software, and preparing gcodes for testing. The day was dedicated to brainstorming and integrating these newly acquired concepts.

- Field trips

On the third day, activities expanded beyond the lab setting. Participants visited a 3D printing machinery company to explore various additive manufacturing techniques and speculate on potential collaborations. Later, a visit to a fishpond of Tainan, a fish farm, provided insights into the local ecology and the processes of fish-scale removal. During this visit, discussions about logistics, such as the distance and stakeholders involved in raw material collection and transportation, helped participants understand the local production processes. These insights were crucial for conceptualising business strategies and connections for a circular material business, linking local ecological and production contexts.

To conclude, participants visited a local museum dedicated to the milkfish, the source of the scales used for material development. Museum staff provided insights into the current uses of this biobased by-product, including its applications, typically in cosmetics. This visit highlighted the historical significance of the milkfish in Taiwanese culture and drove group discussions on potential market niches where these materials could make a significant impact. Other traditional crafts from the region were showcased. The exploration enhanced participants' understanding of local biological resource use's cultural and commercial dimensions, thus increasing appreciation of the materials in the area.

- Collaborative design and prototyping

Days four and five were dedicated to intensive group work, where participants leveraged both digital tools and traditional crafting methods to foster a

collaborative and speculative approach to material and product design. During this phase, participants worked together to conceptualise, craft, design, and 3D print materials and artefacts. The facility provided two custom-modified 3D printers and a robotic arm for 3D printing paste-based materials for testing and prototyping. Participants also accessed conventional tools and spaces from the research centre's woodworking, rocks and ceramics labs.

These resources were used in various combinations to explore materials and technique integrations. Over these two days, groups were free to organise their tasks and collaboratively develop their chosen concepts, speculating on potential scenarios. By the end of the second day, the results demonstrated a blended approach to the projects, reflecting the diverse methodologies and creative insights contributed by each group.

- Final Presentation and feedback.

The workshop culminated on the sixth day with a presentation to an open audience, including university members and the community. This session served as a knowledge-sharing platform, showcasing the groups' projects, discussing the possibilities of this hybrid practice for crafting materials and products, and reflecting on how it can foster local materials' cultural and economic values.

5. Resulting pathways discussion and findings

The workshop's open and flexible approach to materials exploration empowered participants to explore multiple directions. This freedom led to the development of two distinct pathways, each guided by a hybrid practice of materials design that integrates material tinkering, crafts, and digital tools. These pathways demonstrate how expanding the possibilities of emerging materials design and future applications is possible. The pathways also emphasised how participants considered the role of local materials in adding cultural and economic value.

It is important to note that while the workshop explored three distinct pathways, this paper focuses primarily on two. The third pathway, though valuable, is not covered in this analysis because of limited data availability and overlapping with the two main pathways detected from this study.

5.1 Pathway 1: Materials-driven and analogue-focused

This pathway demonstrates the integration of material-driven and analogue techniques, enriched by the capabilities of digital tools to give textures and final shapes. The process commenced with participants examining base materials' properties, qualities, and composition. They focused mainly on enhancing their expressive-sensorial dimensions,

exploring colour and surface characteristics not investigated in previous workshops.

Participants started by assessing and experimenting with the elemental compositions, ingredients, and combinations proposed by the workshop organisers. After understanding the base material, they modified its qualities for new expressions and experiences. They selected additional natural and discarded scraps, such as bamboo and oyster shells, to grind and use as fillers. A typical tinkeringbased experimentation process involves various combinations to alter the base formula and the perception of the final materials.

Different locally sourced waste was searched for developing new compositions. Using the research centre's woodworking and ceramics labs, the participants found additional secondary raw materials and transformed them into powder. These powders were mixed, and quantities were changed with the base materials. Each new mixture underwent testing with 3D printing processes to ensure its processability while modifying aesthetic properties. This iterative process involved material and digital tool tinkering to ensure the printability of the materials and textures. The need for dynamic digital tinkering became apparent as new material compositions emerged. This involved continuous adjustments of 3D printing settings to accommodate the unique characteristics of each bio-composite formulation. Parameters such as extrusion speed and layer height were tuned with iterative loops of 3D printed small test pieces to observe the effects of different settings on material behaviour and 3D printing quality.

The participants followed some characterisation to understand the materials' features and experiences better. After creating a materials and texture palette, they prototyped preliminary artefacts to understand the application possibilities. For instance, adding shell scraps yielded a shiny, translucent material ideal for light-related applications. Another example involved the addition of wood scraps, which absorbed water during mixing and evaporated upon drying, altering the final shape of the 3D printed objects.

As participants explored the use of culturally significant local materials such as bamboo and shells, they recognised the potential of these well-known natural materials to create culturally relevant and economically valuable products with storytelling. They hypothesised the development of a circular materials business involving waste collectors, powder suppliers, material manufacturers, and crafts designers. The proposed materials design considered biodegradability due to the natural composition aiming for environmentally sustainable product disposal. The participants envisioned lamps and souvenirs for the local market. They were inspired during the field trip to the museum, where they understood the visitors' typical purchase of local products. This insight led to souvenirs showcasing local materials and cultural elements, presenting

a new opportunity for the local community. This approach highlighted the discussions on the cultural and economic benefits of using locally sourced materials, also fostering integration between traditional local products and digital technology. Images about the process and results of this group can be seen in Figure 3.

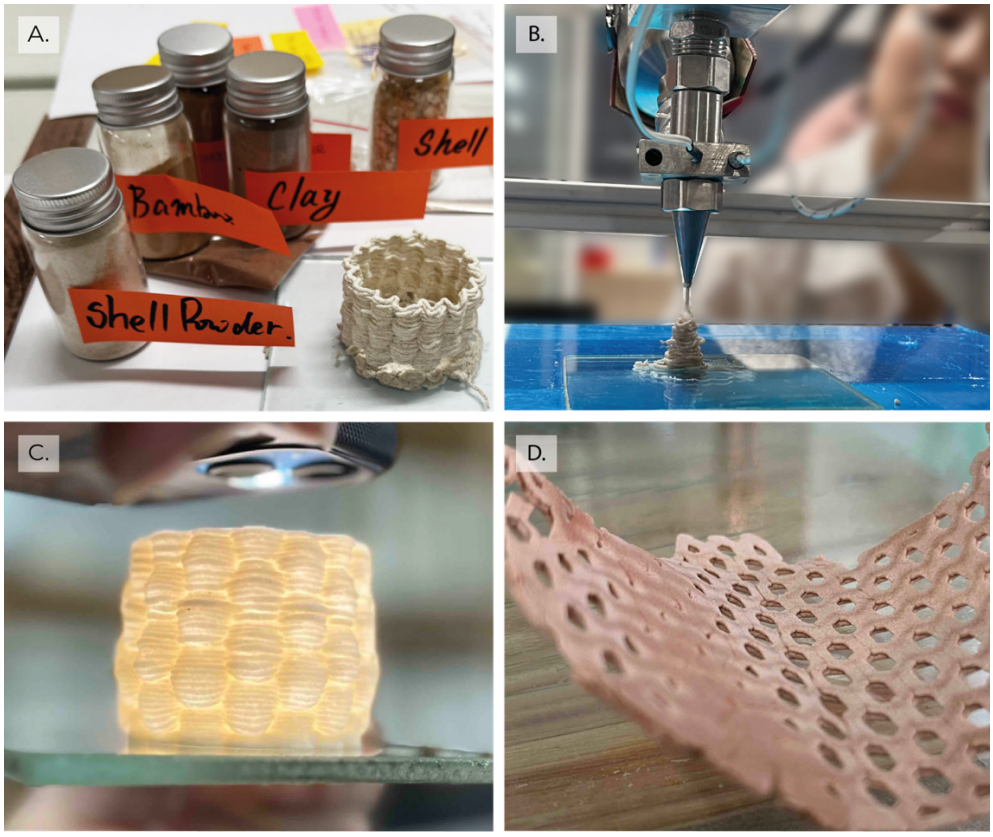

Figure 3 - Pathway 1 process and results: (a) Collection of additional ingredients; (b) Dynamic digital tinkering, observation and noted for replication; (c) new expressions and suggestions from the materials; (d) conceptualising with the material behaviour.

5.2 Pathway 2: Technology-driven and digital-focused

The second direction shows using digital tools and technologies as the main experimentation engine. It demonstrates how expanding the possibilities of emerging materials design and its future applications is possible. In other words, digital fabrication tools mediate the manipulation activity embedded in the tinkering approach for and with materials.

Participants in this group aimed to explore the possibilities enabled by 3D printing, shifting the focus to manufacturing technology. This fact meant that the tinkering activities focused on the technology's use rather than on the variation of the material formulations, investigating the changes in the expressive-sensorial qualities by modifying the 3D printing process parameters.

The participants' journey examined the impact of technologies on the development of emerging materials and their properties. This analysis also considered the interplay between crafts techniques, analogue and digital realms, and the dynamic interaction between technology and creativity. Experimenting with digital tools and technologies facilitated reflection on possible contaminations of local traditional crafts, exploiting new ways of valorising their cultural meanings.

The group started with a tinkering activity of experimentation within the digital domain, creating a set of 3D patterns and shapes to explore the potential exploitation of the main workshop's emerging material (Figure 4a). They then reflected on the possible integration of a bamboo-based structure in the 3D patterns, trying to combine the technical properties and the sensory qualities of the two materials. This choice implied complementary experimentation with bamboo and possible digital tools to process it, such as laser cutting, leading to different formal explorations (Figure 4b).

Considering the consolidated traditional crafts connected to bamboo, e.g., basketry from the milkfish museum, further investigation was performed on conventional crafts and this method of waving.
Some participants in the group had previous experience in making basketry, facilitating the integration of these traditional practices with modern techniques. This fusion combines weaving processes with contemporary materials and reinterpreting conventional materials, introducing bamboo into modern crafts. By experimenting with a first-person approach with bamboo bending techniques (Figure 4c), they embed this material in the 3D patterns.

The tinkering activities finally resulted in a set of 3D patterns with knitted-like bent bamboo, obtaining new potential expressive-sensorial qualities from the combination of materials and techniques (Figure 4d). The selected approaches unlock possibilities for valuing the digital-analogue context, creating innovative ways to combine crafts and design.

Figure 4 resumes this second pathway by showcasing the creation of "Trellis," a conceptual craft element designed for customised gardening structures. The Trellis concept is inspired by conventional structures made from intersecting pieces of wood or bamboo. In this case, Trellis was crafted as a lattice structure using the material from fish scale through 3D printing, in which bamboo was then interwoven to create gardening decorative objects. This group explored the potential of combining such emerging materials with locally valued materials like bamboo, which hold significant cultural and economic value within the community. By employing digitally driven structures for their integration, they envisioned innovative structures and combinations that could offer new material experiences on decorative applications. They hypothesised that communities of

craftspeople and makers could collaborate to develop craft products and enhance their skills to be competitive in the contemporary world, keeping the value of traditional crafts and enhancing them through digital domains.



Figure 4 Pathway 2 process and results: (a) exploration of the material possibilities through 3D printing; (b) experimentation with additional elements and digital tools during the tinkering activity; (c) combination of crafts, digital techniques, emerging and traditional materials, during the hands-on activities; (d) one result of the tinkering activity: Trellis (Product for Nature), a conceptual craft element for customised gardening structures.

6. Considerations

The two pathways resulting from the workshops demonstrate that the integration of practical tinkering approaches with materials, crafts, DIY-Materials and digital tools - such as 3D printing and laser cutting – broaden the possibilities in designing emerging materials and their future applications.

This approach encouraged reflections on the use of local materials and the valorisation of cultural and economic values, as well as encouraging discussion on environmental sustainability. Combining these emerging materials and concepts with meaningful materials from the local culture was also promoted through the pathways. They also recognised the role of craft techniques, seeking to activate the local economy by creating new products.

However, it is important to recognise that the promising and speculative results of this hybrid approach are not only due to the analogue-digital practice of materials design but also to the interdisciplinary collaboration between participants from different regions and the whole nature of the workshop. Collaborative dialogue between practitioners from various disciplines is essential for developing materials, products, and processes. In addition, immersion in the region where these materials and techniques were developed, complemented by participation in local cultural activities, allowed participants to learn from laboratory work and deepen their understanding through field experiences and everyday activities, such as gastronomic rituals and temple visits. This interaction with the local environment enriched the cultural dimensions of the materials.

Based on the outcomes of the workshop, recommendations have been formulated to implement this hybrid materials design practice:

- Comprehensive and graphic documentation. Thorough documentation is essential to capture the knowledge generated during all project phases. This documentation includes recording spontaneous conversations, experimentations, and all trial-and-error processes, which offer a rich source of learning. Complete documentation ensures that projects can be analysed, understood, and replicated by others in the future.
- Process reproducibility. Detailing the steps involved in material development and digital exploration is crucial. Documenting material compositions, fabrication steps, and
- methodologies allows others to replicate and validate findings, which is essential for materials design practice's evolution and scientific credibility.
- Expand knowledge. Developing skills in traditional techniques and new technologies enhances designers' ability to adapt to different production contexts and learn from other participants, e.g., through informal discussion with locals or though collaborative work. Expanding these approaches helps maintain relevance in an ever-changing field and promotes a more versatile and creative design practice.
- Encouraging collaboration. Interdisciplinary collaboration and diverse perspectives enrich the design process. Encouraging cooperation among artisans, designers, scientists, and other experts from different regions can lead to unexpected innovations and more culturally adapted paths.
- Local understanding. Deepening knowledge of local practices, materials, and meanings ensures that products are culturally pertinent and enhances the responsible use of local resources. Understanding the regional actors in the manufacturing process and how materials are managed can lead to more environmentally, socially, and economically concious practices.

- Valuing local resources. Recognising the abundance of local raw materials and using them responsibly can lead to lower the environmental impacts of materials and products. This approach aims to preserve natural resources and strengthens local economies by promoting industries based on locally available resources.
- Research collaborations. Establishing partnerships with research centres interested in promoting local culture and economy can amplify the impact and development of materials design. These collaborations can provide access to resources and foster to real development of new products.

7. Conclusion

The aim of this paper is to investigate the possibilities of the hybrid analogue-digital practice for materials design that lies between crafting, creativity and technology and reflect on how it can foster local materials' cultural and economic values. It explores how tinkering and DIY-Materials empower this process and how designers and researchers can foster collaborative, interdisciplinary environments to creatively work with locally available resources.

The results of the collaborative workshop organised by NTCRI in Taiwan exemplified the potential of this hybrid approach, highlighted their value, encouraged reflection on local culture, as well as on sustainability initiatives, and possible avenues for material design.

It underlined the importance of using local and abundant raw materials, ingredients, or other elements, employing traditional techniques and aesthetics specific to a region, and the relevance of creating material experiences and expressions in final applications to enhance product design.

This combined practice demonstrates significance in speculating about possible futures of production. Furthermore, interdisciplinary and cross-boundary collaboration proves to be efficient in this context. This research is significant for the fields of design and crafts and generates valuable reflections to advance on the intersection of materials design and emerging technologies.

To address the limits of this research, such as further composite material testing with digital technologies, future research should broaden the scope through different workshops and involve more participants. Furthermore, it is advisable to explore how these methods could be applied to other cultural contexts, as well as different types of materials and technologies.

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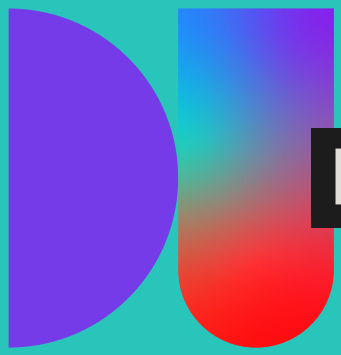

POSTERS

THE EVOLUTION OF GRAPHIC POSTER DESIGN: A META-ANALYSIS OF MEDIA TECHNOLOGY'S INFLUENCE ON CREATIVE PRACTICE

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TRACK 1: DESIGN FOR CHANGE

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

The Evolution of Graphic Poster Design: A Meta-analysis of Media Technology's Influence on Creative Practice

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Track 1: Design for Change

INTRODUCTION

In the digital age, the amalgamation of art, design, and technology has become a potent force for creative evolution. This research examines the reciprocal relationship between media technology and graphic poster design, focusing on the transformative role of digital tools such as TouchDesigner, After Effects, and Augmented Reality (AR) in advancing design practices. The study explores the works of notable designers, including Onformative, Yusuke Murakami, INSgraphizm, Takuya Onuki, Liu Zhizhi, and Toan Vu-Huu, highlighting the profound impact of media technology on design methods and audience engagement.



Figure 1. (From Left to Right) The User Interfaces of TouchDesigner, After Effects and the Visual Effect of Augmented Reality. Credit by Matthew Regan, Medium and Reydar.

RELATED WORKS

Takuya Onuki's "Hiroshima Appeals 2021," which utilizes AR ***(see Figure 2a)***, and Liu Zhizhi's poster for the 10th Beijing Film Festival, blending dynamic 2D and 3D elements ***(see Figure 2b)***, showcase the potential of media technology to push the boundaries of traditional design.



Figure 2. (a) Hiroshima Appeals 2021; (b) the 10th Beijing Film Festival - 2D & 3D Display.

Furthermore, Toan Vu-Huu's poster for the EDHEA Art School ***(see Figure 3a)*** demonstrates the capacity of technology to create dynamic, resonant designs.



Figure 3. (a) Journée portes ouvertes 2020 L'EDHEA; (b) Otherworks by the same Designer.

In parallel, Onformative's "Meandering River," created using AI and algorithm ***(see Figure 4, 5)***, and Yusuke Murakami's "Soundbook", developed through After Effects, illustrate the power of these digital tools in fostering complex, algorithmically generated designs and enhancing traditional design methodologies. Insgraphizm's motion poster for "Interstellar," a blend of digital tools including Cinema 4D and After Effects, underlines the potential of technology to captivate audiences and evoke thematic elements.

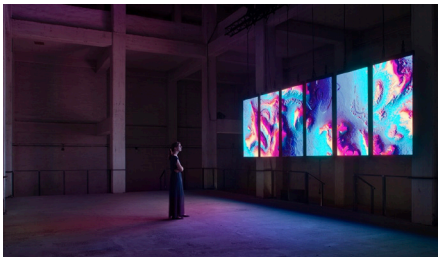

Figure 4. Meandering River, audiovisual art installation, 2018.

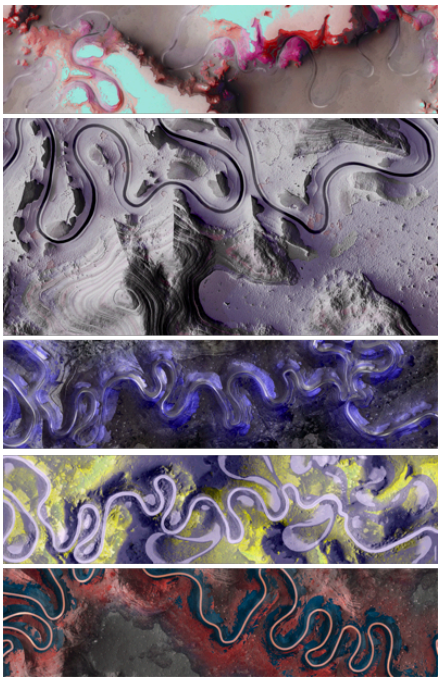

Figure 5. Work Details of Meandering River.

CONCLUSION

This research underscores a significant paradigm shift in graphic poster design, propelled by the evolution of media technology The findings highlight the potential of digital tools as catalysts for creativity and viewer engagement, emphasizing the interdependence of media and graphics and the fluid, dynamic nature of their interaction.

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ENHANCING CHILD DEVELOPMENT THROUGH INTERACTIVE ILLUSTRATION DESIGN IN PICTURE BOOKS: AN INTERDISCIPLINARY APPROACH

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TRACK 3: EDUCATION IN ART AND DESIGN

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

Enhancing Child Development through Interactive Illustration Design in Picture Books: An Interdisciplinary Approach

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Track 3: Education in Art and Design

INTRODUCTION

Children's picture books serve as a vital educational tool, offering a window into the world through which children initiate their journey of reading and comprehension. The role of illustrations within these books extends beyond decoration; they are foundational to a child's learning and development ***(see Figure 1 and 2).*** As the artistic and cultural landscapes evolve, so does the concept of picture book illustrations, with a growing emphasis on interactivity to engage young readers actively. This document examines the progression from traditional illustration to interactive design in children's picture books, highlighting the need to consider children's psychological and physiological characteristics in design to captivate and educate effectively.



Figure 1. Works from Carson Ellis, the Title of this Picture Book is Homes.

THE EVOLVING ROLE OF ILLUSTRATIONS

Traditionally, illustrations in children's picture books have been static, serving to complement the text. However, researchers note a paradigm shift towards illustrations encouraging active participation and engagement in children ***(see Table 1)***. The interactive illustrations can significantly enhance a child's reading experience by aligning with their cognitive development stages and aesthetic preferences.

The Dawn of Illustration: Ancient Expressions	The Renaissance Revolution: Art Meets Science	The Industrial Impact: Printing Press and Mass Production	The Golden Age of Illustration: A Flourish of Creativity	The Advent of Photography: A New Visual Language	The Modernist Movement: Breaking Traditions	The Digital Revolution: From Pencil to Pixel	The Rise of 3D Illustration: Adding Depth to Creativity	The Fusion of Art and Technology: Interactive and Motion Illustration
• **Ancient Cave Drawings**: Early illustrations on cave walls served as a means of communication and storytelling. • **Egyptian Hieroglyphs**: These pictorial writings were historical records and artistic expressions. • **Greek and Roman Pottery**: Illustrated pottery depicted scenes from mythology and daily life. • **Medieval Manuscripts**: Illuminations in religious texts conveyed spiritual themes and narratives.	• **Leonardo da Vinci and Albrecht Dürer**: Their works integrated scientific precision with artistic expression. • **Printing Technology**: Johannes Gutenberg's printing press facilitated mass production of illustrated books, spreading Renaissance ideas.	• **Woodcut Prints**: Allowed for both text and illustrations to be printed simultaneously, increasing efficiency. • **Lithography and Steel Engraving**: Enabled finer details and a greater range of tones, enhancing the aesthetic quality of illustrations.	• **Renowned Illustrators**: Arthur Rackham, Howard Pyle, and Edmund Dulac created imaginative and intricate drawings. • **Children's Book Illustration**: Iconic characters by Beatrix Potter and E.H. Shepard emerged during this period. • **Color Printing**: Became more affordable and widespread, making illustrations more engaging.	• **Impact on Illustration**: Photography complemented and enhanced traditional illustration, leading to greater accuracy and realism. • **Stylized and Abstract Representations**: Illustrators began to use photography as a reference, pushing the boundaries of illustration.	• **Experimentation with Form and Color**: Illustrators like Pablo Picasso and Wassily Kandinsky embraced abstraction and emotional expression. • **New Technologies**: Screen printing and lithography allowed for greater experimentation.	• **Graphic Tablets and Design Software**: Tools like Adobe Photoshop and Illustrator opened up new possibilities for creativity and efficiency. • **Global Reach**: The internet allowed illustrators to showcase work and access a global market.	• **3D Modeling Software**: Created lifelike and intricate images, revolutionizing fields like architecture, medicine, and entertainment. • **VR and AR**: 3D illustrations enhance user experience and offer interactive ways to communicate ideas.	• **Interactive Illustration**: Engages audiences by allowing viewer participation. • **Motion Graphics**: Brings illustrations to life through animation, prevalent in digital media.

Table 1. From Pencil to Pixel: The Evolution of Illustration. (Source: https://kreafolk.com/blogs/articles/evolution-illustration)



Figure 2. Works from Julia Sarda.

IMPORTANCE OF INTERACTIVITY IN ILLUSTRATION

Interactivity in illustration design plays a crucial role in aesthetic value and fostering a child's reading initiative and aesthetic development. By creating an environment that promotes exchange between family members and children, interactive illustrations can significantly enhance the reading experience. This approach can lead to a deeper understanding of content, improved vocabulary, and a more profound love for reading ***(see Table 2)***. Furthermore, interactive design can cater to modern technological advancements, bridging traditional storytelling with contemporary digital experiences.

Enhanced Understanding of Content:	Improved Vocabulary:	Fostering a Love for Reading:
Interactive illustrations often include elements that children can manipulate, such as characters or objects that respond to touch or gestures. For instance, in an interactive e-book, a child might tap on a character to hear it speak or see it move. This engagement helps reinforce the narrative and aids in comprehension. Studies have shown that children who engage with interactive illustrations tend to better grasp the story's plot and characters than those who read static illustrations.	Interactive design can integrate features like clickable words or phrases that provide definitions, synonyms, or pronunciation guides. For example, an interactive storybook might allow children to tap on unfamiliar words, hear them pronounced, and see their meanings. This feature not only helps in the acquisition of new vocabulary but also encourages curiosity and independent learning. Research by ??? indicates that children using interactive storybooks exhibit a 20% increase in vocabulary acquisition compared to traditional books.	By making reading a more engaging and dynamic experience, interactive illustrations can cultivate a lifelong love for reading. Features like animated scenes, sound effects, and the ability to make choices that affect the story's outcome make reading more enjoyable and immersive. For instance, a digital storybook might allow children to choose different paths for the characters, creating a personalized narrative experience. This level of engagement can transform reading from a passive activity to an interactive adventure, thereby nurturing a child's enthusiasm for books.

Table 2. The Three Contents of the approach.

INTERACTIVE STRATEGIES IN ILLUSTRATION

The study explores several strategies for interactive illustration, such as color interaction, which plays a crucial role in attracting the attention of children and stimulating their imagination. We discuss how designers can employ various color palettes and contrasts to create moods and themes that resonate with children. Material interaction is another strategy, where the physical aspects of the book, including pop-ups and varied textures, invite tactile exploration. Participation interaction, such as AR and VR technology, is also highlighted, where the narrative invites the child to become part of the story through decision-making or problem-solving activities.

CONCLUSION

Integrating interactive strategies in children's picture books is essential to creating an immersive and enriching reading experience. This integration's success lies in capturing a child's imagination and sustaining their interest, making reading a delightful and educational activity. We encourage designers to continually innovate and embrace interactivity in their illustration designs to cater to the evolving needs of young readers.

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TALAVERA OF PUEBLA, DESIGN AS AN ELEMENT OF CULTURAL IDENTITY OF PUEBLA, MEXICO.

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TRACK 3: EDUCATION IN ART AND DESIGN

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

Talavera of Puebla, design as an element of cultural identity of Puebla, Mexico.

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Track 3: Education in Art and Design

ABSTRACT | The Talavera pottery brought by the Dominican friars to Puebla, Mexico for reproduction in an area where they found similar characteristics of materials for its reproduction, in addition to qualified labor for its reproduction, where there are elements that maintain their characteristics of origin. These are typical of their culture, tradition and customs where the elements that are reflected in the ceramics for their production are expressed in an original way to maintain the characteristics of their origin, with the passage of time this acceptance becomes a recognition of their Puebla roots, today it is an element that gives it cultural identity and in which it has its designation of origin due to the manufacturing that has taken place over time.



KEYWORDS | Talavera, identity, cultural identity, ceramics.

In Mexico, talking about Talavera is a reference for ceramics that is a visual element of the state of Puebla. This type of craftsmanship has characteristics that make it special. Its origin comes from Spain in the region that bears its name in the area of Toledo known as Talavera de la Reina. In Mexico it made its appearance in the 16th century, which has elements that make it different and that show its elegance in its illustrations that cover a glazed clay with elements such as tin, this technique is brought to Mexico by the Dominican friars, described by the chronicler Mariano Fernández Echeverría y Veytia (1612) where he mentions this special glazed blue ceramic with its own characteristics.

The concept of cultural identity comes with the evolution of Talavera, since this cultural manifestation becomes an amalgam of tradition, culture and appropriation of people, which becomes an element of union of a society, this phenomenon that is develops within the state of Puebla, it does not occur massively throughout the entire territorial extension since it only occurs in the city of Puebla since at the state level it has competition with more popular products, since crafts are made in each region with clay with a more everyday intention and not what happens with this one that could have had a utilitarian use in more economically favored sectors. Hugo Leich (1986) mentions where he describes the areas and workshops authorized in the 17th century in the states of Puebla and Tlaxcala, due to the "ordinances" where some of them are still in force today, there are fewer of them, but those that are It represents this tradition that becomes the pride of the city and its residents. These two states of Mexico share the designation of origin, but the city of Puebla is recognized.

La Talavera has generated belonging and a tradition, which makes it an element of fraternity and identity for the people who live there. Cultural identity is defined by many factors such as religion, customs, values, traditions and in this case by the symbols, elements and color palette that surrounds this type of crafts. Collective memory is an important feature, which is what maintains the validity of these elements found on facades, traditional kitchens or vessels that can be used for daily or decorative purposes.

In the case of Talavera, throughout the centuries of its existence in the area of Puebla and Tlaxcala, it has been considered an element that has grown with the community and with their culture, where it has remained on par with many events that have marked history and traditions. Talavera has maintained this ability to transform itself in certain manufacturing processes and maintaining the basic principles of its decoration and essential materials to be recognized and appropriated as a distinctive symbol of the people who were born here. This type of craft has won the attacks of interculturality, maintaining its visual elements, color palette and the clay with which it is made, today it is recognized and distinguished from others that are made in the same region, by its lines. , color, the same clay that is different from that used by its popular competition that has been adapting to the moments of the state of Puebla and the manipulation carried out by the artisans for a search in the innovation of processes, themes and colors that can be found in those pieces, which gives a diversity with the other ceramics that are not considered Talavera.

In Puebla, given the history of the city, the establishment and flourishing of a culture affected by the arrival of the Spanish and the appropriation of elements brought as part of that luxury and non-popular tradition such as the Talvera, marks in society an element of identity that over time is appropriated and defined as an identity element of the Puebla culture.



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DIGITAL FASHION EDUCATION: A COLLABORATIVE APPROACH TO PREPARING STUDENTS FOR INDUTRY 4.0

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TRACK 3: EDUCATION IN ART AND DESIGN

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

Digital Fashion Education: A Collaborative Approach to Preparing Students for Industry 4.0

Gili Azran, Department of Jewelry and Fashion, Bezalel Academy of Arts and Design, Jerusalem

Track 3: Education in Art and Design

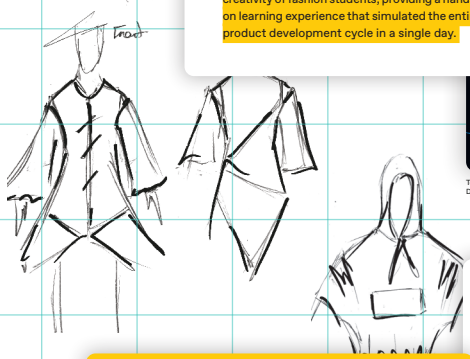
The fashion industry is undergoing a transformative shift towards digitalization and sustainable practices. As educators, it is crucial to equip students with the necessary skills and knowledge to thrive in this evolving landscape. This poster presents a collaborative initiative between academia and industry leaders, aimed at bridging the gap between traditional fashion education and the cutting-edge technologies shaping the future of fashion.

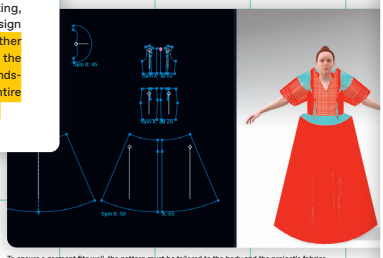


This image shows the final project submission after students completed the process from initial sketches and digital simulations to the finished sewn product. The fabrics and patterns used were scanned in advance.

In a unique "Product in a Day" course, Bezalel Academy of Arts and Design in Jerusalem partnered with Delta Galil, a global leader in innovative design, manufacturing, and marketing, and Browzwear, a pioneer in 3D clothing design software. This collaboration brought together the expertise of industry professionals and the creativity of fashion students, providing a hands-on learning experience that simulated the entire product development cycle in a single day.

These sketches were created after receiving the topic and concept, taking into account the textiles and patterns from Delta.





To ensure a garment fits well, the pattern must be tailored to the body and the project's fabrics. Digital simulation allows students to test the fabric before sewing and refine their projects.

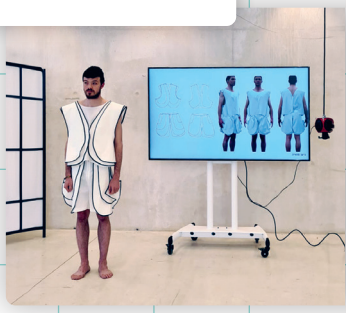
The event challenged students to create leisurewear outfits using Browzwear's VStitcher software, which allows for the creation of digital twins of physical garments. Delta Galil provided custom 3D garment blocks, digital assets, and physical fabrics, enabling students to explore volume, texture, and draping while working with industry-standard materials.

Under the guidance of Bezalel Academy's faculty and Browzwear's experts, students developed patterns based on Delta Galil's blocks, designed their garments, and simulated realistic renderings before stitching and presenting the physical pieces. This immersive experience not only taught students the technical skills required for 3D fashion design but also fostered their creativity and problem-solving abilities.

This collaborative approach to fashion education not only enhances students' technical skills but also cultivates a mindset of innovation and adaptability, crucial for navigating the ever-changing landscape of the fashion industry. By embracing digital solutions and optimizing non-digital processes, aspiring fashion professionals can create unique experiences and contribute to a more sustainable and efficient fashion ecosystem.

The collaboration between Bezalel Academy, Delta Galil, and Browzwear highlights the importance of industry-academia partnerships in preparing students for the future of fashion. By exposing students to cutting-edge technologies and real-world challenges, this initiative equips them with the necessary tools and mindset to succeed in an industry that is rapidly embracing digitalization and sustainable practices.

Furthermore, the integration of 3D design software into the academic curriculum empowers independent designers to establish their own design studios and cater to one-on-one clients, expanding their career opportunities and fostering entrepreneurship in the fashion industry.



This image displays the result of a digital fashion course submission. After scanning the fabric and simulating it on an avatar, the model is shown in the picture. The combination of digital simulation, the avatar, and the patterns allows students to be creative and gain a deep understanding of pattern making.

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GLOBAL COLLABORATION FOR SUSTAINABILITY: AN INNOVATIVE EDUCATIONAL APPROACH

TRACK 3: EDUCATION IN ART AND DESIGN

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

Global Collaboration for Sustainability: An Innovative Educational Approach

Track 3: Education in Art and Design

AHEA Association for Higher Education and Accreditation

ISEP International Student Exchange Programs

COIL Collaborative Online International Learning

GNLA Globally Networked Learning Academy

Collaborating with ***AHEA/ISEP/COIL/GNLA*** offers students a unique global connection. Many haven't traveled abroad, so this networked course lets them engage with diverse cultures remotely. Through intercultural projects and discussions, students broaden perspectives by interacting with peers from varied backgrounds. I, from Iran, see this as a starting point to connect my country to the world despite increasing isolation due to government restrictions. The program cultivates essential intercultural communication skills and a global mindset. We're eager to facilitate cross-border collaboration and knowledge beyond classroom limits.

Cross-Cultural Collaboration for Sustainability: Insights from a Globally Networked Education Project

This poster examines a collaborative project between international students developed through the **AHEA/ISEP/COIL/GNLA**. The goal is for **4D (animation) and Sustainable Systems for Buildings** students to collaboratively propose solutions for sustainability challenges worldwide, guided by the UN Sustainable Development Goals.

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AHEA/ISEP COIL/GNLA program

spring 2023

Development Process

1 Collaboration Contract

My peer and I drafted a collaboration contract outlining guidelines to enable an effective partnership. We established shared expectations for communication, conflict resolution, and accountability to facilitate a successfully collaboration.

2 Crosscultural Icebreaker

We designed impactful icebreakers to foster cultural exchange and empathy among diverse students. Crafting connective experiences broke barriers, cultivated understanding, and enhanced collaboration between differing worldviews.

3 Identifying Intersections Between Our Courses

The next critical step was identifying intersections between our three courses to find potential common ground for the COIL collaboration. In an online meeting, we each described key aspects of our individual courses while capturing keywords on a Miro Board. We then highlighted areas of overlap or possible connections between the courses.

4 Sustainability as a Common Theme

Our analysis revealed sustainability as a common theme between the courses. Though we explored sustainability distinctively, the UN's 17 Sustainable Development Goals provided a shared framework. We decided to use these goals to guide our integrated curriculum and collaborative project.

5 Final Project's Instructions

Our collaborative course converged on a project where students would identify a real-world problem using the UN Sustainable Development Goals, research it, approach the issue, ideate solutions, and propose an approach, communicating it visually. We structured the 9-week project into timed phases: introduction and team connections, topic development, research, ideation, proposal creation, production, and presentation.

Socially and Environmentally Responsive Initiative

Visual Communication and Architecture Collaborative Project

The 7-week project takes students through establishing cross-cultural connections, researching the site and model, developing sustainability proposals, designing branding, adapting systems, simulating features, animating, presenting, and final deliverables. This comprehensive initiative enables students to apply analysis, 3D modeling, animation, and collaboration skills while creatively designing for environmental and social impact. Peer feedback and international cooperation help students synthesize diverse views to refine their work.

Week 1 Oct 1-7 — **Introduction and Connection**

Students have their first video conference to start intercultural interactions. They play an icebreaker game with questions to introduce themselves, share facts, and build agreements. Students also share cultural backgrounds to increase mutual understanding. More video conferences are scheduled to continue developing connections throughout the program. **The initial activities and relationship building set the foundation for meaningful collaboration.**

Week 2 Oct 9-13 / **Week 3** Oct 16-20 — **Research and Brainstorming**

Students select a building site and researched climate, social issues, and environmental concerns in the surrounding area. Referencing UN Goals, they identify improvement opportunities. After placing their Revit model on the site and analyzing energy consumption, they research socioeconomics, culture, community needs, and local environmental issues. With this research, students brainstorm building adaptations to respond to the climate and provide social and environmental benefits per UN goals. They then propose solutions for social and environmental improvements based on their research.

Week 4 Oct 23-27 — **Logo Sketch and Solution Proposals for the Building**

Students brainstorm logo designs that reflect the vision and values of their organization. Students analyze the climate data for their building site, considering factors like temperature, humidity, wind patterns, and solar exposure. Based on this climate analysis, they propose architectural adaptations to optimize the building for the local environment.

Week 5 Oct 30-Nov 3 — **Storyboarding and Solution Proposals for the Building**

Students storyboard and plan their logo reveal videos. They analyze the modified Revit model to evaluate energy performance vs. the baseline. Students align passive proposals with sustainability goals in their logo design. To visualize ideas, they create concept sketches and renderings showcasing proposed enhancements. Students share feedback to refine proposals.

Week 6 Nov 6-10 — **Submission**

Students animate initial logo reveal drafts and provide peer feedback for improvements. They then refine animations based on critiques to clearly convey logo meaning. Students also justify proposed passive strategies with simulations, quantifying potential energy savings and comfort improvements. They verify alignment with sustainability and performance goals.

Week 7 Nov 13-17 — **Animations and Finalizing the Proposal +Reflection Video**

Students present research, logo animations, and building conclusions, explaining their analysis and decisions for optimal location-based systems.

For a final video, students record scripts, visuals and narrative to showcase their work. They edit this into a cohesive, engaging video summarizing research, proposals, logos, and learning.

Objectives:

- Foster intercultural exchange and teamwork between students.
- Facilitate direct global communication and idea exchange between students to broaden worldviews.
- Serve as a pilot collaboration between the two universities to open the door for more extensive global partnerships and networked learning projects worldwide.
- Equip students with real-world experience in sustainability problem-solving to empower them as ambassadors capable of spearheading positive change.
- Inspire creative thinking about sustainable community-oriented designs aligned with UN Sustainable Development Goals.



"My peers for this project are very kind and welcoming people. I got to learn a lot about their cultures, favorite foods, and love for family. I am very excited to work on this project and learn more from them."



"We all played the card game and chatted with each other, and overall had a very good time. I'm very excited to meet with them again, and work on this project together with them! They all seem like incredibly nice and smart people."

Final Animations

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HUMAN MOBILITY AND DESIGN

Author: Lilian González González
Design projects: Sofía López Sánchez, Rodrigo Ortiz Cruz, Eduardo Murillo Zavala
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TRACK 4: TRANSLOCALITY

DESIGN ACROSS BORDERS UNITED IN CREATIVITY

HUMAN MOBILITY AND DESIGN

Author: Lilian González González , **Design projects:** Sofía López Sanchez, Rodrigo Ortiz Cruz, Eduardo Murillo Zavala
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Track 4: Translocality





INTRODUCTION

During the research seminar course, students of the industrial design bachelor's degree must develop design projects based on complex social problems that provide design solutions for the common good. in this poster you can see the solutions proposed by some of the students.

The problem addressed here is the migration and homelessness that are relevant issues today that impact various aspects of society, such as decent employment, the reduction of inequalities, peace and justice. In this study, we focus on understanding how the current social context affects people's perception of migration, within the framework of the Sustainable Development Goals of the World Health Organization.

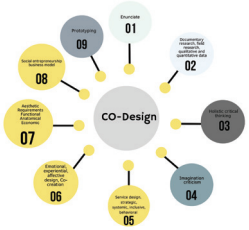
These research projects were carried out in order to generate products or services that can assist in the daily life of this social problem for the common good.

According to the National Migration Institute in 2022, 444,439 migrants from different nationalities, mainly from the northern triangle,
Honduras (72,928), Guatemala (69,515) and El Salvador (27,245) were registered in Mexican territory. This represents:



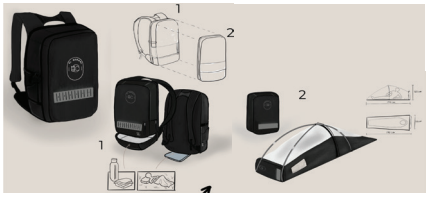
METHODOLOGY

The students across different stages: accompanying by design methodologies and mainly ased on the "Designing Social Experience for the Common Good" Guide and the theoretical framework "Design from Peace", a product of González, Lilián's doctoral program.



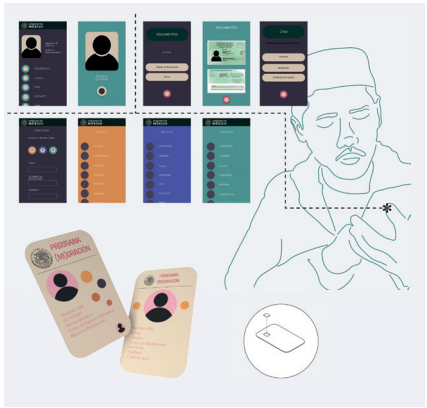
DESIGN SOLUTIONS

1. **"El morral",** by Sofia López Sánchez.
This bagpack is designed for homeless people who do not feel safe leaving their belongings in one place and need to take them with them, as well as not having a stable place to sleep. It is a portable, easy to transport, durable and accessible, avant-garde backpack for homeless people with foldable shelter, hygiene products, inflatable pillow and thermal blanket .



2. Identification Card and App for migrants, by Rodrigo Ortiz Cruz. The app is a tool for the migrant designed to give them autonomy, freedom, and a proper way to exer- cise their rights under the rule of law. The objective of this project is to create a path not only for access to the Mexican legal system, but also to generate a legal and digital identity that helps to make visible the migrant and their temporary or permanent status and integration in the country. At the same time, it provides the opportunity to improve their overall quality of life through courses in different areas of knowledge to apply and train themselves in different fields and possible professions.

The migrant obtains an object that provides them with a sense of belonging and physical identity that will be digitized and secured every time they take a course or experience a change in their life as a migrant in Mexico.



3. "Structure to load" by Eduardo Murillo Zavala
After conducting interviews at the Casa Peña shelter in Mexico City, it was discovered that they face a big problem regarding their personal belongings, since most of them do not have backpacks that can withstand the physical demand of the long trip through Mexican territory. This problem is especially difficult for those traveling with children, since they must carry their children's belongings in addition to their own.

The project consists of an ergonomic structure designed to protect and carry the objects of migrants in irregular transit situations. The design has a rigid external structure that conforms to the user's back, allowing them to carry a large amount of weight.



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Escuela de Arquitectura, Arte y Diseño

WORKSHOP ABSTRACTS

DESIGNING FOR SOCIAL JUSTICE AND HUMAN RIGHTS: BUILDING NETWORKS FOR VICTIMS OF VIOLENCE AND FAMILIES OF THE DISAPPEARED

Frederique Krupa

ABSTRACT |

This 90-minute workshop explores the intersection of design and social justice, focusing on creating international education-based networks to support families of the disappeared and victims of violence in Latin and South American communities. Participants will engage in collaborative activities and discussions to understand how design can be a powerful tool in addressing human rights issues, preserving memories, and fostering social interventions.

KEYWORDS | DESIGN FOR SOCIAL INNOVATION, DESIGN FOR SOCIAL JUSTICE, HUMAN RIGHTS, PARTICIPATORY DESIGN, VICTIMS OF VIOLENCE AND DISAPPEARANCE

CMF STRATEGY DESIGN USING GENERATIVE AI

Juan Carlos Marquez Cañizares and Grisaelda Oyervides

ABSTRACT |

Objectives:

Identify the potential of generative AI for CMF strategy creation.
To provide participants with state-of-the-art tools for CMF strategy design using generative AI.
Develop skills for the application of CMFs in products.

Audience: product design professionals and students

Number of participants: 20

Agenda:

15 min Introduction to CMF strategy
25 min Identification and analysis of trends and users
20 min Moodboard development
20 min Generative AI tools for CMFs
10 min Break
20 min Design and communication using prompts
70 min Implementation of CMF strategies

Equipment required:

1 color laser printer
100 sheets of opaline for the printer
20 scissors
10 glue sticks

5 double-sided tape
5 transparent adhesive tape
3 blue masking tape
10 white Foamboard
20 sharpie markers of different colors
200 post its of assorted colors

Space requirements: projector, worktables (6), chairs with casters (22), (5) whiteboards with casters

KEYWORDS | CMF, AI, PRODUCT DESIGN

NEW TURN IN DESIGN RESEARCH AND EDUCATION - A PANEL DISCUSSION

Satu Miettinen, Nicola Morelli, Mari Suoheimo, Heidi Pietarinen and Amalia Amalia de Götzen

ABSTRACT | This proposal suggests a panel discussion about the new turn in design research and education.

This panel explores the new turn in the design research and education paradigm where there is a higher recognition of addressing the systems and complexities. The design discipline is evolving with the social, economic, and technical systems it interacts with, and this context is now severely challenged by multiple crises concerning environmental aspects, social inequalities, wars, migrations, and deep cultural changes.

This panel discusses the turn in the service design paradigm from the micro-level operational and methodological practice towards designing at the macro level, which concerns more complex and strategic systems. This turn is discussed first through a literature review, then with service design researchers in a co-design workshop, and verified through data collected in industry interviews. This panel asks if a new turn in service design research and education has occurred.

It was already Papanek (1971) who initiated the discussion of complexities in design. The issues of sustainability and social context need to be considered when designing. Buchanan (2001) addressed the knowledge production and the epistemologies of design. He was asking for the value of design research. Krippendorff's (2006) book "The Semantic Turn" has been a cornerstone in outlining a new way to look at design as a science that helped designers both to review the semantic concerns in design history and present the philosophical background to this as well as argue for the user-centredness that the new technologies pose the design artifacts. This panel proposes that design research and education have grown into a new era and the questions they are facing are even more complex than in the last turn.

KEYWORDS | NEW TURM, PARADIGM SHIFT, DESIGN EDUCATION, DESIGN RESEARCH, PANEL DISCUSSION

DEAR AI, WHAT DO I WANT TO SAY AND WHAT DOES IT LOOK LIKE? TOOLS AND METHODOLOGIES FOR IMAGE MAKING

Jasmin Rubinovitz and Nomi Geiger

ABSTRACT | In the era of information overload, designers face the challenge of navigating a constant stream of thoughts, ideas, and data. This workshop explores the art of choosing compelling subjects, finding personal connections, and defining one's voice. Participants will explore methodologies for visual self-expression by using classic image-making techniques alongside innovative tools, including artificial intelligence (AI) capabilities such as generative text and image models. They'll gain hands-on experience with cutting-edge editing and image creation tools, providing them with diverse avenues to express the□mselves visually.

The workshop is inspired by a successful 13-week class we recently piloted at a renowned design academy. This class combined visual design and image-making techniques with cutting-edge AI tools and capabilities, providing insights into the creative process in today's digital and AI-driven era.

ipant in selecting a topic they are curious about. We'll explore identifying the values associated with the chosen topic alongside various searching techniques to uncover valuable references that can aid in the creative process of expressing those values.

Stage two: (40 minutes) Introducing external tools and datasets
Short lecture: AI and generative models tool

In the second phase of the workshop, participants will engage in a hands-on image-making activity. They will utilize the theme and references chosen in the first part of the workshop and introduce new tools that harness generative AI to further explore and perfect their design ideas. The goal is to create an original image that effectively communicates the intended message.

By the end of the workshop, participants will leave with a unique image created in collaboration with the latest advancements in generative AI.

Wrap up and questions (10 minutes)

About us:
Two professionals from contrasting fields - a computer scientist specializing in AI and technology, and a graphic artist adept at creating images and designs. Our diverse expertise allows us to collaborate uniquely in teaching initiatives.

Equipment Needed:

Screen / projector
Laptops with internet access
Participants will need to register for an account on an online platform, announced before the workshop, as we anticipate that the generative AI tools ecosystem will continue to evolve rapidly. We will select the best platform based on its features and suitability for the workshop's purpose.
Drawing materials (optional)
Printer (optional)

KEYWORDS | ARTIFICIAL INTELLIGENCE, IMAGE MAKING, VISUAL COMMUNICATION, GRAPHIC DESIGN, GENERATIVE AI, AI, ART, AI IN ART AND DESIGN, TECHNOLOGY, EDUCATION, SELF EXPRESSION, HUMAN AI COLLABORATION, DIGITAL TOOLS, INNOVATION, HANDS-ON LEARNING, INSPIRATION, ORIGINALITY, CREATIVE PROCESS, DESIGN EDUCATION

PHYSICALISING SYMPTOMS: THE ROLE OF MATERIALS IN SUPPORTING INTIMATE DATA COLLECTION TO IMPROVE AWARENESS AND COMMUNICATION IN HEALTHCARE.

Ginevra Terenghi*[ab] , Arthi Manohar[a], Serena Cangiano[b]

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ABSTRACT | Healthcare is undergoing a transformation, shifting the agency from doctors to patients. This change requires patients to be more involved and informed, especially when facing global health challenges. Improving health and data literacy is essential for enabling patients to collaborate in decision-making and new knowledge definition. To support selfawareness and communication abilities in patients, this proposal suggests a structured workshop based on experimental activities and supported by physical materials to encourage participants to reflect on the experience and externalisation of diseases as both, researchers and patients. The goals are twofold: to promote the use of diverse sensory techniques for sharing personal health data among different backgrounds of researchers, and to contribute to the development of a systematic approach for data representation that includes both visual and tactile elements.

KEYWORDS | DATA PHYSICALIZATION, PATIENT EMPOWERMENT, DATA COLLECTION

1. Introduction

The ability to properly describe and communicate symptoms is critical for patients to support a diagnosis which can inform and facilitate treatment decision-making (Meskó & deBronkart, 2022). To build proper communication between patients and doctors, not only health literacy is required (Feng et al., 2021), but the personal vocabulary of feelings and perceptions also needs to expand. Considering symptoms as expressions of the disease they are caused by (Offenhuber, 2024), this proposal suggests the practice of data physicalisation to explore new modalities of representing and communicating intimate and healthcare information aimed to promote awareness and support people affected by any kind of illness (from common influenza to recurrent complex diseases) in improving communication modalities.

This proposal suggests a structured workshop based on experimental activities and supported by physical materials to encourage participants to reflect on the experience and externalisation of diseases as both, researchers and patients. Outputs and discussion are considered to expand the visual and physical variables contributing to the definition of a multisensory vocabulary. On the other hand, participants are meant to acquire new communication skills that can be integrated into different design research activities.

2. Activity

The workshop takes place in person and is planned to last about 2 hours.

Activities are organised as follows:

- Workshop presentation (10').
- Ice-break: Participants introduce themselves by providing the personal definition of "symptom". Groups are organised (20').
- A set of labels reporting some generic symptoms of common diseases (e.g. fever, headache) is provided. Participants select the most relevant and add what is missing based on their personal experience (15').
- The kit of materials is distributed across groups. The kit includes different units of wood, polyester, and foam available in different shapes (sphere, cube and triangular prism) and two sizes (small and

big). To facilitate the assemblage, pegs are also provided. Units have holes on each side that fit the pegs so they can be combined

· (5').

· A set of labels describing the physical variables (e.g. shape, weight, texture) is brought to the table. Participants are asked to explore and familiarise themselves with the variables based on the material kit previously provided (15').

· Participants work in groups selecting and associating the physical variables to the symptoms (15').

· Based on these associations, participants use material units to recreate the symptoms of the disease they are working on (20').

· Participants present their artefact and explain their motivations (20'). Pictures of the final artefact are taken, while vocal descriptions are recorded. Discussion and feedback close the session.

Preliminary results are meant to drive the final conversation around practices of intimate and healthcare data representation, specifically leading to understanding how materials can support symptom representation and how patients and doctors can benefit from physicalisation practices.

3. Intended Audience

The workshop is part of a PhD in design considering participatory approaches based on data physicalization to promote women's agency in healthcare. The pilot of the format has been run three times with people with different backgrounds. The project originated from the need to address the health and societal threat of antibiotic resistance. As urinary tract infections (UTIs) are among the most common causes of resistance development, and because UTIs affect mainly women due to anatomic factors, the original format addresses women specifically. For the reason of broadening the conference attendees' participation and the research

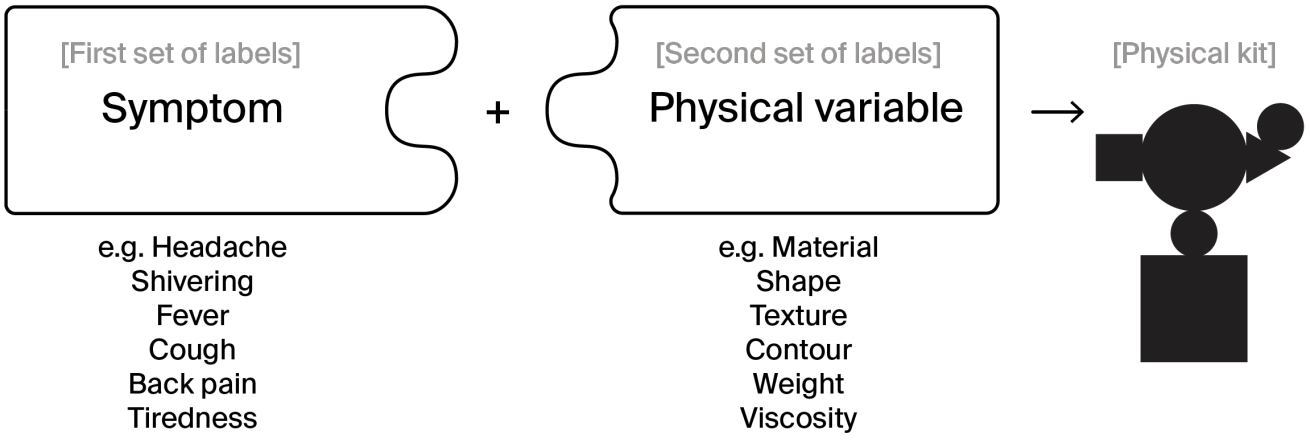

Figure 1. The intended process of the activity.

interest as well, this proposal opens the focus to common diseases, such as influenza. This allows focusing on specific symptoms that can be further studied across different pathologies in the future.

The workshop is designed to have a maximum of 20 participants work in groups of 5 people each (groups can be adapted based on the number of attendees). No specific requirement or prior knowledge is needed. First of all, designers interested in data representation and communication should benefit from taking part, but participation is also recommended for researchers in the field of healthcare, patient-doctor relations, and for those who are interested in intimate data and self-narrative practices.

4. Expected Outputs

The objective of the activity is to encourage the adoption of various sensory methods for conveying personal information and fostering empowerment in health-related issues. Specifically, the workshop aims to encourage the exploration of methods for patient selfnarrative and personal data representation and support the development of a shared language by identifying new correlations based on the translation of data through different sensory modalities. The insights will support the ongoing work to establish a design framework for representing data through both visualization and physicalisation.

5. Space and Equipment Required

The activity will take place in a standard room, with one table for each group and seats organised around. A projector will be used for the initial presentation. A part of the kit provided, pens and stationery to write in various colours are required.

6. Post Workshop Plans

Physical results produced during the activity will be added to the collection of outputs of other workshop sessions. The research environment where these outputs are produced will provide an additional occasion for the research to confront approaches regarding the adoption and understanding of material for communication among different environments and expertise levels. Artefacts will be associated with their verbal description and made available (anonymised) on an open repository. To facilitate the exploration of the association of symptoms, variables and material, the artefacts are planned to be 3D scanned (with the support of tools such as LUMA AI).

As the public interaction with materials for research purposes allows the collection of data which is very often difficult to analyse, this repository is not only meant to promote the workshop strategy but also providing a setting to explore decoding possibilities to facilitate meaning and information deduction from material and artefacts from which the design community can benefit from.

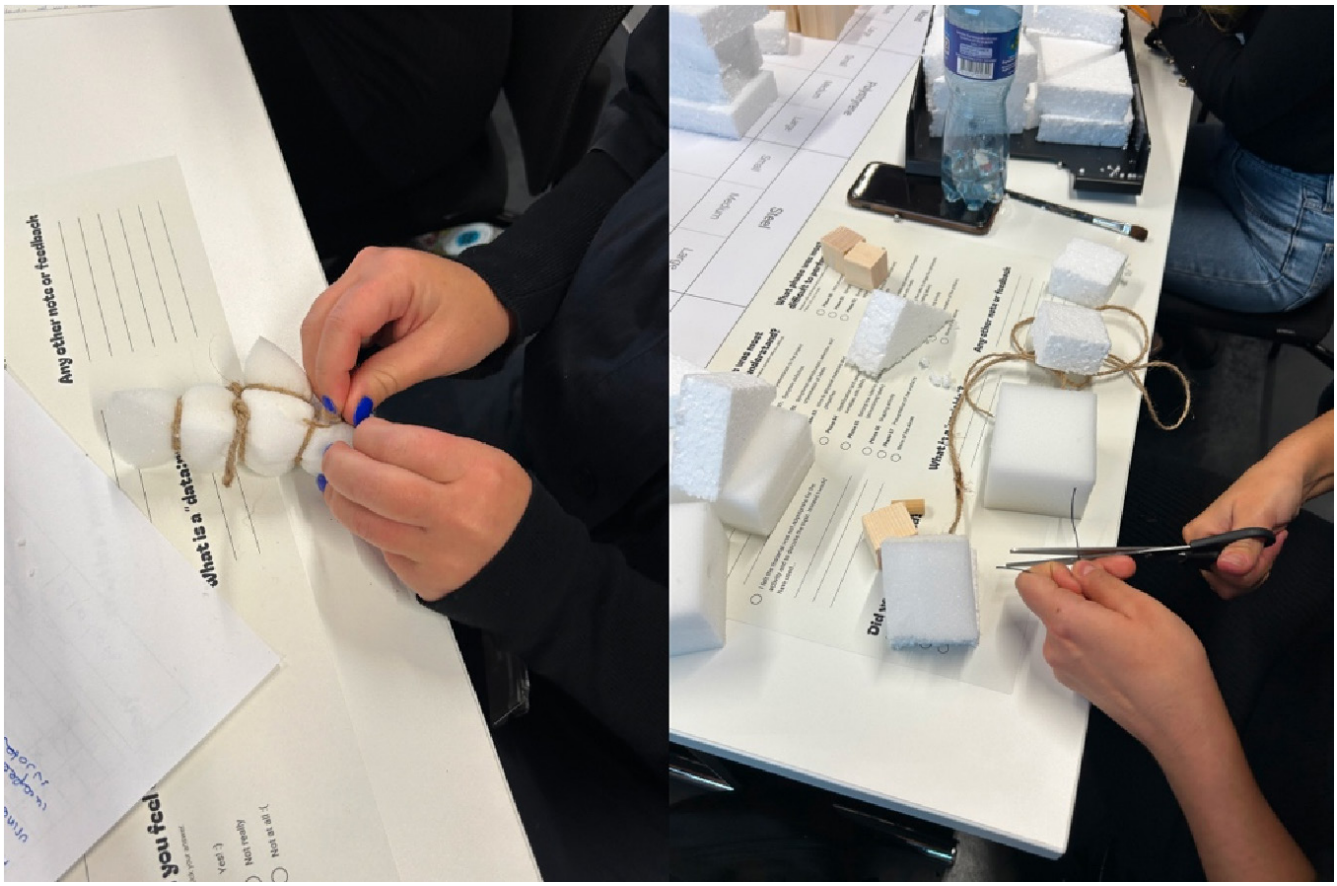

Figure 2. Participants during the pilot workshop. SUPSI, October 2023.

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CODEX ARTIFICIALIA: A NEW CREATIVE ACT TO RESIST THE HYPE OF SMART COMMODIFICATION AND DECOLONISING TOMORROW

Silvio Cioni and Giovanni Caruso

ABSTRACT | In this progressive gathering and collaborative workshop, we explore the symbiotic relationship among artificial intelligence (AI), design, and capitalist structures. The creative endeavour involves assembling a codex – understood here as an organised compilation of information and guidelines – that encapsulates the essence of ownership, labour, and commodification within the expansive realm of AI capitalism concerning the future of design practice.

As we delve into this exploration, it is crucial to acknowledge AI's profound impact on the contemporary design landscape and the risks and opportunities it poses.

Integrating AI technologies redefines traditional paradigms, influencing how designers conceptualise and bring their ideas to fruition, potentially subverting the notions of authorship and creativity. This transformation inscribes itself in the context of capitalism, extending beyond technical aspects and permeating fundamental concepts such as ownership and creativity as commodities. Within this context, the codex from the future aims to provide a nuanced understanding of these complex relationships, offering insights and alternative possibilities for the evolving nature of design within an AI-driven capitalist framework. The goal is to create a new meaningful space that problematizes an imaginary built around the rhetoric of augmentation and improvement of human beings without addressing what these optimistic public discourses fail to surface.

Through synthesising instructions and illustrations, participants will contribute to the codex and actively engage in interpreting the symbolic representations of ownership, navigating the complexities of labour, and offering hints on reshaping this collaboration. This collaborative effort is a collective future exploration of the intersections between design, artificial intelligence, and the economic structures that shape today's creative landscape.

KEYWORDS | AI FUTURES, PARTICIPATORY SPECULATIVE DESIGN, COLLECTIVE IMAGINATION, AI CAPITALISM, COMMODIFICATION OF CREATIVITY, AI-INFUSED DESIGN PRACTICE

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DESIGN AS COMMUNITY CARE: DRAFTING A NEW MANIFESTO FOR DESIGN EDUCATION

Arden Stern and Danielle Foushee

ABSTRACT | Abstract: In an era defined by multiple social, political, and ecological crises in which design has often been complicit, we need a manifesto that sets forth radical new principles for design education rooted in community care and civic responsibility. This workshop will facilitate the co-creation of a set of shared principles and actions with an international group of Cumulus participants, resulting in a draft manifesto to be published in the conference proceedings.

Design history is awash with manifestos that offer principles for ethical practice, ranging from the De Stijl Manifesto (1918) to First Things First (1964) to more recent manifesto-like documents such as the Decolonising Design Editorial Statement (2016). These manifestos guide designers during times of crisis, but few have catalyzed action-oriented practices for civic participation and community collaboration that create new professional pathways for design school graduates. We need a new framework for bringing design students, educators, and communities together.

Traditional community engagements in design education — especially in the U.S. — center the priorities of corporate funders and powerful institutions rather than the needs of people, communities, and ecosystems, and often exacerbate the problems design purports to solve. With this manifesto, we seek to build an international community of care among design educators to activate our collective values in local contexts across the globe.

Though design educators are the target audience for this workshop, all are welcome; our goal is to gather a group of 9-15 attendees, including the two facilitators. Participants will be invited to continue collaborating remotely to revise and expand the manifesto document for a future co-authored publication.

KEYWORDS | MANIFESTO, DESIGN EDUCATION, COMMUNITY ENGAGEMENT, ETHICS

REFUGEOLY GAM

Vicente Esteban

ABSTRACT | This is a project to create awareness of the refugee situation, and the proposed format(s) have been tested for several years with optimum results. Please check the game's website (https://www.refugeoly.org/) to see how the game is played. The requirement for this activity is a black floor space to place a vinyl sticker (3x3 meters) with the game. A TV monitor is also required to introduce the game before playing it. There can be 2 to 3 sessions per day.

Refugeoly is a serious game whose main purpose is not just to play for fun but also to understand a humanitarian crisis. This board game is designed to experience, based on real facts, the dramatic journey of refugees trying to get into a country that can give them asylum. Playing Refugeoly turns the player into a refugee and becomes conscious of the real circumstances a refugee must go through on the journey to safety. Refugeoly has been built into a game with the testimonies of refugees and NGO volunteers in refugee camps in Greece, Turkey, Spain, and France, as well as information from different organisations. This paper aims to explain the design process, the game mechanics, the different tested game formats, the feedback from the general public, academics and students who have played it and its future development.

The proposal is a gaming activity in which the players embody the role of a refugee, and through playing this floor game, they can have an immersive experience of the circumstances that refugees have to go through in their journey to safety. This game has been played in several institutions in the last few years and has received very good feedback, especially as a pedagogical tool to understand and learn the realities around forced migration.

This serious game is supported by a website where users can download, print and play the game: https://www.refugeoly.org/

KEYWORDS | REFUGEE, SERIOUSGAMES, MAFIA, BORDERS, MIGRANTS, NGO

CO-CREATING COLLABORATIVE CULTURES: HOW TO TEACH COLLABORATION IN DESIGN SCHOOL

Peter Martin

ABSTRACT | Design pedagogies have a legacy of promoting an individualistic basis of creativity and expression that persists today within many art school curricula. However, design practices in a deeply interconnected world cannot rely on the "creative genius" of individual designers to be wholly inclusive, relevant, effective, and sustainable. The complex and dynamic social situations and cultural histories require a creative capacity that extends beyond the strengths, skills, and lived-experience any individual designer can provide. The challenges and opportunities we now face require a level of innovation emerging from synergistic processes and collaborative cultures of designing that extend far beyond coordinated assemblies of multiple specializations typically applied within complex projects.

However, co-creating such collaborative cultures require participating creatives to have a basis of awareness and skill that design curricula often do not explicitly address. As a result, many students find collaborative projects to be frustrating and negative experiences. Often, students "survive" these projects by dividing up the work equally and present a coordinated summation at the end without having achieved any creative synergy and integration of the diverse strengths, experiences, and values involved. This, unfortunately, enables dominate cultural norms to prevail and determine the processes, outcomes and recognitions involved in the projects.

How do we teach design students to be "collaborative" when creative processes often depend on vulnerability and intuition that are not easily achieved within the particular social dynamics and distinct emotional dimensions of collaborative spaces?

This 90-minute workshop engages ten-to-twenty design educators in: (1) Forming an understanding of creative collaboration as a cultural process; (2) Co-creating a contextualized narrative of why design students should develop the mindsets, understandings, and skills for

creative collaboration; (3) Considering the social, emotional, and cognitive experience and scope of students learning how to collaborate; and, (4) Gaining resources and examples of design students learning and being assessed in their capacities for creative collaboration.

The scope and approaches within this workshop have been developed with insights from diverse fields such as organizational culture, sociology, critical theories, and innovation studies. The methods and tools introduced in this workshops have been tested by the author in multiple undergraduate design studio courses.

The basis of this workshop is a ten-component framework, developed by the author, organizing collaboration as a cultural process emerging from an integrated environment activated by "cultural" participation. This framework structures a set of practical exercises in-which workshop participants are introduced to critical collaborative mindsets and viable collaboration methods for engaging design students in developing their understandings and skills for creative collaboration. Throughout these exercises participants are provided with tools and applied examples they can utilize in their future experiments in teaching collaboration.

KEYWORDS | DESIGN PEDAGOGY, DIVERSITY INCLUSION AND EQUITY WITHIN COLLABORATION, TEACHING COLLABORATIVE DESIGN METHODOLOGY

RETHINKING DESIGN EDUCATION: TEACHING IF WE COULD BE RISKY

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ABSTRACT | Within contemporary design education, educators are seeking innovative ways to engage students while responding to the shifting needs of industry and the needs of the community in which they work. This session explores current attempts to create new practices while identifying the constraints imposed by institutions against a landscape of ambition and realities that is ever changing. It will reflect on attempts to create new student experiences while analysing those attempts that resulted in failure. It will cover established innovative approaches while proposing new forms of student engagement for future consideration while equipping educators with strategies to challenge the status quo within their programmes.

KEYWORDS | INNOVATIVE DESIGN EDUCATION, DESIGN TEACHING PRACTICES, FUTURE-ORIENTATED LEARNING, CONSTRAINTS IN HIGHER EDUCATION, LEARNING EXPERIENCES

1. Introduction

We have and are teaching differently that we did before. Even if the marks stay on the same scale or the budgets have become more limited or the students busier than ever. Whether it is a flipped classroom or a service learning experience or cross-campus projects in which design students team up with students from other departments and learn valuable (soft) skills they would have never been able to learn without it, many of us are still looking for ways to engage our students in ways that both stretch us and our discipline as well as challenging our students and meeting them where they are. This is not to say all wheels should be reinvented; some skills are simply skills to acquire… but there is so much to be done and so many things to try if we were given the chance.

What would we do if we really could do things differently? If budgets were more friendly, if time and location was not so restrictive, if the course load provided us space to define our own challenges and take on our own themes, if we were given more room to liaise closely with diverse communities or embed further in industry or were able to engage students in a way that their journey is celebrated more than their outcome? What if we could no longer teach as we were taught, or were able to develop media or approaches that reflect technological shifts or even mirrored ways in which we ourselves like to learn?

This session will engage participants in exploring current best practices as well as develop what may become future best practices; reflecting on our own ambitious attempts as well as potential failures in which we, as educators want to do, currently do or did just that. Through an interactive session we will refer to established approaches such as Project-Based Learning, Peer-to-Peer teaching, micro-credentials and gamification etc. but also analyse what makes a learning experience innovative, while proposing new forms for future consideration.

1.1 Objectives

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· Explore and reflect on Innovative teaching practices: gain insights into diverse teaching methodologies and understand the factors that contribute to their effectiveness.

· Identify and (propose ways to) overcome constraints in design education: develop strategies to mitigate common constraints, enabling flexibility and creativity in teaching practices.

· Propose future-oriented design learning experiences: propose concrete, innovative teaching models that can be implemented in their own educational contexts, promoting deeper student engagement and learning.

· To create a small team of motivated educators to continue working together or reflecting on this topic post workshop.

1.2 Target audience

This workshop is designed for design education faculty who teach, with specific focus on post-graduate level, including design education programme directors. Although we will not make a distinction between practice-based and research-orientated coursework, both outcome orientated as well as theory-based practice is welcome. Expected Number of Participants: Approximately 20 participants.

1.3 Format

Participants will start collectively by an explanation and timing of the experience-based session. The format gives participants a chance to be very engaged with a fellow conference attendee, and gain in-depth knowledge into another participant's educational vision and engagement.

These teams will be given a booklet (also available in digital format) which offers 5-7 topics as starting point. The starting points will be in various formats: an audio fragment, a film, a short text, a collection of social media posts) that will instigate a discussion that will happen in small teams (of 2-3 people). The medium and content will drive the discussion, in turn the medium/content will drive a reflection on how they engaged with the content. Each team will be given an assignment to find a space from which to work, which in turn will inform a question regarding spaces to work (ie. what space do students need)... so on and so forth. After the discussions, the teams will return and share their vision on what form would suit the course outline they have been given in their booklet, as well as summarising what shifts (if any) would need to happen for schools to allow this sort of experience. The session will close by itemising steps that they would like to take in their own programme to innovate around curriculum or design education while inviting educators to be involved in a working group on this topic.

About the Authors:

Dr. Andrea Wilkinson is an experienced educational leader with expertise in social design and inclusive interfaces. Actively involved in teaching and research she focuses care-based design initiatives with a focus on aging and inclusion.

Dr. Rita Maldonado Branco is a design researcher focusing on communication design for health. Her work involves designing tools for interaction and support for social relationships with a focus on dementia care.

Jennifer McKnight is an accomplished graphic designer and professor in design. She is passionate about design education and committed to serving her community through design.

Dr. Eve Stirling is a design lecturer interested in digital spaces and their relation to time and space. Her work explores agency and making through speculative design fiction.

Acknowledgements: Wilkinson, Maldondo Branco and Stirling would like to thank the European Commission for granting their proposal to start the Erasmus Mundus Joint Masters in Design and Care; ResponseAbleFutures (http://responseable-futures.eu). The first European Masters in Design and Care, this international programme begins in 2025 and will provide the opportunity to both explore and challenge fundamental aspects of design education while prioritising the student experience and responsible design citizenry. Next to this, as part of the Global Associated Partner Universities of ResponseAbleFutures, Mcknight would like thank UMSL for continuing to support her in her efforts to engage her students with a global perspective.

DESIGNING WITH THE DESERT: CROSSBORDER PEDAGOGIES FOR SUSTAINABLE BIOREGIONS

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ABSTRACT | Design education, as we know it, is deeply rooted in Eurocentric teachings dating back to the 20th century that focus on capitalist values of extractive productivity, an emphasis on form and function, and replicability for mass production—a legacy of the Industrial Revolution. However, these priorities are no longer sufficient. Designers must shift towards the sustainment of life. We must repair and unmake the still-prevalent paradigm that fosters overproduction, overconsumption, and disconnection from our local ecosystems. Over the past decades, design doing and thinking have shifted toward more plural and systemic approaches in research and theory. This 90-minute workshop aims to create a platform primarily (but not exclusively) for US and Mexico-based design educators to embrace our shared climates and soil and converse about the transformative potential of unlearning/relearning design and shape novel ways of teaching and learning through bioregional and cross-border collaborations.

We will share our experiences from "Designing with the Desert," an initiative started at Arizona State University (ASU) in the United States. This initiative began in the Spring of 2024 with talks by design professionals and academics who reflected on living and working in the Sonoran Desert—a bioregion with many sustainability challenges. A charette in September of 2024 at ASU titled "Sustaining Life on Earth," explored how design educators and students can collaboratively learn, unlearn, and relearn design practices relevant to the desert by producing the first iteration of a manifesto for designing with the desert. These discussions sparked debates on designing with the desert to sustain its life while also teaching and learning in it.

This workshop is designed for educators, researchers, practitioners, and students in the fields of design, sustainability, and social innovation. It is particularly relevant for those interested in participatory design, cross-cultural collaboration, and social-ecological transitions. We anticipate 15-20 participants, allowing for meaningful interaction and collaboration. Using a values-based framework, participants will examine how current design practices and artifacts prioritize certain relationships with nature while overlooking others. This activity will generate questions and commitments for designers to engage more pluralistically with nature and foster discussions on cross-border and bioregional collaborations for change.

Planned Agenda

This 90-min workshop includes the following activities:

- Introduction (15 minutes)
    - Presentation of Designing with the Desert, highlighting the ecological and cultural significance of the desert regions along the Mexico-US borderlands, and discussing its geopolitical implications. Breakout into teams
- 1st Exercise: how do we value nature in the way we teach design today? (15 minutes)
    - Examining current design education practices and their limitations centered on a values-based approach, prompting participants to share experiences and identify areas for unlearning.
- Share-out (15 minutes)
    - Participants share and walk through the boards to explore unlearnings and build on each other's contributions.
- 2nd Exercise: what if we teach and learn design through a variety of instrumental, intrinsic, and relational values of our bioregions? (15 minutes)
    - Participants consider how design can be practiced and taught with local ecosystems and non-human entities, rather than for or despite them.
- Plenary Closings (25 minutes)
    - Discuss proposed design and pedagogical practices and consider next steps for cross-border bioregional collaborations. This segment emphasizes the importance of cross-border (primarily Mexican-US) design schools' collaboration, focusing on competencies necessary for knowledge production that sustains life.
- Final Remarks (5 minutes)

Equipment Required

- Projector/screen for presentation
- Whiteboards or easel paper pads
- Markers
- Audio system (2 microphones and 2 speakers)

KEYWORDS | CROSSBORDER DESIGN PEDAGOGIES, CO-DESIGN, DESIGN EDUCATION, DESIGN FOR SUSTAINABILITY, MORE-THAN-HUMAN DESIGN

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Michelle Fehler is a Biomimicry Professional and a Visual Communication Designer who focuses on defining a life-centered design thinking methodology by infusing biomimicry thinking into the human-centered design process.

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DESIGNING PLURAL FUTURES

Xochitl Arias and Paula Wuth

ABSTRACT | All design is design of futures. However, when design as a culture explicitly engages with the topic of futures, its contribution displays on at least two levels.

On one level, it involves making different visions of the future tangible, which means to make them communicable. This is, enabling their dialogic nature in two, three, and four dimensions inherent to design languages, whose narrativity produce effective imprints that support projects ranging from future literacy to social innovation.

On a second level, it involves the practice of designing a future on itself; this is, where the object resulting from the design process is precisely an image of some entity's possible future, whether it is a person, an institution, a territory or a nation. This is the level of design as a process, where a future can be a design outcome.

In the profoundly transitional context in which we live, the contribution that design makes to developing anticipation skills and competencies has relevance in design education and in general education. UNESCO considers that "global changes require more inclusive and agile responses," and that future thinking is a competency that improves our ability to shape solutions that prepare us for this by creating "long-term resilience" (UNESCO, Futures literacy 2024) . Within this, the properties of design as a language enrich the field of future studies offering open and effective perspectives, tools, and alternatives.

Thus, referring to the plural consideration of design and futures, or the epistemic-geographical diversity of these fields, "design" and "futures" have an unfinished agenda. We propose a seminar-workshop (a "hands-on reflection" or a "reflective making session") organized by institutions illustrating this in order to:

- Characterize Key Themes: Explore relevant themes for future thinking education and general education from a perspective of futures design from different cultural and geographical origins.

- Initiate Transformative Projects: identify short and medium-term projects able to ignite collaborations in this subject among Cumulus member institutions, translating documented practices in design and futures education into transferable knowledge.

This event would have the format of a design-oriented futures laboratory mixed with a research seminar and could be deployed in two blocks of 120 minutes each.

Participants

The workshop is tailored for academics and researchers from diverse universities who are keen on collaborating on future studies in research, teaching and outreach. Participants will have the opportunity to exchange their experiences and insights in futures design. We aim to foster a diverse mix of backgrounds among participants, enhancing the richness of discussions and collaborative projects. This workshop welcomes those who have undertaken projects, courses, or initiatives in the field of design and future studies, providing a platform to share and develop meaningful initiatives on the matter.

KEYWORDS | ANTICIPATION, PLURALITY, RESILIENCE, SUSTAINABILITY

GREEN THREADS: SUSTAINABLE FASHION JAM

Lourdes Martinez

ABSTRACT | This is an engaging 90-minute social innovation workshop designed for 15 participants. The main objective is to raise awareness of the primary problems associated with fast fashion and then collectively devise innovative solutions.

Some of the numerous consequences of fast fashion include water pollution, excessive waste and landfill usage, high carbon emissions, exploitative labor practices, depletion of natural resources, negative impacts on biodiversity, and overproduction and overconsumption. After gaining a deeper understanding of these issues, participants will embark on an ideation journey where they can unleash their creativity.

We will draw inspiration from various sustainable practices in the fashion industry to initiate an ideation jam, where participants will explore various quick and tangible tools to co-create innovative and impactful solutions. Together, we will brainstorm and develop actionable ideas on how we, as consumers and stakeholders in the fashion industry, can make a meaningful impact and drive change towards sustainability from our unique standpoints.

Participants will join a journey to transform the fashion landscape and craft a more sustainable future.

KEYWORDS | CO-CREATION, SOCIAL INNOVATION, CLIMATE CHANGE, SUSTAINABILITY, PARTICIPATIVE DESIGN, IDEATION, SOCIAL CHALLENGE, DESIGN THINKING, POSITIVE TRANSFORMATION

BEYOND WORDS: IMAGE, GESTURE AND EMPATHY

Pixie Tan, Nidya Shanthini Manokara and Melissa Quek

ABSTRACT | What is lost when we rely solely on data and words in our design research? How can we become more attuned to our participant experiences and develop empathy through embodied experiences?

Drawing on the visceral experience of translating between two distinct artistic languages, in this two-hour workshop we aim to find non-verbal methods to capture and communicate the ephemeral things that words cannot express. We invite participants to explore the ephemeral nature of human feelings through a combination of movement and visual zine-making techniques.

Guided by two facilitators - one from each discipline - the workshop will follow a structured yet creative process. Firstly, In small groups, participants will verbally share experiences centred around the themes of transience, human connection and what's lost in translation when we rely only on words. These experiences will then be expressed through individual and/or collective gestures, allowing each participant to physically embody its meaning - as they comprehend it to be. These gestures will be captured through photography, creating a visual record of the movement.

Secondly, inspired by aspects of applied drama where experiences are shared and authorship dissolved, participants from different groups will then interpret and communicate these photographic captures into 2D visual forms such as collages and drawings, using zine-making techniques to compile their work. This creative process will facilitate the translation of movement into visual art, further exploring the nuances of human connection.

The workshop culminates in a sharing session where participants will present their interpretations, discovering similarities and unique perspectives within the group. The final product of the workshop will be a collaborative embodied zine composed entirely of images—

physical and embodied images such as kinesthetic, aural, and tableau—expressing the rich tapestry of non-verbal communication and movement. This collective experience will highlight the transformative power of decolonizing traditional forms of expression and encourage alternative ways of listening and understanding in the design process.

KEYWORDS | EMPATHY, EMBODIED DESIGN, CROSS-DISCIPLINARY, ZINE MAKING, MOVEMENT, RESEARCH METHODS, GESTURES

APPLICATION WORKSHOP CUMULUS CONFERENCE MONTERREY 2024

Track 3: Education in Art and Design

THEME

Empathy in Design. *Physical Visualization as a creative approach to improve empathy.*

OBJECTIVE

Experiencing an experimental approach to practice your empathy skills.

TARGET AUDIENCE

Design Educators, Professionals in Art & Design.

EXPECTED NUMBER OF PARTICIPANTS

10 to 16

SCHEDULE

90 minutes workshop

NEEDED EQUIPMENT

A classroom with tables where participants can work together is small groups.



Abstract

Communication and Multimedia Design (CMD) is a bachelor level design education programme at Amsterdam University of Applied Sciences (AUAS). At CMD we aim to help develop a critical attitude among our students regarding the complex society we live in. Our students realize that it is essential to be empathetic towards the people for whom they design something, regardless of their beliefs and socio-cultural background.

However, often misconceptions arise when interpreting research-information that we use to get an understanding of the people with whom and/or for whom we design something. How can we explore that information in a way where we are aware of our own biases, and where there is greater understanding of contextual factors that influence everyone's interpretation?

We noticed that our design students need a suitable approach to step out of their own mindset to empathize with other people. As we know empathy is a skill that can be developed (Zaki, 2017), we have created a workshop that uses *physical visualization* as a creative approach to help improve empathy skills. With this workshop, we aim to stimulate social and cultural awareness and understanding through a co-creation making process of tangible *conversation pieces.* These conversation pieces are not the end goal; they are the starting point to discuss the various personal interpretations. We exchange and appreciate these interpretations as they help us to become aware of the diversity in how we understand each other.

Joint physical visualization means reflecting on the stories of people involved on the one hand, and experimenting with different forms of visual language, materials, and physical space to make those stories emotionally insightful on the other hand. (Huron, et al., 2023).

The participants of this workshop take home an experience that can help them empathize with other human beings in an alternative way the next time they start a design or co-creation process.

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ROBOTICS WITH US IN OUR MEANINGFUL PLACES: COMBINING ART-BASED METHODS WITH AI TO BUILD EMPATHY BETWEEN HUMAN-ROBOT INTERACTION

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ABSTRACT | This workshop explores the intersection of empathy and Human-Robot Interaction (HRI) through the art-based method of placemaking. Empathy, traditionally divided into cognitive, affective, and compassionate forms, has expanded to include digital empathy in the context of technology. The workshop will focus on designing empathetic HRI by understanding how robots may affect our connection to environments and places. The workshop includes two sessions: the first builds empathy by exploring meaningful places for participants, while the second envisions future scenarios where robots are integrated into these spaces. Participants will engage with AI tools and performative exercises to explore these future environments, culminating in a discussion on the role of empathy in HRI and how it can be fostered in future interactions with robots. This workshop aims to create new insights into designing empathetic interactions between humans and robots in evolving environments.

KEYWORDS | EMPATHY, HUMAN-ROBOT INTERACTION (HRI), DIGITAL PLACEMAKING, DESIGN FICTION, ARTBASED METHODS

Introduction

Empathy becomes even more relevant in this current era of mobilisation, humanitarian crises, and growing technological and digital advancement. Empathy is traditionally divided into cognitive, affective, and compassionate empathy. Recent years the definition has expanded (Sarantou & Miettinen, 2022) to cover also digital and kinesthetic empathy (Reynolds & Reason, 2012). Digital empathy is a skill related to the use of technology, including ethics and good manners in communication and interaction with other users (Sreejun & Chatwattana, 2023). For empathy to develop in the interaction between a human and a robot, the factors that can be used to build reciprocity during the interaction must be identified (Park & Whang, 2021). Empathy has a long history in human-centered design (Mattelmäki, 2014). The empathic design introduced by Leonard and Rayport (1997) covers techniques that require collaborative skills, an open mindset, curiosity, and advanced observational and emotional skills.

Emerging solutions in robotics, technology, and artificial intelligence (AI) will guide us to approach empathy at different levels. These technological achievements are already affecting our ways to communicate, feel, and act within new kinds of environments combining both human and non-human. This creates a need for solutions for envisioning different futures. Future foresight methods such as design fiction (Durfee & Zeiger, 2018) help to experiment with fictional worlds through diegetic prototypes and scenarios, which shake our thinking when designing new ways of interaction and communication. Future foresight tools combined with art-based methods such as placemaking open ways to evoke curiosity, while dealing with feelings and emotions connected to places.

In this 120-minutes workshop, we aim to gather 20 scientists from diverse research fields to discuss the possibilities of designing Human-Robots interactions (HRI) using the art-based method called Placemaking. Placemaking derives from cultural geography

(Lew, 2017) and is associated with a sense of place (Othman, et al., 2013). We perceive art-based and performative placemaking (Björn, et al., 2023) as a way to express feelings and emotions connected to future environments and places. This workshop aims to foster a shared understanding of imminent research questions at the intersection of empathy and human-robot interaction (HRI). It offers insights into understanding our imaginary future with robots and the effects of the environment on interaction and emotions. New approaches are tested to envision different futures and to build empathy between human-robot interaction by combining artbased and performative placemaking.

The workshop includes two design sessions. In the first session, we build empathy with the place. The aim is to understand a person's needs and emotions and what makes a place meaningful for them. In the second session, the participants envision how a meaningful place will look in the future if robots are brought into that place. The future scenarios are created with the help of AI. Through the performance, we go inside those scenarios. The workshop ends with discussing how these methods help to build and understand empathy in the interaction with humans and robots. The discussion aims to point out the meanings of empathy, and can these meanings be met in future scenarios with robots.

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THE COUNTRY OF ORIGIN EFFECT: MAPPING DESIGN VALUES AND PATTERNS

KEYWORDS: COO, DESIGN, VALUES, STRATEGIC, PATTERNS, SYSTEMS



The Country of Origin (COO) is a complex, multidimensional phenomenon influenced by various factors explored since the 1960s. Initially, this effect was defined through observation and empirical evaluations. However, decades of studies have revealed its intricate impact on a country's economy. A critical aspect is the evolving country-image, shaped by successful storytelling and consumer perceptions. This perception, built through various parameters, affects purchasing decisions and requires strategic promotion. A country's brand and product image, often influenced by renowned categories, can significantly sway consumer decisions.

In the 1990s, Roth and Romeo highlighted the importance of aligning marketing strategies with the country's image and relevant product categories to meet consumer expectations. This alignment considers the consumer's social status, familiarity with the product, and emotional connection to the product's cultural and traditional background. Various factors, including pricing, technology, perceived quality, and aesthetics (linked to status symbols), play crucial roles and can be optimized through precise design strategies.

Moreover, the COO now extends to intangible values such as services, which enhance the positive perception of a product category and impact the overall COO positively. This broader understanding reflects the evolving complexity of consumer perceptions and the necessity for dynamic and inclusive marketing strategies to leverage the COO effect effectively.

The *main objective* of our workshop, is that through a round table format, discuss and map out the COO effect comparing Mexico and Italy to define a set of characteristics or categories. A *specific objective* is to use those categories for a survey or questionnaire for a research project that will be translated into an analytic tool for advanced design.

Our *target audience* are researchers and postgraduate students interested in design management, advanced design and identity that seek to identify the design for value aspects. We expected a small number of *participants between 10-15*.

The *agenda* runs between 1 hour and a half maximum, divided into 3 sections: introduction, mapping and discussion. The *equipment required* is a projector, post-its, whiteboard for collaborative ideas and a space with tables.

As an input we will use systems thinking methodologies, placing research questions, templates and cards. The interaction with the participants registering on this round table workshop will help to produce an interesting output to compare values and patterns for the COO effect.

SYSTEMIC DESIGN INTERVENTIONS: UNDERSTANDING THE TRANSFORMATION TOWARDS THE CIRCULAR PLASTIC ECONOMY THROUGH THE LENS OF AQUACULTURE CASE.

Aleksandra Stasiak

ABSTRACT | The global ocean pollution and increase in plastic resources calls for action. The circular economy (CE) strategies grew in popularity. The implementation complexity is still challenging, with limited practical examples of long-lasting implementation. This doctoral research paper discusses the circular economy transformation in aquaculture. Research by design and System-Oriented Design (SOD) is the major methodological backdrop for exploring the systemic changes within the circular economy transformations. The conducted data collection explores the complexity of the process and interventions of circular practices with the dynamic nature of systemic relations. The doctoral research aims to contribute to open discussion and accelerate progress in better circular practices for plastic resource management from the collaborative work of design practices with the industry. Using the design methodology aims additionally to connect creativity and visualizations in approaching complex problems for transdisciplinary practice.

KEYWORDS | SYSTEM-ORIENTED DESIGN, PRODUCT DESIGN, PLASTIC OCEAN POLLUTION, CIRCULAR PLASTIC ECONOMY, SYSTEM THEORY

1. Introduction

The transition towards a blue economy and aquaculture has led to a significant increase in plastic resource use, which has tripled over the past 50 years (Skirtun et al., 2022). The high use of plastic resources is being identified to have further ripple effects towards global inequality, unsustainable practices, and a triple planetary crisis (UNEP, 2024). The fish breeding industry has been steadily growing with a focus on food production and Norway is among some other countries in Asia and South America where the blue economy is a part of a national strategy (FAO, 2022; Skirtun et al., 2022). Plastics are used in a variety of applications in the major construction of fish pens and supportive elements like ropes, nets, fish pens, feeding pipes, buoys, as well as walkways, handrails (Skirtun et al., 2022; Sundt et al., 2018). The growing focus on aquaculture results in growing production and consequently growing waste of plastic components (Skirtun et al., 2022) with an estimate of 25000 tons ending up in the sea (Huntington, 2019). The debris, along with macro- and microplastic pollution deriving from aquaculture, pose a direct threat to marine life. This, in turn, has a domino effect, impacting human life, recreational activities, and cultural values (Skirtun et al., 2022).

In response to global plastic pollution and resource scarcity, the CE strategies promise more responsible resource use as part of the EU Green Deal international intervention. In aquaculture, the adoption of circular systems can have transformative impacts. These systems are anticipated to substantially decrease plastic use and mitigate climate impacts, contributing to a more sustainable industry. Furthermore, they are aimed for enhancing traceability which can lead to improved accountability, logistics, and management. The reduction of plastic consumption is expected to mitigate environmental burden but also encourage the development of local knowledge and technology. Moreover, such an approach should contribute to process optimization and energy efficiency, further pushing the industry's environmental responsibility and operational effectiveness (Greene et al., 2022). Differing from other types of fishing, aquaculture is characterized by a higher

control level over the materials, where implementation of circular strategies can add up the positive impact on the macro- and possibly microplastic streams. Although the involvement of industry itself is crucial for such a transition, circular plastic solutions would require the development of design systems for best reduction, reuse, repair, and recycling practices. Consequently, these require control measurements along with governmental considerations such as innovation and facilitation of recycling activities (Skirtun et al., 2022).

While looking into the definitions of CE increasingly look beyond merely the 3Rs of reuse, repair, and recycle and turn towards the systemic perspective (Kirchherr, Yang, Schulze-Spüntrup, Heerink, & Hartley, 2023; Superti, Houmani, & Binder, 2021). In a recent study, Kirchherr et al. (2023, p. 2) highlighted the view for "fundamental systemic shifts, particularly with regards to existing supply chains". However, the systemic approach, while being integrated into the scholarly discourse, is often overlooked by practitioners who may prefer implementing minor adjustments (Kirchherr et al., 2023). The practical implementation and the concept of the CE find incoherency and complexity as it remains filled with diverse conventions, definitions, and interpretations, often reducing it to merely a buzzword. Such ambiguity creates overwhelming complexity and difficulties for companies in implementing CE in practice (Desing et al., 2020; Kirchherr et al., 2023), especially if only economic reasons are being addressed (Tosi, Gusmerotti, Testa, & Frey, 2024).

This tension between the growing trend of CE and bottlenecks with implementation finds its direction within collaborative study and flexible design (Tosi et al., 2024). Ecodesign or design for circularity, which uses a lifecycle approach, has a critical role in product development, encouraging business practitioners and designers to consider a product's journey through various life stages of plastics beyond mere recyclability. The CE furthers this concept by transforming design strategies into economically viable practices (Doorsselaer, 2022; Grimstad, Ottosen, & James, 2023). It encompasses an array of areas including products, systems, business models, and services (Kirchherr et al., 2023; The Ellen MacArthur Foundation). The design of fishing gear and aquaculture equipment in plastics differs, however, from consumer plastics due to their specificity of application. The design takes into account multiple factors such as safety, durability, and mechanical properties for use throughout multiple cycles. For plastic as a component, understanding the physicochemical changes during the use phase may be critical for safety and recyclability (Grimstad et al., 2023) that will affect circular solutions.

CE reflects the high level of design, systemic, value chain and business model complexity that meets with various difficulties in applying interventions in practice (De Angelis, 2021; Ghisellini, Cialani, & Ulgiati, 2016; Tosi et al., 2024) and is dependent on local systemic factors (Ghisellini et al., 2016). Plastic, a prevalent material in various industries,

contributes to a layered and complex issue, particularly within the context of systemic immaturity. The circular economy of plastics has been studied from multiple angles, but there is a gap in the exploration of these perspectives from a design viewpoint, particularly in fields like fish farming.

The role of design in sustainability transitions has been gaining attention. It can visualize complex systems, identify key leverage points, and develop strategies for sustainability. Design methodologies could reshape current practices, minimizing plastic waste, optimizing resource use, and enhancing overall sustainability (Ceschin & Gaziulusoy, 2016). Design has therefore widened its spectrum, shifting its intervention focus from solely product design to a 'cradle-to-cradle' approach. This method highlights the full life cycle of a product, spanning from the extraction of raw materials to its eventual waste (McDonough & Braungart, 2002). Consequently, this broadened perspective from the product to its life-cycle stages has significantly lifted the contribution of design to environmental interventions, enabling a more comprehensive and holistic viewpoint on the matter (Tura et al., 2019).

Sevaldson (2022) who worked broadly with the term system-oriented design, identifies that systemic perspective helps in understanding the complexities and interconnectedness in the systems. Such complexities can be translated to what CE represents as entering or being a basis for building new systems. This perspective sees systems as an interconnected whole, paying attention to the dynamics, relations, and complexity of the systems, and subsystems involved. The systemic perspective also addresses the issues of changeability, which finds also its application in the context of the design in CE, given the dynamic nature of resource use, waste generation, and environmental impacts (Sevaldson, 2022). The circularity seems connected to systemic thinking where the challenge lies in effectively communicating these systems due to their inherently non-linear structure. As Meadows (2009, p. 5) notes, "systems happen all at once," signifying the interdependencies of systemic components can be difficult to grasp. The complexity can theoretically explode into infinite constructs in each direction, making it impossible to build knowledge on. Thus, boundaries need to be established and created to fit within human cognition as a form of visualized mental model (Meadows, 2009; Stephens, 2013).

Current barriers recognized in the change towards circular value chains in this study include the challenge of achieving profitability in new business models, insufficient global regulation, and ineffective enforcement of regulations. In the project the access to an adequate volume of secondary resources has been identified as a concern. For such a transition to be successful, new value chains collaborate between all stakeholders in the chain, ranging from producers, fish farmers, and recyclers, to consumers. Such changes in the system and between the systems can be achieved through recognition of leverage

points that play an important role on the interventions. The leverage points in the systems are points that can direct the shift in the systemic dynamics to consciously initiate the change towards the intended goal (Meadows, 2009).

This study explores the systemic interventions in the transformative process toward circularity within the multidimensional landscape of policies, stakeholders, materials, and communication. The study is based in the aquaculture case study with the use of by the methods of GIGAmapping. Research by design and SOD is a practical methodology enabling mapping complexity that allows looking at the system dynamics and having a broader understanding of the complex problem (Sevaldson, 2022). Using design methodology for industrial application has the potential to bring broader perspectives and stronger transdisciplinary transformations toward tackling the global pollution crisis and the local potential for change. The experimental design methodologies can also open for creativity approaching communication between various stakeholders and the complexity for the circular plastic systems in the innovation for sustainability. Specifically, two questions were subtracted:

- What are the CE interventions in the study introduced by the project influencing systemic shift?
- How does SOD methodology impact multistakeholder collaboration towards CE implementation?

2. Background

The Norwegian authorities have ambitions for the country to emerge as a pioneer in the circular economy, allocating extensive financial resources. The Action Plan for Circular Economy, under the umbrella of the EU's Green Deal, seeks to ensure resource consumption remains within the planet's capacity (Stoknes & Rockström, 2018) and to double the use of circular materials in the forthcoming decade.

System theory and CE literature are the backbone for understanding the recent transformation trends in organizations in the doctoral study (Kirchherr et al., 2023; The Ellen MacArthur Foundation). The methodological fundament is leaning on SOD in the context of the aquaculture-specific value chain. Regarding interventions for the CE, these embrace a broad range of actions. Certain actions related to the specific project case are predefined in the aquaculture circular transitions. In terms of other systemic interventions, these are the emergence of the analytical part of the SOD. In SOD the approach towards the problem is dynamic rather than single problem-solving oriented.

The project is set to develop new solutions within value chains for the aquaculture industry by establishing closed loops for plastic equipment. This will be achieved through reuse, repair, lifetime extension, and the incorporation of recycled materials in new products, leading to savings in

material resources, energy, and costs. A more sustainable approach to plastic resource utilization post-end use in the aquaculture industry necessitates changes across the entire value chain. From a circular perspective, an increased focus on material recycling and design for reuse and recycling is prioritized. Additionally, the new equipment designs will also need to factor in resource efficiency requirements following the Taxonomy Regulation (Regjeringen, 2021).

The project owners in the collaborative project case study aspire to generate knowledge that has international reach within the circular economy with their operations spanning multiple countries including Norway, Chile, Iceland, Canada, and the UK. Plastic-made aquaculture equipment constitutes approximately 43% of the turnover, with around 42% dedicated to material recycling. The company aims to raise this to 100% in the following years, which project partners aim towards.

This study aims to facilitate the reuse and extension of the lifespan of various aquaculture equipment such as floats, bottom rings, clamps, walkways, nets, ropes, handrails, feed hoses, and various pipes. Through substantial investments, partners have allocated more funds to the recycling and production technology. This allows for the allocation of human resources towards the development of circular strategies, thereby reducing financial risk for the companies involved. The collaborative nature of the project further enhances the understanding of the multifaceted complexity involved.

3. Methods and research design

The method of GIGA-mapping involves the visualization of complexity to make it available for all participants, to at all times in the process have an overview of the totality of the states of the system (Ashby, 1960) and thus be able to perform analysis upon these variables. The analysis can be performed by identifying flows, expectations, communications and so forth.

GIGA-mapping is therefore a form of visualizing complexity and acknowledging visual communication, dynamics within the system, and changeability aspects to embrace a more holistic approach. SOD is aiming not to solve problems, but rather embrace complexity to understand and navigate through complex situations (Checkland & Poulter, 2020; Sevaldson, 2022). The use of SOD in a multistakeholder project facilitates a holistic analysis and design approach. This is achieved by aligning the products from one process with the starting points of another, enhancing the communicative capacity of key points, and diversifying perspectives within the process. Consequently, the design process employs visualizations to interconnect complex systems, aiming to foster transdisciplinary communication and potentially establish novel communication channels (Giraldo Nohra, Pereno, & Barbero, 2020). In the circular economy process shift, the designers address the complexity, with multiple dimensions to follow from flows of materials, energy, or stocks.

Combination of system thinking, circularity, and transdisciplinary approaches therefore of a system-specific behavior beyond the objects including communications, relations, and possible interventions with the use of the visual GIGAmap tool (Sevaldson, 2022).

GIGAmapping lead further to introduction of the interventions in the system and across the value chain. Data collection is based on the constantly ongoing and developing work packages of the partners involved in the project. Involved partners include the production value chain: solution provider, major suppliers, customers, and a recycler. Additionally, the project involves research centers in polymer science, and an ocean research center.

- Semi-Structured Interviews: This project employs semi-structured interviews to facilitate open communication among project partners. Interviews were conducted with four key partners involved in the value chain and principal operations.
- Additionally, interviews were carried out with research centers specializing in plastics and ocean research based in Norway.
- Partner Workshops: Workshops utilized models and tools from Peter Jones & Kristel Van Ael's "Practice Tools for Systemic Design" (Jones & Van Ael, 2022). The primary goal of these workshops is to establish a common language to address issues, thereby mitigating misunderstandings and miscommunications among various fields. Shared methodologies, such as workshop tools, aim to foster collaboration, addressing cultural and national strategies (Jones & Van Ael, 2022).
- Field Work and Observations: Field visits to fish breeding operation sites were conducted to gain a visual comprehension of the practical challenges.
- Active Generation of Project Documents: All partners participate in the work packages integral to the project, leading to knowledge creation and new project inputs. This dynamic co-creation of knowledge is a part of visualization and gigamapping processes.

4. Results

The major volumes of plastic materials have been pre-identified to apply circular interventions within the studied case. The three major interventions of reuse and recycling of fishing nets, prolong lifetime of load-bearing materials and recycling of plastics from the floating collars have been identified for the project focus. Using the systemic design process the other existing interventions have been mapped and connected to the expanded strategies of the 3Rs: prolonging lifetime, reduce, repair, recollect, reverse logistics, reuse, recycle remanufacture and remarket (The Ellen MacArthur Foundation, 2013; Uvarova, Atstaja, Volkova, Grasis, & Ozolina-Ozola, 2023) (Figure 1).

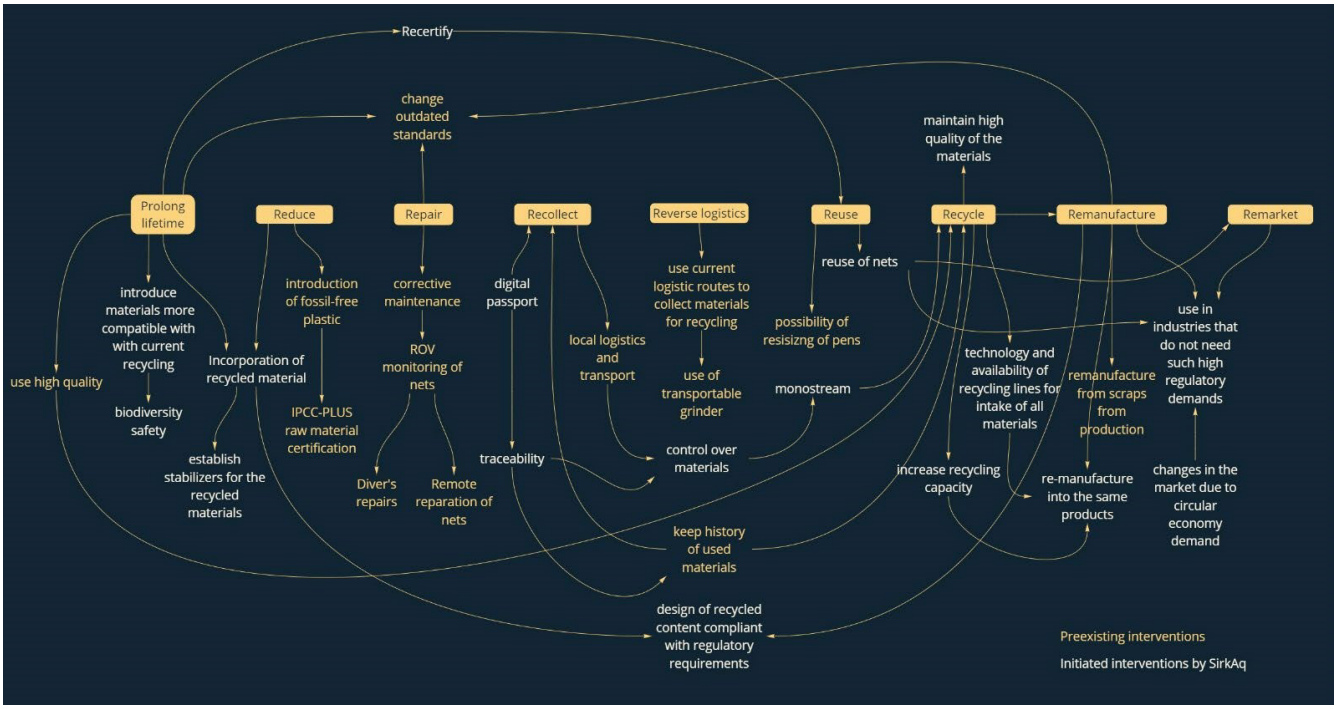

Figure 1. Identified pre-existing strategies within the value chain embracing circular economy.

4.1 Prolonging Lifetime and Standards

In heavily regulated sectors such as those involving load-bearing materials, high-quality and durable materials are used, contrasting with areas like packaging where plastics often have shorter lifespans and does not require any additional construction safety considerations. The use of recycled materials in remanufacturing is currently limited, primarily due to safety and durability requirements, which can present barriers to innovation.

Addressing these challenges necessitates enhanced collaboration at various levels. Stronger connections between organizations at the macro level, involving regulatory bodies, industry groups, and research institutions, could lead to effective national and international frameworks. These frameworks can provide guidelines for incorporating recycled materials into remanufacturing, ensuring safety and durability, and contributing more significantly to a circular economy.

4.2 Reuse

The strategy of reusing components can be applied within the same operation or outside the industrial environment, primarily depending on the quality and potential application of the components. However, implementing reuse strategies outside the organization introduces a new layer of complexity and requires the formation of new partnerships. Often partnerships are not yet mature on the market hence the other level of unpredictability. Despite these challenges, such strategies present significant opportunities for entrepreneurial development. Communication within such

opportunities requires further examination of the accessibility of materials, technological applications, and market demands.

4.3 Recertification

Currently, load-bearing materials are standardized for specific lifetimes. However, there's potential for extended use if weaker elements are replaced and the product is recertified. The project aims to influence standards and prolong the lifespan of materials by incorporating a circularity approach in load-bearing construction and supporting economically viable recertifications. Despite these efforts, a systemic environmental challenge has been identified. The recertification process for new materials can result in substantial emissions and costs, largely due to transportation and reassembly. This creates significant barriers to the implementation of circular strategies. Therefore, it's crucial to thoroughly examine the relationship between circularity and environmental impact.

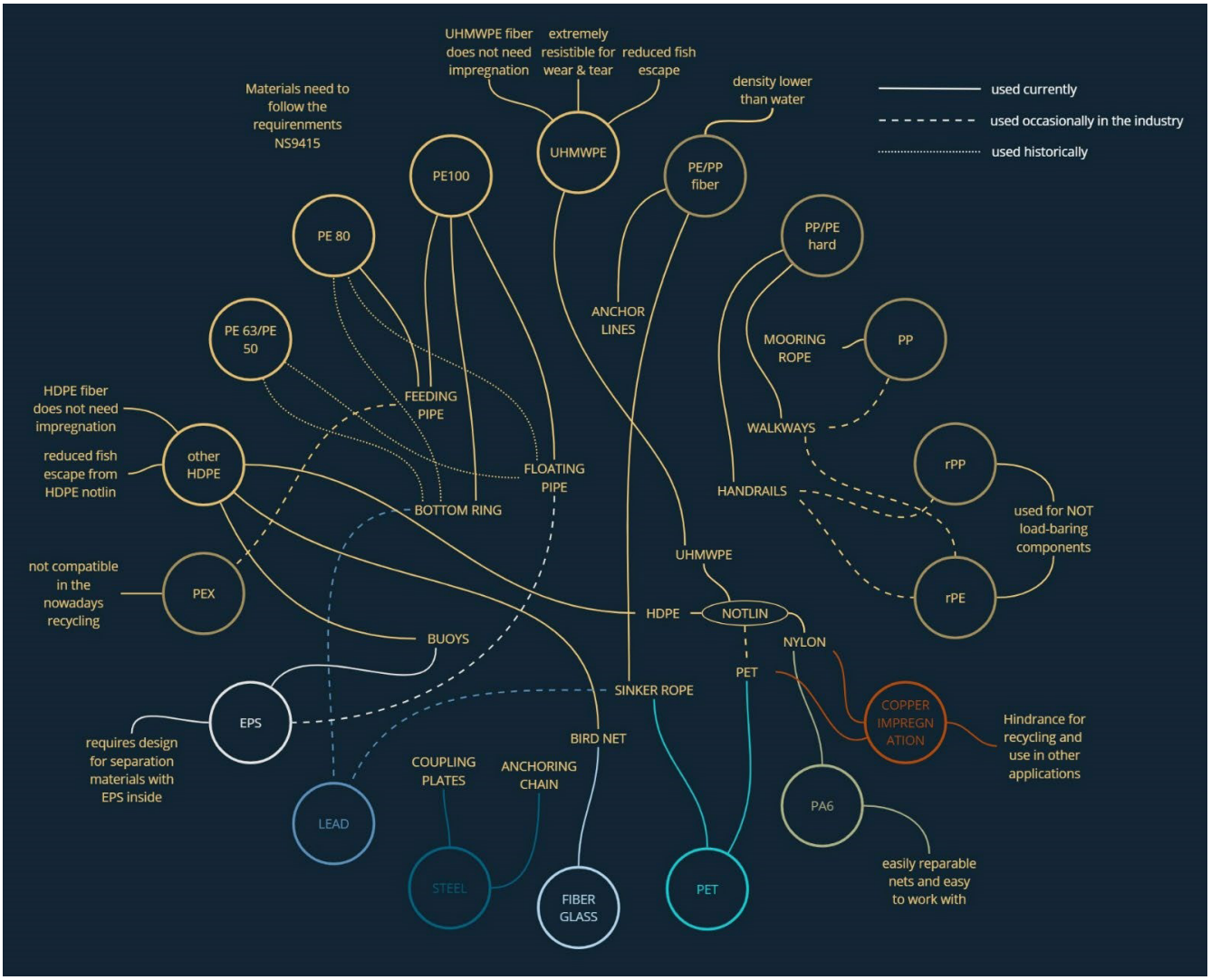

Figure 2. Visualization of different plastic and connected metals used in the major components of fish pens

4.4 Materials in product design

The plastic materials used in the fish pens design consist of multiple types and qualities of plastics (Figure 2). Some are connected to metals that are an integral part of the construction.

The current diversity of materials echoes the challenges inherent in the design process. In Figure 2, the materials that contribute to the major volumes are of a higher number than the amount of the products these are used for. The use and application of materials hinge on various factors such as function, production period, type of application, economic circumstances, location, and the availability of parts in the value chain. However, the selection of materials often overlooks the potential for recycling in a technological sense, as well as the availability of recycling technology locally. Additionally, the relationship with other stakeholders and market needs for reuse purposes is often not taken into consideration. These two interventions from the design for circularity perspective require more attention in the early stage of business development.

Recycled materials, such as rPP or rPE, encounter obstacles from a regulatory perspective as they fail to meet the required properties for load-bearing materials. The widespread expectation that recycled materials should perform identically to virgin plastics often impedes the acceptance of changes in material performance. However, embracing these changes as features rather than flaws could open up new possibilities from a systemic design perspective and prompt a shift in design focus.

From the communication perspective, the study shows the tension between the stakeholders. While designers do not have enough knowledge of materials, engineers don't have enough knowledge about design for circularity. This tension creates a restricted approach towards finding solutions and difficulties in handling complex problems based on long experience and regulatory landscape.

4.5 Changing factors

Regulatory changes and technological advancements have necessitated significant alterations within the material handling process, including repurposing, resizing, and material replacement. Regulations have prompted the substitution of certain materials in construction with higher-quality alternatives, while others have been replaced due to non-recyclability. These interventions, while embodying a commitment to circular design, introduce system delays. Materials produced to date will persist in product stock, eventually reaching their end-of-life phase and requiring new applications, as is the case with materials like polyethylene 63 (PE 63) or PE 80 (Figure 2). From a circular perspective, material loops returning to the same system will not be endless, necessitating the development of new solutions beyond incineration due to the systemic delay

(Meadows, 2009). This unpredictability of supply and end markets, especially regarding recycling facilities, poses a significant challenge.

4.6 Collaboration and Practical Competence

1. Repair & Maintenance

Creating more robust ties with service companies could significantly improve the practical competence involved in introducing superior practices to maintain high quality while closing the loop in aquaculture. A particular area of study is how servicing practices, specifically mechanical and technological interventions, impact the quality of materials post-use.

It is crucial to consider how these servicing practices interact with the materials at hand. The wear and tear on materials due to mechanical stress, as well as the potential effects of technological interventions, can significantly influence the materials' quality and, subsequently, their suitability for reuse or recycling.

However, the study of communication interventions with repair and maintenance services warrants careful consideration. The focus should be on developing practices that do not cause harm to the materials and ensuring the control of impurities which involves a broader understanding and redefining "waste treatment" to "material treatment" by stakeholders and employees. Sustaining high quality throughout the product's lifespan is crucial, not just for the immediate functionality of the product but also for its potential to be recycled and integrated back into the production cycle. By optimizing these aspects, the efficiency and sustainability of practices in the aquaculture industry, can contribute to a more circular economy.

2. End-phase & systemic pressure

Initial design strategies in various industries frequently rely on the technology and capacity available during the end-phase of the product lifecycle. However, the practical scalability of these resources can often be limited, posing challenges for the effective implementation of these strategies. For example, while chemical recycling is frequently highlighted as a promising future solution to close the loop in waste management, this technology is not yet accessible on a practical scale with a low emissions factor. This discrepancy between theoretical potential and practical application can create gaps in the system.

Recognizing these limitations is the first step toward effective intervention. By acknowledging the constraints inherent in current practices, strategies can be adjusted and refined to better align with the realities of available technology and capacity. Further, fostering a stronger connection to the end phase from the outset of the design process can serve as a proactive intervention. This forwardthinking approach can guide the design strategy to consider end-phase resources and limitations from the beginning, rather than attempting to adapt the product or process retrospectively.

This intervention could promote a more balanced resource management within the system. By integrating end-phase considerations into initial design strategies, resources can be allocated more effectively, potential waste can be minimized, and the system can move closer to achieving a circular model. This aligns with the principles of sustainable development, advocating for a system that meets present needs without compromising the ability of future generations to meet their own needs. The application of such interventions, therefore, has the potential to significantly advance sustainable practices in aquaculture.

The recycling industry appears to be significantly underestimated during both the planning and practical phases. This leads to high pressures on the end phase, with little predictability about the incoming materials and potential market. A progressive development approach could balance the system's resource input and output and improve management capacity. Changes in extended producer responsibility are shifting the roles of producers towards taking full responsibility for their equipment and recycling processes. These shifts might increase ambiguity around the role of recyclers, potentially leading to more specialized roles or diminished roles.

4.7 Systemic Perspective

This study examines the shift towards circularity enabled by new rules initiated by policy and law changes in the EU. The shift towards CE changes communication dynamics and fosters collaboration of embedding new paradigms not only in the one organization but rather across firms. Drawing however from the feature or systems simultaneousness and leverage points, circularity could benefit from being further analyzed as information flow and paradigm shifts as leverage points that can be further explored based on SOD methodology.

5. Discussions and conclusion

This doctoral research embraces two major perspectives of CE and its application in the aquaculture sector. The first perspective focuses on the transition toward a circular economy within the aquaculture sector. This part of the research is dedicated to the exploration of the ongoing shift from a traditional linear model to a circular one in aquaculture. By studying the practices in the case and principles being adopted, as well as the challenges encountered during this transition, the research aims to highlight the strategies that can be helpful.

The second perspective involves the application of SOD and Research by Design methodologies to manage the complexity of the circular economy. Given the intricate and systemic nature of CE, which involves a wide array of interconnected elements and dynamics, this research will utilize the SOD approach to assist in understanding and managing these complexities.

5.1 Circularity transition in the aquaculture context

The aquaculture industry has a strong level of control over the materials and from that perspective, it has a great area of development CE shift. The aquaculture touches as well on multiple globally valid resource and sustainability issues that has itself a great potential translate the knowledge between industries, fields and disciplines.

The analysis identified several critical areas for intervention in the transition towards CE. The dynamics of systemic shift but also micro, meso, and macro levels are interesting from their role of transitions that Kirchherr et al. (2023) discuss. As in many other areas, recycling stands still strongly as a major focus of projects requiring more attention from the perspective of strong pressures toward circular understanding at scale and interconnected processes that face challenges due to unpredictability in the supply and end markets (Ghisellini et al., 2016). The research found that the pressure on the end phase of the recycling process could be reduced with a stronger connection to service companies and a more pragmatic approach to design ambitions. Recognizing the limitations of the current situation and ensuring a stronger connection to the end phase from the outset could lead to more balanced resource management within the systemic understanding.

Systemic changes in regulations of material handling have been necessitated, where technological advancements and interventions have introduced new dynamics to the value chain. However, technology is still not compatible with higher demands for recycling, application, and market expectations. Some materials are still not compatible with recycling technology and the end-phase is disconnected from the early design phase and material choice. Such a disconnection may suggest the root cause problem within the function of CE itself. This may not be seen as an independent system but a paradigm as a leverage point that needs more attention beyond organizational structure, signaling a complete paradigm shift within the systemic shift.

5.2 Use of methodology

The use of SOD as a methodology for addressing complexity and the dynamics between the systems are easier recognizable to address tensions (Tosi et al., 2024). Adopting a systemic design perspective can open up new possibilities in the CE transitions especially since a higher level of communication is required to handle a large scope of resource problems. The application of experimental frameworks can catalyze cross-disciplinary discussions among stakeholders involved in the value chain and connected to the Norwegian economy, moving beyond the field-specific terminology. GIGAmapping can be particularly effective in this regard. As a tool for transdisciplinary communication, the study shows that invited participants from a range of backgrounds

are able to contribute to the dialogue and therefore reduce the epistemological gap (Giraldo Nohra et al., 2020). The diverse perspectives brought to the table illuminate the complexity of the subject, rather than reducing it. In this way, GIGAmapping enables participants to embrace the multifaceted nature of their discussions fully. It serves as a platform for an in-depth understanding of field-specific challenges and for fostering collaboration among diverse stakeholders. By facilitating a comprehensive discussion, GIGAmapping has a potential to lead to more innovative and effective discussions on the large scale systemic circularity shift.

SOD can be further studied and hence has the potential to be embraced as a methodology in discussing real-life complexity in the field of aquaculture, plastic pollution or similar.

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STRANGE STRANGERS IN STRANGE LANDS : A COLLABORATIVE STORYTELLING GAME FOR COMMUNITY BIODIVERSITY ACTIVISM

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ABSTRACT | This workshop explores collaborative storytelling games for speculative fabulation in Community Bioiversity Activism, aimed at: researchers and practitioners in design; those interested in Speculative Design, Queer, More-Than-Human and Decolonial perspectives on design and society; and biodiversity and community activism.

The Strange Strangers Playset (see Figure 1) is based on a Biodiverse Futures Design Framework, in which futuring practices framed by Queer Ecology1 are articulated; and which is designed to support Community Biodiversity Activism2 through Speculative Design (Jeffcott & Ferreira, 2021). It draws on the Conceptual Character3 of the Strange Stranger, who decentralises the human by framing all beings as "uncanny, familiar and strange simultaneously." (Morton, 2010). The playset is designed around a collaborative storytelling game, Strange Strangers in Strange Lands (See Figure 2). Collaborative storytelling games create a space which permits the making together of futures, such that they are materialised in the present2. The design of such games is a scaffold to shapes a space for the creation of fictional worlds and influences the sorts of futures that emerge. (Acharya & Wardrip-Fruin, 2019; Begy, 2013; Coulton et al., 2016). Strange Strangers in Strange Lands is designed to allow collaborative creation of biodiverse futures based on the principles of Sympoesis, where we make better futures together with others (Haraway, 2016); of prioritising transitional states over fixed categories; of storytelling to engender care; of playfulness as a speculative strategy; and of Pluriversality: embracing multiple worlds. The Playset is designed to support Community Biodiversity Activism, through making such speculative practices tangible to community members. The hope is that the sensitivity to possible futures engendered by collaborative and biodiverse speculative practices can help communities to oppose mono-cultural futures in the shadow of a narrow, human-oriented present. Workshop participants will explore the emergence of possible biodiverse futures from the perspective of

More-Than-Human3 beings. The objectives of the workshop are to: explore how collaborative storytelling games can support speculative practices in Community Biodiversity Activism; frame the world from a Strange Stranger's perspective; identify environmental challenges; create biodiverse futures in response through collaborative storytelling gameplay; debate the feasibility and value of emergent futures; and explore how futures can become materialised through design. The three hour workshop draws on the methods of speculative fabulation and making, collaborative game play, storytelling, concept mapping. The workshop (50 minutes) opens with an introduction (10-15 minutes) and an icebreaker guessing game (10 minutes). Following this, participants will work as a group identifying a local environmental challenge (10 minutes). After a break (10 minutes), the group will play the Strange Strangers in Strange Lands collaborative storytelling game (45 minutes), in which the group will co-create a pluriverse of fabulated futures or elseworlds. This is followed by a discussion of the feasibility and desirability of these futures, through a mapping exercise (15 minutes), ultimately choosing one particular future to focus on. Following a short break (10 minutes), the last part of the workshop will involve working in smaller groups to materialising that future in the here and now through speculative design activity prompts (40 minutes); afterwards, we will share and discuss the outcomes collectively (20 minutes). During the workshop, participants will make use of laptops and projectors, flip charts, craft materials (scissors, coloured pens, glue sticks, stickers etc) and lo-fi physical prototyping materials (Modelling Clay, LEGO Bricks, Sandboxes etc). Through these activities, the Strange Strangers in Strange Lands will result in the tangible outcomes of nascent speculative elseworlds that represent possible futures, speculative design artefacts that materialise those worlds, the gain of expertise in critically assessing pluriversal futures, and an understanding of how speculative gaming and a design framework situated in queer ecology can support community biodiversity activism through speculative design.

KEYWORDS | SPECULATIVE DESIGN, COMMUNITY ACTIVISM, QUEER ECOLOGY, FABULATION, BIODIVERSITY

[1] a lens that rejects arbitrary binaries between beings blurs the false dichotomy between nature and humanity.

[2] The myriad ways in which communities take action towards protecting their ecosystem, whether within or in opposition to existing systems of environmental management and legislation.

[3] An archetype personifying a philosophical concept (Deleuze & Guattari, 1994)

[4] Such a space for the emergence of fictional worlds has been referred to alternatively as a Diegetic Void, in which an empty space is provided that imposes some character on the world that emerges (Jara, 2023), and as a Simulation Gap, where the suspension of disbelief is required to breach the boundary condition between the fictional and the real. (Begy, 2013)

[5] A name for "post humanist constituencies" that encompasses "non-humans and other than humans such as things, objects, other animals, living beings, organisms, physical forces, spiritual entities, and humans." (Bellacasa, 2017)

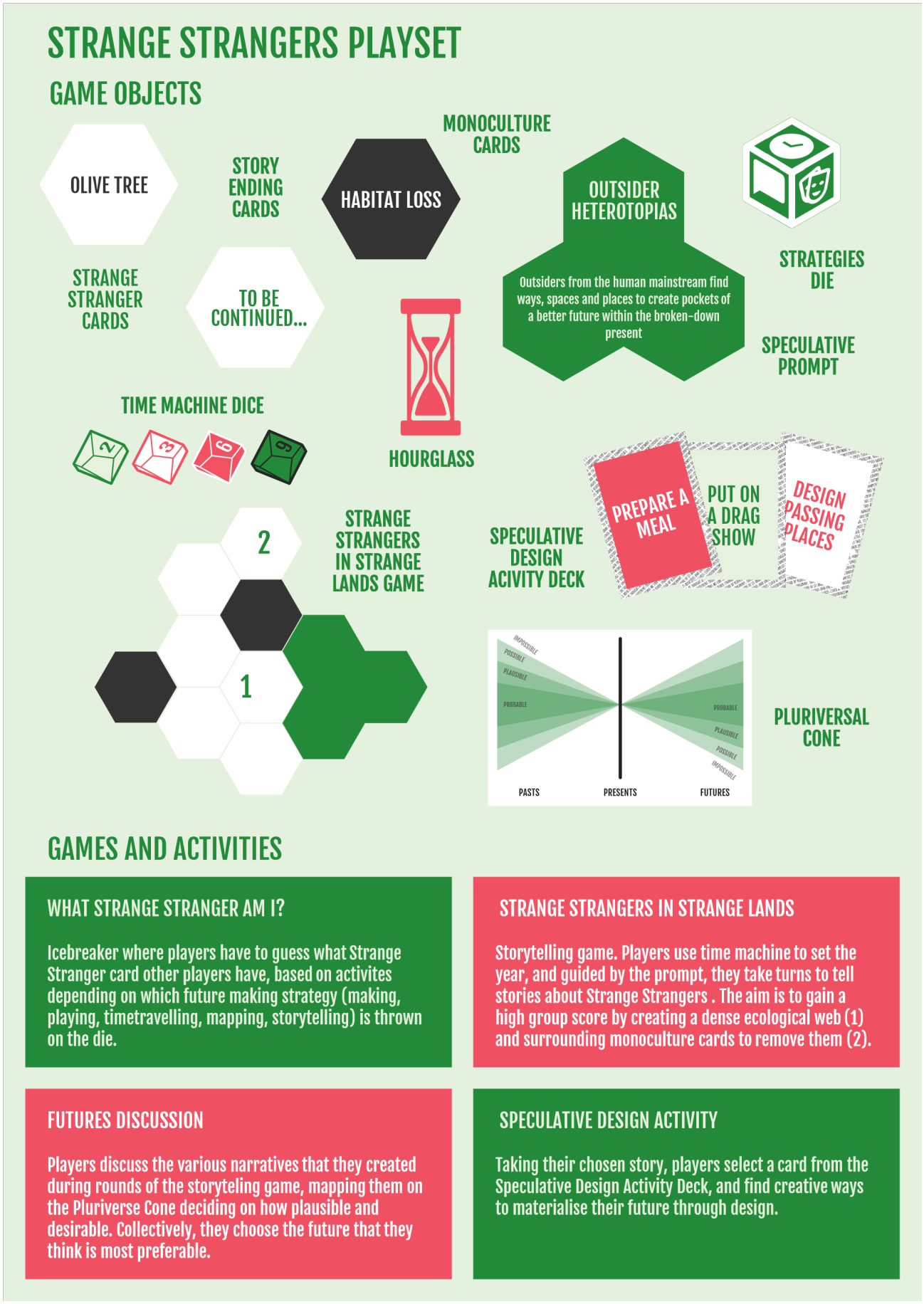

Figure 1. Overview Diagram of the Strange Strangers Playset, showing its game objects and games and activities

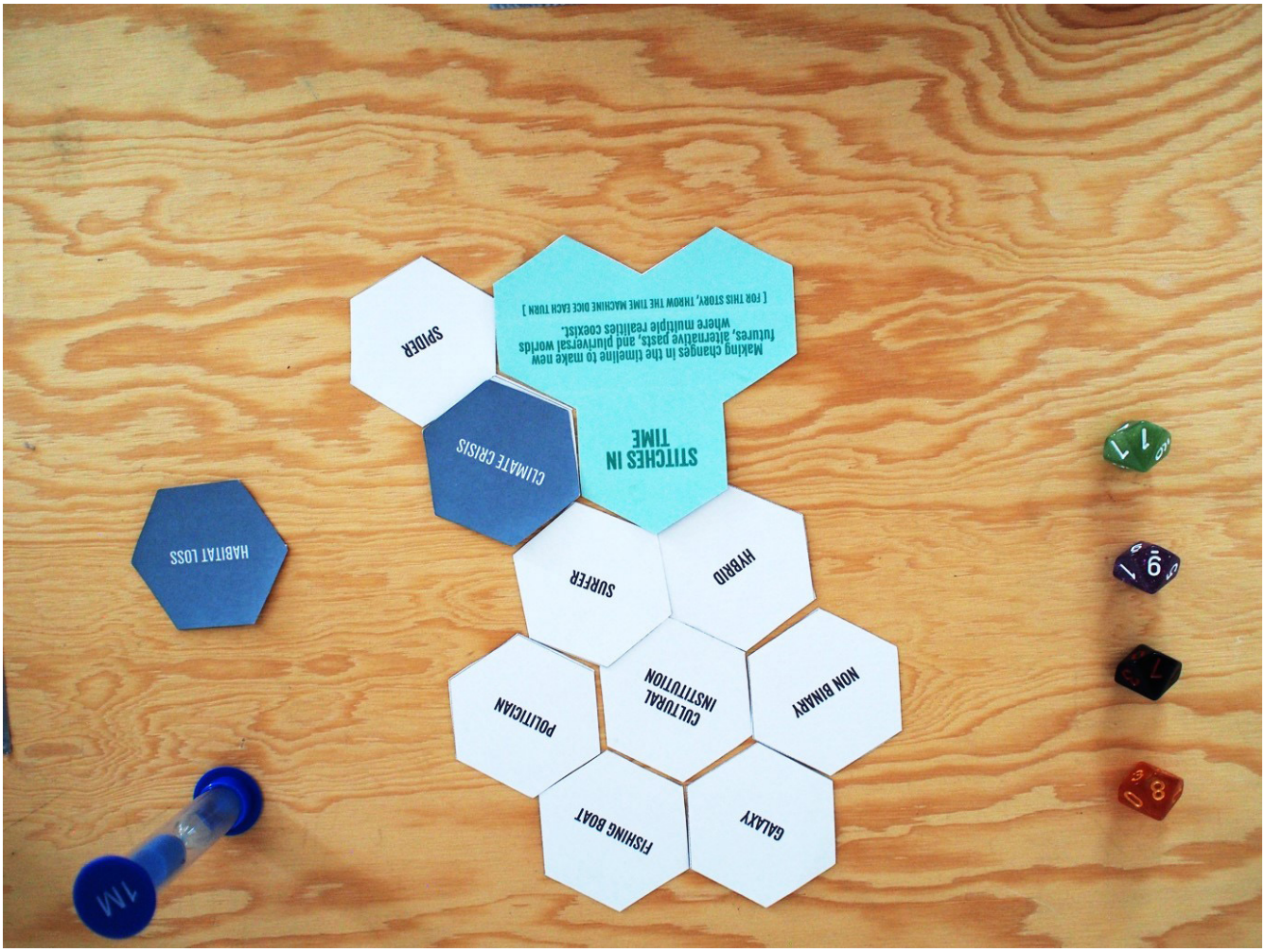

Figure 2 : Illustration of a game of Strange Strangers in Strange Lands in progress : players take turns to build up an ecosystem map by telling a story based on speculative prompts, aiming to maximise the biodiversity while eliminating monoculture cards (in grey).

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SLIDE DECKS ABSTRACTS

ART AND DESIGN ACTIVITIES AS DATA

Dávid Farkas and Ádám Radványi

ABSTRACT | Generalizing tendencies and creating comparable analytics for art and design have long been challenging due to the diversity of activities in these fields. No single database has been designed to serve as a comprehensive basis for such research.

To address this, we have developed a dynamic, form-based web application to administer and manage activities ranging from publications and events (including exhibitions and media appearances) to awards, artworks, and other creations. This web application integrates with the university's other systems, enabling the conclusive identification of students, teachers, researchers, and their collaborations.

With this data, we can generate detailed reports for our staff and their leaders on their achievements. Additionally, we created a collaboration map that visualizes the internal and external collaborations of our university in a network, highlighting highly collaborative individuals and allowing us to monitor the evolution of these networks over time. Furthermore, we built a Natural Language Processing-based competency finder to identify faculty and students proficient in specific skills, even if those skills are not explicitly listed in any of the input texts.

Leveraging our experience with these tools, we are now developing a more generalizable, user-friendly, and AI-based version of the platform and database. This enhanced system aims to benefit not only our institution but also other art and design institutions globally.

KEYWORDS | DATA SCIENCE, NETWORK, COLLABORATIONS, AI, DIGITAL TRANSFORMATION

CULTIVATING COMMUNITY COLLABORATIONS TO FOSTER SOCIETAL CHANGE

Claire Campion

ABSTRACT | Within the context of the third level Design education, the student is appropriately insulated within the classroom environment as they are guided through the structured collegiate experience. However, as educators, it is increasingly evident that, through our pedagogical methodologies, we must work to cultivate collaborations between students and external communities. Responsive teaching that asks students to answer live project briefs with associated real world design problems encourages a proactive way of learning rather than the traditional reactive style of study. 'Real world' briefs demand that students engage and collaborate with individuals and communities that sit outside of the expected academic populace. In this way we encourage young designers to solve design problems that work towards societal change – they are asked to confront the realistic demands on the contemporary designer in a changing world.

At the National College of Art and Design (Dublin, Ireland) Communication Design students join the Design Bureau as part of their third year of study. A teaching space is cultivated that encourages exploration, experimentation and both internal and external collaboration. Internally, students are taught to progress their skills with a cross-disciplinary approach as Graphic Design, Illustration and Moving Image Design students work together. Additionally, live project briefs are set that demand students collaborate externally with various communities, breaking down the barrier between the academic setting and real world societal design problems.

During the 2024 Spring Trimester the Design Bureau was presented with the opportunity for students to contribute to the conversation around future development opportunities for a local vacant textile mill. Property, land ownership and the accommodation crisis are hugely current societal issues in Dublin and so this invitation to set a project brief that would include the young creative voice in this discussion was a unique and important opportunity. With the guidance of tutors, multi-disciplinary student groups responded to the vacant mill as a catalyst for creativity. Once a building's intended purpose has been fulfilled or is no longer required, its role transitions

and presents new opportunities. Its components can be salvaged or recycled, contributing to sustainable practices. The end of its primary use doesn't signify the end of its story; rather, it marks the beginning of a potential transformation or a journey toward its next phase.

Throughout the project, students engaged in collaborations with local community groups and the Dublin City Council. In this way students stepped outside of the insulated classroom setting and into the real world space of design for positive societal change.

Concurrently, during the spring trimester, students took part in the Creative Boardroom project. This unique initiative asked Communication Design students to collaborate with directors of businesses from the Institute of Directors, Ireland; to develop innovative and effective solutions that address the complex environmental challenges we face in Ireland today. This government supported project is the first of its kind with a series of workshops hosted to facilitate intergenerational conversations and design sprints on the topic of climate change. The initiative offers a further example of collaborations that expand the academic experience while simultaneously allowing students to address global challenges.

KEYWORDS | CULTIVATING COMMUNITY COLLABORATIONS, FOSTERING SOCIETAL CHANGE, RADICAL PEDAGOGY, EDUCATIONAL INNOVATION

GOTA AND GULSHAN: POETIC ADORNMENT

Nida Abdullah

ABSTRACT | This talk will discuss an ongoing research investigation and ongoing development of a body of work. This is a research inquiry that explores making practices surrounding a textile adornment material “gota”, which traces its roots to the pre-colonial Indian sub-continent. This project focuses on the practice of embodied making as a form of witnessing. It engages with a inherited lineage of practices, materials, presences, histories, bodies, temporals and false borders. In this way the research examines gota’s (also known as gota patti, gota kinari, zari work or lappe ka kaam) socio-cultural significance as a communication object.

Gota is an ornamental embroidery technique which originates in pre-colonial India. It traces its lineage through a cross cultural fascination between the Mughals and the Persians. This shared interest in embellishment created a fertile ground for the development of gota in pre-colonial India, where materials and labor were easily exploitable.

Gota developed into an appliqué and embroidery technique using gold and silver tinsel thread (known as zari) onto fabrics such as cotton, chiffon and silk. It has distinct pleating, twisting or folding style markers which make up its visual language. Gota adorned objects are forms of knowledge transfer across many generations, typically handed down from mother to daughter. The use of precious metal and intricate hand work made it accessible historically only to the royalty, wealthy class, where the technique was used on elaborate dresses for occasions, especially weddings. For those of less wealth, these dresses would cost a lifetime’s savings and possibly even debt to its owners. In this way, gota becomes an object that transfers with it a kind of soft power as it is typically handed from woman to woman.[1]

The research inquiry asks how can gota adorned objects be a form of cross-generational and cross-border knowledge transfer? How can they embody ways of making? These forms of visual inquiry incorporate the poetic concept of “gulshan,” an Urdu and Persian word for garden. This is the closest translation, though it falls short in capturing the full social, cultural and spiritual meaning of the word. Gulshan is a poetic symbol for [the] beloved, a symbolic place of immense beauty or happiness. Here this concept may reference a land or time now lost. These textile

compositions as inquiry include multilingual typography, traditional gota patterns and motifs (elements such as peacocks, paisleys, and floral features), embroidered with gold zari; exploring the shared cultural meaning and memory of gulshan.

How does the poetic concept of gulshan intersect with the adornment practice of gota? How might multilingual typography (in Urdu, Farsi, Arabic and English) intersect with floral gota and zari kaam (textile adornment practices) calling up a brightness that we (diaspora) hold in our collective memory and collective imagination? How will these compositions sit within a long and inherited practice of poetic adornment? How does gulshan intersect with bare-e-saghir (subcontinental) diasporic adornment practices of gota and zari across time, bodies, borders and space?

[1] Mahar , Rida , Nabeel Ahmed, Yusra Asad, and Ramsha Aftab. “The Exquisite Crafts and Textile Culture of Sindh.” Textile Resource Centre IVS , 2021. January 1. https://medium.com/@trc_75910/the-exquisite-crafts-and-textile-culture-of-sindh-6bff438ee8be.

KEYWORDS | GOTA, INDIAN-SUBCONTINENT, FIBERS, DECOLONIZATION

TRANSFORMATION TO A CIRCULAR CAMPUS

Kwok Yiu Chan, Chi Yeung Choi and Chun Ting Leung

ABSTRACT | Circular Campus Initiative

The Hong Kong Design Institute (HKDI) stands as a design education institution in Hong Kong. Deeply rooted in experiential learning, the institute allows students to engage in hands-on activities that necessitate a variety of materials, ranging from textiles to construction elements. However, upon the end of these educational activities, a significant amount of these materials is often wasted.

This situation presents an imperative to reassess and incorporate resource management strategies in teaching and learning activities, design and research projects both inside the institute and with the community.

The institute is embarking on a transformation into a “Circular Campus”, a new initiative that aims to agglomerate design education, applied research and campus operations. This initiative is driven by the Butterfly Diagram of Circular Economy Systems, identifying the “Technical Cycle” and “Biological Cycle” to bring circular economy theory into practice with on-site recycling, redistributing, and redesigning of valuable resources for educational and communal use.

II Go-Greenovate Campaign

A campus-based campaign, Go-Greenovate, is established that emphasizes and promotes the importance of innovation and creativity in driving sustainability practices forward. The term combines Green – representing sustainability; and Innovate – representing creativity and innovation, encourage institute staff, students, and the surrounding community to achieve a shared goal of reducing waste across different platforms, demonstrating how creativity and resourcefulness can be applied to creating greener solutions for learning, teaching and design commercialization.

After surveying on campus operations and material consumptions in learning and teaching activities, tracking systems are set up to monitor the amount of materials that are used and can be redistributed, reused, or recycled through the internal cycles of the circular campus and external cycles with partnering communities and non-profits organizations.

Multi-disciplinary projects are identified from working group discussions among design programmes and campus administrations. The common goal of sustainability has enabled a wide spectrum of design specialists within the institution to work together for more impactful and holistic solutions that are relevant to societal needs. By integrating circularity principles and sustainable practices with design innovation, design projects with real-life challenges are introduced to educate future designers to enhance their vocational and professional skills.

III Significance

The Go-Greenovate campaign aims to become a knowledge hub for applied design research on sustainable design and craftsmanship that can bridge the connection among academia, industry and community.

KEYWORDS | HONG KONG DESIGN EDUCATION, CIRCULAR DESIGN, CIRCULAR ECONOMY, DESIGN PEDAGOGY

TECHNOLOGY AND MĀORI NARRATIVES IN DESIGN EDUCATION AND RESEARCH

David Hakaraia

ABSTRACT | Aligned with New Zealand's commitment to enhancing Māori student participation and achievement in higher education, my research and teaching philosophy is rooted in the Tertiary Education Strategy. This strategy recognises Māori as tāngata whenua (indigenous people of N.Z) and Crown partners under Te Tiriti o Waitangi, mandating that Tertiary Education Organisations facilitate Māori educational success by respecting and integrating Māori language, culture, and values.

At the heart of my teaching philosophy is the belief that students are creative and responsible arbiters of design and mātauranga Māori (Māori knowledge). I strive to cultivate an inclusive and culturally responsive learning environment where Māori perspectives are central. Integrating Māori knowledge, values, and perspectives into the curriculum ensures that Māori students see their identities reflected in their studies. This includes the use of Māori language and the incorporation of tikanga Māori (Māori customs). Additionally, I encourage students to be critical thinkers who can engage with emerging technologies and understand their impact on diverse people and the planet. This fosters the creation of innovative students who appreciate the unique whakapapa (genealogy) and relationships we have with our surroundings. Promoting an educational approach where students work across disciplines and embrace inclusivity, we envision a world where designers are empowered to create with profound and practical impact. My research philosophy is centred on exploring how modern fabrication techniques and Māori narratives can combine to create contemporary Māori design. This approach aims to take Māori creativity in a new direction while drawing on a rich legacy of history and cultural development. By expanding traditional Māori conceptual thinking into modern design, new avenues of learning and understanding are exposed. Key aspects of this research include the integration of digital technologies. Experimentation with digital technologies such as laser cutters, CNC machines, and 3D printers offers an opportunity for Māori knowledge to be communicated and shared using modern mediums. These tools of expression can offer a level of integrity comparable to traditional arts and crafts.

Addressing the debate within the Māori community about the merit of contemporary Māori art and design versus customary practices, as discussed by Damian Skinner in "The Carver and the Artist," is another crucial aspect of my research. There is a tension between maintaining traditional narratives and embracing contemporary innovation. My research seeks to bridge this gap by showing that modern techniques can enhance rather than diminish the cultural significance of Māori design. Enhancing understanding through storytelling is also vital. Storytelling is crucial for the intergenerational transmission of knowledge. By incorporating narratives into design, we can convey important cultural values, history, and societal norms. This includes using traditional art forms like Whakairo (carving), Raranga (weaving), and Tā moko (tattoo), alongside modern technology to create tangible cultural expressions.

My work contributes to the survival and well-being of Māori as a people. It aims to foster greater knowledge and use of Māori language and tikanga Māori, as well as the development of mātauranga Māori. By combining traditional Māori knowledge with modern technological capabilities, this research enhances Māori cultural expression and creates broader applications in the field of contemporary Māori design. Through this integration, we aim to empower a diverse community of students and faculty to make significant contributions to society and culture both nationally and internationally.

KEYWORDS | INDIGENOUS, MĀORI, DESIGN, EDUCATION, STORYTELLING

CO-DESIGNING HEALTH COMMUNICATION FOR NEURODEVELOPMENTAL DISORDERS IN SOUTH ASIA

Alifiya Mutaher and Reema Deshpande (online)

ABSTRACT | The Project is a collaborative initiative between an India-based non-profit mental health organisation, a UK-based University, a Nepal-based parent-led non-profit for Autism, and a Sri Lanka-based government medical college, supported by three funders. It endeavours to establish an evidence-based pathway for the early detection and intervention of neurodevelopmental disorders (NDDs), focusing on Autism and Intellectual Disability (ID) among young children in districts in India, Sri Lanka, and Nepal.

Our team worked alongside the project's Community Engagement Team to co-design and develop a communication strategy and tools for caregivers, facilitated by frontline workers (FLWs) to engage with the project care pathway. The co-design process highlighted several critical insights in community engagement in low-income settings for a complex and stigmatised health condition in South Asia.

The objectives of the communication tools were twofold: firstly, to increase awareness regarding child development delays and care pathways for ASD and IDs and secondly, to foster acceptance and engagement with project interventions led by FLWs. Community engagement builds trust, mobilises resources, fosters sustainable collaborations crucial for better health outcomes (WHO 2020), and strengthens local knowledge and capacities, promoting involvement in health programs (O'Mara-Eves 2015).

To design comprehensive communication tools, Quicksand led a year-long co-design process with various stakeholders, including

- Audience of the Communication Tools: Caregivers and parents of children with ASD and IDs and typically developing children.
- Health System Cadres: System Level Health workers and Health Specialists

- Program Teams: Community Advisory Boards including Autistic Individuals, Country Site Program Teams including NDD specialists and Global Program Leads

We applied a framework of co-learn, co-decide, and co-design (McKercher 2020). We engaged with each stakeholder to different degrees, using various approaches across project stages. This process led to outputs co-created by multiple stakeholders, centering the voices of parents and caregivers of children with ASD.

Given that the project had a limited budget and a fixed time frame, it required us to design communications tools that were applicable across the four project sites while accommodating local nuances. Co-designing with stakeholders from each site was essential in informing a communication strategy that reflected the unique contexts and negotiated the needs of each site, instead of imposing communication tools that sought to enforce behaviours that didn't meet the population where they were. Sustained engagement with stakeholders instead of a one-time interaction for ongoing decision-making, buy-in, stakeholder ownership and long-term sustainability of a communication strategy was critical.

The process demonstrated the need for thoughtful community engagement and how project plans needed to reflect this in resource and time allocation.It was also evident that all stakeholder touchpoints needed clear objectives that would respect community involvement, particularly in contexts where time poverty is a genuine challenge.

We aim to share insights at the intersection of design and global health, contributing to a deeper understanding of the complexities in co-design and community engagement in South Asia. We emphasise the critical role of community-centred approaches in achieving sustainable health outcomes.

KEYWORDS | COMMUNITY ENGAGEMENT; CO-DESIGN; PARTICIPATIVE DESIGN; INCLUSION; NEURODEVELOPMENTAL DISABILITIES; COMMUNICATION TOOLS; SOUTH ASIA; UNIVERSAL HEALTH COVERAGE

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REPRESENTING RISK: RADICAL COLLABORATION IN A DESIGN CLASSROOM

Angela Norwood and Yaqing Helen Han

ABSTRACT | A collaboration between an undergraduate design course and an international, multi-modal research project collecting data on perceptions of risk in LGBTQ2S+ young women in three cities: Melbourne; New York; and Toronto yielded novel opportunities for interdisciplinary knowledge exchange. The course was delivered as a vertical studio — comprising second through fourth-year undergraduate Design students. The international research team functioned as clients by introducing the research project to the class, providing access to the data, and visiting at key points throughout the term to ensure project progress and success. The students, many of whom identify as members of the population targeted in the research, worked to organize, amplify, and honour the data shared by participants in the form of web-based data visualizations and a physical pop-up gallery.

In an effort to reach broader audiences, social science researchers have been grappling with different modes for data translation and knowledge mobilization. Design education has been exploring ways to integrate social science research methodologies to inform applied outputs. While design is increasingly well-versed in various modes of co-creation and participatory processes, collaborations between designers and research teams remain relatively rare. However, such partnerships recognize the value of interdisciplinary cooperation and provide co-learning opportunities for both the research team and design students. Recent findings highlight the substantial impact of creative artifacts on public discourse, education, and policy-making, (Leahy, 2022) as they provide an opportunity to foster awareness by means of creation, sharing, and exhibiting data translations.

These novel collaborations between designers and researchers provide numerous opportunities for graphic design to transform research findings. UX/UI design can facilitate the accessibility of research findings through digital interfaces, such as websites and mobile applications. Information design can systematically visualize and organize both quantitative and qualitative data, enabling more effective translation of research results to diverse audiences. Communication design can employ visual systems to represent complex information, and convey

in-depth knowledge. Thus, graphic design emerges as an exceptional means of knowledge mobilization, serving to present and represent research data, while simultaneously creating accessible platforms for knowledge dissemination.

The vertical studio format provided a space that enabled knowledge from both fields to flow, clash, intersect or fuse. That knowledge exchange coupled with the diversity of the students' skill sets and interests in relation to the data, was leveraged as interdisciplinary, instructional material." (Peterson & Tober, 2014) Our reflections reveal that the topic of risk not only defined the research, it also permeated the vertical studio and creative making. The sense of community in the classroom, fostered by affiliation through gender identity with each other and the research participants, allowed for freer exploration of visual forms, deeper compassion for the experiences recounted in the dataset, and easier collaboration through organic team restructuring.

We will share selections from the exuberant visual output of the course and subsequent pop-up exhibit. The semester-long experience with the design students inspired the researchers to reconsider their approach to their own research.

KEYWORDS | DESIGN EDUCATION AND RESEARCH TRANSLATION, INTERDISCIPLINARY COLLABORATION IN DESIGN EDUCATION, PERCEPTIONS OF RISK AMONG LGBTQ2S+ YOUTH, INFORMATION DESIGN AND DATA VISUALIZATION VERTICAL STUDIO, SELF-SELECTING TEAMS

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KINESTHETICS AND INTEROCEPTION: FUTURE DESIGNS FOR MORE THAN FIVE SENSES.

Eugenia Bertulis

ABSTRACT | Designers are often described to be translators, developing and iterating specifications across analytic, written, visual, and experiential languages such as sound and touch. Especially when partnering with technology-centric teams, written and analytic languages can be more highly valued, resulting in largely neo-liberal utilitarian measures for design success. On the other hand, ethical design practitioners champion further human (and more-than-human) modes of sense-cognition. For example, moving beyond Visual Design and considering all five "classic" or "Aristotelian" senses can synesthetically extend design touchpoints into experiential channels. This presentation shares a progression of design moments, starting with analytic design briefs and collaborative visual design criteria development, and concluding with audience-engaged interactive experiments and sensory design examples, investigating future opportunities in design considering kinesthetic and interoceptive senses.

The examples critique the current modernist-colonial default visual design languages that result from "usability" studies and simplistic form-follows-function hierarchies. Furthermore, the design explorations shared interrogate the role of "Artificial Intelligence" and other tools enabled by Big Data and Surveillance Capitalism, comparing supporting, hybrid, and Centaur models in Design for all the senses.

KEYWORDS | USER-EXPERIENCE DESIGN, DESIGN AND TECHNOLOGY, HUMAN-CENTERED METHODS, SENSE-COGNITION, DESIGN FUTURES

DECOLONIZING DESIGN: EQUITY IN PARTICIPATION

Juliana Edith Rojas Reyes, Jordana Baron and Isabel Sandoval

ABSTRACT | Circular Campus Initiative

The initial objective of our project was to co-design a comprehensive package that promotes a supportive and gender-equitable environment for young adolescents in Indonesia, enabling them to grow and thrive. This objective necessitated a holistic approach, considering not only the adolescents themselves but also their key influencers, including parents, family members, and religious leaders. To achieve this, a powerhouse team was formed, comprising the GEAS Youth Advisory Board, Johns Hopkins Center for Communication Programs, PKBI Bali, and ThinkPlace US.

Process:

Our process began with a thorough review of existing literature to synthesize information that would frame the design process. This involved generating insights and identifying opportunity areas that could serve as focal points for intervention. Subsequently, we conducted co-design workshops to transform these insights into actionable ideas. The ideas generated were then prioritized and further developed into concrete design concepts.
These design concepts were translated into prototypes, allowing us to visualize potential interventions. These prototypes ranged from medium to high fidelity and were rigorously tested and iterated upon to refine their effectiveness and feasibility.
Establishing Equitable Relationships:

A central question throughout our project was, “How might we establish equitable relationships with the communities with which we are designing?” As a global north-founded, based, and funded organization conducting a project in the global south, we recognized the importance of leveraging our diversity. Our team consisted of designers from both the global south and north, which enriched our perspectives and approaches.

To ensure equitable relationships, we made our local partners integral members of the team, providing them with the necessary support to build ownership of their roles. This approach was crucial in fostering an environment of mutual respect and collaboration, where local insights and expertise were valued and incorporated at every stage.

Community-Centered Design:

As designers, we adhere to the principle of placing users and the community at the center of the design process, engaging them in every step. While this user-centric approach is not new to our discipline, what is innovative in our project is the commitment to ensuring that for every stakeholder we involve, we strive to give more than we take. This philosophy is part of our broader effort to decolonize our practice, ensuring that our interventions do not perpetuate existing power imbalances but instead empower and uplift the communities we serve.

In conclusion, our project represents a concerted effort to create a gender-equitable environment for young adolescents in Indonesia through a collaborative and community-centered design process. By integrating diverse perspectives and fostering equitable partnerships, we aim to develop interventions that are not only effective but also sustainable and empowering for the local communities. This approach highlights the importance of decolonizing design practices and prioritizing the needs and voices of those we seek to support.

KEYWORDS | EQUITY, PARTICIPATORY, DECOLONIZATION, SOCIAL IMPACT

STRATEGIC FORESIGHT FOR SOCIAL IMPACT: UTILIZING DESIGN TO PROMOTE EMPATHY AND INTERCULTURAL UNDERSTANDING

Ellen Hlozan and Alex Lobos

ABSTRACT | Strategic foresight is a pivotal tool for navigating future uncertainties by systematically envisioning potential outcomes. Bridging the gap between science fiction and strategic planning enables a proactive engagement with unforeseen forces that significantly influence today and tomorrow.1 This presentation explores how strategic foresight promotes empathy and intercultural understanding, which are crucial in today's globally interconnected society.

At a recent industrial design graduate studio, students were introduced to strategic foresight tools, including weak signal scanning and scenario building,2 which help to identify fragmented indicators of future trends and explore potential futures based on these signals. They used these tools to create speculative scenarios across social, technological, environmental, economic, and political (STEEP) categories.3 Students presented their scenarios via imaginative short videos. This format stimulates discussions on uncertainty and the dynamics of change, thereby fostering a deeper understanding of the potential societal impacts.4 Student's scenarios ranged from envisioning economies devoid of money—where AI provides necessities and human motivation shifts from materialistic to intrinsic values—to nations collaborating extensively to mitigate resource scarcities and balance population demographics, and even presenting a decayed city of Venice where material pollution has taken over natural resources and urban infrastructure, making waste one of the only resources available. As a second part of the assignment, students developed speculative solutions for issues identified in the scenarios. These solutions included novel systems for indoor farming, modular housing made out of corals, minimally invasive medical scanning devices, and many more.

These scenarios and speculative designs help students to understand potential large-scale changes in a structured manner, enabling them to visualize a sequence of cause and effect that could result from certain developments. This visualization also helps to understand how different futures might coexist, encouraging students to think critically about the broader implications of design decisions.5 Integrating strategic foresight in the design process provides several key benefits, including:

1. Mitigating Risk: Foresight methods help designers think beyond the immediate, consider the long-term consequences of design decisions, and work towards a more desirable future.

2. Bridging Across Boundaries: Foresight encourages designers to consider diverse perspectives and anticipate challenges related to cultural, geographical, and economic differences. This fosters empathy and promotes the creation of solutions that cater to a wider range of users.

3. Designing Towards Autonomy: Through scenario building, designers can envision futures where users have greater agency and control over their lives. This empowers designers to create solutions that support user autonomy and promote a proactive approach to shaping the future, instead of simply reacting to challenges.

Strategic foresight is not about predicting the future; it helps to prepare for it in a way that incorporates empathy, ethics, and a broadened understanding of cultural dynamics into the design process. Teaching future designers to employ foresight in their work allows them to create more thoughtful, inclusive, and culturally aware designs that improve human interactions and societal cohesion on a global scale. This approach ultimately helps to cultivate a design philosophy that values change and actively contributes to a preferable, empathically connected future.

KEYWORDS | STRATEGIC FORESIGHT, SPECULATIVE DESIGN, SOCIAL CHANGE, INDUSTRIAL DESIGN, FUTURES SCENARIOS, DESIGN RESEARCH, DESIGN PROCESS

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THE EVOLUTION OF COLLABORATION: TRACKING BENEFITS OF ALTERNATIVE INSTRUCTION METHODS

Deidra Arrington and Hawa Stwodah

ABSTRACT | Universities offering degrees in fashion design and fashion merchandising/ marketing silo the program tracks with little interaction or collaboration between the two, which is counterintuitive in the preparation of students in an industry where designers and merchandisers work together to bring creative ideas to fruition through saleable, desirable fashion products. The lack of collaboration and basic understanding of the function of design and merchandising in fashion education led two professors (1 from design and the other from merchandising) to the creation of a new course combining fashion design and merchandising students in a studio environment where they spend a semester creating a line of apparel.

The course and research explore the incorporation of action learning and simulation teaching methods in fashion education prepares students seeking fashion careers. It contributes to the field of fashion education by introducing a method of cooperative teaching, which includes peer teaching, experiential learning, critiques, and critical thinking resulting in the cross-pollination of parallel and intersecting, but disparate disciplines. The instruction is made possible through teachers from analogous, but differing backgrounds, who bring insight into the classroom demonstrating to students the team work and flexibility required to fuel an inspired result. Students learn to adapt to different work environments and creative problem solving through the simulation of a 'real world' workplace. The studio course created to address the void in the curriculum has been monitored and documented since August 2019. The course has transitioned through several disruptive semesters where modalities have pivoted and counter-pivoted and has mirrored the changes occurring in the fashion industry.

The course is process oriented, meaning it is organized to lead students, who work in teams, through the entire line development process as it generally occurs. Students are given a prompt for the semester, which have included denim, adaptive apparel, inclusive sizing, and activewear.

Based on the prompt, students research the consumer, marketplace, and industry. They identify the inspiration and the ethos of the brand they will create. Sketches of proposed looks are presented, from which the line is selected. The final selections become flats and are rendered in CLO3D. Technical aspects of line development such as, cost sheets, specifications, and line sheets are required. Lastly, marketing and advertising plans are created. To enhance the learning of each process step, guest speakers address topics in their areas of expertise including, team building, textiles and fibers, forecasting, sustainability, and marketing. An industry critic, with expertise in the particular topic, takes on the role of creative director and visits the class (in person and on zoom) throughout the semester to evaluate the progress of the teams. They are present in the studio for the final presentations, where a 'critic's choice' winner is selected.

The teaching methods of the course have resulted in a greater appreciation of design and merchandising from their respective counterparts, an increase in student engagement in the studio, and an elevation in work quality.

KEYWORDS | FASHION DESIGN AND FASHION MERCHANDISING, COLLABORATION, COOPERATIVE TEACHING, EXPERIENTIAL LEARNING, CRITICAL THINKING, CROSS-POLLINATION, SIMULATION OF A 'REAL WORLD' WORKPLACE, PROCESS ORIENTED

WE ALL NEED A HOME: CO-CREATING SUSTAINABLE SHELTER

Tibor Danyi

ABSTRACT | The Research Group for Solidarity in Architecture Lakni Kell (We All Need a Home) initiative in Hungary is based on a solidarity framework for design thinking practices. We assert there is no acceptable architecture and design without solidarity with other citizens/communities/the public. Unhoused populations are our core concern with homelessness resulting from a housing crisis one of the greatest challenges facing many so-called “developed” societies, particularly in North America and Europe.

We learn with community partners as we collaborate to contest complex socio-economic conditions. Resulting interventions in public and private spaces are small scale with increasingly complex programmatic ambition. These efforts expand the conception of designers as citizens while improving the lives of people we serve.

This design-build project learns from from cross-disciplinary architecture and social psychology research insights. Ultimately a team of researchers, students, citizen allies and unhoused residents created a durable, protected living space that minimizes the ecological footprint while addressing more equitable social possibilities.

The research phase employed qualitative methods to document survival strategies and creative techniques by which this community finds shelter despite a forbidding housing policy context. Those findings illustrated how participants creatively used local materials and simple techniques to realize functional homes with minimal ecological impact compared to more advanced housing technologies. Adaptive insights from these individuals in marginalized communities evidence resistance to systemic obstacles within the homeless care system, allowing otherwise unhoused people to keep relationships intact in “homes”.

With these ecological and social findings as a basis, the student-led collaborative design established sustainable materials, a means of co-construction that included students and the resident family and neighbors, and definition of the housing program through the lens of the family’s needs. Construction with donated, up-cycled materials ensured a circular economy and minimal

ecological impact. This included timber from demolished houses, leftover thermal insulation, festival tent membranes, and door panels. A couple who had established a highly vulnerable shelter in the gardens (leaking and subject to flooding) participated across the entirety of these processes and informed many decisions about how to achieve a viable house and home reflective of their sense of belonging.

As an example of socially engaged architecture the prototype has catalyzed ongoing dialogue with political leaders about the potential for transformations of public parcels in Pecs, a municipality of 140,000. This shelter for an unhoused couple can be a model for more systematic use of the gardens for permanent housing, particularly considering that local homeless organizations do not provide long-term housing for married couples, partners, and families.

The project demonstrates how environmental sustainability goals might also serve economic and ultimately social sustainability outcomes: minimizing waste produced in the consumer society model can contribute to the alleviation of social inequalities through the framework of solidarity. Finally this project provides an expanded sense of the possibilities of co-creation to engage with solidarity and in an equitable way with the lived expertise of unhoused communities to address serious social problems.

KEYWORDS | CIRCULAR ECONOMY, HOMELESSNESS, SOCIAL SUSTAINABILITY, PARTICIPATION

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OFF ROAD, TRY OUT & THE CHOREOGRAPHY OF MAKING

Nelleke Karst

ABSTRACT | Every conference we attend, exchanging information with global colleagues, we notice that how we do things is not so common. Perhaps even unique. We'd love to share what we do during Cumulus Monterrey, and start a dialogue.

Minerva Art Academy

Minerva Art Academy is an international learning community with four bachelor and four master programmes, spanning art, design, art education and popular culture.

Ten years ago, the Design bachelor built a programme that transformed compartmentalized majors into a broader, more open playing field, stimulating the crossing of boundaries between disciplines.

A set or a flexible playing field

Besides offering set courses, our students can also, to a high degree, influence their educational path, with the goal of allowing them to create their imagined future professional practice. Our program offers structural as well as one-off opportunities for students to flexibly plan their desired study route.

Major Cross overs: Off Road

In the propaedeutic year students go through a program of 5x7 weeks in which they get acquainted with our different design disciplines. Many incoming students haven't developed a strong preference for a specialism yet. Before year 2, they pick one of the five specific majors, ór the 6th: Off Road Design. On this transdisciplinary route, they can combine up to three majors during the rest of their study-journey.

This allows students to decide how they wish to describe themselves on their future business card. From 'installation building graphic designer' and an 'illustrating product maker' to a font focused storyteller'.

For whom?

After the first academic year, about 20% of our students choose the Off Road major, amounting to roughly 30 students. This shows that the majority of our students prefer a set major route, leading up to a specific specialty. In the Off Road group, about half consciously choose in the spirit of our intentions. To critically approach and shape their future profession. The other half are students who, generally speaking, have difficulty choosing direction and fear missing out.

Mapping out your own study journey

Off Road; the lesser trodden path. Carving out your own route. Like a jeep in an empty dessert. In his poem 'The road not taken", Robert Frost described a fine case of FOMO[1] avant la lettre, which resounds in determining one's study programme. Choosing this path asks of students to map out their own route. To critically ask themselves what they want to learn, in what order and through which medium. To trust in their own ability to create depth instead of fearing what they are missing out on.

Rooted in trust

Operating from a place of trust is essential to us, where also so much in education is about control, limiting the space for play and innovation. When starting this endeavor, crossovers were scarce and difficult to organize. When wanting to tear down the borders, we wanted to be progressive. Offer freedom, based on trust in the abilities of our students.

Why all his flexibility?

The future is now: create your own professional practice
Providing a clear definition of our profession is becoming more and more difficult. Pascal Gielen[2] stated that, as the future is racing towards us at an ever-increasing speed, this means that the preparing for 'employable graduates' is outdated. The future lies in the present and students must not be prepared for a future profession but should 'create' these professional practices themselves.

To offer educational support, the assignments in our course are described as Design Dilemmas. Not assignments with only one possible answer but issues in which students are challenged to consider possible 'solutions' while creating. Allowing for a specialty- as well as an off road- approach.

Try Out: a choreography of making

Along the way, Try Out became a motto for us.
The meaning of Try Out in theatre terms, offers the department the opportunity to have the audience (the user, those involved) be part of the development of education, and to experiment interactively with intended goals.

How else do we cross borders?

Besides the major routes, we offer a so-called “Switchboard semester” in which students can choose a wide variety of options outside of their regular program, allowing them to move closer towards their desired positioning. Ranging from taking courses in other specialty areas in our academy or doing an individual project, e.g. focusing on artistic research, or starting a business. The crossing of boundaries also happens in the theory components of our course. In theory, thinking through making is highly encouraged. Like critically editing a classic art history book, by (literally) cutting away, reshuffling, and adding new content or form to the book.

Additional slide deck input

In addition, we will present how our students try things out.
Like making a time-based installation for an interactive font.
Or work on theory by making.
We’ll conclude by circling back to the theme of the conference.
Through perspectives. Empathy. And creating the future in the now.

*1 Houghton, R. (2015). https://robinhoughtonpoetry.co.uk/2015/08/23/the-road-not-taken-fomo/

*2 Gielen, P. (2013). Kritisch Vitalisme. Culture + Education (37), 36 – 42.

KEYWORDS | OFF ROAD, TRY OUT, CHOREOGRAPHY OF MAKING, FLEXIBILITY, FUTURE IS NOW, EXPERIMENT, MAJOR CROSS-OVERS, DESIGN DILEMMA

THE FUTURE OF CRAFT

Elena Andreea Tron (online)

ABSTRACT | This research as part of an ongoing Master Thesis in Fashion Design entitled “The Future of Craft”addresses the challenge of keeping craft alive in a future where it is increasingly at risk of being replaced by new technologies. The thesis proposes a positive view of an uncertain future, following in the footsteps of Ursula K. Le Guin’s “Carrier Bag Theory of Fiction”. The essay posits that stories, and by extension cultural practices, should collect and hold diverse experiences rather than follow a singular, heroic trajectory. Le Guin’s metaphor challenges the dominant narrative of the lone hero overcoming obstacles, advocating instead a more inclusive, collaborative approach.

Similarly, the integration of digital tools with traditional craft techniques fosters a holistic design process, creating synergies that embody both the precision and innovation of technology and the tactile, experiential wisdom of craft. This blend can lead to innovative practices, combining the efficiency and replicability of digital methods with the ingenuity and longevity inherent in craft traditions.

Through a series of speculative scenarios, the research envisions futures where craft evolves into an innovative design tool, where traditional craftsmanship and modern technology coexist harmoniously, and where sustainable practices become integral to fashion. The study aims to inspire a sustainable and creative future rooted in the timeless principles of traditional craftsmanship.

As a research methodology, I chose practice-based research, based on my dual role as a practitioner and my strong belief that craft can only be studied holistically through practice. This approach posits that the most profound understanding of craft emerges through direct practice, where embodied knowledge is acquired through the act of creation and experiential engagement.

The themes I have chosen to research include

- Traditional weaving: Chosen for its familial significance and its role in preserving embodied knowledge.
- Zero Waste Pattern Making: Based on traditional folk clothing patterns, speculating on their evolution.
- 3D Weaving: Selected as the most advanced form of weaving to date.
- Bioplastics: Experimenting with kitchen-made fabrics as a form of grassroots innovation.
- AI: Embraced as a design assistant.

While most of the current discussion around craft focuses on its preservation, this thesis proposes to liberate it from the constraints of the past and, through speculative scenarios, allow it to evolve organically into an optimistic future.

KEYWORDS | THE FUTURE OF CRAFT, PRACTICE BASED RESEARCH, SPECULATIVE SCENARIOS, WEAVING, ZERO-WASTE PATTERN MAKING, BIOPLASTICS, CO-CREATION, FASHION DESIGN, MATERIAL INNOVATION

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