CLAUDIA NICHETTI
DANIEL VENTURA
JÚLIO CARLOS DE SOUZA VAN DER LINDEN
LUCIENE MACHADO
EDITORS

Design, Culture and Innovation

Volume Five

PERSPECTIVES, EXPERIENCES AND CONNECTIONS

UFRGS
UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
PGDESIGN UFRGS
LDCI Lab Design Cultura Inovação
marcavisual
editora e projetos culturais

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preface

Luciene Machado

The traditional view of Design as an activity focused exclusively on the form or function of objects has continuously expanded, with **Design assuming a strategic and cognitive role in culture**, education, and innovation. This evolution parallels the history of humanity itself, as designing is an inherent human capacity. From the earliest artifacts created to meet survival needs to contemporary systems, services, and experiences, **Design expresses the human ability to conceive solutions and assign meaning** to the world. More than mere objects, artifacts embody knowledge, values, beliefs, and memories, becoming constitutive elements of cultures.

From this perspective, **Design can be understood as a cognitive process** that drives the transformation and evolution of societies and fosters new experiences. Contemporary scholarly work highlights this shift toward an interdisciplinary approach, demonstrating that **Design transcends the creation of artifacts** to integrate knowledge and technologies from diverse fields, connect various stakeholders, mediate relationships, and develop solutions guided by human values and sustainability.

It is within this scenario that the **intersection of Design, Culture, and Innovation gains strength**. Design does not merely keep pace with the transformations of society, **it also acts as an agent of transformation** itself. It serves to interpret social changes, celebrate cultural identities, and shape possible futures—thereby reaffirming its role as an interdisciplinary field of knowledge rather than one solely dedicated to creating products and services. This argument, prominent in recent literature, shifts Design from a passive role to a leading one in shaping new scenarios and generating experiences, meanings, and positive societal impacts.

In this context, the ***Design, Culture & Innovation* collection** was conceived with the aim of disseminating the results of research and projects conducted by members of the **Design, Culture, and Innovation Laboratory (LDCI)** - a group comprising master's and doctoral students as well as researchers. The LDCI is affiliated with the Postgraduate Program in Design at UFRGS (PGDesign/UFRGS). Led by Professor Júlio Carlos de Souza van der Linden, PhD, the LDCI fosters discussions and research regarding the multidimensional nature of Design. It views Design as a complex activity - considering its role and impact on education, culture, innovation, business, sustainability, technology, processes, industry, and creativity - as well as the relationship between Design and designers and other stakeholders in innovation processes.

This book, ***Design, Culture & Innovation,*** is now in its fifth volume (2026), marking the first time it has been published entirely in English. It retains the structure of previous volumes, being divided into three sections, each centered on a thematic axis related to Design. Each section features chapters presenting research findings from master's and doctoral studies conducted within the Postgraduate Program in Design at UFRGS (PGDesign/UFRGS).

To briefly **look back at the collection, the first volume** - released in 2019 - was organized around three thematic axes corresponding to three movements of a cycle (Design, Culture & Innovation; Culture, Innovation & Design; Innovation, Design & Culture) and six chapters covering topics such as the multidimensionality of design, organizations, fashion, sustainability, the creative process, student profiles, reflections on the roles of design in collaborative processes, and the perception of design by project managers. First volume can be accessed via the following link: https://lume.ufrgs.br/handle/10183/199123

The **second volume**, released in January 2022—also organized around the same three thematic axes as the first volume—presents six chapters covering topics such as: the transformation of culture through Design; the attitudinal competencies of designers; forces of innovation and their effects on culture; tools for defining design project requirements; visual communication; decision-making in Design Projects; aspects of the design process related to "what to do"; a model for teaching Design within the university-industry relationship; Design for Urbanity; and designer responsibilities regarding the conception of the urban environment. Second volume can be accessed via the following link: https://lume.ufrgs.br/handle/10183/242392?show=full

The **third volume**, released in 2023, is structured into six chapters grouped around three research focuses. The first comprises two chapters addressing the role of designers in urban projects. The second group contains chapters revolving around themes of Design and Education, covering approaches such as: cross-cultural collaborative learning in Design (the Global Studio project), Learning Experience Design, Design as an educational tool for interdisciplinary projects in higher education, Venture Design, and investor behavior in startup evaluation. Third volume can be accessed via the following link: https://bibliotecadigital.ufrgs.br/handle/10183/267473

The fourth volume, released in January 2025, was structured around three thematic axes—Design & Culture, Design & Education, and Design & Innovation—and eight chapters addressing topics such as: the relationship between design, territory, and citizenship; Participatory Design in urban revitalization; the role of Design as a collaborative practice; Design and social innovation in public and community contexts; culture and creativity; Design as a cultural process; pedagogical approaches bridging theory and practice through active methodologies; integrative reasoning and thinking models for addressing contemporary problems; Design Literacy and Design as an essential cultural competence; UX competencies; Design and technology in entrepreneurial ecosystems; and user-driven innovation. Fourth volume can be accessed via the following link: https://lume.ufrgs.br/handle/10183/301899

This **fifth volume** reflects the breadth of the field of Design by bringing together research across three thematic axes and comprises eight chapters. The **first section** explores the axis **DESIGN FOR SOCIAL, URBAN, AND PUBLIC TRANSFORMATION**, opening the book with analyses that examine the relationship between Design, territory, and citizenship. It presents Chapter 1, on the role of Design in urban revitalization (The role of Design in urban revitalization: intangible values over time), and Chapter 2, on Design Practices in public innovation (Design Practice in public innovation: evidences from Brazilian innovation labs). The **second section** explores the **EXPERIENCE AND INTERACTION DESIGN** axis, encompassing Chapter 3, which investigates Design experiences related to the use of AI agents (Experience design for ai agents: an analysis of human-centered guidelines in llm-owning companies).

Concluding this volume, the third section—**METHODS, LEARNING, AND KNOWLEDGE PRODUCTION IN DESIGN**—comprises five chapters presenting research on creative process techniques applied in educational settings (Chapter 4: Applying creative process techniques in educational environment: biomimetics, morphological matrix, and prototyping); an investigation into the skills required of designers in the Fourth Industrial Revolution (Chapter 5: Skills for designers in the fourth industrial revolution: a systematic literature review); innovation through Design and Education (Chapter 6: Innovation through design in collaborative educational environments: a methodological proposal for project-based learning); co-creation in Experience Design (Chapter 7: Two epistemologies of co-creation in experience design: distinguishing experience and representation); and Design Education and learning experiences (Chapter 8: Interpreting UX metrics in Design Education: the CXM-EDU model for observing collaboration and learning experience).

We hope that this work will be well received by the academic Design community, that it will contribute to the theoretical foundation of new research, and that it will generate new research interest.

Design, Culture and Innovation

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The role of design in urban revitalization: Intangible values over time

Claudia Nichetti
Davi Franco Viegas Pereira
Júlio Carlos de Souza van der Linden

Abstract

This chapter analyzes the perceptions of stakeholders involved in urban revitalization projects regarding the role of design in generating value for people and cities over time. The research adopts a qualitative approach based on semi-structured interviews with nine professionals engaged in projects in Brazil and Europe. The data were analyzed using a qualitative-quantitative approach, enabling the identification of the frequency, incidence, and level of convergence of perceptions among stakeholders. The results indicate that design is recognized as a strategic process capable of influencing behavior, experience, and the use of urban spaces. Intangible values - such as identity, sense of belonging, and meaning - emerge as the main contributions of design to urban projects. On the other hand, the findings reveal limitations related to fragmented processes, the late incorporation of design tools, and institutional constraints within public management. It is concluded that the potential of design depends on its integrated, continuous, and strategic application.

Keywords: Design; Urban Revitalization; Intangible Values; Management.

1. Introduction

Contemporary urban transformations have intensified the complexity of city planning, design, and management processes, requiring approaches capable of integrating spatial, social, cultural, and cognitive dimensions. In this context, design has increasingly been recognized as a continuous and strategic process in the production of urban space, not merely as a project-oriented activity focused on form, but as a practice that mediates relationships, meanings, and experiences. In this sense, the built environment directly influences human behavior by shaping patterns of mobility, permanence, and social interaction (ZENG et al., 2024; SUN et al., 2025), while also contributing to the construction of symbolic meanings and collective identities associated with place (CARMONA et al., 2023). Urban space can therefore no longer be understood solely as a physical support structure but rather as a relational and experiential system in which design plays a central role in mediating the relationship between people and their environment.

Public spaces exert a significant influence on cognitive processes, affecting perceptions, emotions, and forms of territorial appropriation. Environmental perception refers to the selective process through which individuals capture and interpret environmental stimuli, influenced by previous experiences and individual contexts, whereas environmental cognition involves the organization, interpretation, and storage of such information, guiding behavior (GIFFORD; STEG; RESER, 2011). From this perspective, the built environment can be understood as an extended cognitive system in which spatial, visual, and symbolic elements contribute to structuring the urban experience (GRUOSSO; DEL SIGNORE; DI CINZIO, 2025). This approach brings design closer to interdisciplinary fields such as environmental psychology and user experience studies, reinforcing its dynamic, situated, and interaction-oriented nature.

At the same time, the scope of design in public space projects has expanded to incorporate approaches such as placemaking (WHITE, 2001; GEHL, 2013), place branding (ANHOLT, 2007), and perspectives related to design, identity, and territory, as well as participatory tools aimed at creating more inclusive and people-centered spaces (SANDERS; STAPPERS, 2008). These practices reveal a shift in focus from the object to the process, highlighting the capacity and importance of design in articulating multiple stakeholders, interests, and scales of intervention. Despite this progress, however, significant gaps remain in understanding how design is effectively incorporated into urban revitalization processes, particularly from the perspective of the professionals involved. Studies indicate that the quality of public spaces depends on the integration of different project dimensions and coordination among institutional actors (CARMONA et al., 2023), while also pointing to structural limitations such as fragmentation between project phases, political discontinuity, and procurement models that restrict the strategic role of design.

Given this context, it is important to examine the role of design through dimensions that enable a broader understanding of its contribution to urban revitalization processes. In this study, the term “stakeholders” refers to professionals involved in the conception, planning, and implementation of urban space projects. First, attention is given to the influence of design on human behavior, considering that design decisions shape patterns of use, interaction, and spatial appropriation. Second, the study highlights the generation of intangible values related to the symbolic and emotional dimensions of urban experience, including identity, sense of belonging, and well-being. Furthermore, design is understood as a strategic and iterative process involving professional practice within collaborative and complex contexts. Finally, it is relevant to examine the integration of design into public management and cross-sector partnerships, considering both its potential for innovation and the institutional challenges and tensions that emerge between public and private interests.

Accordingly, the main objective of this study is to analyze the perceptions of stakeholders involved in urban revitalization projects regarding the role of design, investigating how its competencies contribute to the development of solutions that generate value for both people and cities over time. Specifically, the study seeks to understand how these stakeholders perceive the impact of design on human behavior; identify the intangible values generated by design in urban projects; analyze the role of design as a continuous and strategic process; investigate the structural and institutional limitations affecting its implementation; and identify the relationships between design, public management, and public–private partnerships.

2. Methodological procedures

This study adopts a qualitative, exploratory, and interpretive approach, suitable for investigating complex phenomena related to professional perceptions and practices within the urban context (CRESWELL; POTH, 2018). The research is based on semi-structured interviews, a technique that enables in-depth analysis while providing flexibility in guiding responses and exploring emerging themes (MARTIN; HANINGTON, 2012; KVALE; BRINKMANN, 2009).

2.1 Research Design and Participant Selection

Participants were selected through purposive sampling, considering the relevance of their professional experience in urban revitalization projects (PATTON, 2015). Inclusion criteria comprised involvement in multidisciplinary urban projects (architecture and engineering), place branding, service design, experience design, urban interventions, and territory-oriented public policies. In this study, the term “stakeholders” refers to professionals and institutional agents involved in the conception, planning, and implementation of urban projects, acknowledging the multidisciplinary and collaborative nature of these initiatives.

The sample consisted of nine (9) participants, including designers, architects, and professionals from related fields, working in different locations across Brazil and Europe. This diversity contributes to a broader understanding of design-related practices and perceptions within distinct institutional and cultural contexts, particularly regarding public management and the integration of design into strategic processes. Although some participants were identified through professional networks and previous contacts, all met the predefined criteria of involvement in relevant urban revitalization projects, ensuring consistency between the sample and the objectives of the study.

2.2 Data Collection

Data collection was conducted between September and December 2025 through semi-structured interviews carried out in an online environment using the Google Meet platform. Participants were invited through formal contact via email and WhatsApp and were previously informed about the objectives of the study and the selection criteria through the provision of explanatory materials.

Table 1 – Profile of Interviewed Stakeholders and Areas of Expertise in Urban Projects

Participant	Background	Area of Expetise	Location
01	Architecture	Multidisciplinary urban projects (architecture and engineering)	São Paulo, Brazil
02	Architecture	Architecture, branding, and environmental graphic in urban projects	Porto Alegre, Brazil
03	Architecture	Landscape architecture, urban planning, and urban park projects	São Paulo, Brazil
04	Architecture	Wayfinding design and spatial experience in urban contexts	Brussels, Belgium
05	Architecture	Urban projects focused on experience, image, and city identity	São Paulo, Brazil
06	Architecture	Retail design, brand experience, and interventions in urban spaces	Porto Alegre, Brazil
07	Architecture	Urban sports facility projects (skate parks)	São Paulo, Brazil
08	Architecture	Achiteture and interior design with an interface to urban space	Lisbon, Portugal
09	Design	Design policy, urban fumiture, and signage systems	Portugal

Source: Developed by the authors (2026).

A total of thirty (30) initial contacts were made, of which eleven (11) responded. Of these, nine (9) resulted in completed interviews (Table 1). Some participants were identified through prior involvement in well-known urban projects featured in the media and social networks, complemented by referrals and professional networks, thereby broadening the scope and diversity of the sample. The interviews followed a semi-structured guide, allowing for the exploration of topics aligned with the research objectives while also enabling the incorporation of emerging issues throughout the interview process (GUEST; BUNCE; JOHNSON, 2006).

2.3 Data Analysis Procedures

The data were analyzed using a qualitative interpretive approach aimed at understanding the meanings attributed by the interviewees to the role of design in urban revitalization projects. Initially, all interviews were transcribed, enabling the identification of recurring themes and relevant excerpts related to the research objectives. Subsequently, the data were coded and organized into thematic categories, establishing connections between the empirical findings and the adopted theoretical framework (BARDIN, 2011; STRAUSS & CORBIN, 2008; SALDAÑA, 2016).

The analytical categories were organized into four main dimensions:
(i) the impact of design on human behavior;
(ii) the intangible values generated by design;
(iii) the role of design as a process and professional practice;
(iv) the relationship between design, public management and partnerships.

Following the categorization process, a complementary qualitative-quantitative strategy was adopted to identify patterns of recurrence, perceptual trends, and levels of alignment among the interviewees (MAXWELL, 2010). Four analytical indicators were defined:
- **Frequency of occurrence:** the number of interviewees who mentioned a given attribute;
- **Percentage incidence:** the proportion of interviewees who mentioned the attribute in relation to the total sample (n = 9);
- **Level of convergence:** the degree of alignment among interviewees' perceptions regarding a specific attribute;
- **Level of divergence:** the presence of contrasting interpretations, positions, or evaluations concerning a specific attribute.

The classification of convergence was established according to the percentage incidence of the identified references:
- **High convergence:** attribute mentioned by more than 70% of the interviewees;
- **Moderate convergence:** attribute mentioned by between 40% and 70% of the interviewees;
- **Low convergence:** attribute mentioned by less than 40% of the interviewees

Divergence, in turn, was analyzed qualitatively based on the interview content, considering the presence or absence of contradictory viewpoints among participants. The following classification was adopted:

- **High divergence:** coexistence of clearly opposing or conflicting views regarding the analyzed attribute;
- **Moderate divergence:** presence of varying levels of agreement or partially differing interpretations, without a predominance of direct opposition;
- **Low divergence:** predominance of similar interpretations, although with minor variations in emphasis or approach.

Thus, convergence and divergence were treated as complementary dimensions, but not necessarily as inversely proportional. An attribute could present a moderate incidence while simultaneously exhibiting high divergence if interviewees expressed contrasting views on the topic. This situation was observed, for example, in issues related to conflicts between public and private interests and the use of branding strategies in urban spaces.

The combination of these indicators made it possible not only to identify the most recurrent themes in the interviews but also to understand the degree of consensus, tension, and complexity present in stakeholders' perceptions. The results of this analysis are summarized in Table 2, which combines quantitative information on frequency and incidence with a qualitative interpretation of the observed levels of convergence and divergence.

3. Results and Discussion

The results of the study are presented through a synthesis of the perceptions of the interviewed stakeholders. This synthesis considers the attributes identified in the interviews, as well as their frequency of occurrence, percentage incidence, and level of convergence among participants, according to the criteria established in the methodology. This approach makes it possible not only to highlight the most recurrent aspects but also to identify divergences and tensions within stakeholders' perceptions, thereby contributing to a broader understanding of the role of design in urban revitalization projects. The table below presents this synthesis, organizing the main findings of the study in an integrated and comparative manner across the different thematic dimensions analyzed.

Table 2 – Qualitative–quantitative synthesis of stakeholders' perceptions.

Category (Specific Objective)	Identified Attribute	Frequency (n=9)	Incidence (%)	Convergence	Divergence	Interpretive Summary
IMPACT ON BEHAVIOR	Influence on well-being and emotional state	7	78%	High	Low	Strong consensus that design influences perception, comfort and experience
	Induction of use and permanence in spaces	6	67%	Moderate	Low	Design acts as a driver of behavior and social interaction
	Orientation and legibility (wayfinding)	5	56%	Moderate	Low	Particularly relevant for signage and wayfinding specialists
	Inclusion and accessibility	4	44%	Moderate	Moderate	Recognized, although with varying levels of emphasis
	Perceived safety	3	33%	Low	Low	Associated with lighting, spatial organization and environmental quality
INTANGIBLE VALUES	Sense of belonging	7	78%	High	Low	One of the most recurrent attributes
	Construction of place identity	8	89%	High	Low	Main value attributed to urban design
	Symbolic/ cultural value	6	67%	Moderate	Low	Associated with memory and meaning
	Experience and meaning of place	7	78%	High	Low	Design as a producer of meaning
	Indirect economic value	5	56%	Moderate	Moderate	Recognized, but not always central
	Criticism of excessive branding as a design driver	3	33%	Low	High	Clear divergence among stakeholders (especially across professional profiles)

Category (Specific Objective)	Identified Attribute	Frequency (n=9)	Incidence (%)	Convergence	Divergence	Interpretive Summary
DESIGN AS A PROCESS	Design as a continuous/ strategic process	8	89%	High	Low	Strong conceptual alignment
	Involvement from the early stages	6	67%	Moderate	Moderate	Desired, but not always practiced
	Late involvement (problem)	5	56%	Moderate	Moderate	Reveals a practical gap
	Multidisciplinary integration	7	78%	High	Low	Design viewed as an articulating element
	Use of methods (design thinking, co-creation, etc.)	6	67%	Moderate	Low	Present, but not standardized
	Use of technologies (AI, BIM, modeling)	5	56%	Moderate	Low	Increasingly incorporated

Category (Specific Objective)	Identified Attribute	Frequency (n=9)	Incidence (%)	Convergence	Divergence	Interpretive Summary
STRUCTURAL LIMITATIONS	Fragmentation between design and implementation	6	67%	Moderate	Low	Recurring problem
	Budget constraints / lowest-cost approach	7	78%	High	Low	Strong impact on design quality
	Lack of an innovation culture	5	56%	Moderate	Moderate	Especially evident in the Brazilian context
	Technical/ industrial limitations	4	44%	Moderate	Moderate	Related to implementation challenges

Category (Specific Objective)	Identified Attribute	Frequency (n=9)	Incidence (%)	Convergence	Divergence	Interpretive Summary
DESIGN AS A PROCESS	Bureaucracy and institutional rigidity	7	78%	High	Low	One of the main barriers
	Lowest-price procurement processes	6	67%	Moderate	Low	Directly affects project quality
	Lack of political continuity	5	56%	Moderate	Low	Impacts long-term planning
	Limited integration between design and management	6	67%	Moderate	Low	Restricts the strategic role of design
	Potential of public–private partnerships	6	67%	Moderate	Moderate	Viewed as a viable solution
	Conflict between public and private interests	4	44%	Moderate	High	Significant divergence among stakeholders

Source: Developed by the authors (2026).

The qualitative-quantitative analysis of the interviews reveals a high degree of convergence among stakeholders regarding the role of design as a strategic agent in the enhancement of urban spaces, particularly in relation to place identity construction, the generation of a sense of belonging, and its influence on human behavior. At the same time, relevant divergences emerge in issues such as the influence of branding on the conception of public spaces and the balance between public and private interests. Structural limitations - especially those related to public management, procurement models, and the fragmentation between design and implementation - appear as critical factors constraining the role of design as a continuous process. Nevertheless, public–private partnerships emerge as a potential means of partially overcoming these barriers, albeit accompanied by tensions and challenges.

3.1 Stakeholders' Perceptions of the Impact of Design on Human Behavior

The findings reveal a high degree of convergence among stakeholders regarding the impact of design on user behavior in urban spaces. Design is understood in a broad sense, extending beyond its aesthetic dimension and assuming an active role in mediating the relationship between individuals and their environment. Most interviewees associate design with a direct influence on well-being, emotional states, and perceptions of spatial quality. One stakeholder noted that "the landscape influences one's mood and well-being", reinforcing the idea that the quality of the built environment directly affects users' everyday experiences. Similarly, another interviewee pointed out that design helps to "place people in a position of comfort", highlighting its capacity to generate positive feelings and shape the way spaces are experienced. These perceptions suggest that characteristics of the built environment directly influence human behavior in urban settings.

In one of the interviews, a stakeholder reported that, in a location where they had participated in a complementary intervention project, "a flow of people was generated solely by the revitalization". According to Zeng et al. (2024), "built environment factors significantly influence collective walking behavior in urban spaces", demonstrating the direct relationship between spatial configuration and patterns of use (ZENG et al., 2024). Complementarily, urban environmental factors shape pedestrian environments, influencing walking behavior and the spatial distribution of users (SUN et al., 2025), further reinforcing the influence of design on everyday experiences.

Elements such as spatial organization, lighting, urban furniture and visual language were also identified as key determinants of how users experience urban environments, stimulating permanence, circulation and spatial appropriation. In this sense, design acts as a driver of behavior, contributing to the activation and dynamization of urban spaces. One interviewee described the case of a friend who regularly uses a dog park within a placemaking project area despite not owning a dog, simply because the urban furniture allows him to comfortably occupy and enjoy the space. Reflecting on this example, the interviewee emphasized the capacity of urban projects to prevent people from "isolating themselves because of the way the space is used" and to create environments that

genuinely foster “connection”. This perception is reinforced by accounts associating design with the creation of safer and more welcoming environments, particularly in projects that “make people feel safe” through spatial reorganization and visual enhancement. Such findings are consistent with studies indicating that modifications in urban design are directly associated with changes in pedestrian behavior and patterns of social interaction (KHOGALI et al., 2025), highlighting the active role of design in shaping urban dynamics.

Another interviewee (5) emphasized how aesthetic revitalization can influence public behavior: “An aesthetically pleasing place attracts attention, makes people want to stay, and encourages interaction. We need that”.

Visually rich environments designed at a “human scale” (experienced at approximately 5 km/h, the average pedestrian speed) encourage people to remain in a place, whereas inhospitable environments tend to promote only rapid transit through the space (GEHL, 2013). Furthermore, one stakeholder argued that urban infrastructures such as bridges, crossings, and pedestrian overpasses offer opportunities for aesthetic interventions in which “the cost is not that high, but the impact is enormous”. The interviewee elaborated: “If you have the good idea of painting the underside of a bridge, adding some lighting, creating a space for performances, or installing an outdoor gym, the investment is very small compared to building an entire bridge. Yet the return for the population is enormous”.

This perceived return is associated with an increased sense of safety generated by the presence of other people, creating a form of “passive surveillance” through the presence of “eyes on the street”, which makes the space psychologically more attractive to potential users (JACOBS, 2011).

Another recurring theme concerns the ability of design to enhance the legibility of space, facilitating orientation and use. As noted by one of the interviewees, design is not limited to providing information but also plays a role in integrating and guiding the user experience: “the map follows the position where you are”, indicating a concern with clarity and intuitiveness in the relationship between users and their environment. This dimension reinforces the role of design in creating more accessible and comprehensible spaces. Recent studies further expand this discussion by considering urban space as an extension of human cognition, influencing perceptions, emotions and behaviors. In this sense, public spaces function as extensions of cognition, shaping behavior, emotions and social interactions (GRUOSSO; DEL SIGNORE & DI CINZIO, 2025).

In addition, design is frequently associated with the creation of connections between people and places. One participant emphasized that urban projects seek to “create public spaces that will actually be used”, highlighting the intention to promote engagement, appropriation and the effective use of urban spaces. In another account, design was described as contributing to people’s ability to recognize and identify with their surroundings, as they “know where they are just by looking”, reinforcing its role in the construction of identity and symbolic orientation. Although mentioned less frequently, issues related to inclusion and accessibility were also identified, suggesting a broader understanding of design as a tool for addressing the diversity of users. One interviewee emphasized the importance of considering different user profiles and needs, highlighting initiatives aimed at inclusion, such as adaptations in visual communication and attention to gender and accessibility issues.

Overall, the findings indicate that the impact of design on behavior is widely recognized among stakeholders, with the greatest convergence occurring in aspects related to spatial experience, use and perception. The interviews reveal that design functions not only as an element that shapes the physical environment but also as an active agent in the construction of social, emotional, and symbolic relationships within the urban context. Furthermore, design-driven innovation provides new ways of perceiving and occupying space, often suggesting new forms of use and interaction.

The findings suggest that the impact of design on behavior operates through three primary mechanisms: the enhancement of sensory experience, the encouragement of permanence in space, and the facilitation of spatial orientation.

3.2 Stakeholders’ Perceptions of the Intangible Values Generated by Design in Urban Projects

Intangible values constitute the primary dimension of design’s contribution identified by the interviewees. A strong degree of convergence was observed among participants regarding the association of design with place identity construction, the generation of a sense of belonging, and the attribution of meaning to urban spaces.

Place identity emerged as the most recurrent attribute and was understood as the result of the articulation of the physical, cultural and symbolic characteristics of a territory. In this sense, design is perceived as a mediator of this process, contributing to projects that are “born from a relationship with the place, the people, the culture and the ecosystem” (Interviewee 01). This perspective reinforces the understanding of design as a contextual practice grounded in the interpretation of local conditions and territorial characteristics. Such an understanding suggests that urban spaces are not merely physical environments, but also symbolic constructs, with public spaces functioning as sites of social interaction and collective identity formation (GRUOSSO; DEL SIGNORE & DI CINZIO, 2025).

A sense of belonging also emerged consistently and was associated with the capacity of design to strengthen the relationship between people and place. One interviewee emphasized that a project should “create a brand for the environment, generating belonging and identity with the place” (Interviewee 02), highlighting the role of design in fostering emotional bonds and enabling users to recognize and connect with their surroundings. Similarly, another interviewee stated that design allows people to “know where they are just by looking” (Interviewee 02), reinforcing its function in the construction of perceptual identity and spatial recognition. This dimension has been widely discussed in the literature, which suggests that the perceived quality of public spaces directly influences place attachment and users’ sense of belonging (CARMONA et al., 2023).

The experiential dimension of design is also strongly emphasized in the interviews. Stakeholders highlighted that design has the capacity to transform functional spaces into meaningful experiences by adding symbolic and emotional value. In this sense, one interviewee described design as the “stitching point of everything that the environment needs to express” (Interviewee 04), integrating elements such as architecture, landscape,

signage, and narrative into a coherent and meaningful experience. This perspective suggests that urban environments can embody multiple layers of meaning, as urban spaces incorporate social and symbolic values that shape the way people interpret and experience places.

Furthermore, design is associated with the creation of symbolic landmarks and the construction of collective memory. One stakeholder emphasized that design has the power to "transform something that is merely functional into something meaningful" (Interviewee 05), highlighting its ability to re-signify urban spaces. This transformation is directly related to the creation of experiences that encourage permanence, attention, and emotional connection with place. Well-designed urban spaces therefore foster the construction of shared meanings and strengthen the relationship between individuals and territory, contributing to the development of lasting bonds (CARMONA et al., 2023).

However, the analysis also reveals important divergences, particularly regarding the use of branding strategies in public spaces. Some interviewees expressed a critical view of the excessive presence of brands, arguing that, from the users' perspective, "the most important thing is whether there is a sports court" (Interviewee 05), thereby relativizing the role of branding in the urban experience. In contrast, other stakeholders viewed place branding as a natural process of territorial enhancement and repositioning (Interviewee 01), revealing different interpretations of its relevance.

At this point, it is important to distinguish conceptually between "place branding" and "branding". According to Anholt (2007), "place branding" involves the transfer of a concept traditionally associated with products and services to cities and places. The author argues that cities and places share similarities with the image of corporate and product brands. Furthermore, "place branding" can be understood as the outcome of a particular form of urban policy (BRENNER & THEODORE, 2002), in which "branding" is used as a tool for constructing the identity and image of a city, place or region. "Branding", in turn, may be understood as a strategic brand management process involving the creation and articulation of symbolic, functional, and emotional elements with the objective of building identity, generating differentiation and influencing brand perception and value among stakeholders (KELLER, 1993; AAKER, 1996; SAMMUT-BONNICI, 2015).

This tension suggests that intangible values may be either enhanced or distorted depending on how design is applied. The presence of commercial interests, when not balanced with users' needs and the specific characteristics of a territory, may compromise both the authenticity of a place and users' appropriation of space.

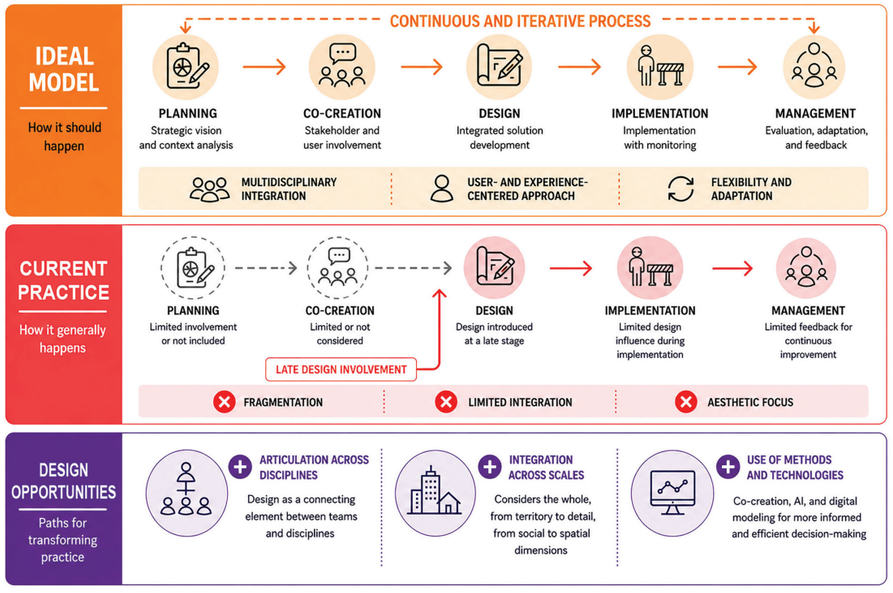
Finally, indirect economic value was also recognized as an outcome of the intangible values generated by design. In several accounts, design was associated with the capacity to enhance attractiveness, strengthen place image, and stimulate economic dynamics, although this was not identified as the central focus of stakeholders' perceptions. In this regard, studies indicate that well-designed public spaces contribute not only to social well-being but also to economic vitality and urban attractiveness (CARMONA et al., 2023).

Overall, the findings indicate that intangible values - particularly identity, sense of belonging, and meaning - constitute the primary domain of design's contribution to urban projects. These values are widely recognized by stakeholders as fundamental elements in the qualification of urban spaces and in fostering enduring relationships between people and the city.

3.3 The Role of Design as a Process and Professional Practice

The findings indicate a strong conceptual alignment among stakeholders regarding the understanding of design as a continuous, strategic and integrative process. Design is frequently described as a practice that connects different stages of a project and integrates multiple disciplines, moving beyond the traditional view focused solely on formal outcomes. This understanding suggests that urban design requires systemic and user-centered approaches, in which urban projects integrate multiple dimensions - spatial, social and perceptual -through interdisciplinary processes (GRUOSSO; DEL SIGNORE; DI CINZIO, 2025).

Figure 1 – Design as a process



Source: Developed by the authors (2026).

This perception is explicitly reflected in several interview accounts. One interviewee defined design as a "process [that] has continuity; it is something that must constantly feed back into itself", further stating that "design is a verb" (Interviewee 06), emphasizing its dynamic and evolving nature. Similarly, another interviewee stressed that "there is no urban project without design", reinforcing its central role in the conception and development of urban solutions. From this perspective, urban design should be understood as an iterative and adaptive process in which planning and design are not linear activities, but continuously evolve in response to social and spatial dynamics (YUAN; MALIKI, 2026).

Design is also recognized as a tool for addressing the complexity inherent in urban projects, particularly through its capacity to integrate different scales, disciplines and variables. As one interviewee observed, it is a field that "looks at technique, behavior, functionality - it looks at everything, adopting a transversal and systemic approach. This understanding suggests that contemporary urban design requires people-centered approaches in which the quality of public spaces is assessed through integrated dimensions such as comfort, protection, and user experience (YUAN & MALIKI, 2026).

However, when examining professional practice, a significant contradiction emerges between stakeholders' perceptions and the reality of project processes. Although there is strong convergence regarding the understanding of design as a continuous, strategic and integrative process (89%), its practical application remains fragmented. Professionals recognize the importance of incorporating design from the earliest stages of projects, yet they report that this does not always occur in practice. This discrepancy reveals a gap between the conceptual understanding of the role of design and its effective integration into the planning, development and implementation of urban interventions.

One interviewee stated that design "has to be part of the planning process; otherwise, it does not work", highlighting the need for strategic involvement from the outset. Conversely, several accounts indicate that design is still frequently introduced at a late stage or applied in a fragmented manner. In some cases, its role is limited to conceptual or aesthetic phases, without effective participation during implementation. This limitation is illustrated by the statement of one participant who remarked that "we are never actually responsible for the implementation itself", pointing to a disconnect between design and execution. This recurring issue highlights the need for greater integration among planning, design, and management processes to ensure the effectiveness of urban interventions (CARMONA et al., 2023).

Another recurring theme concerns the fragmentation among disciplines and the difficulties associated with integrating fields such as design, architecture and urban planning. In contrast to this perception, some interviewees emphasized the importance of integrated approaches, arguing that the ideal is to "work in a linear way, integrating external and internal areas, buildings, and landscape". This perspective reinforces the potential of design as an articulating and synthesizing element, suggesting that effective urban projects depend on the coordination of multiple stakeholders and areas of expertise (GRUOSSO; DEL SIGNORE & DI CINZIO, 2025).

In addition, stakeholders reported the use of a variety of design methods and tools, although these practices are not standardized. Strategies such as co-creation, digital modeling, artificial intelligence, and iterative processes were mentioned as resources that contribute to greater efficiency and higher-quality outcomes. One interviewee highlighted that artificial intelligence has enabled "significant gains in speed, particularly in information analysis", indicating recent transformations in professional practice. This trend is consistent with approaches that emphasize adaptive and data-driven processes as support mechanisms for decision-making in complex projects (YUAN; MALIKI, 2026).

Overall, the findings indicate that, although there is strong convergence regarding the understanding of design as a strategic process, structural limitations continue to hinder its full implementation, particularly with respect to continuity across the different phases of a project. Nevertheless, there is evidence of an ongoing effort to consolidate design as an integrative practice capable of articulating technical, experiential and social knowledge in the development of more effective urban solutions.

3.4 Relationships Between Design, Public Management, and Public–Private Partnerships

The analysis of the interviews reveals that the relationship between design and public management is marked by structural challenges that directly affect the integration and effectiveness of design in urban revitalization projects. A high degree of convergence was observed among interviewees regarding barriers associated with bureaucracy, institutional rigidity and procurement models. The implementation of urban projects depends on institutional structures capable of integrating planning, management and decision-making processes, as effective urban planning requires the articulation of public policies, urban design and an understanding of social interactions within urban spaces (YUAN; MALIKI, 2026).

Procurement and contracting processes are generally based on the criterion of the lowest price and are therefore widely criticized, being perceived as a limiting factor for project quality. One interviewee stated that "the cheapest option is rarely the best, and the best option is rarely the cheapest" (Interviewee 07), highlighting the inadequacy of this model for projects that require innovation and complexity. In addition, one participant reflected that "the urban realm is what is left over", referring to the limited attention and planning often devoted to urban spaces in many Brazilian cities. Similarly, another interviewee emphasized that "the lowest bid wins", a practice that discourages more qualified and strategic approaches. This limitation reinforces the idea that the quality of urban space is directly related to the capacity to integrate multiple criteria - including social, spatial, and functional dimensions - into decision-making processes (CARMONA et al., 2023).

Another relevant issue concerns administrative discontinuity and the absence of long-term planning. According to one interviewee, "in Brazil, there are no plans that extend beyond two years", which compromises project continuity and the consolidation of consistent urban strategies. This limitation is associated with political cycles and the

lack of coordination among successive administrations. Such a condition suggests that the absence of institutional continuity undermines the effectiveness of urban policies and hinders the implementation of sustainable solutions over time (CARMONA et al., 2023).

Furthermore, the fragmentation between the design, implementation and management phases is identified as one of the main obstacles to the effective role of design. One interviewee emphasized that "there is no point in proposing a solution if you are not able to follow up and see its implementation", highlighting the importance of process continuity for the effectiveness of proposed solutions. This finding underscores the need for integrated processes in which urban design is understood as a continuous practice involving multiple stakeholders and interdependent stages (GRUOSSO; DEL SIGNORE; DI CINZIO, 2025).

Difficulties in integrating different sectors and the limited recognition of design at the strategic level were also mentioned by the interviewees. In this regard, although there appears to be some openness toward incorporating design into urban projects, the implementation process itself often creates barriers, suggesting that the challenges lie not only in acceptance, but also in operationalization. This finding indicates that the effectiveness of urban design depends on the capacity to coordinate different stakeholders, including government agencies, private-sector organizations and civil society (GRUOSSO; DEL SIGNORE; DI CINZIO, 2025).

On the other hand, public–private partnerships (PPPs) emerged as a relevant alternative for enabling urban projects. Some interviewees reported positive experiences with this model, emphasizing that "everyone benefits" when collaboration exists between the public and private sectors. In these cases, private organizations contribute resources and operational agility, while public authorities provide institutional support and access to public space. This dynamic suggests that contemporary urban governance requires coordination among multiple actors and collaborative mechanisms to implement complex urban projects (YUAN; MALIKI, 2026).

In addition to public–private partnerships, mechanisms involving the concession of public spaces to private entities were mentioned as strategies to expand the capacity for investment, maintenance, and management of urban areas. One participant highlighted that the privatization of a high-cost urban space allows for "revenue sharing, with part of the income being reinvested in other parks".

However, these partnerships also present challenges. The presence of brands and commercial interests in public spaces is perceived ambiguously. While some interviewees recognize the potential of branding as a strategy for place enhancement, others warn of the risks associated with competing interests, arguing that the primary focus should remain on user experience and the quality of public space. This tension reflects the potential for value conflicts in urban environments, where different economic, social, and symbolic interests compete for influence in shaping urban projects (CARMONA et al., 2023).

Overall, the findings indicate that strengthening the role of design in urban projects depends on advances in public management, including the revision of procurement models,

greater integration between project phases and the incorporation of design into strategic levels of decision-making. Although public–private partnerships appear promising, they require a careful balance of interests to ensure that the benefits generated are effectively returned to society.

4. Conclusion

This study aimed to analyze the perceptions of stakeholders involved in urban revitalization projects regarding the role of design, with a particular focus on its contribution to value creation over time. Adopting a qualitative approach, the findings demonstrate that design is widely recognized as a strategic agent in the qualification of urban spaces, particularly through the generation of intangible values and the mediation of relationships between people and their environment. Overall, a high degree of convergence was observed among participants regarding the capacity of design to influence user behavior by promoting well-being, guiding the use of spaces and encouraging permanence and sociability. This perception reinforces the understanding of design as an active element in shaping urban experiences, extending beyond its aesthetic dimension to assume a relational and sensory role.

With regard to intangible values, the findings indicate that attributes such as identity, sense of belonging, and meaning constitute the primary domain of design's contribution to urban projects. The ability to foster connections between people and places, as well as to attribute meaning to spaces, emerged as one of the most significant aspects of professional practice, highlighting design as a cultural and symbolic practice in addition to a technical one.

The analysis also confirms the understanding of design as a continuous, strategic and integrative process, capable of articulating different disciplines, scales and stakeholders. However, a gap was identified between the theoretical and conceptual understanding of design and its practical application in urban projects. This gap is reflected in the late involvement of design in project processes, the fragmentation between project phases and the limited participation of designers in the implementation of proposed solutions. These issues reveal structural challenges that hinder the consolidation of design as a systemic practice within the urban context.

Among the main limitations identified are barriers related to public management, including bureaucracy, procurement models based on the lowest-price criterion, administrative discontinuity and the limited integration between planning, design and implementation. These factors restrict the strategic role of design and undermine the continuity of processes over time. In this context, public–private partnerships emerge as a viable alternative for enabling urban projects, although they also raise concerns regarding the balance between public and private interests.

The study also highlights the importance of design in urban revitalization projects as an articulator of both behavioral and symbolic dimensions. While recurring patterns were identified across stakeholders' perceptions, the findings also revealed divergences and complexities inherent to the field, contributing to a broader understanding of the role of design in contemporary urban contexts.

Finally, future research could expand the number of participants, include a wider range of territorial contexts, and incorporate the perspectives of additional stakeholders, such as public managers, users and local communities. Such efforts would contribute to a more comprehensive understanding of the challenges and opportunities associated with the integration of design into urban revitalization processes.

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02

Design pratice in public innovation: evidences form brazilian innovation labs

Neilton Feliciano Costa
Júlio Carlos de Souza van der Linden

Abstract

Design has increasingly been associated with the public sector as a promising means of fostering innovation. Through its application, principles such as collaboration, empathy and experimentation are introduced into efforts to address public problems, recognising that such problems, owing to their dynamic and complex nature, require systemic and multidisciplinary approaches: capabilities that are not always available within bureaucratic structures. innovation labs have become known as key spaces for the introduction of emerging methods and technologies in the public sector, including Design. This chapter aims to analyse the ways in which Design is incorporated into innovation labs within the Brazilian public sector, by identifying the modes through which it is accessed as an organisational capability and the patterns according to which it is mobilised in the innovation practices and processes conducted by these spaces. Methodologically, the chapter is structured as a multiple-case study involving 15 laboratories operating in the Brazilian public sector, using in-depth interviews as its primary data collection method. The findings reveal a widespread presence of Design in the practices of the laboratories analysed. Although the discipline is understood and employed through different interpretations, the data indicate the prominence of Design Thinking (DT) as the principal gateway for the introduction of Design into the public sector. Design capabilities are incorporated into innovation environments through a variety of mechanisms, most notably through the engagement of external actors. The discipline is operationalised through training activities, facilitation processes and project development. Finally, the evidence suggests a limited institutionalisation of professional designers within the context under study.

Keywords: Design and Technology; Public Innovation; Innovation Labs; Design in the Public Sector; Design Thinking.

1. Introduction

Innovation has become a central theme in the public sector agenda (BASON, 2010; MULGAN & ALBURY, 2003; OECD, 2017). Faced with increasingly systemic and complex challenges, political actors, society and public institutions have come to recognise that fostering an innovation-oriented mindset within government is essential for effectively addressing the multiple social expectations of citizens who are increasingly demanding regarding the quality and delivery of public services (OSBORNE & GAEBLER, 1992). Consequently, citizen participation, state digitalisation, and the integration of services and policies are commonly cited, among other factors, as strategic pathways towards a more innovative and responsive state that is better equipped to meet societal needs (CAVALCANTE & CUNHA, 2017; OECD, 2024).

Particularly over the last two decades, a growing convergence between Design and the public sector has been observed (CAVALCANTE, MENDONÇA & BRANDALISE, 2019; IDEO & NESTA, 2017; UK DESIGN COUNCIL, 2013). In this context, the discipline has been advocated as a driver of innovation culture within public organisations, bringing with it a set of tools, methods and principles that guide innovation-oriented processes and initiatives. Among these principles are the promotion of collaborative practices, the centrality of human needs in the framing of problems and the design of solutions, and an exploratory, creative and experimental approach to project development. As argued by Bason and Austin (2022), Design has the potential to steer the public sector towards a more human-centred and integrated model of governance, ultimately contributing to more efficient and effective public policies.

Innovation labs are specialised units dedicated to promoting and fostering a culture of innovation within the public sector (SCHIUMA & SANTARSIERO, 2023). Particularly during the first decades of the twenty-first century, they have become established as components of government structures across the world, including in Brazil (Sano, 2020). Within these environments, a broad range of techniques, tools and approaches aimed at generating innovations in the treatment of public problems are employed. Furthermore, these spaces typically place strong emphasis on experimentation, collaborative work and the stimulation of creativity (ACEVEDO & DASSEN, 2016; TÕNURIST, KATTEL & LEMBER, 2017). As an emerging technology and catalyst for innovation, Design naturally occupies a prominent position in the activities undertaken by these spaces (CARSTENSEN & BASON, 2012; KIMBELL, 2015; MCGANN, BLOMKAMP & LEWIS, 2018).

This chapter aims to analyse how Design is incorporated as a catalyst for innovation in Brazilian public sector innovation labs, investigating the ways in which it is introduced as an organisational capability and materialised in the practices and operational dynamics of these spaces. Methodologically, the research adopts a multiple-case study design, taking innovation labs operating within the Brazilian public sector as its unit of analysis. Fifteen laboratories were examined, with semi-structured interviews serving as the primary data collection instrument. The findings were analysed using categorisation techniques, revealing patterns and themes relevant to the research objectives. The evidence presented derives from the author's master's dissertation on the same topic, which remains unpublished.

The findings point to the centrality of Design, both as a practice and as a discourse, within the innovation agendas of the organisations studied. The presence of the discipline manifests itself in multiple ways; however, Design Thinking (DT) emerges as the primary entry point for the introduction of Design into the public sector. This internalisation occurs through different mechanisms, particularly through significant reliance on external partners. The discipline is mobilised as the subject of training activities, as a group facilitation tool and as an approach to innovation project development. Overall, the study identified a low degree of institutionalisation of Design professionals within the context analysed, alongside a strong dependence on DT and external actors in the deployment of Design practices. This raises concerns regarding the superficiality of its application and its actual capacity to generate meaningful impact and transformation within the public sector.

2. Methodological Procedures

The research summarised in this chapter was conducted as part of the author's master's dissertation, which remains unpublished, and adopts a qualitative approach with predominantly descriptive and exploratory objectives. The methodological strategy follows a multiple-case study design, as theorised by Yin (2015). The units of analysis consisted of fifteen innovation labs operating within the Brazilian public sector. The study was guided by the following research question: how is Design incorporated as a catalyst for innovation in Brazilian public sector innovation labs? The relationship between empirical data and theoretical propositions was established through systematic coding and the development of themes and categories, enabling the identification of recurring patterns and variations in the ways Design is integrated and mobilised across different laboratories. The findings are interpreted on the basis of the convergence of evidence across sources, the recurrence of patterns among cases and dialogue with the literature on Design and public innovation presented in the theoretical framework.

Table 1 presents the innovation labs included as units of analysis in the study. Case selection followed the logic of theoretical replication characteristic of multiple-case study research (YIN, 2015), seeking to capture the diversity of contexts in which the selected laboratories operate and thereby enable the identification of recurring patterns and meaningful variations in the use of Design. Data collection was conducted through semi-structured interviews with key informants from each laboratory, with interviews lasting approximately two hours on average. Priority was given to informants occupying leadership positions due to their ability to provide information relevant to the research objectives. The interviews were subsequently transcribed and coded using the coding procedures proposed by Saldaña (2016). This process was conducted in two cycles. In the first cycle, descriptive codes were assigned to the interview transcripts. In the second, the codes identified during the initial cycle were grouped into broader themes and categories in accordance with the objectives of the study.

Table 1 - List of units of analysis

Innovation Labs		Host Institution	Government Sphere	Year Established
1	LAB.ges - Laboratório de Inovação na Gestão	Governo do Estado de Espírito Santo	Executive	2017
2	LaboraGov - Laboratório de Gestão Inovadora	Ministério da Gestão e da Inovação em Serviços Públicos - MGI	Executive	2019
3	Pólen - Laboratório de Inovação em Gestão Pública	Fundação Oswaldo Cruz - Fiocruz	Executive	2022
4	GNova Lab	Escola Nacional de Administração Pública - Enap	Executive	2016
5	LabLuz	Tribunal de Justiça do Estado do Ceará	Judicial	2020
6	LIGO – Laboratório de Inovação Goiás	Governo do Estado de Goiás	Executive	2020
7	ÍRIS - Laboratório de Inovação e Dados	Governo do Estado do Ceará	Executive	2019
8	Labee9	Tribunal de Justiça do Estado do Rio Grande do Sul	Judicial	2020
9	IColab - Laboratório de Inovação do Tribunal de Contas da União	Tribunal de Contas da União - TCU	Autonomous	2015
10	Legallab - Laboratório de Inovação e Inteligência	Tribunal de Justiça do Estado do Amazonas	Judiciário	2022
11	Liods - Laboratório de Inovação e Objetivos do Desenvolvimento Sustentável	Tribunal Regional Eleitoral do Paraná - TRE-PR	Judicial	2019
12	Laboratório de Inovação do TRE-PE	Tribunal Regional Eleitoral de Pernambuco	Judicial	2023
13	Lab InovaAnac	Agência Nacional de Aviação Civil - ANAC	Executive	2017
14	SeringalLab	Ministério Público do Estado do Acre	Autonomous	2023
15	Inovatchê	Tribunal Regional Federal da 4ª Região - TRF4	Judicial	2019

Source: Developed by the authors (2026).

3. Public Sector Innovation

Interest in public sector innovation has long been a prominent concern among both political actors and public managers (OECD, 2017; POLLITT & BOUCKAERT, 2004). Although innovation-oriented thinking is advocated across a broad spectrum of political perspectives, its implementation is often hindered by characteristics commonly associated with public bureaucracies, including risk aversion, organisational rigidity, hierarchical communication structures and limited tolerance for change (BASON, 2010; MULGAN & ALBURY, 2003; OSBORNE & GAEBLER, 1992). In this regard, the prominence of innovation as a policy concern gained significant momentum after the 1970s, amid fiscal crises and broader debates concerning the role of the state in society, as well as its capacity to deliver effective solutions to citizens while maintaining socially acceptable levels of quality and cost (OSBORNE & GAEBLER, 1992; POLLITT & BOUCKAERT, 2004). The underlying assumption is that an innovation-oriented approach is indispensable for developing more effective and efficient responses to social problems characterised by high levels of complexity and interdependence, which have become increasingly prevalent in an environment marked by growing instability and uncertainty (ACEVEDO & DASSEN, 2016; BASON, 2010; MULGAN, 2007).

Mulgan (2007) conceptualises innovation as the introduction of new ideas that create public value. Such ideas must exhibit a degree of novelty, extending beyond mere incremental improvements; they must be effectively implemented rather than merely conceived; and they must demonstrate practical utility. The OECD (2024), in turn, understands public innovation as part of a broader effort to improve the reliability, responsiveness and equity of public services, recognising that these attributes contribute to strengthening trust in governments and public administration. The 2008 financial crisis, the COVID-19 pandemic, the climate emergency and ongoing geopolitical conflicts are cited by the organisation as evidence of the need for governments to develop rapid and flexible responses that can keep pace with evolving citizens' needs. The OECD (2024) further notes that public services have increasingly embraced co-creation with users and the intensive use of digital technologies and data in order to enhance efficiency and adaptive capacity. At the same time, a growing trend towards the personalisation and proactive delivery of services can be observed, alongside the incorporation of citizen participation mechanisms, thereby reinforcing accessibility, responsiveness and alignment with democratic values.

In the Brazilian context, particularly since the 1990s, there has been a cross-cutting effort to promote public policies aimed at strengthening the innovation capacities of the Brazilian state and making it more responsive to citizens' needs (CAVALCANTE & CAMÕES, 2017; CAVALCANTE & CUNHA, 2017; FARAH, 2006). Drawing on a broader body of literature, Cavalcante and Cunha (2017) identify contemporary trends in public innovation that include expanded collaboration and partnerships, network-based governance, service integration, enhanced transparency and accountability, the intensive use of information and communication technologies (ICTs), and the strengthening of public bureaucracy through professionalisation and improved responsiveness to social demands. The pursuit of a more innovative state in Brazil is therefore part of a broader global movement that recognises innovation as a strategic state capability. This movement has encouraged the diffusion of innovation-oriented practices and mindsets throughout public bureaucracies through various policies and initiatives, including the establishment of innovation labs, as discussed in the following section.

3.1 Public Sector Innovation Labs

Structured as spaces designed to foster and enable innovation within the public sector, innovation labs have been established across a wide range of government settings around the world (ACEVEDO & DASSEN, 2016; MCGANN, BLOMKAMP & LEWIS, 2018; SCHIUMA & SANTARSIERO, 2023; TÕNURIST, KATTEL & LEMBER, 2017). Their popularity is a relatively recent phenomenon, with most of these organisations having been created over the last three decades. A frequently cited milestone is the establishment of MindLab in 2002 as an experimentation unit within the Danish government (CARSTENSEN & BASON, 2012). In Brazil, as argued by Sano (2020), the emergence of these spaces gained significant momentum from the 2010s onwards. The author notes that, as a contemporary and still under-systematised phenomenon, innovation labs lack a consolidated definition and operate without uniform institutional or methodological structures, being characterised instead by flexibility and heterogeneity in their practices.

Most authors nevertheless recognise a shared interest in establishing innovation labs as spaces somewhat removed from central bureaucratic structures, characterised by a strong collaborative orientation and dedicated to addressing systemic and complex problems (BLOMKAMP & LEWIS, 2023; SCHIUMA & SANTARSIERO, 2023). In this sense, they share the common objective of engaging public servants and citizens in the search for ideas and solutions with innovative potential, drawing on a broad repertoire of techniques, tools and approaches. This makes them important sites of experimentation within the public sector. These innovation environments typically demonstrate a strong interest in co-creation, the exploration and adoption of emerging technologies and methodologies, and the advancement of non-traditional skills and tools within public administration (EVANS & CHENG, 2021; LEWIS, 2022; MCGANN, BLOMKAMP & LEWIS, 2018; WILLIAMSON, 2015). According to Sano (2020), these environments are also closely associated with contemporary discussions surrounding open innovation and citizen participation. They therefore constitute important spaces for the introduction of emerging approaches in the public sector, including Design.

4. Design in the Public Sector

The growing convergence between Design and the public sector stems from the central role that the field has come to occupy in contemporary debates on innovation, particularly within the context of government innovation labs (BASON, 2016; DESIGN COMMISSION, 2013; IDEO & NESTA, 2017; UK DESIGN COUNCIL, 2013). The discipline has increasingly been associated with reform-oriented perspectives that conceive innovation as a driver of transformation, and it has been mobilised as a catalyst for innovation through the promotion of participatory and human-centred approaches (BASON & AUSTIN, 2022; SANDERS & STAPPERS, 2008). In this process, Design has

become closely aligned with contemporary trends in the broader field of public innovation, such as participation, systems thinking and network-based forms of action, contributing to a deeper understanding of citizens' needs and, consequently, to the formulation of more effective public policies (BASON, 2016; KIM, 2023; KIMBELL, 2015; LEWIS, 2022).

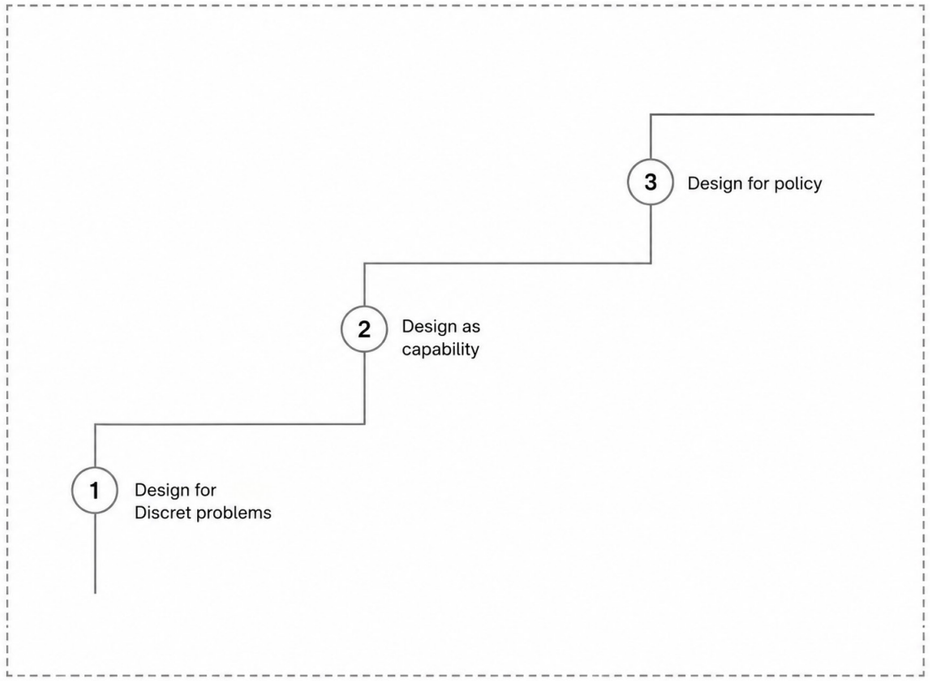
As a driver of innovation, Design is associated with attitudes and values that reinforce creativity and citizen-centredness as essential elements in the creation of public value through innovation (Bason, 2016). The creative process is understood as iterative and non-linear, based on the premise that the development of potential innovations does not result from the search for "correct" or "definitive" answers, but rather from an exploratory process of inquiry and experimentation (MCGANN, BLOMKAMP & LEWIS, 2018). This perspective is commonly associated with concepts such as integrative thinking and interdisciplinarity, which are regarded within the field as important means of strengthening innovation (BAILEY & LLOYD, 2016; JUNGINGER, 2013; KIM, 2023). Other elements frequently associated with Design in the public sector include the encouragement of co-creative approaches, which view participation and collaboration as central to innovation processes (SANDERS & STAPPERS, 2008); the emphasis on citizens as a key pathway to improving public policies (BASON & AUSTIN, 2022); and the promotion of prototyping and testing throughout the policy design process, making a more experimental and less risk-averse stance both possible and legitimate (KIMBELL & BAILEY, 2017). As argued by Bason (2017), when appropriately integrated into organisational practice, Design can guide organisations towards a new paradigm of public governance characterised by greater participation, citizen-centredness, experimentation and cross-disciplinary collaboration.

In practical terms, the presence of Design in the public sector can be observed through a heterogeneous set of tools, processes and techniques. These include qualitative approaches aimed at exploring problems and understanding user experiences, such as ethnographic research, in-depth interviews, shadowing and user diaries. Design practice also involves the development of artefacts such as user journeys, stakeholder maps, experience maps, personas and service blueprints. In the generation and development of solutions, common practices include co-creation workshops, ideation sessions and participatory activities involving different organisational actors and users. Prototyping, often conducted at low levels of fidelity, constitutes another prominent element and may take the form of mock-ups, simulations, enactments and preliminary versions of services or interfaces, enabling the testing and iteration of solutions prior to implementation (IDEO & NESTA, 2017; KIMBELL, 2015; LIEDTKA et al., 2020; UK DESIGN COUNCIL, 2013). These elements tend to be mobilised in context-specific ways, varying according to the authors examined, institutional priorities and organisational capabilities, which reinforces the non-uniform character of Design adoption within the public sector.

Bason and Austin (2022) argue that recognising and defining the application of Design as an approach within the public sector, although detectable through practices and tools such as those described above, remains challenging due to the wide range of elements that may be involved in this process, as well as the idiosyncrasies associated with individual practitioners and the contexts in which they operate. The authors nevertheless propose three dimensions through which the presence of Design in public sector settings can be identified: exploring the problem space, generating alternative scenarios, and enacting new practices. The first of these dimensions relates to the capacity of Design to provide decision-makers with tools to broaden their ability to explore, understand and engage with problems, rather than rushing prematurely towards solutions. This dimension encompasses practices such as user research and qualitative methods, including those derived from ethnographic approaches. Building on this, Design supports the discussion and development of new ideas and concepts, emphasising the role of communication, the synthesis of divergent perspectives and, above all, creativity. Collaborative workshops provide illustrative examples of Design acting as a facilitator in this process. Finally, Bason and Austin (2022) argue that the discipline contributes to the enactment of new practices by offering identities, concepts, products and services that help make public policies tangible for users and stakeholders. In this regard, the authors observe that the ability to create experiences and artefacts with strong relational and symbolic qualities lies at the heart of the designer's competencies, a capability that can be mobilised as a catalyst for change within organisations.

The UK Design Council (2013) proposes a diagnostic framework to help public organisations assess their level of Design adoption: the Public Sector Design Ladder. The model adapts the original Design Ladder (KRETZSCHMAR, 2005), initially developed in Denmark as a measure of maturity in the use of Design within private organisations, to the public sector context. Through this framework, it is possible to distinguish three levels of Design adoption within the state apparatus. At the first level, Design is mobilised on an episodic basis to address discrete problems, functioning as a technical resource applied to specific situations with the aim of improving outcomes. At the second level, Design becomes internalised as an organisational capability within government itself. Beyond relying on external specialists, public organisations make deliberate efforts to build the capabilities of civil servants, who begin to assimilate methods, repertoires and attitudes associated with the field of Design. Finally, at the most advanced level, Design is integrated into the policymaking process itself and is appropriated by decision-makers as a strategic capability. At this stage, particular emphasis is placed on multidisciplinary collaboration, the articulation of different dimensions of a problem, and the presence of Design throughout the entire policy cycle, from conception to implementation (Figure 1).

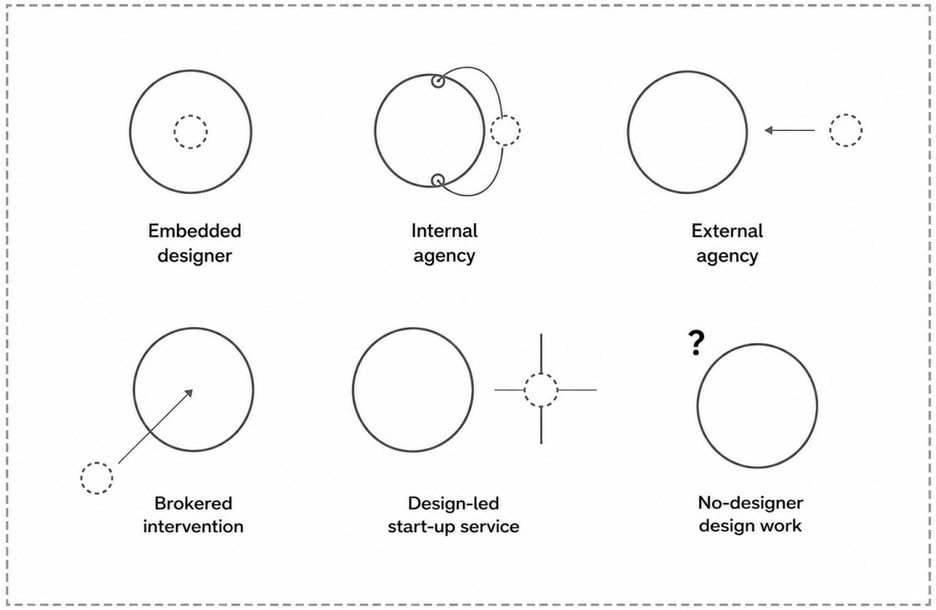
Figure 1 - Public Sector Design Ladder.



Source: Adapted from UK Design Council (2013).

The internalisation of Design capabilities within the public sector can also be analysed through the categorisation proposed by the Design Commission (2013). According to this framework, Design interacts with the public sector in six distinct ways. At the first level, there is No-designer design work, in which public service managers deploy Design methods without professional Design input. The External agency model refers to the commissioning of design expertise from external organisations for specific projects, characterising a project-based and weakly internalised use of the discipline. Brokered intervention, in turn, involves intermediary organisations that facilitate access to Design expertise, reducing risks and supporting Design procurement and implementation. A further step is represented by the Internal agency model, in which a dedicated design unit operates within government and collaborates with other parts of the organisation on project-based initiatives. At a more advanced level, the Embedded designer model places Design professionals directly within public sector organisations, contributing to the development of internal Design capabilities. Finally, Design-led start-up service refers to situations in which design-led teams operating outside traditional public service structures engage in developing services that address specific public needs identified by public institutions (Figure 2).

Figure 2 – Modes of Internalising Design Capabilities



Source: Adapted from Design Commission (2013).

Both the Public Sector Design Ladder proposed by the UK Design Council (2013) and the categorisation developed by the Design Commission (2013) suggest that the adoption and use of Design within the public sector is far from homogeneous, encompassing different levels of maturity and distinct modes through which Design is introduced into bureaucratic settings. Furthermore, the operationalisation of Design as a concept, discourse and disciplinary field does not appear to be uniform, reflecting the various ways in which it may be mobilised, legitimised and promoted within the public sector (VAZ & FERREIRA, 2021). These different manifestations nevertheless share a common understanding of Design as a driver of innovation in contexts traditionally characterised by limited tolerance for risk, associating the discipline with collaboration, creative thinking and multidisciplinarity. Design Thinking (DT) constitutes one of the principal modes through which Design is operationalised and manifested in the context under analysis and, given its centrality, is discussed in the following section.

4.1 Design Thinking

Design Thinking (DT), as a cognitive strategy grounded in empathy, human-centredness and an exploratory orientation, is frequently singled out as a particularly valuable tool or approach in discussions of public sector innovation, especially within the context of innovation labs (BRINKMAN et al., 2023; CAVALCANTE, MENDONÇA & BRANDALISE, 2019; LEWIS, MCGANN & BLOMKAMP, 2023; LIEDTKA et al., 2020; MCGANN, BLOMKAMP & LEWIS, 2018; MINTROM & LUETJENS, 2016). Its prominence derives both from its polysemic relationship with the broader field of Design (JOHANSSON-SKÖLDBERG, WOODILLA & ÇETINKAYA, 2013; KIMBELL, 2011) and from its considerable influence within contemporary discourses on public sector innovation (CAVALCANTE, MENDONÇA & BRANDALISE, 2019; LIEDTKA, SALZMAN & AZER, 2017). As conceptualised by Kimbell (2011), DT may be understood as what designers bring to their practice, encompassing their knowledge, design approaches and the ways in which they structure and make sense of their activities.

Johansson-Sköldberg, Woodilla & Çetinkaya (2013) distinguish between two principal ways of understanding DT. The first, termed "designerly thinking", emerges from scholarly reflections on design practice and seeks to characterise the distinctive competencies of the Design field, with particular attention to the cognitive processes mobilised by designers when addressing problems throughout a design process. The second, referred to simply as "Design Thinking", developed primarily within the field of management and has been appropriated as a repertoire of practices aimed at fostering innovation and generating value, often without a robust theoretical grounding in the Design discipline. In this latter sense, DT may be understood as a simplified translation of "designerly thinking", which helps explain its diffusion across organisational contexts, including the public sector, albeit sometimes at the cost of reducing its conceptual complexity.

As a set of practices and attitudes that seek to emulate, across different contexts, the design methods associated with the Design field, DT is generally characterised by, among other features, an experimental and creative orientation, abductive reasoning, iterative processes and multidisciplinarity, elements that are often credited with contributing to the development and diffusion of technologies, products and services in market contexts (BROWN, 2009; MARTIN, 2009). As argued by Liedtka et al. (2017), DT operates both as a common language and as a structured approach to problem-solving, particularly in relation to complex challenges. Consequently, it can contribute to objectives ranging from the enhancement of competitive advantage to the resolution of social problems, a bridge that has led many scholars and practitioners to advocate its use within the public sector. In this context, the diffusion of DT through innovation labs, by translating and simplifying concepts and practices, appears to play an important role in the operationalisation of Design within the public sector, making accessible principles that were originally rooted in professional Design practice and are not traditionally part of the repertoire of public policymakers.

5. Results and Discussion

The incorporation of Design into environments oriented towards experimentation, such as innovation labs, does not occur in isolation but rather in conjunction with a broader ecosystem of approaches, methods and tools that are likewise aimed at fostering innovation (SANO, 2020; TÕNURIST, KATTEL & LEMBER, 2017). The study identified a significant range of tools, techniques and methodological guidelines employed by innovation labs in the conduct of their activities, either alongside or in combination with approaches more directly associated with Design. Among the most prominent are those grouped under the label of "agile methodologies", including project management methods such as Scrum, Lean Inception and Design Sprint; disciplines such as behavioural science and data science; emerging technologies such as artificial intelligence and machine learning applications; widely used techniques including brainstorming, storytelling and empathy maps; and even planning tools long established within the field of public administration, such as the GUT matrix, used for prioritising activities, and the 5W2H framework, employed in project planning and structuring.

The inclusion of tools that have already been extensively adopted in organisational contexts, such as the 5W2H framework and the GUT matrix, nevertheless suggests differences in the maturity levels of Brazilian innovation labs, particularly regarding their capacity to generate and develop genuinely innovative solutions within the public sector. As a result, highly novel approaches, such as futures thinking, coexist with tools and techniques that have long been established within the field of public management and which, due to contextual considerations, continue to be mobilised as part of the broader innovation ecosystem. Taken together, this broad and heterogeneous repertoire of methods reflects the flexible methodological orientation that characterises the practices of the innovation labs studied.

The ways in which Design is introduced into innovation labs, the primary focus of the study summarised in this chapter, were likewise found to be heterogeneous, manifesting through a plurality of pathways. Evidence of this can be seen in the variety of interpretations and theoretical perspectives through which the discipline is invoked, as presented in Table 2, highlighting its capacity to encompass and articulate diverse subfields and professional practices. Innovation labs engage with Design through a broad spectrum of approaches, ranging from established fields such as Service Design and Editorial Design to less institutionalised and emerging practices such as Speculative Design and Design Futures. This diversity underscores the discipline's ability both to shape and to be integrated into different innovation practices, offering multiple perspectives through which problems and challenges may be understood and addressed.The selection of particular Design approaches appears to reflect the political, technical and discursive objectives that shape the activities of these innovation labs at different points in time.

Table 2 – Design Subfields Mentioned by Innovation Labs.

Design Subfield	Frequency of Mentions
Design Thinking	15
Design Sprint	4
Design Futures	3
Ethnographic Design	2
Systemic Design	2
Accessible Design	1
User-Centred Design	1
Critical Design	1
Service Design	1
Editorial Design	1
Emotional Design	1
Speculative Design	1
Strategic Design	1
Visual Design	1
Neurodesign	1

Source: Developed by the authors (2026).

Despite this diversity, a degree of convergence was identified around a set of core principles and practices. Across all the perspectives mentioned, there is a consistent emphasis on elements such as co-creation, human-centredness, empathy and active listening. Principles and practices of this kind are widely associated in the literature with the role of Design as a driver of innovation (BAILEY & LLOYD, 2016; BASON, 2017; KIMBELL, 2015; LEWIS, MCGANN & BLOMKAMP, 2023), suggesting that these environments are aligned with broader arguments, also observed in the experience of governments around the world, that link Design to innovation and change.

Consistent with a significant body of literature concerning Design and the public sector (BRINKMAN et al., 2023; CAVALCANTE, MENDONÇA & BRANDALISE, 2019; LIEDTKA et al., 2020; MCGANN, BLOMKAMP & LEWIS, 2018; MINTROM & LUETJENS, 2016), most references to Design within the innovation labs studied were associated with the practice of Design Thinking (DT), as also illustrated in Table 2. Across all the laboratories investigated, DT was presented as a privileged approach for conducting innovation processes and, in some cases, was identified as the primary approach for this purpose. In the accounts provided by interviewees, DT appears at times as a method, contributing a sequence of stages and phases for the development of innovation projects, and at other times as a source of guiding principles for innovation processes, including empathy, user-centredness and collaboration (BROWN, 2009; LIEDTKA, SALZMAN & AZER, 2017; UK DESIGN COUNCIL, 2013).

Drawing on the classification proposed by Johansson-Sköldberg, Woodilla and Çetinkaya (2013), it becomes clear that the understanding of DT expressed by the innovation labs is rooted in its interpretation as a managerial capability, promoted and disseminated as a popular resource for fostering innovation within organisations. No connection is made by the interviewed laboratories between DT and "designerly thinking", as described by Johansson-Sköldberg, Woodilla and Çetinkaya (2013), highlighting the predominantly non-academic origins of DT discourse in these settings. Given its prominence and ubiquity, DT nonetheless appears to function as an important gateway through which Design enters the innovation labs studied, helping to make the discipline more intelligible and accessible within the context under analysis (JOHANSSON-SKÖLDBERG, WOODILLA & ÇETINKAYA, 2013; KIMBELL, 2015).

Design-related knowledge and capabilities are introduced into the innovation labs studied through multiple pathways, reflecting, to some extent, the different ways in which these spaces are constituted and the institutional support networks they are able to mobilise. As illustrated in Figure 3, these pathways include: (a) the mobilisation of competencies by team members with prior training in Design; (b) participation in training programmes related to innovation, typically undertaken by laboratory teams or strategically selected members thereof; (c) the engagement of external consultancies, particularly during the creation and structuring of these spaces; (d) benchmarking activities involving other innovation labs; and (e) the autonomous and practice-based exploration of methodologies associated with the field of innovation. The evidence suggests that innovation labs do not rely on a single pathway for accessing Design capabilities but instead draw upon a combination of these mechanisms, according to their specific contexts and objectives. These pathways also appear to be conditioned by the institutional maturity of the laboratories, with more established organisations being more likely to employ Design professionals as part of their permanent staff and to possess the resources necessary to access external partners capable of transferring Design-related knowledge.

The categories identified reveal the fragility of internalised Design capabilities within the public sector, particularly given the frequent reliance on external partners as a means of accessing the discipline. Evidence of this can be found in the widespread use of innovation consultancies, which are repeatedly described as the primary channel through which laboratories first encounter principles and practices associated with Design, especially Design Thinking (DT). Similarly, benchmarking activities conducted with innovation units and organisations where Design has already been practised with some degree of continuity constitute another important mechanism for accessing Design-related knowledge.

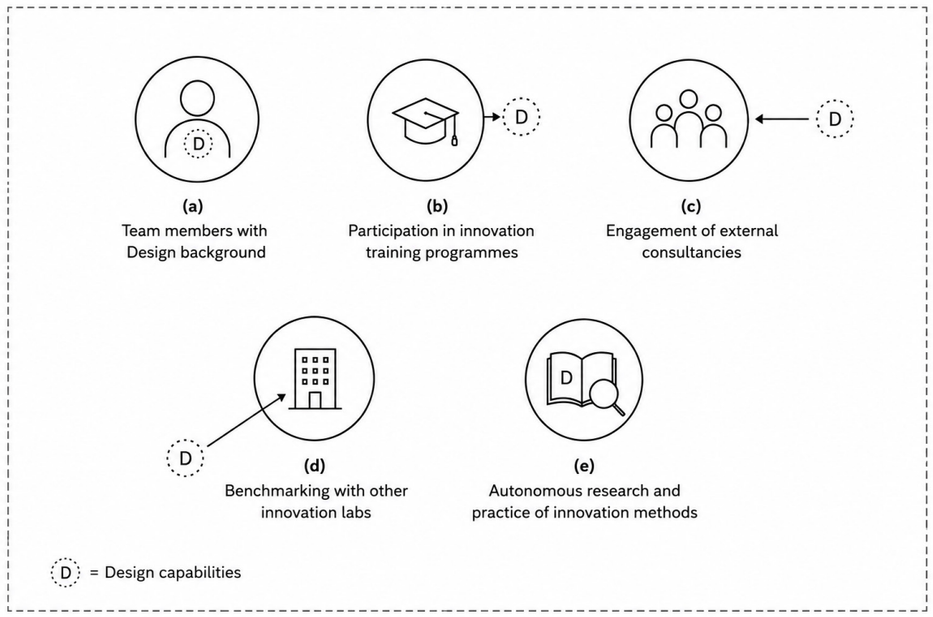
More diffuse forms of access, such as training programmes linked to public sector innovation agendas and the independent exploration of specialised materials, likewise point to the central role of Design as a recurring approach within innovation-related discussions, where it is frequently presented as a means of fostering innovation. The presence of professionals formally trained in Design, although less prominent, emerges as an endogenous opportunity for the dissemination of the discipline within the context

studied. In such cases, innovation labs benefit from the presence of individuals capable of promoting Design as a pathway to innovation, highlighting their important role as agents of organisational change.

In dialogue with the modes of access proposed by the Design Commission (2013), the findings reveal a strong dependence on exogenous actors in the development of Design capabilities, particularly through arrangements resembling the category of External Agencies. Innovation labs frequently reported relying on external consultancies and specialised partners as a means of introducing Design-related methods, tools and practices. By contrast, the categories of Brokered Interventions and Design-led Start-up Services, although identified by the Design Commission (2013), were not reported as significant pathways for accessing Design capabilities in the cases studied.

With regard to endogenous forms of access, the innovation labs themselves appear, once trained and established, to function as an Internal agency, working with other parts of the bureaucratic apparatus as a specialised Design service unit in individual projects and thereby disseminating Design capabilities throughout the wider public sector. The presence of Embedded designers also constitutes an important pathway for accessing Design capabilities within innovation labs, although their strategic role appears to remain limited. Furthermore, a significant number of cases involved the mobilisation of Design without the mediation of Design professionals, corresponding to a configuration akin to No-designer design work. Given their relevance, these latter two findings are explored in greater detail later in this chapter.

Figure 3 – Modes of Access to Design Capabilities.



Source: Developed by the authors with AI assistance (2026).

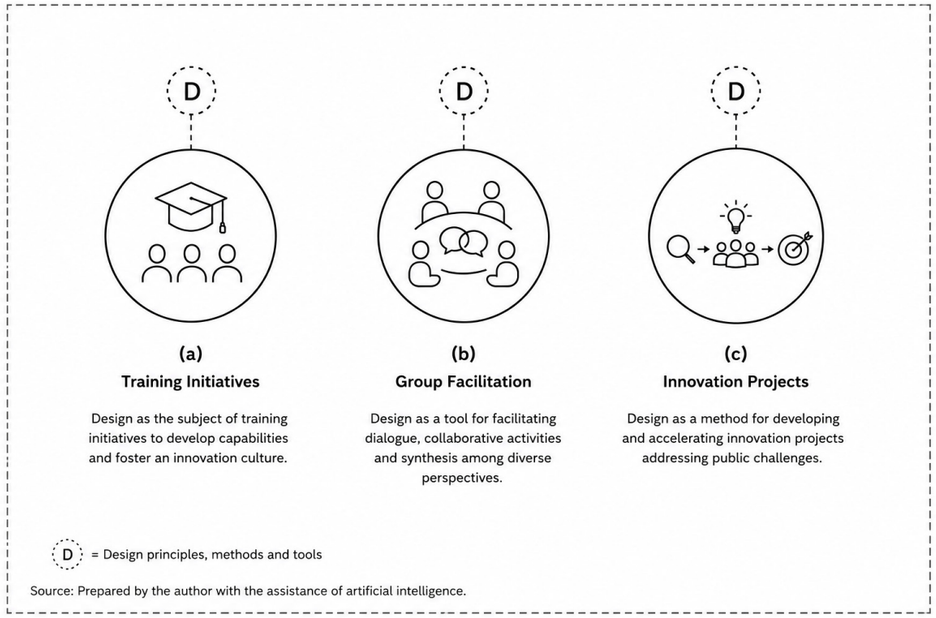
The strategies through which Design is incorporated into the routine activities of innovation labs, particularly Design Thinking (DT), given its prevalence in the context studied, can be grouped into three main patterns: (a) as the subject of training initiatives; (b) as a tool for group facilitation; and (c) as a method for the development and acceleration of innovation projects (Figure 4). As the subject of training initiatives, Design is presented as an important component of efforts aimed at developing capabilities and disseminating an innovation culture within the public sector. Such initiatives take diverse forms, ranging from extensive training programmes comprising multiple modules and lasting several months to short courses and workshops related to innovation, which typically last only a few hours. Within this latter format, DT workshops stand out as a particularly common offering across the innovation labs studied, serving as a vehicle for introducing innovation-related concepts to public servants and organisational teams on an occasional basis.

As a tool for group facilitation, Design is mobilised as a mediator of activities and dynamics involving groups pursuing a variety of objectives, generally associated with innovation agendas. In this role, the discipline is valued for its ability to encourage dialogue, facilitate collaborative activities and produce syntheses from divergent viewpoints. Once again, DT emerges as an influential platform capable of providing a repertoire of tools and a shared language for conducting these collaborative processes. DT-related principles, such as empathy and collaboration, are positioned as guiding principles for fostering openness to different perspectives and supporting the collective construction of reflections on specific issues or challenges.

As a method for the development and acceleration of projects, Design assumes its most strategic and consequential role within the context studied, being applied directly to problems of a public nature. In this capacity, Design is mobilised variously as a source of guiding principles, as a methodological framework, and as the basis for a repertoire of tools employed in collaborative projects focused on public challenges. As noted previously, a variety of Design manifestations can be observed in this role, ranging from more established approaches such as Service Design to emerging practices such as Design Futures.

Design Thinking (DT) likewise remains highly relevant, functioning as a widely adopted foundational method for the development of innovation projects across the innovation labs studied. This mode of incorporating Design into innovation labs is particularly noteworthy because it allows for a more substantive exploration of the discipline's potential as a catalyst for change within the public sector. By enabling a deeper engagement with Design principles, longer and less superficial interactions with the discipline, and outcomes that can be observed and evaluated, this form of application provides greater opportunities for Design to contribute meaningfully to innovation processes and organisational transformation.

Figure 4 – Modes of Access to Design Capabilities.



Source: Developed by the authors with AI assistance (2026).

The three patterns identified can be associated with the Public Sector Design Ladder proposed by the UK Design Council (2013). Depending on their organisational structure and level of institutional maturity, the innovation labs studied mobilise Design to address discrete and often operational problems, typically drawing upon the technical repertoire associated with fields such as Editorial Design and Web Design. Training initiatives in which Design occupies a central role, in turn, suggest an aspiration towards the second level of the Design Ladder, where the objective is to internalise a Design mindset as a pathway to fostering an innovation culture within the public sector. Innovation projects developed through Design, meanwhile, represent the form of activity most closely aligned with the third level of the ladder, in which Design informs both the conception and implementation of public policies.

The accounts provided by the innovation labs indicate a clear predominance of activities associated with Levels I and II of the Design Ladder (Table 3): (I) Design for Discrete Problems and (II) Design as Capability. Only two of the laboratories studied provided evidence of employing Design from a more strategic perspective, justifying their classification within Level III of the Design Ladder, as detailed in Table 2. The findings therefore suggest that, in many of the innovation labs analysed, Design is still used in a relatively sporadic and exploratory manner, limiting its potential contribution to the internalisation of an innovation culture within the context studied. Evidence of Design being employed at the policy level remains comparatively rare, suggesting that the strategic integration of Design into policymaking processes is still incipient within the Brazilian public sector innovation ecosystem.

Table 3 – Distribution of Innovation Labs Across the Public Sector Design Ladder.

Design Ladder Level	Number of Labs	Percentage
Level I – Design for Discrete Problems	7	46.7%
Level II – Design as Capability	6	40.0%
Level III – Design for Policy	2	13.3%
Total	15	100%

Source: Developed by the authors (2026).

Finally, notwithstanding the recurrent presence of Design as both a methodological resource and a discursive element within innovation labs, the findings point to important limitations in its effective institutionalisation, particularly with regard to the occupation of more strategic positions by Design professionals.

Although eight of the innovation labs studied had designers permanently integrated into their teams at the time of the research, the presence of these professionals in strategic roles was significantly limited, occurring in only two cases. Furthermore, eight laboratories were identified that, despite employing methodologies, approaches and tools derived from the Design field, had not institutionalised the presence of Design professionals within their teams, suggesting a pattern of Design adoption without designers. In these cases, access to Design expertise depended largely on relationships with external partners, particularly through the engagement of consultants. The recruitment of Design interns also emerged as a frequent strategy for accessing Design expertise, although one characterised by weak organisational ties and by the confinement of Design activities to operational functions.

These findings therefore reveal an important dimension of the relative invisibility of Design professionals within the public sector, associated with their limited institutional integration within the organisations studied. They also resonate with Junginger's (2013) argument that the traditional role of Design in the public sector has generally been confined to policy implementation stages, particularly in product development and graphic communication, thereby constraining its capacity to operate more strategically as a catalyst for innovation.

Taken together with the evidence presented above, the findings reveal a duality within the innovation labs studied. On the one hand, Design enjoys considerable visibility and is widely mobilised as a discursive and methodological pathway to innovation. On the other, significant weaknesses remain in its effective operationalisation, particularly with regard to its integration into the more strategic dimensions of public policymaking. These limitations are especially evident in the difficulty of embedding Design in a manner that enables it to contribute consistently and substantively to the formulation and implementation of public policies.

6. Conclusion

The findings of this study indicate that Design occupies a prominent position within the Brazilian innovation labs analysed, being consistently and explicitly articulated as a catalyst for fostering an innovation culture in the public sector. In this role, the discipline supports the introduction of methods, tools and guiding principles aimed at bringing greater dynamism to public policymaking processes, orienting them towards collaboration, exploratory approaches and human-centredness.

Design is not mobilised in a uniform manner but through a plurality of interpretations and applications. The approaches identified range from established fields such as Service Design and Editorial Design to more recent practices such as Speculative Design and Design Futures. Among these multiple manifestations, Design Thinking (DT) stands out as an important gateway through which Design enters the public sector. At the same time, DT appears to draw more heavily on a repertoire associated with innovation management and organisational development than on the broader body of academic knowledge accumulated within the Design field itself.

As an organisational capability, Design is introduced into innovation labs through a variety of pathways, most notably through reliance on external partners, including consultancies, benchmarking activities and training initiatives. Operationally, the discipline is mobilised according to a number of identifiable patterns, functioning as the subject of training programmes, as a tool for facilitating group dynamics and, more substantively, as a method for the development of innovation projects.

The evidence suggests that the prominence Design enjoys in the discourse of the innovation labs studied is not easily translated into a more strategic and substantive role in their day-to-day activities. Furthermore, the limited institutionalisation of Design professionals within the public sector and the strong dependence on external partners raise concerns regarding the risk of superficial, episodic and insufficiently systemic applications of Design. From this perspective, DT, although relevant as a gateway into the field, also points to a risk of oversimplifying the discipline by presenting it in a stereotypical and formulaic manner. Indeed, critiques of Design in the public sector often emerge from precisely this form of engagement, frequently associated with a perceived naivety regarding the complexities involved in the formulation and implementation of public policy. Such critiques resonate with the predominance of the lower levels of the Design Ladder identified in this study, where Design is mobilised either to address discrete problems or as a capability-building mechanism, without achieving full strategic integration into policymaking processes.

A broad research agenda remains open. Future studies should investigate the institutional conditions required for consolidating Design as a strategic capability within the public sector; its concrete effects on policy formulation and implementation; the extent to which DT contributes to fostering innovation in public organisations; the discursive uses of Design within public sector innovation agendas; and the factors that condition the integration of Design professionals into governmental organisations. Further research is essential to advancing understanding of how Design, both as a field of knowledge and as a professional practice, can be more effectively adapted to the realities of the public sector.

Design presents itself as a promising technology for public sector transformation. Through it, important elements of contemporary public sector agendas, such as collaboration and human-centredness, can be strengthened. Given the complexity of contemporary social problems and the systemic nature of their causes and consequences, Design's capacity to catalyse more innovative approaches within public organisations should not be underestimated. This potential, however, is contingent upon its degree of institutionalisation. Without the consolidation of internal capabilities and its incorporation beyond episodic or superficial applications, Design is likely to remain a limited resource, falling short of its broader potential as a driver of transformation in the public sector.

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03

Experience design for ai agents: an analysis of human-centered guidelines in llm-owning companies

Fernando Souza Ferreira
Gilberto Consoni
Júlio van der Linden

Abstract

Recent advances in large language models have driven the expansion of artificial intelligence agents, capable of planning and executing actions autonomously to achieve goals, shifting the challenge from technical development to the design of human-centered experiences. In this scenario, the aim of this research was to analyze how LLM-owning companies structure and communicate design principles for AI agents. Through a thematic documentary analysis of public materials from 22 companies, only three organizations (OpenAI, Google, and Microsoft) were identified as providing consolidated guidelines on agent design. The comparative analysis revealed convergences and gaps between these corporate principles and academic frameworks of human-AI interaction. The main results are: (i) the identification of five thematic axes that structure theoretical-practical alignment, AI visibility, contextualized interactions, feedback mechanisms, adaptive evolution, and trust; and (ii) the mapping of significant asymmetries, such as the absence of prototyping guidelines and iterative error treatment in some companies. It is concluded that, although there is progress toward human-centered practices, corporate guidelines remain fragmented and lack integration with consolidated principles from the literature, indicating opportunities to improve the design of agents that are more ethical, understandable, and aligned with human agency.

Keywords: User Experience; AI Agents; Human-AI Interaction; Human-Centered Artificial Intelligence; Large Language Models; Design Principles.

1. Introduction

Recent advances in large language models (LLMs)[1] and in the Transformer architecture[2] have profoundly redefined the field of artificial intelligence (AI), by introducing mechanisms capable of interpreting contextual relationships with speed, precision, and scalability (VASWANI et al., 2023). This technological leap has driven the development of artificial intelligence agents, understood as goal-oriented autonomous systems capable of perceiving and interpreting context, reasoning about alternatives, making decisions, and executing actions adaptively, with minimal human intervention (ACHARYA; KUPPAN & DIVYA, 2025). As a consequence, a transition can be observed in human-computer interactions: from predominantly static interfaces to collaborative, adaptive experiences mediated by agents that continuously learn from users (CAPOSINO, 2025).

In this new paradigm, user experience (UX) becomes even more critical. UX encompasses pragmatic and hedonic dimensions (HASSENZAHL, 2018), varying across individuals, contexts, and over time. Interactions with AI agents, therefore, do not depend solely on the technical quality of the models, but on how these systems are designed to support human needs, communicate intentions, reduce uncertainties, and establish trust (STEVENS, 2025). The emergence of multimodal agents, hyper-personalization, and generative interfaces reinforces that digital experiences are now living products, which evolve after launch and require continuous cycles of design, learning, and adaptation (CAPOSINO, 2025).

At the same time, the expansion of autonomous systems brings ethical, social, and practical challenges, ranging from amplified inequalities to security risks and loss of privacy, which require adequate governance and design approaches aligned with human-centered artificial intelligence (HCAI) (GUENAT et al., 2022). In this context, the field of human-AI interaction (HAII) seeks to integrate human-computer interaction (HCI), human factors, ethics, and computer science to ensure that intelligent systems remain understandable, transparent, and controllable, preserving human agency (XU, 2025).

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[1] Large Language Models (LLMs) are artificial intelligence systems trained on enormous volumes of text to understand and generate natural language. LLMs can adapt to different uses, such as answering questions, summarizing texts, translating content, maintaining conversations, and supporting reasoning processes. This capability occurs because these models learn language patterns and use this learning to produce coherent responses (Naveed et al., 2025).

[2] The Transformer architecture is a structure capable of observing several parts of a sentence at the same time and identifying which words are most important for understanding the meaning of the text. This mechanism is called attention. Because it is efficient and capable of capturing relationships between distant words, the Transformer has become the basis of many current artificial intelligence models, including large language models (Vaswani et al., 2023).

At the same time, the expansion of autonomous systems brings ethical, social, and practical challenges, ranging from amplified inequalities to security risks and loss of privacy, which require adequate governance and design approaches aligned with human-centered artificial intelligence (HCAI) (GUENAT et al., 2022). In this context, the field of human-AI interaction (HAII) seeks to integrate human-computer interaction (HCI), human factors, ethics, and computer science to ensure that intelligent systems remain understandable, transparent, and controllable, preserving human agency (XU, 2025).

Despite the growing relevance of design for AI agents, important gaps persist in both literature and practice. Studies show that UX frameworks for AI rarely address continuous feedback integration, improved personalization capabilities, or iterative cycles (SCHRÖDER & FISCHER, 2025). Other authors highlight emerging challenges in human-AI interaction, such as generative variability, unjustified dependence, co-creation, and the inherent uncertainty of models, which require new design principles (WEISZ et al., 2024). Research on prototyping also reveals practical difficulties in alternating between technical and experiential levels, visualizing internal states, and incorporating feedback during execution (LIANG et al., 2025). In addition, studies on human-centered design applied to AI emphasize that the construction of effective agents requires empathy, hypothesis formulation, and a deep understanding of the real context of use, steps that are still poorly consolidated in technical teams, but are fundamental to avoiding solutions misaligned with users' expectations, limitations, and values (CEREJO, 2023). This perspective reinforces that designing AI agents is not merely a matter of engineering, but a process of design, critical evaluation, and alignment between the capabilities of algorithms and experiential value.

Despite this scenario, it remains unknown to what extent the major companies developing LLMs, which define global standards for the ecosystem, communicate design principles for human-centered agents, or how such principles relate to accumulated scientific knowledge. Considering that companies that commercialize LLMs tend to provide formal usage guidelines, it is expected that they also make available structured principles on how to design good AI agents.

In view of this, this article investigates what LLM-owning companies publicly communicate about how to design user experiences for AI agents. The study is based on a thematic documentary analysis (MORGAN, 2022) of official materials from companies developing language models in order to answer three questions: (RQ1) how these companies communicate human-centered principles in public materials; (RQ2) which design principles are recommended for building agents; and (RQ3) how such corporate principles align with or diverge from the literature on human-centered artificial intelligence.

Thus, the contribution of this article is twofold. From a scientific standpoint, it offers the first comparison between corporate guidelines and the main theoretical frameworks of UX for AI, revealing convergences and gaps. From an applied standpoint, it contributes to enabling designers, engineers, and organizations to adopt design practices more aligned with human-centered AI, for the creation of agents that are safer, more ethical, more transparent, and more coherent with the needs of human beings.

2. Methodological Procedures

This research aimed to analyze design principles from LLM-owning companies for the user experience of artificial intelligence agents. It is an inductive and applied study, as it starts from the empirical analysis of corporate documents to build interpretations and propose practical improvements in design principles for AI, whose complexity imposes new challenges on designers, arising from uncertainty about the capabilities of models and the breadth and unpredictability of their results (LIANG et al., 2025). In addition, it has a descriptive-exploratory nature, as it seeks to identify and interpret patterns in the design principles present in corporate AI documentation.

For the systematic analysis of public materials, a thematic documentary procedure was adopted (MORGAN, 2022) with the aim of identifying user-centered corporate recommendations and their design relevance for agents. The empirical scope comprises:

1. Definition of research questions;
2. Selection of LLM-owning companies;
3. Selection of documents that describe human-centered design principles;
4. Analysis of convergences and divergences between corporate approaches and the scientific literature on UX for AI.

2.1 Research Questions

Table 1 - Research Questions

ID	Research Question	Focus
RQ1	How do companies communicate human-centered principles for agents in public materials?	Communication Focus
RQ2	What are the design principles communicated by companies for building human-centered agents?	Content of the principles
RQ3	How do companies' design principles align with the principles present in the literature on human-centered artificial intelli	Theorical-pratical comparison

Source: Developed by the authors (2026)

2.2 Company Selection Criteria

The selection criteria included companies:

- CSE1 - that own LLMs;
- CSE2 - that provide LLMs for text outputs rather than video, image, or audio.

Companies that did not meet both criteria were disregarded.

2.3 Document Selection Criteria

The selection criteria included documents:

- CSD1 - that constitute consolidated, public, and accessible corporate knowledge;
- CSD2 - that are authored by the selected companies;
- CSD3 - that describe design principles for agents.

Documents that did not meet all three criteria were excluded. These criteria were adopted to ensure authentic, credible, representative, and meaningful documents for answering the research questions (MORGAN, 2022).

2.4 Content Analysis

The documentary analysis (MORGAN, 2022) was conducted through an interpretive reading to identify how companies communicate AI design principles in their public materials. This interpretive process followed the principles of thematic documentary analysis, allowing the design principles made explicit by each company to be categorized.

For the analysis, summative content analysis was adopted (HSIEH & SHANNON, 2005), combining (i) the identification and comparison of recurring keywords and expressions related to design theories and (ii) the interpretation of the content based on the semantic patterns found. For each emerging category, verbatim excerpts and analytical paraphrases were extracted, ensuring the adopted criterion between the interpretations and the textual evidence present in the corporate documents.

Finally, a synthesis and comparison stage was carried out, relating the content of the corporate principles to the companies' design intentions for building human-centered agents. This stage made it possible to identify convergences and divergences between the corporate principles and the theoretical background of this study, responding in an integrated manner to the three research questions (RQ1, RQ2, and RQ3).

3. Human-AI Interaction and Artificial Intlligence Agents

This section is dedicated to presenting an overview of human-AI interaction and artificial intelligence agents, as well as presenting related works that have addressed design recommendations for intelligent systems.

3.1 Human-Centered Human-Artificial Intelligence Interaction

Human-AI interaction (HAII) is the field that: (i) investigates how to design, evaluate, and improve interactions between humans and intelligent systems and (ii) operationalizes the principles of human-centered artificial intelligence (HCAI), which emerged from the foundations of human-computer interaction (HCI) (XU et al., 2021). While HCI deals with making computational systems usable, efficient, and accessible (GRUDIN, 2018), HCAI expands this scope so that autonomous, adaptive, and unpredictable systems are reliable, transparent, ethical, and aimed at enhancing, rather than replacing, human performance (SHNEIDERMAN, 2020, 2022; XU et al., 2023). Despite advances in HCI and HCAI, Xu (2025) highlights that HAII still does not fully integrate practice and theory, which requires greater articulation among computer science, design, psychology, and ethics in order to develop truly human-centered solutions.

For such articulation, Xu (2025) proposes human-centered human-AI interaction (HC-HAII), which is structured into four main components: objectives, scope and research questions, methodology, and design paradigms. Objectives are guided by the HCAI perspective in order to place the human at the center of research and in final control of AI systems. The scope and research questions are guided by the HCAI perspective in order to address gaps in the design, development, implementation, and use of AI systems. The HC-HAII methodology promotes interdisciplinary collaboration among human factors, HCI, and user experience (UX), as well as integrated innovation. Finally, design paradigms, from the HC-HAII perspective, promote multilevel design, which ranges from simple human-AI interactions to ecosystems (e.g., multi-agent systems, human-AI teams, AI-AI coordination) and sociotechnical dimensions (e.g., organizational, cultural, and ethical systems). In summary, HC-HAII proposes establishing a bridge between technology and design with a focus on ensuring that the advancement of automation remains at the service of human agency.

In the context of the agency of interactions with intelligent systems, Jiang et al. (2024) highlight four central axes: collaboration, competition, conflict, and symbiosis. Human-AI collaboration can manifest at different levels of intelligence - assisted, augmented, cooperative, and autonomous - combining human capacities for ethics, creativity, and empathy with AI competencies in analysis, speed, and prediction. Human-AI competition emerges both in digital games and in work dynamics and presents challenges related to resource equity, explainability of decisions, and preservation of the human role. Human-AI conflict refers to divergences in tasks or relationships, which can be mitigated through visible, understandable, and controllable decision-making processes. Finally, human-AI symbiosis is supported by four pillars: human-in-the-loop (feedback in the AI

learning cycle), explainable AI (XAI), user-friendly AI, and responsible AI. This perspective highlights the importance of AI literacy so that users can understand the capabilities and limitations of the technology, interact effectively, assess its reliability and credibility, use it responsibly and ethically, and adapt to its constant evolution (SÜßE; KOBERT & KRIES, 2021).

3.2 Artificial Intelligence Agents

Artificial intelligence agents are autonomous systems capable of perceiving their environment, reasoning, and acting independently to achieve specific goals with minimal human interference (ACHARYA; KUPPAN & DIVYA, 2025; NISA et al., 2025; SAPKOTA & ROUMELIOTIS; KARKEE, 2026). These systems are also capable of explaining their decisions, describing the alternatives considered, actions executed, adaptations made, and the reasons for each choice (SADO et al., 2023). By connecting reasoning to the autonomous execution of actions, agents become able to use tools, navigate the internet, interact with other applications, and respond dynamically to changes in the environment through reactive intelligence and adaptability (CHACON-CHAMORRO et al., 2025).

The adaptability of AI agents is enabled by pre-trained large language models (LLMs), which perform multiple interactions and interpret instructions in natural language, known as prompts, in order to guide their responses (ZAMFIRESCU-PEREIRA et al., 2023). Among the main approaches to prompt design, the following stand out: (i) language dynamics, which involves communicating intentions and exploring contexts and meanings; (ii) direct task specification, based on clear instructions (zero-shot); (iii) specification by demonstration, which uses explicit examples (few-shot); (iv) specification by memetic proxies, which employs cultural references or characters as semantic shortcuts; (v) behavior restriction, which seeks to reduce ambiguities; (vi) serialization of reasoning, which divides the process into steps to increase precision; and (vii) prompt metaprogramming, which creates prompts capable of generating other prompts, expanding the adaptability and autonomy of the model. The purpose of these approaches goes beyond obtaining responses: it is about shaping the linguistic and cognitive behavior of models, transforming prompt design into an interpretive, design-oriented, and strategic practice aligned with human intentions, contexts, and values (REYNOLDS & MCDONELL, 2021).

In addition, agents can be classified into seven types: reactive, proactive, limited-memory, model-based, goal-oriented, Theory of Mind (ToM), and self-aware—the latter two being capable of inferring human emotions, beliefs, and intentions, and of reasoning about their internal states (NISA et al., 2025). Despite their advances, these systems present two central limitations: hallucinations, plausible but incorrect responses, and high sensitivity to prompts, in which small variations in formulation produce divergent results. Both scenarios require manually designing prompts to ensure the consistency and reliability of interactions (SAPKOTA; ROUMELIOTIS & KARKEE, 2026). Another critical aspect in prompt design is the prevention of prompt leaking, which consists of attacks that seek to extract the system's internal instructions, compromising its security, privacy, and intellectual property (HUI et al., 2024).

3.3 Related Works

The nature of artificial intelligence agents imposes new challenges on designers, which requires the investigation of specific human-AI interaction practices. Principles and prototyping cycles become essential to improving the usability and effectiveness of the human-centered design process in generative systems. In this context, Amershi et al. (2019) synthesized, from guidelines proposed over 20 years of research and professional practice, a set of 18 principles for human-AI interaction design. The principles were refined in four phases by a team of 11 researchers and reviewed by more than 60 designers and usability specialists. The consolidated set was categorized into four moments: initially, during interaction, in case of error, and over time.

- Initially: make clear what the system can do; make clear how well the system can perform.
- During interaction: time services based on context; show contextually relevant information; match relevant social norms; mitigate social biases.
- In case of error: support efficient invocation; support efficient dismissal; support efficient correction; scope services when in doubt; make clear why the system did what it did.
- Over time: remember recent interactions; learn from user behavior; update and adapt cautiously; encourage granular feedback; convey the consequences of user actions; provide global controls; notify users about changes.

Weisz et al. (2024), in turn, developed six design principles for human-generative AI interaction through an iterative process inspired by the principles of Amershi et al. (2019). The initial formulation was based on a literature review on generative AI applications, resulting in seven preliminary principles (WEISZ et al., 2023). The authors then conducted four refinement iterations, which included workshops with designers, a modified heuristic evaluation to test clarity, relevance, and coverage, and practical applications of the principles in two product design projects.

- Responsible design: use a human-centered approach; identify and resolve value tensions; expose or limit emergent behaviors; test and monitor potential harm to the user.
- Design for generative variability: leverage multiple outputs; visualize the user journey; enable curation and annotation; highlight differences among outputs.
- Design for mental models: guide the user regarding generative variability; teach effective use through examples; understand the user's mental model; teach the system about the user.

- Design for co-creation: help the user formulate effective prompts; provide generic input parameters; offer controls relevant to the use case; support the co-editing of outputs.
- Design for appropriate trust and reliance: calibrate trust with explanations; provide justifications for outputs; use friction to prevent over-reliance; indicate the role of AI.
- Design for imperfection: make uncertainty visible; evaluate outputs with domain-specific metrics; offer ways to improve outputs; provide feedback mechanisms.

Liang et al. (2025) sought to understand the key activities performed by engineers during the prototyping of agent user experiences, through a study conducted with 12 participants. The study identified an iterative cycle for agent prototyping: design, execution, debugging, and refinement. Based on the iterative cycle of agent prototyping, the study identified three main design implications:

- Offer understandable and configurable interaction components: interface actions should have clear nomenclature, preview features to facilitate the discovery process and the suggestion of effective prompts, as well as resources that reveal prompts for quick editing.
- Allow alternation between levels of technical information and user experience: the prototype should allow the presentation of different amounts of information during agent execution to be alternated, in order to avoid conflicts between the needs of engineers and users. Engineering professionals require details to understand the agent's behavior, while users may become overwhelmed by excessive information.
- Favor agile cycles of design and testing: it is recommended to offer review resources, such as indicators of the agent's current status, alerts and update messages, and personalization features, such as variation in execution speed and in the size of the agent's response.

Finally, Schröder & Fischer (2025) presented a systematic literature review on user experience frameworks applied to generative AI systems, analyzing 16 studies in terms of their contributions and gaps in relation to consolidated theoretical and practical principles. The results indicate that only three frameworks explicitly address prototyping methods in the design of generative AI systems. In this respect, the analysis reveals five main opportunities for improving user experience frameworks for AI:

- Iterative design: strengthen feedback cycles and incorporate usability testing in early stages, for the early identification of problems.
- User requirements: adopt structured methods for elicitation and continuous feedback integration, in order to align expectations and design goals.
- Holistic experience: consider emotional dimensions of satisfaction and long-term user engagement, ensuring experiences that go beyond functional utility.
- Trust and control: improve transparency for users and increase control over AI decisions, in order to promote ethical collaboration.
- Adaptability and context: apply responsive and context-sensitive design techniques and promote improved personalization capabilities, adjusting interactions to individual preferences and situational conditions.

4. Results and Discussion

The presentation of the results is structured around the three research questions, which address the communication focus, the content of the principles, and the theoretical-practical comparison.

4.1 RQ1 - How do companies communicate human-centered principles for agents in public materials?

Twenty-two LLM-owning companies that enable the construction of AI agents based on textual processing were selected, originating from seven countries. The selection was conducted between November 8 and November 15, 2025, with an exploratory character and without the intention of exhausting or systematically mapping the entire global ecosystem of companies developing language models. The survey was carried out through internet searches using the term "LLM companies" and a consultation with ChatGPT using the prompt: "List LLM-owning companies for text processing. Consider: (i) private or public companies, (ii) companies that are the main developer, (iii) include global companies, and (iv) exclude companies whose primary focus is only image, audio, or video generation." Companies that did not meet the criteria were not selected: regarding CSE1, model-hosting repositories, for example, HuggingFace, or companies that use third-party models, for example, Perplexity; and regarding CSE2, companies whose primary focus is not a textual solution, such as Stability AI, Runway, Midjourney, ElevenLabs, Pika Labs, and Synthesia.

Next, for each selected company, the addresses of the models' technical documentation were identified, to which two search methods were applied: (i) an exploratory verification to locate explicitly presented design principles for AI and (ii) the use of the keywords "design," "guideline," and "experience" in the internal search mechanisms of these documentations. If no guideline was identified in the technical documentation, a complementary internet search was carried out using the expression "{Company Name} design guidelines," with the objective of locating specific portals related to the company's design operations and, within them, identifying possible design principles for AI. This strategy aimed to cover, in a broad and structured manner, the main public institutional sources relevant to the analysis.

As a result of this process, three documents were identified that present design principles directly applicable to agent prototyping, essential elements for guiding human-AI interaction practices, which will be analyzed in light of the principles of human-centered artificial intelligence. For the remaining companies, no proprietary materials were found that (CSD2) were authored by the companies themselves and (CSD3) presented design principles for agents. The following table summarizes these findings.

Table 2 - Technical Documentation and Design Principles of the Models

Company (Country)	Reference Model	Documentation	Design Principles
OpenAI (USA)	GPT	https://developers.openai.com/	https://developers.openai.com/apps-sdk/concepts/design-guidelines
Microsoft (USA)	Copilot	https://learn.microsoft.com/en-us/copilot/microsoft-copilot	https://microsoft.design/articles/ux-design-for-agents/
Google DeepMind (USA/UK)	Gemini	https://ai.google.dev/gemini-api/docs	https://pair.withgoogle.com/guidebook/
Cohere (Canadá)	Command	https://cohere.com/developers	Not found
Meta AI (USA)	Llama	https://llama.meta.com/docs	Not found
Anthropic (USA)	Claude	https://docs.claude.com/en/home	Not found
Salesforce (USA)	XGen	https://www.salesforce.com/agentforce/	Not found
IBM (USA)	Granite	https://www.ibm.com/granite/docs	Not found
Mistral AI (França)	Mistral	https://docs.mistral.ai	Not found
Amazon AWS (USA)	Titan	https://builder.aws.com/learn/topics/agentic-ai	Not found
Aleph Alpha (Alemanha)	Luminous	https://docs.aleph-alpha.com	Not found
Tencent (China)	Hunyuan	https://cloud.tencent.com/document/product/1729	Not found
Alibaba (China)	Qwen	https://qwen.readthedocs.io	Not found
xAI (USA)	Grok	https://docs.x.ai/docs/overview	Not found
Baidu (China)	ERNIE	https://ernie.baidu.com/	Not found
Reka AI (Singapura)	Reka	https://docs.reka.ai/overview	Not found
Snowflake (USA)	Artic	https://docs.snowflake.com/en/arctic	Not found
Databricks (USA)	DBRX	https://docs.databricks.com/aws/en/developers/	Not found
Writer (USA)	Palmyra	https://dev.writer.com/home/introduction	Not found
NVIDIA (USA)	Nemotron	https://docs.nvidia.com/nemo/agent-toolkit/latest/index.html	Not found
DeepSeek (China)	DeepSeek	https://www.deepseek.com/	Not found

Source: Developed by the authors (2026)

As a response to RQ1, it was observed that only 3 of the 22 companies analyzed disclosed design principles aimed at the prototyping of artificial intelligence agents. Among them, OpenAI (2025) concentrates this content directly on pages of the technical documentation of artificial intelligence models, while Google (2025) and Microsoft (2025) organize it in specific addresses related to the companies' design operations. The analysis of this content will be deepened in the responses to RQ2 and RQ3.

4.2 RQ2 - What are the design principles communicated by companies for building human-centered agents?

OpenAI (2025) describes that its design principles for agents should be conversational, intelligent, simple, responsive, and accessible. The guidelines also delimit good and bad uses: agents are appropriate when they support tasks with clear beginnings and endings, generate immediate value, and can be presented in a visually simple way; however, complex flows, long or static content, duplication of system functionalities, exposure of sensitive information, and promotional uses should be avoided. In addition, OpenAI defines rules for tone and proactivity: content should be concise, contextual, and non-promotional, while proactive interventions can occur only when strictly relevant to the user's intent. Unsolicited re-engagements[3] are prohibited, and any intervention must make explicit its reason and timing. The guiding design principles are:

- Conversational: provide an experience that is integrated and natural to the flow of dialogue.
- Intelligent: use context to anticipate intentions and generate relevant responses.
- Simple: concentrate each interaction on a single action or clear outcome.
- Responsive: ensure lightness and speed in execution, without overloading.
- Accessible: provide inclusive support for a wide variety of users.

Google's (2025) design principles, in turn, emphasize that experiences with AI should prioritize users' autonomy and different levels of literacy in the design of AI-supported flows, in order to increase their efficiency without compromising their agency. They should also align data and models with real contexts of use, recognizing that natural interactions with AI vary according to the situation and that systems may be used in unexpected tasks, beyond the intended scope or training data. In addition, safety should be treated as an evolving process, since new risks may emerge with the use of AI in complex tasks and varied contexts, which requires proactive safeguards, continuous safety adaptation, and adjustments to

[3] Re-engagements are attempts by the AI agent to reactivate interaction with the user without the user having requested it. In other words, they are messages, reminders, suggestions, or calls to action that appear to bring the user back to the conversation, resume a task, or promote some use, even when there is no clearly expressed intent from the user.

the models. The company reinforces the need to incorporate feedback mechanisms capable of interpreting results, monitoring changes, and guiding improvements, since human-AI interaction operates as a bidirectional learning cycle in which AI personalizes its responses while users adjust their behaviors. Finally, experiences with AI should be useful and inspire creativity, in order to enhance what people value in work and leisure. In summary, these principles are organized into five central axes:

- Design for the appropriate level of user autonomy
- Align AI with real-world behaviors
- Treat safety as an ever-evolving effort
- Adapt AI based on user feedback
- Create useful AI that enhances work and leisure

Finally, Microsoft (2025) highlights agents as a new chapter in human-computer interaction. The company organizes its design principles into three complementary dimensions: Agent (Space), Agent (Time), and Agent (Core). Agent (Space) is the physical and digital space in which agents operate, connecting people, events, and knowledge without replacing or reducing the human role, in an accessible, multimodal, and unobtrusive way, with fluid transitions between proactive and reactive modes. Agent (Time) is described as designing agents that interact across past, present, and future with other agents or people, using contextual history to inform decisions, adopting a posture of encouraging rather than notifying, and continuously evolving according to users' preferences, behaviors, and needs. Agent (Core), in turn, refers to the central elements of the design of an individual agent, highlighting uncertainty as an inherent characteristic of agents and transparency, control, and consistency as fundamental elements. In summary, Microsoft's principles are organized as follows:

- Agent (Space)
  - Connect, do not collapse: agents should bring people and knowledge closer together, without replacing humans.
  - Easy to access, yet practically invisible: agents should offer voice, text, sound, and image interaction and should perform "invisible" processing for fluid transitions between foreground and background.
- Agent (Time)
  - Reflecting on history beyond states (from past to present): use past memory to contextualize present interactions, connecting events and behaviors to generate relevant responses.
  - Encouraging more than notifying (around "now"): it should proactively engage in a contextual way that is sensitive to the environment and to the user's preferences, gradually empowering users.
  - Adaptation and evolution (from present to future): continuously adjust to different devices, modes, and preferences, as well as to users' behavior, feedback, and accessibility.
- Agent (Core)
  - Embrace uncertainty, but establish an appropriate relationship of trust: the level of uncertainty should always be visible and accessible to the user in order to avoid excessive trust.
  - Transparency, control, and consistency are fundamental elements of all agents: agents should be transparent and controllable so that users can visualize and personalize their actions, preferences, and connections.

As a response to RQ2, the principles communicated by OpenAI, Google, and Microsoft converge toward a central ethical principle: agents should expand human capabilities without reducing their autonomy, with experiences that are transparent, safe, contextualized, and genuinely useful to the user. Although they adopt different narratives - OpenAI emphasizing the conversational experience, Google prioritizing sociotechnical alignment, and Microsoft positioning agents that operate in space, time, and the functional core - all converge in defense of a design that balances utility, simplicity, control, and trust. Next (RQ3), the extent to which these corporate principles align with or diverge from the literature on human-centered artificial intelligence is analyzed.

4.3 RQ3 - How do companies' design principles align with the principles present in the literature on human-centered artificial intelligence?

To analyze the extent to which the design principles for AI communicated by companies align with or diverge from the literature on human-centered artificial intelligence, a synthesis composed of five thematic axes was developed. These are: (i) AI visibility (technical clarity and human values); (ii) contextualized interactions (user control and understanding of multiple outputs); (iii) feedback mechanisms (repair and refinement); (iv) adaptive evolution (human-AI co-creation, continuous personalization); and (v) trust (transparency, explanation of decisions and executions). These themes were derived from the four related works in this study and structure a broad analytical space to guide the interpretation and classification of the verbatim excerpts from the corporate principles. The following table presents the relationship between each theme and the respective reference works.

Table 3 - Thematic Axis of the Related Works

Thematic Axis	Human-AI Interaction Design Guidelines (Amershi et al., 2019)	Generative Design Principles (Weisz et al., 2024)	Practical Prototyping Implications (Liang et al., 2025)	Framework Improvement Opportunities (Schröder and Fischer, 2025)
AI visibility (technical clarity and human values).	Make clear what the system can do and how well it can perform.	Responsible design: align values and mitigate risks.	Provide understandable and configurable components.	Structure user requirements and expectations.
Contextualized interactions (user control and understanding of multiple outputs).	Adjust the timing and context of responses, display relevant information, conform to norms, and mitigate social biases.	Design for mental models and variability: guide the user regarding multiple outputs and teach effective use.	Allow alternation between technical and experiential levels.	Promote control and contextual adaptability.
Feedback mechanisms (repair and refinement).	Facilitate activation, rejection, and correction.	Design for imperfection: make uncertainty visible, offer means for improvement, and provide feedback channels.	Favor agile testing and review cycles.	Strengthen iterative design and continuous feedback.
Adaptive evolution (human-AI co-creation, continuous personalization).	Remember interactions, learn from the user, update cautiously, and encourage feedback.	Design for co-creation: support prompt formulation and the co-editing of outputs.	----	Incorporate a holistic and context-responsive experience.
Trust (transparency, explanation of decisions and executions).	----	Design for appropriate trust and reliance: calibrate trust and justify outputs.	----	Trust and control through transparency and ethics.

Source: Developed by the authors (2026)

4.3.1 AI Visibility (technical clarity and human values)

Only OpenAI and Microsoft present principles that converge with the need to make explicit the purpose, scope, and behavior of AI agents from the beginning of the interaction. OpenAI emphasizes a clear and reliable experience, with transparency regarding the agent's status and the context needed for users to understand the results. Microsoft reinforces this orientation by highlighting the need to make visible, in real time, the agent's status, skills, and connections, even when it operates in the background. These corporate principles correspond to the recommendations to make clear what the system can do and make clear how well the system can perform (AMERSHI et al., 2019), to the commitment to responsibility toward human values (WEISZ et al., 2024), and to the importance of clear nomenclatures for system actions (LIANG et al., 2025). In summary, OpenAI's and Microsoft's principles follow the theory of human-centered AI by treating visibility, technical clarity, and human values as requirements for autonomy and human control, while OpenAI presents a gap in this respect.

4.3.2 Contextualized Interactions (user control and understanding of multiple outputs)

OpenAI, Microsoft, and Google converge with the thematic axis of contextualized human-AI interactions and controls adjusted to users. OpenAI emphasizes that experiences should feel like a natural extension of the system's conversational flow, guiding each interaction to focus on a single clear action and tools to anticipate the user's intent based on context.

Microsoft reinforces this perspective by highlighting that agents should be intuitive, accessible, and multimodal, in order to provide information based on the user's social and cultural environment and to simplify flows and reduce cognitive load. Google, in turn, highlights the need to design for different levels of autonomy, considering tasks, expertise, and the effort required to use the system, recognizing that people engage with AI in different ways depending on the context.

These corporate orientations converge with recommendations from the literature, such as adjusting the timing and presentation of information according to context (AMERSHI et al., 2019), designing interactions that respect users' mental models (WEISZ et al., 2024), adapting interactions to individual preferences (SCHRÖDER & FISCHER, 2025), and alternating between degrees of technical detail and simplicity (LIANG et al., 2025). Therefore, the three companies incorporate central principles of human-centered AI by promoting situated, context-sensitive interactions adjusted to the level of control desired by the user.

4.3.3 Feedback Mechanisms (repair and refinement)

In the thematic axis of feedback mechanisms (repair and refinement), it is observed that only Microsoft and Google present explicit principles, while OpenAI does not detail guidelines on iterative correction or failure treatment. Microsoft emphasizes that it is necessary to signal the likelihood of uncertainty in order to avoid excessive trust by users in the models and to incorporate feedback collection mechanisms that allow the agent to refine its performance based on users' behavior and responses.

Google, in turn, characterizes mechanisms for analyzing interaction so that AI learns from users' behaviors and feedback, which support the interpretation and adjustment of results. Such principles are aligned with theoretical recommendations to facilitate efficient correction or rejection of results (AMERSHI et al., 2019; SCHRÖDER & FISCHER, 2025; WEISZ et al., 2024) and to design for imperfection, providing feedback mechanisms and ways to improve system outputs (WEISZ et al., 2024). They also dialogue with the need for clear infrastructure for editing and iteratively reviewing the agent's actions (LIANG et al., 2025), and with the importance of structured feedback cycles to strengthen the iterative design of generative systems (SCHRÖDER & FISCHER, 2025). In summary, Microsoft and Google demonstrate consistent alignment with the literature on human-centered AI, while OpenAI presents a gap in this respect.

4.3.4 Adaptive Evolution (human-AI co-creation, continuous personalization)

In the theme of adaptive evolution between humans and AI, the three companies converge in recognizing that agents should learn from the user over time, but they do so with different intensities and focuses. OpenAI only highlights that agents should use conversational context to anticipate intentions and support the user with progressively more relevant interactions, without describing formal memory mechanisms.

Microsoft, the only company that formulates a structured temporal model—past, present, and future—recommends considering historical memory, connected databases, and mechanisms of continuous evolution in agent design, in order to inform and interact with current events and tasks. Thus, the agent progressively expands its complexity to empower users in the long term. Google emphasizes real-world-centered evolution, in experiences that enhance people's work and leisure through AI. Guided by continuous feedback, the evolution of human-AI interaction follows a bidirectional cycle in which users adjust their behaviors and AI personalizes responses based on this learning over time.

Taken together, these corporate principles align with the theoretical principles of remembering interactions, learning from user behavior, updating and adapting cautiously (AMERSHI et al., 2019), helping the user formulate effective prompts (WEISZ et al., 2024), and considering emotional dimensions of satisfaction and long-term user engagement (SCHRÖDER & FISCHER, 2025). However, it is noted that only Microsoft presents an explicit vision of co-creation and systemic evolution, while OpenAI and Google focus on incremental adaptation.

4.3.5 Trust (transparency, explanation of decisions and executions)

In the thematic axis of trust, the three companies analyzed converge in stating that human-centered agents should be transparent, understandable, and controllable.

OpenAI presents an operational approach centered on safe use, prohibiting practices that may reduce trust, such as exposure of sensitive data, promotional messages, or unsolicited re-engagements, and reinforcing that proactivity should occur only when contextual and non-intrusive, in order to preserve user agency.

Microsoft goes further by structuring trust as a central principle of agent design, stating that these systems must earn human trust. The company introduces the idea of transparency, in which users can visualize the agent's actions, automations, settings, and states, as well as personalize its functioning. It also highlights the importance of recognizing and communicating agents' natural uncertainties, aligning with the principles of explaining why the system did what it did (AMERSHI et al., 2019) and designing for trust, with explanations and justifications for outputs (WEISZ et al., 2024).

Google reinforces this set by positioning safety as a continuous effort, asking designers to implement safety measures for different levels of risk and to review strategies as the user's context evolves. This view is coherent with the principles of responsibility, ethical governance, and trust calibration (AMERSHI et al., 2019; SCHRÖDER & FISCHER, 2025; WEISZ et al., 2024). Taken together, the three companies emphasize that trust is not only a technical attribute, but a sociotechnical process sustained by explanations, mechanisms of control, and responsibility, which are foundations of human-centered human-AI interaction.

In response to RQ3, the comparative analysis shows that OpenAI, Google, and Microsoft incorporate the foundations of human-centered artificial intelligence in distinct yet convergent ways. While OpenAI prioritizes simple and safe conversational experiences, Google emphasizes sociotechnical alignment, graduated autonomy, and feedback-based evolution, and Microsoft presents the most comprehensive approach, structuring human-AI interaction in the space, time, and functional core of agents. The following table presents the verbatim excerpts classified by thematic axis.

Table 3 - Thematic Axis of the Related Works

Thematic Axis	OpenAI	Microsoft	Google
AI visibility (technical clarity and human values).	"Always show why and when your tool is resurfacing." "Provide enough context so users understand the purpose of the nudge." "The overall experience must always feel like ChatGPT: clear, helpful and trustworthy."	"Agent status, or what the agent is doing, is clearly visible at all times." "Agents' associated knowledge, tools/ skills, and connections with people and other agents are transparent and customizable." "Agents that operate as background processes have a user-facing mechanism to view and control actions and automations."	----
Contextualized interactions (user control and understanding of multiple outputs).	"Experiences should feel like a natural extension of ChatGPT, fitting seamlessly into the conversational flow." "Tools should be aware of conversation context, supporting and anticipating user intent." "Each interaction should focus on a single clear action or outcome." "Tools should feel fast and lightweight, enhancing conversation rather than overwhelming it."	"Transparency, control, and consistency are foundational elements of all agents." "Individual agents and multi-agent systems are easily discoverable, intuitive, and accessible." "Any human-facing agent supports multimodal inputs and outputs." "Agents deliver information based on contextual environment, social and cultural information… and user preferences." "Agents can simplify flows or dynamically generate cues to direct the user's attention at the right moment."	"Design for the appropriate level of user autonomy… consider different user tasks, expertise, and the effort required to steer the AI system." "People engage differently with AI systems based on their context." "People also prefer to remain in control of which tasks tools should execute, how, and to what end."
Feedback mechanisms (repair and refinement).	----	"The level of certainty and reasoning behind a recommendation are visible… to avoid overreliance." "An agent adapts to user behavior and feedback" "An agent uses data in memory to inform and engage with current events and tasks." "Agents use memory and connected databases to provide more relevant results based on richer historical data." "Agent interaction can be gradual, evolving and growing in complexity to empower users over the long term." "An agent is shaped by and evolves through continuous user interaction."	"Adapt your AI system with feedback from people, during individual interactions and over time." "Set up feedback mechanisms that can be used to interpret AI outcomes." "Account for changes introduced by AI." "Align datasets and models to people's interactions with AI systems in real-world contexts." "AI learns from users to personalize their experiences, and users adapt their behaviors and workflows in response to AI outcomes." "Human-AI interactions are a bidirectional feedback loop." "Adapt your AI system with feedback… over time." "Focus on creating experiences that seamlessly integrate and enhances aspects of work and play." "AI can amplify human expertise."
Trust (transparency, explanation of decisions and executions).	"Avoid… surface sensitive or private information directly in a card." "Avoid spam, jargon, or promotional language." "Not allowed: unsolicited promotions, upsells, or repeated attempts to re-engage." "Proactivity should feel like a natural continuation of the conversation, not an interruption."	"Agents require a huge degree of user trus – which must be earned." "Agents are not designed to replace or belittle people." "Humans can customize agent settings… and are in control of when the Agent is on/off." "Embrace uncertainty, but establish trust."	"People expect tools… to improve their efficiency… [and] prefer to remain in control." "Treat safety as an evolving endeavor." "Develop safeguards for different risk levels." "Be prepared to adapt and modify safety strategies… as user context evolves."

Source: Developed by the authors (2026)

5. Results and Discussion

This research aimed to analyze design principles from LLM-owning companies for the user experience of artificial intelligence agents, in light of the literature on human-centered human-AI interaction (HC-HAII). Based on a thematic documentary analysis of public materials, 22 global companies were examined, of which only 3 (OpenAI, Google, and Microsoft) presented specific corporate design principles for AI agents.

The comparison of these materials with theoretical references such as Amershi et al. (2019), Weisz et al. (2024), Liang et al. (2025), and Schröder & Fischer (2025) made it possible to identify convergences and gaps between corporate practice and theory. This scenario suggests that a large share of companies still treats agent design as an operational layer subordinated to the technical development of models, rather than as a strategic axis of human-AI interaction.

When compared with the references of Amershi et al. (2019), Weisz et al. (2024), Liang et al. (2025), and Schröder & Fischer (2025), the corporate principles present convergences, but also gaps. OpenAI presents guidance for conversational experience, simplicity, operational safety, and limits of use (good and bad applications, tone, proactivity), but does not make explicit mechanisms of iterative feedback, an axis that the literature highlights as essential for treating errors as opportunities for joint learning and for structuring iterative design cycles. Google, in turn, emphasizes user autonomy, sociotechnical alignment, evolving safety, and continuous feedback, but does not detail the visibility of the agent's internal behavior to the same degree present in Microsoft's guidelines. Microsoft offers the most systemic vision, closest to the notion of agents as sociotechnical "ecosystems," structuring principles in the space, time, and core of agents and emphasizing memory, progressive adaptation, transparency, control, and uncertainty.

In response to RQ1, the results indicate that the public communication of human-centered principles for agents is still incipient in the LLM ecosystem. Although there is a predominant discourse of responsibility and safe use on companies' websites, only 3 of the 22 organizations analyzed provide explicit design principles for agents in corporate-authored documents. This reinforces Xu's (2025) finding that HAII still does not fully integrate theory and practice: most companies focus on technical documentation for APIs, model performance, and use cases, but not on guiding how to design human-centered experiences with AI agents.

Regarding RQ2, it was observed that OpenAI, Google, and Microsoft converge on the ethical principle that agents should expand human capabilities without reducing their autonomy. OpenAI emphasizes the conversational and proactive experience, in order to avoid intrusion, spam, or loss of trust. Google organizes its principles around calibrated autonomy and alignment with the real world. Microsoft structures agents to simultaneously address historical memory, continuous evolution, and user control. These corporate principles point to an understanding that agents are sociotechnical partners and not automated tools.

In relation to RQ3, the thematic synthesis into five axes showed adherence, but no company fully covers the repertoire of the human-centered AI literature. In the axis of AI Visibility (technical clarity and human values), OpenAI and Microsoft directly approach the recommendations to "make clear what the system can do" and "make clear how well the system can perform" (AMERSHI et al., 2019), as well as value-oriented responsible design (WEISZ et al., 2024). In the axis of contextualized interactions with user control, the three companies converge with the literature by emphasizing context, mental models, graduated autonomy, and adjustment of the experience to users' preferences (WEISZ et al., 2024; LIANG et al., 2025; SCHRÖDER & FISCHER, 2025). In the axes of feedback mechanisms and adaptive evolution, Microsoft and Google are more strongly aligned with theory, by addressing feedback, uncertainty, continuous learning, and bidirectional human-AI cycles, while OpenAI presents gaps. Finally, in the axis of trust, the three companies reinforce the importance of transparency, control, and safety as a continuous process, in line with the proposals of Shneiderman (2020, 2022), Amershi et al. (2019), and Weisz et al. (2024).

The results suggest that the corporate guidelines analyzed incorporate elements of HC-HAII (XU, 2025), such as human agency, final control, transparency, and responsibility, but still in a fragmented way and with limited operational guidance for the daily work of designing and prototyping agents. While theory emphasizes prototyping cycles, explicit mechanisms for error correction, co-creation with users, systematic exploration of generative variability, and iterative testing methods, companies' guidelines tend to remain at a more descriptive and normative level. This reinforces the diagnosis of Schröder & Fischer (2025) that UX frameworks for generative AI still offer little practical guidance on prototyping methods and testing cycles with users.

As a contribution, this study: (i) comparatively maps the current state of public communication of design principles from three of the main global actors in AI agents; (ii) proposes a theoretical-thematic synthesis into five axes that integrates different streams of the HAII and HCAI literature; and (iii) highlights approximations and gaps between this theoretical framework and corporate practice. For designers, researchers, and product managers, the results suggest that adopting "best practices" provided by LLM providers is not enough; it is necessary to complement them with principles of human-centered human-AI interaction.

5.1 Limitations

This research presents limitations that should be considered when interpreting the results. As a descriptive-exploratory study, it does not seek to exhaust the discussion on design principles in the market or to encompass the entire theoretical production on human-centered AI. The empirical field includes 22 LLM-owning companies, but only three provide design principles for agents in consolidated corporate documentation. The analysis relies exclusively on public materials, which prevents assessing the extent to which such principles are actually applied in internal design and development practices. In addition, the use of thematic analysis involves the researcher's interpretations and judgments in the selection of verbatim excerpts, classification into thematic axes, and conceptual approximation with the literature. Finally, the temporal scope concerns a rapidly changing domain; thus, new guidelines or subsequent updates may alter the panorama presented, requiring continuous revisions.

5.2 Future Work

As future work, it is suggested: (i) to conduct empirical studies with designers and product teams to investigate how corporate guidelines are effectively applied in practice; and (ii) to systematically and practically compare design frameworks for agents, both from the literature and from the market, in order to support iterative design cycles and strengthen the development of ethical, understandable, and truly user-centered agents.

6. Conclusion

This research revealed that design principles for AI agents are still not widely disseminated in the LLM ecosystem. Among the 22 companies owning the analyzed models, only three (OpenAI, Google, and Microsoft) publicly provide guidelines applicable to agent design, revealing a mismatch between the discourse of responsibility in AI and the provision of guidance for product teams.

From a practical standpoint, the results show that corporate guidelines only partially cover the requirements for human-centered design, leading designers, engineers, and managers to rely on specialized literature to complement conceptual and operational gaps. At the same time, companies have the opportunity to evolve these guidelines into more complete frameworks, integrating UX principles, prototyping practices, and mechanisms of ethical governance. In summary, this study demonstrates that companies are moving toward more human-centered AI and contributes to guiding the future development of AI agents that are not only functional, but also understandable, reliable, and aligned with human agency.

6.1 Author Note

Generative artificial intelligence (ChatGPT, OpenAI) was used as an auxiliary tool for grammatical and academic writing refinement and for translating the manuscript, originally written in Portuguese, into English. The final text was reviewed and edited by the authors.

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04

Competences for designers in the fourth industrial revolution: a systematic literature review

Gabriela de Oliveira Dutra
Silvia Trein Heimfarth Dapper
Júlio Carlos Souza van der Linden

Abstract

This study is a systematic review that analyzes recent literature on the competencies and role of the designer. The results indicate that designers need to develop competencies beyond those traditionally associated with the field. Among these are competencies related to: the ability to work in a transdisciplinary and collaborative manner, with both humans and other non-human agents; the ability to use technology and large amounts of data to solve complex problems; the ability to analyze problems through a systemic and interdisciplinary lens; and skills related to entrepreneurship and adaptability. Furthermore, designers must remain grounded, particularly regarding the ability to represent ideas visually.

Keywords: Competencies; Skills; Design; Technology.

1. Introduction

The era in which we live, referred to by some researchers as the "Fourth Industrial Revolution," is characterized by the reconfiguration of relationships between humans and machines, the prevalence of technologies such as artificial intelligence, and the abundance of data that places us at the threshold of a paradigm shift (CAIN; PINO, 2023). According to Zhang (2023, p. 312), the designer is the mediator of these new relationships.

Emerging technologies, particularly disruptive ones, are continuously reshaping society and generating increasingly complex challenges. In this context, design - described by Zhang (2023) as a creative practice focused on addressing human needs through problem-solving - must be reconsidered in terms of the competencies required of designers as the complexity of contemporary challenges continues to grow (CAIN; PINO, 2023).

As new technologies emerge, bringing with them new challenges and opportunities, design practices change and evolve (ZHANG, 2023). Thus, the roles of design are dynamic in the face of the growing complexities of the contemporary world, and approaches focused on multidisciplinary collaboration and the intensive use of data are increasingly necessary in the decision-making process (FLEISCHMANN, 2022). Thus, Matthews et al. (2023) assert that it is important to consider what role design will play in the Fourth Industrial Revolution.

In this context, the following research question was formulated: "What competencies are necessary for designers in the face of the paradigm shifts brought about by emerging technologies?", to analyze recent literature on changes in designers' competencies and professional roles.

This study presents a systematic literature review based on a protocol adapted from Conforto et al. (2011). By identifying emerging design competencies, it contributes to both professional practice and design education, supporting their adaptation to the challenges and opportunities associated with technological and societal change.

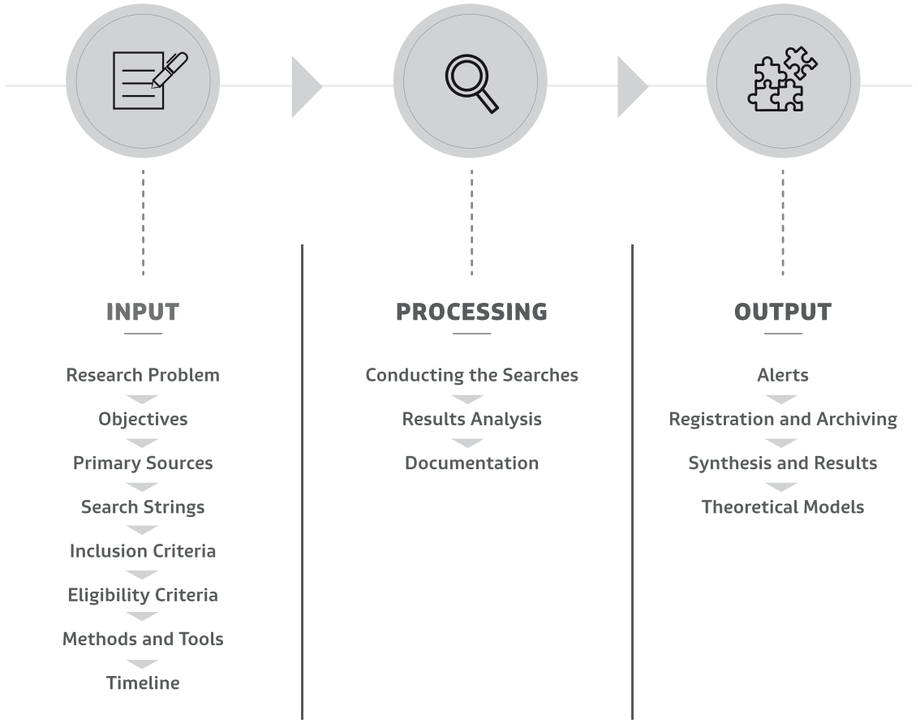
2. Methological Procedures

According to Gough et al. (2012), a systematic literature review is distinguished by rigorous, explicit, and replicable methods, which enhance the reliability of its findings. Furthermore, Moher et al. (2015, p. 335) state that a systematic review must address a "clearly formulated question," "select and critically evaluate relevant research," and "collect and analyze data from the studies included in the review."

Conducting a systematic literature review is important for identifying what has already been investigated on a given topic, thereby providing an understanding of the current state of knowledge and highlighting areas that require further research and deeper analysis. This type of review offers a comprehensive overview of existing knowledge, the methods used to generate it, variations among studies, and the gaps that remain in the field. Moreover, systematic reviews contribute to a robust understanding of a topic by synthesizing evidence from multiple studies and incorporating different perspectives (GOUGH et al., 2012).

This review adopts the structure proposed by Conforto et al. (2011), which comprises three stages: input, processing, and output. Figure 1 illustrates these stages.

Figure 1: Stages of the systematic literature review.



Source: Developed by the authors (2026), adapted from Conforto et al. (2011).

At the input stage, the guiding research questions are defined, along with the objectives to be achieved; the primary sources, that is, the key authors in the field who will provide the foundation for the subsequent stages of the research; the search strings; the inclusion and eligibility criteria; the search methods and tools; the timeline for conducting the systematic review; and the supporting tools to be employed.

During the processing stage, searches are conducted, data are analyzed, and documentation is compiled. At the conclusion of the systematic literature review, the output stage is reached, during which researchers may establish database alerts to receive notifications when new studies on the topic are published. This procedure facilitates the continuous updating of the article repository. The selected and analyzed studies are then stored in a repository, and a final report is prepared to synthesize both the identified studies and the resulting theoretical framework. The stages of the systematic literature review in this study are described below.

2.1 Input

This systematic review aimed to analyze recent literature on possible changes in designers' competencies and roles to help the design community adapt to the new technological context. To achieve this objective, the following research question was formulated: "What competencies are necessary for designers in the face of the paradigm shifts brought about by emerging technologies?"

Regarding search sources, the following databases were used: SCOPUS (www.scopus.com) and Web of Science (www.webofscience.com). The search strings were constructed using terms related to design practice, skills, and technology: *("graphic design" OR "visual design" OR "UX design" OR "design practice" OR "design studio" OR "digital design" OR "user experience design") AND ("abilit*" OR "capabilit*" OR "skill*" OR "knowledge") AND ("data" OR "data-driven" OR "machine" OR "startup" OR "start-up" OR "tech*" OR "innovation").*

The following inclusion criteria were defined: a) articles published between 2022 and 2025; b) articles available for open access; c) works related to the research's areas of interest (such as Design, engineering, multidisciplinarity, interdisciplinary application of computing, interdisciplinary applications, art, social sciences, humanities, business, management, communication, decision sciences); d) articles published in academic journals; e) works in English, Portuguese, Spanish, or French.

For the exclusion criteria, the following were considered: a) duplicate articles; b) unavailability of the full text; c) works incorrectly classified by language. For the qualification criteria of the collected studies, the following questions were considered: **(C1)** Does the study establish a connection with the theme of this work? **(C2)** In methodological terms, is the study presented clearly and in a manner that allows for replication? **(C3)** Are images, graphs, or tables clear and understandable? **(C4)** Do the conclusions or final considerations offer guidance for future work?

With respect to data management and organization, Zotero and Excel were used to document, organize, and manage the records identified during the review process. The search for articles was conducted in January 2025, and the analysis and synthesis of the selected studies were undertaken between January and March 2025.

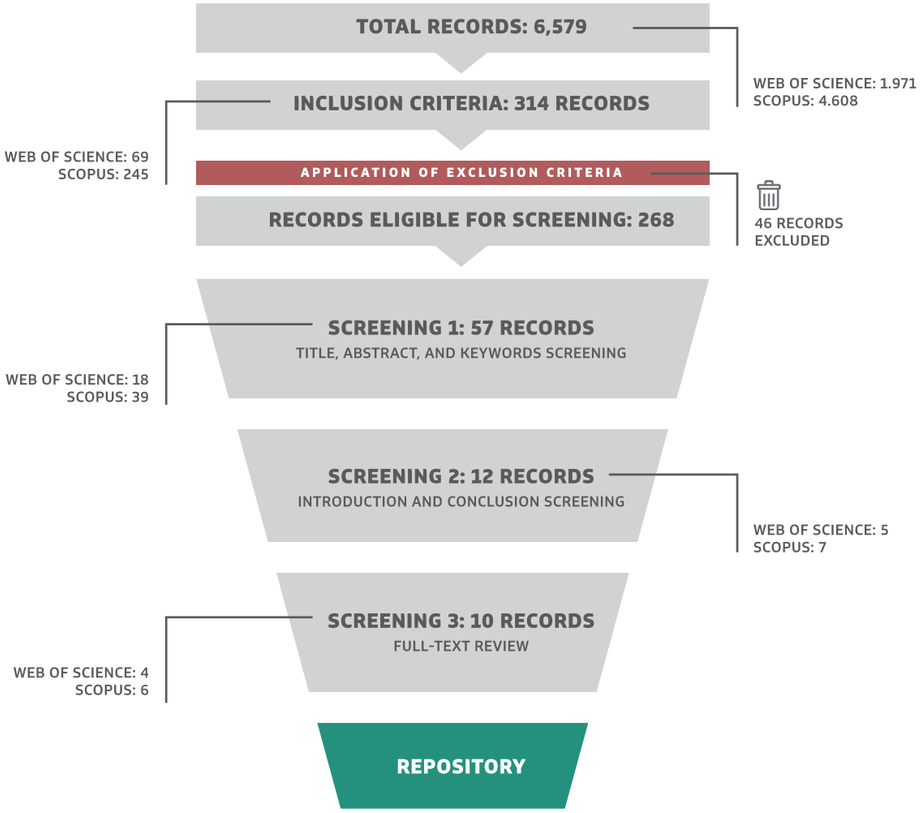
2.2 Processing

The defined search terms are entered into the selected databases. The inclusion, exclusion, and quality criteria are then applied to identify studies that are potentially relevant to addressing the research questions. To implement the inclusion criteria, the filtering tools available within each database were used to define the publication period, subject areas, document type, and language. Following this stage, the exclusion criteria were applied.

Using the search string, 1,971 records were identified in Web of Science and 4,608 in Scopus. After applying the filters available in each database, a total of three hundred fourteen (314) articles remained, comprising sixty-nine (69) from Web of Science and two hundred forty-five (245) from Scopus. Forty-five (45) records were excluded because they were duplicates, and one (1) record was excluded because it was not published in

one of the languages specified in the selection criteria. Consequently, two hundred sixty-eight (268) articles were retained for the screening of titles, keywords, and abstracts. Figure 2 presents the number of articles from each database that remained after the application of the filters.

Figure 2: Number of articles selected in each filter.



Source: Developed by the authors (2026).

Consequently, following the screening of titles, keywords, and abstracts, fifty-seven (57) articles were identified as potentially relevant and selected for the review of their introductions and conclusions. After this stage, twelve (12) studies were retained for full-text review, and ten (10) articles were ultimately included in the synthesis. Table 1 presents the studies included in the final review.

Table 1: Studies selected for the synthesis.

WEB OF SCIENCE				
Study	Title	Authors	Year	Methodology
E01	A dialogue about experiences of collaboration in design practice	Vita, Jane.	2023	Qualitative approach using focus groups and thematic analysis.
E02	Design education in transition: A multidisciplinary design classroom with non-allied disciplines	Fleischman n, Katja	2022	Qualitative approach using interviews.
E03	Navigating Design, Data, and Decision in an Age of Uncertainty	Cain, John; Pino, Zach.	2023	Narrative literature review.
E04	The value of sketching in the teaching of graphic design. Developing skills in a higher education institution	Springer, Leonardo.	2023	Narrative literature review.
SCOPUS				
E05	Destroy All Humans: The Dematerialization of the Designer in an Age of Automation and its Impact on Graphic Design—A Literature Review	Matthews, Benjamin; Shannon, Barrie; Roxburgh, Mark.	2023	Narrative literature review.
E06	Exploring an Interdisciplinary Curriculum in Product and Media Design Education: Knowledge Innovation and Competency Development	Kao, Yi-Fang; Chen, Hung-Cheng; Lo, Jung-Hua.	2023	Qualitative approach, curriculum proposal, and evaluation questionnaire.
E07	New Design Knowledge and the Fifth Order of Design	Mortati, Marzia.	2022	Narrative literature review.
E08	Teaching design students machine learning to enhance motivation for learning computational thinking skills	Wang, Hung-Hsiang; Wang, Chun-Han Ariel.	2024	Mixed-methods approach using quasi-experiment.
E09	The Ethical Turn of Emerging Design Practices	Zhang, Li.	2023	Narrative literature review.
E10	Validation of a preliminary competency assessment scale for Malaysian graphic design graduates	Wong, Shaw-Chiang; Idris, Muhammad Zaffwan.	2022	Mixed-methods approach using a questionnaire.

Source: Developed by the authors (2026).

In percentage terms, out of a total of ten (10) studies, 40% of them are from Web of Science, and 60% from Scopus.

2.2 Output

In this phase, the ten (10) articles selected in Filter 3 are analyzed and interpreted. Table 2 summarizes the studies and their main contributions.

Table 2: Studies selected for the synthesis and their main contributions.

Study	Title	Contributions
E01	A dialogue about experiences of collaboration in design practice	Vita (2022) argues that multidisciplinarity and co-creation are fundamental to innovation processes. By mastering tools that systematize creativity and broaden stakeholder participation, designers take on the role of facilitators in this process. The study highlights the challenges and benefits of multidisciplinary collaboration in innovation, while also offering a perspective on the future of this process. The author emphasizes that design fosters debate, allowing different perspectives to be considered. Organizations are increasingly recognizing the value of collaboration and the importance of viewing stakeholders—whether human or non-human—as partners in building project knowledge.
E02	Design education in transition: A multidisciplinary design classroom with non-allied disciplines	The article highlights a shift in design practice, which is evolving from creating value through artifacts and objects to generating value in "social and economic processes." This transition is driven by designers' ability to solve complex problems. The author states that contemporary technological transformations make design dynamic, requiring designers to know how to handle data and use it in decision-making. Furthermore, the complex problems of today's society demand multidisciplinary collaboration, allowing for the consideration of different perspectives on a given subject. The author emphasizes the importance of teaching design students to work collaboratively with other disciplines. The study supports the idea that designers can act as facilitators in the collaborative process of solving complex problems.
E03	Navigating Design, Data, and Decision in an Age of Uncertainty	he study addresses the question of whether the sketching technique is still important for design practice, even with the paradigm shifts brought about by new technologies. According to the author, this technique remains relevant to design practice, particularly with regard to concept development, idea generation, and communication. Designers need to know how to communicate their ideas assertively, both verbally and visually, and the sketching technique can help explore and mediate ideas.
E04	The value of sketching in the teaching of graphic design. Developing skills in a higher education institution	The study addresses the question of whether the sketching technique is still important for design practice, even with the paradigm shifts brought about by new technologies. According to the author, this technique remains relevant to design practice, particularly with regard to concept development, idea generation, and communication. Designers need to know how to communicate their ideas assertively, both verbally and visually, and the sketching technique can help explore and mediate ideas.
E05	Destroy All Humans: The Dematerialization of the Designer in an Age of Automation and its Impact on Graphic Design—A Literature Review	The study explores debates regarding the graphic design community's concerns about the possible replacement of humans by machines, and, on the other hand, authors' optimistic views on the potential for machines to serve as partners to humans in the design process. The authors suggest that design should move away from more technical and operational tasks and focus on skills associated with negotiation and facilitation, moving toward approaches such as "co-design, participatory design, service design, and speculative design."
E06	Exploring an Interdisciplinary Curriculum in Product and Media Design Education: Knowledge Innovation and Competency Development	The transformations brought about by new technologies are driving rapid changes in the design industry, making the competencies required of designers increasingly "complex and varied." Among the competencies cited by the authors are interdisciplinary skills, so that designers can bring different perspectives to their projects; social skills to communicate assertively with other stakeholders; leadership to guide the process, motivate team members, and make critical decisions; and entrepreneurship to identify opportunities and innovate. To this end, the authors propose an interdisciplinary curriculum.
EO7	Teaching machine learning to design students to enhance motivation for learning computational thinking skills	According to the authors, in the Fourth Industrial Revolution in which we live, computational thinking—described as "a set of activities that apply fundamental concepts of computer science to problem-solving, system design, and the understanding of human behavior"—is essential for addressing complex problems through algorithms and logic. The complex problems of today's world often require the management of technological, systemic, and social complexities. The authors assert that the integration of artificial intelligence tools can enhance computational thinking, creativity, and the ability to innovate. Thus, they argue that incorporating artificial intelligence and machine learning into design studies is crucial so that students can "explore new forms of automation, data-driven insights, and user interactions that were previously unattainable"—knowledge necessary for the future of the profession.

E08	Teaching machine learning to design students to enhance motivation for learning computational thinking skills	According to the authors, in the Fourth Industrial Revolution in which we live, computational thinking—described as "a set of activities that apply fundamental concepts of computer science to problem-solving, system design, and the understanding of human behavior"—is essential for addressing complex problems through algorithms and logic. The complex problems of today's world often require the management of technological, systemic, and social complexities. The authors assert that the integration of artificial intelligence tools can enhance computational thinking, creativity, and the ability to innovate. Thus, they argue that incorporating artificial intelligence and machine learning into design studies is crucial so that students can "explore new forms of automation, data-driven insights, and user interactions that were previously unattainable"—knowledge necessary for the future of the profession.
E09	The Ethical Turn of Emerging Design Practices	The study investigates, from a philosophical perspective, the design practices emerging in an era marked by constant transformation. Society faces various challenges and opportunities regarding new technologies, which drive changes in design practice and the emergence of new approaches, such as social design and ethical design. This is because traditional affirmative design practices are no longer sufficient to address the increasingly complex problems of the contemporary era. With the transformations of this era, the relationships between humans and technology are changing, and design can act as a mediator between the two, reflecting ethically on how technology impacts people's lives.
E10	Validation of a preliminary competency assessment scale for Malaysian graphic design graduates	The authors argue that digital transformation and the increasing complexity of design problems, among other contemporary changes, impact graphic design. These changes expand the scope of the practice and open up new possibilities for action in society. To explore these new possibilities, designers are expected to develop competencies relevant to these new contexts. According to the study, the competencies required for graphic design in Malaysia include leadership, management skills, marketing, self-efficacy, reflective thinking, communication, and industry knowledge, among others. According to the authors, these competencies reflect studies conducted in other countries.

Source: Developed by the authors (2026).

The studies reviewed converge on the conclusion that contemporary society is experiencing a period of continuous transformation driven by disruptive technologies. These changes affect design practice by both demanding the development of competencies, particularly those that distinguish human capabilities from those of machines, and expanding the possibilities for design action within society.

3. Theoretical Framework

The designer is a professional who deals with intractable or ill-defined problems. Intractable problems are inherently unpredictable, making it impossible to apply standardized methods with guaranteed outcomes. As designers begin to unravel these problems, new challenges emerge, increasing the complexity of the design process (GRILO & VAN DER LINDEN, 2022). Consequently, design practice is characterized by uncertainty. According to Cross (1998, p. 6), this uncertainty represents both a "frustration" and a "joy" in design practice, reflecting the "ambiguous" nature of design.

As noted by Cross (1998), design is an "emergent" process in which the problem and the solution develop simultaneously. When dealing with ill-defined problems, designers cannot limit themselves to simply synthesizing available information and proposing a solution, since many aspects of the problem only become apparent through processes of exploration and experimentation.

In this sense, designers begin the process without possessing all the information relevant to the solution. As Cross (1998, p. 5) highlights, "the directions taken during the exploration of the design territory are influenced by what is learned along the way, and by partial glimpses of what may lie ahead" (our translation).

Cross (1998) characterizes design as an "exploratory" process that extends beyond the conventional solutions typically expected for a problem. When presented with a design brief, designers look beyond the explicit requirements, seeking to examine the problem from multiple perspectives. Consequently, they are not limited to reproducing familiar examples but are instead driven by the exploration of new possibilities.

In this sense, Grilo & van der Linden (2022, p. 280) argue that, when confronted with an intractable problem, designers broaden their understanding of the problem by exploring fields of knowledge beyond Design itself. This multidimensional approach involves the interplay of "science, humanities, art, and technology," leading the authors to characterize design thinking as "a discipline of an interdisciplinary nature."

According to Grilo & van der Linden (2022, p. 281), problem-solving is made possible through "knowing how." The "how" of design, according to Verganti et al. (2022, p. 214), refers to the process itself—that is, the tools, methods, and collaborative practices involved in design activities. The "what" of design, which Verganti et al. (2022, p. 281) associate with the object, the new solutions developed, and the decisions made, is stimulated by "gaining knowledge through the intractable problem" (GRILO & VAN DER LINDEN, 2022, p. 281).

Furthermore, Grilo and Van der Linden (2022) argue that "knowing how" and "knowing what" are associated with "knowing how to interpret and knowing how to act." Through design thinking, this interrelationship enables designers to interpret and

shape the “best choices among the many possibilities” generated by intractable problems. Consequently, the knowledge that emerges from engaging with such problems contributes to the development of designers’ competencies.

Cross (1998, p. 1) defines the ability to design as “natural design intelligence.” This intelligence is innate to human beings and differs both from the intelligence of other animals and from the artificial intelligence of machines. However, while all individuals possess this ability to some degree, some stand out as “good designers,” exhibiting a more refined development of this capability. According to Cross (1998, p. 2), this difference may be explained by factors such as a possible “genetic endowment” or “social and educational development.”

Although natural design intelligence is a universal human trait, designers approach intractable problems consciously, “intentionally and intuitively integrating different forms of knowledge” (GRILO & VAN DER LINDEN, 2022). This awareness develops through practical experience as designers address a variety of intractable problems throughout their careers. Consequently, the capacity to design evolves with expertise, which is largely developed through practice and contributes to the continuous refinement of this capability.

As new technologies emerge and influence design practice, designers may need to develop new competencies to adapt effectively (COSTA & PELEGRINI, 2019). Competence is conceptualized by Brandão and Bahry (2005, p. 180) as “synergistic combinations of knowledge, skills, and attitudes, expressed through professional performance in a given context or within a specific organizational strategy”. When describing a competency, it is important to consider an “expected performance or behavior,” that is, what the “professional must be able to do”.

Designers acquire competencies as they explore emerging technologies and reinvent their practices, particularly when working in organizations that actively engage with a specific technology. This may be the case with “AI Factories”, studied by Verganti et al. (2022), where the intensive use of artificial intelligence significantly influences the design process. Therefore, when considering the competencies designers require within a particular context and in relation to a specific technology, it is necessary to “identify these organizations, as well as professional[s], faculty, and students who can serve as sources of data on new fields of practice driven by emerging technologies” (COSTA & PELEGRINI, 2019).

As emerging technologies become increasingly integrated into the design process, it is important to examine the competencies required of designers. According to Costa & Pelegrini (2019), “companies and individuals are experimenting with hybrid creative practices [and] new models of organization and work, which transcend traditional conceptual and disciplinary boundaries.” In this environment, “there are no specialists, but rather individuals who are testing their competencies in practice.”

In Costa & Pelegrini’s (2019) proposed competency model for emerging technologies, a “common competency for design practice related to all technologies” was identified, encompassing two main dimensions: the “ability to decide on the legal, ethical, and cultural limits of the personal and socially responsible use of technologies, understanding the potential risks”; and the ability to “understand, analyze, and evaluate the impact of technologies on social, economic, and cultural contexts”. According to Costa & Pelegrini (2019), in the context of experimentation with emerging technologies in the design process, such as artificial intelligence, professional roles become blurred and conventional practices are transformed.

Therefore, it is important to understand these practices to “predict, anticipate, and proactively prepare for foreseeable changes, as well as act to bring about desired changes”. Grilo & Van der Linden (2022) likewise argue that “understanding how designers operate is a way to identify the competencies these professionals employ in solving design problems.”

4. Results and Discussion

Regarding the results, the articles were analyzed to understand how they address the research questions, as shown in Table 3. The manner in which the studies address the questions posed in this systematic review is detailed below.

Study	What skills are necessary for designers in the face of the paradigm shifts brought about by new technologies?
E01	It can be stated that, for the author, the ability to work collaboratively is central to the present and future of design practice. It is through collaborative methods that design ensures all stakeholders have a voice, enabling the sharing of multidisciplinary knowledge - from both humans and machines - to solve the problem.
E02	The study demonstrates that the ability to work in a multidisciplinary manner is important for addressing the complex problems of the contemporary world through multiple points of view. In this sense, this ability must be fostered starting in university education.
E03	According to the study, in the face of emerging technologies, collaboration between design and other fields of knowledge becomes essential to promote more open, inclusive, and diverse approaches. Furthermore, the study highlights the importance of adaptability and flexibility as key competencies for designers. The adoption of a broad and systemic perspective, combined with the ability to collect and use data in an ethical and responsible manner, is one of the main highlights of the research.
E04	The author argues that, even with the advent of digital technologies, the ability to communicate visually and share ideas through sketching remains highly relevant to the design process.
E05	The article makes a satisfactory contribution to the research question by discussing the dematerialization of design in the face of emerging technologies. Skills related to entrepreneurship, adaptability, collaboration, communication, and critical thinking are cited as essential in this new era.
E06	The study proposes that, by having access to an interdisciplinary curriculum, design students can develop skills important for the future of design, such as critical thinking.
E07	The author focuses primarily on the new knowledge that designers must acquire to order to prepare for the future of the profession. For her, the ability to work with data is central.

E08	The authors describe how teaching machine learning can help design students develop computational thinking, which is important for design professionals to know how to deal with complex systems.
E09	The study asserts that traditional design practices are no longer sufficient to address increasingly complex problems. In this regard, what emerging practices are emerging, requiring skills related to the ability to question and reflect on the process from an ethical perspective?
E10	It argues that interdisciplinary knowledge is essential for addressing the complexity of current challenges. In addition to the skills that must be acquired to assume a more strategic role, designers should not abandon traditional skills related to the operational and aesthetic dimensions.

Thus, the studies selected for synthesis provide a suitable basis for addressing the research questions. Drawing on the collected data, the results are presented and discussed below. This section synthesizes the reviewed literature and examines the competencies designers need to navigate the transformations associated with the 21st century.

The 21st century presents both challenges and opportunities for design to strengthen its role in the innovation process and demonstrate its relevance to society. However, according to Mortati (2023), higher education institutions do not appear to be keeping pace with the transformations reshaping design practice. Instead, they continue to adhere to principles inherited from the Industrial Revolution, favoring solutions characterized by long life cycles and grounded in “generalization” and “standardization.”
In this context of constant change, where experiences and services can be dematerialized, a new logic for designing solutions emerges. This logic demands artifacts characterized by “infinite options,” “short life cycles,” and increasing levels of personalization. To respond to these emerging demands, design practice must evolve not only in relation to the objects being designed but also in terms of the forms of participation and control within the design process (MORTATI, 2023, p. 25).

There appears to be a broad consensus among scholars that design practice is becoming increasingly complex. This complexity requires designers to “continuously access the knowledge that allows them to better perform their functions” (VITA, 2023, p. 175). Furthermore, technological advances demand greater “flexibility” and “adaptability” in the ways designers approach their practice (VITA, 2023, p. 179). According to Cain & Pino (2023), designers must embrace the uncertainty and ambiguity inherent in the design process, recognizing that solutions are no longer expected to be complete and definitive but instead remain open to ongoing development and evolution.
In light of these developments, Zhang (2023) argues that new design practices are emerging, indicating that design is evolving in response to technological change. Some scholars characterize the current era as one of Post-humanism, in which human beings are no longer the sole focus, but instead coexist with non-human agents, objects, and the environment.

Verganti et al. (2020) predict that transformations in design practice will bring the field closer to organizational theories, particularly those related to leadership, which is intrinsically connected to processes of “sense-making”. Wong & Idris (2022) reinforce this perspective, suggesting that the role of designers is likely to become increasingly strategic and managerial. The following sections present the main themes identified in the reviewed studies.

4.1 New Technologies and Data

The disruptive technologies of the 21st century may require changes in both design processes and designers' competencies. According to Fleischmann (2022), designers must keep pace with technological innovation, as they play an important role in shaping the future of the field.

In its early stages, design focused primarily on the creation of tangible artifacts, with an emphasis on graphic and industrial products. Subsequently, its scope expanded to include the development of interaction tools and interfaces. Over time, the evolution of the field led design to incorporate approaches centered on processes, strategies, and business-related elements that are intangible in nature. Today, design is entering a new phase, characterized by Mortati (2023, p. 27) as one of "transformations." This phase is driven by data and value creation, directing designers' efforts toward the development of intangible forms of value, such as "data feedback loops" and "pathways to transformation".

According to Mortati (2023), data play an essential role in this new phase of design, as they are increasingly used to support decision-making, influence behavior, and predict future scenarios. The intensive use of data also raises important questions related to "ethics, culture, and social debates," requiring designers to develop new competencies in these areas. Mortati (2023, p. 29) identifies two relevant design practices associated with this new phase: "data conceptualization" and "data exploitation and (ab)use." The author defines "data conceptualization" as an approach to interpreting and making sense of data beyond simple visualization, whereas "data exploitation and (ab)use" represents a "new path for studying behaviors and new user experiences." Fleischmann (2022) further argues that data can provide designers with a "systematic view" when analyzing problems.

Cain & Pino (2023) highlight that data visualization, physicalization, sonification, and storytelling are valuable tools that enable designers to communicate complex ideas effectively. The authors further argue that designers must equip themselves with new techniques to capture, structure, analyze, and manipulate data. In addition, they should develop an understanding of algorithms and simulations to enhance the effectiveness and usability of their projects.

Cain and Pino (2023) further explore the increasing integration of data into design practices, arguing that this shift is essential for designers to remain relevant, effective, and responsible in contemporary contexts. The importance of data becomes even more pronounced with the advancement of artificial intelligence, which can identify patterns and associations within large datasets. In this context, human designers play a complementary role by interpreting results and exercising judgment regarding causal relationships.

According to Mortati (2023), artificial intelligence is assuming a leading role in the development of highly personalized solutions, particularly within the "AI Factories" investigated by Verganti et al. (2022). As a result, designers must redefine their relationship with machines, viewing them not merely as tools but as active partners that influence the design process and contribute to decision-making. These transformations also create new opportunities for co-creation, expanding the possibilities for collaboration between humans and intelligent technologies.

Artificial intelligence, according to Mortati (2023), plays a leading role in the development of "highly personalized" solutions, particularly within the context of the "AI Factories" studied by Verganti et al. (2022). In this scenario, designers need to reconfigure their relationship with machines, viewing them not merely as tools but as active partners that influence the design process and participate in decision-making. These transformations also point toward new opportunities for co-creation, expanding the possibilities for collaboration between humans and intelligent technologies.

Mortati (2023) refers to this period as the "Digital Revolution," in which humans are no longer the sole actors involved in solutions and decision-making processes. Artificial agents and other organisms also become part of these systems, meaning that outcomes are no longer entirely under human control. In this new era, where multiple forms of data shape both the inputs and outputs of design, the focus shifts from developing near-perfect solutions to designing adaptive systems capable of continuous evolution and learning.

The use of artificial intelligence in design can help solve complex problems, optimize processes, expand creativity, and generate data-driven insights, among other applications (Wang and Wang, 2024). Consequently, designers need to develop proficiency in AI tools and learn how to leverage their capabilities effectively. One perspective argues that achieving such proficiency requires designers not only to use AI technologies but also to understand their underlying principles and actively participate in their development - a challenge for which many professionals do not yet appear adequately prepared. According to Mortati (2023), the difficulties associated with designing AI-based solutions stem primarily from the technical complexity of these technologies, their dependence on data, and the unpredictable interactions they generate. To address these challenges, designers must develop competencies that enable them to understand what AI systems can do, evaluate their performance, and manage the complexity of the solutions they produce. Furthermore, as AI increasingly assumes the role of an active agent within the solution itself, additional layers of complexity are introduced into the design process (MORTATI, 2023).

Mortati (2023) presents another approach through which designers can engage with AI in contexts where intelligent agents play a central role in both the design process and the resulting outcomes. In this perspective, designers are responsible for managing the systems' "feedback loops". Their role involves providing and curating the data used to train AI systems, enabling them to learn from information and generate increasingly effective responses. Cain & Pino (2023) further argue that designers must recognize the inherently iterative nature of this process, as each user interaction contributes to the continuous evolution and personalization of the system. This perspective underscores the importance of close collaboration between designers and data scientists, whose combined expertise supports the development, monitoring, and refinement of AI-driven solutions (MORTATI, 2023).

Wang and Wang (2024) further argue that computational thinking is an essential competency for designers, enabling them to apply machine learning and artificial intelligence to problem-solving, enhance creativity, and develop algorithmic reasoning.

Based on the literature reviewed, the figure below organizes the competencies associated with emerging technologies and data into three dimensions: knowledge, skills, and attitudes.

Figure 1: Competencies related to new technologies and data.

KNOWLEDGE, SKILLS, AND ATTITUDES

Competencies for Emerging Technologies and Data

Knowledge	Skills	Attitudes
Structure and functioning of AI systems and their subfields, data, algorithms, and simulations. Computational thinking.	Interpret and derive meaningful insights from data beyond simple visualization. Explore and analyze data to study behaviors and design new user experiences. Communicate complex ideas effectively using data. Collect, structure, analyze, and manipulate data.	Willingness to engage in continuous learning and keep up with technological innovations. Innovative mindset and responsible use of technology.
Structure and functioning of AI systems and their subfields, data, algorithms, and simulations. Concepts of co-creation between humans and artificial agents. Limitations and capabilities of AI systems.	Integrate AI as an active partner in the design process and interpret causal relationships in data. Continuously train AI systems with data and manage continuous learning cycles. Develop solutions that evolve and learn continuously. Master AI tools and applications to optimize processes, foster creativity, and generate data-driven insights. Manage complexity and uncertainty in AI-assisted design. Apply computational thinking and AI systems to solve complex problems and generate creative solutions.	Openness to collaborating with AI and technologies as active agents. Flexibility to deal with unpredictable and collaborative processes while embracing a degree of uncertainty. Innovative mindset and responsible use of technology.

Source: Developed by the authors (2026).

The knowledge of the structure and functioning of artificial intelligence systems, data, algorithms, and simulations provides the foundation for a range of competencies. These include interpreting data beyond simple visualization, exploring and analyzing information to understand behaviors, communicating complex ideas through data, and applying AI-related techniques within the design process. Effective collaboration with intelligent systems also requires an understanding of their capabilities, limitations, and the fundamental principles of machine learning. In terms of attitudes, the literature highlights cross-cutting dispositions such as openness to continuous learning, innovation, and responsible technology use. Moreover, the integration of artificial intelligence into design practice demands a willingness to collaborate with artificial agents and the flexibility to navigate unpredictable processes, including accepting a reduced degree of direct control over outcomes.

4.2 Collaboration and Multidisciplinarity

Collaboration in design can take various forms, including co-creation, co-design, and participatory design. Despite their differences, these approaches share a common principle: incorporating the perspectives of those affected by the outcomes of the design process (VITA, 2023, p. 178). According to Fleischmann (2022), ongoing transformations in the field have increasingly positioned designers as collaboration-oriented professionals who must work across disciplinary and social boundaries to address complex challenges and generate positive societal impact. As a result, designers are expected to engage effectively in dialogue with individuals from diverse backgrounds, experiences, and perspectives.

Interaction and collaboration among stakeholders are fundamental to the innovation process, as they ensure that diverse perspectives and values are taken into consideration. In this context, Vita (2023, p. 173) argues that designers can play a key role as facilitators, employing methods and tools that foster co-creation and multidisciplinary collaboration. Similarly, Mortati (2023) highlights the importance of transdisciplinarity and participation—by both humans and other “species” - in contemporary design practice.

According to this perspective, design moves beyond the traditional boundaries of the discipline, shifting its focus from material artifacts alone to broader concerns involving perceptions, relationships, and culture.

Given the complexity and diversity of contemporary design artifacts, designers must “access and learn to use resources that promote the integration of diverse perspectives” (VITA, 2023, p. 179). According to Vita (2023), exposure to multiple viewpoints broadens designers’ knowledge and enhances learning through collaborative practices. In a similar vein, Mortati (2023, p. 23) argues that designers must engage in dialogue not only with other people but also with “machines and microorganisms,” reflecting the expanding network of actors involved in contemporary design processes.

Cain & Pino (2023, p. 202) argue that, in an era of data-driven decision-making, design processes must become increasingly “open and collaborative,” enabling a wide range of stakeholders - both human and non-human - to participate in decision-making. Similarly, Vita (2023) contends that collaborative approaches to complex problems allow

designers to develop a deeper understanding of both the challenges at hand and the ambiguous contexts in which they are situated. This emphasis on ambiguity aligns with Cross's (1998) view that uncertainty is an inherent characteristic of design, requiring designers to navigate situations in which problems and solutions are not fully defined from the outset.

According to Fleischmann (2022), technology empowers citizens and democratizes design, bringing people closer to the design process and repositioning designers as co-creators and facilitators rather than sole authors of solutions. The author argues that contemporary design practice requires multidisciplinary teams to address increasingly complex challenges. Consequently, design education should prepare students to work effectively in multidisciplinary environments and to facilitate broad participation in design processes. This requires curricula that reflect industry needs while fostering both specialized expertise and the generalist competencies necessary for collaboration across disciplines.

Matthews et al. (2023) argue that collaborative design practices contribute to the development of essential soft skills, including empathetic observation and listening, data analysis, assertive communication, and collaboration. However, the authors note that university programs tend to place greater emphasis on technical competencies than on these interpersonal and facilitative capabilities. They further suggest that the operational aspects of "designing" may increasingly be automated through the use of user data. As a result, the designer's role may shift toward mediating and facilitating interactions among stakeholders, as well as interpreting, evaluating, and refining the outputs generated by intelligent systems. Rather than directly creating solutions, designers would be responsible for ensuring that machine-generated outcomes effectively meet user and societal needs.

In this context, interpersonal skills are fundamental to contemporary design practice. Competencies in management, research, and communication are already highly valued by employers when recruiting design professionals. Matthews et al. (2023, p. 371) argue that the competencies designers should prioritize are primarily related to "collaboration, management, negotiation, and facilitation." Effective collaboration, in turn, requires designers to communicate ideas clearly, build shared understanding among stakeholders, and demonstrate empathy throughout the design process.

Wong & Idris (2022) emphasize that empathy is a critical competency for designers, contributing to their versatility and adaptability in dynamic professional contexts. According to the authors, empathy enables designers to navigate conflicts, collaborate effectively in teams, listen actively to diverse perspectives, make informed decisions, solve problems, and facilitate organizational and social change.

Kao et al. (2023) argue that team alignment is essential in design projects and that designers play a key role in coordinating stakeholders to ensure that shared objectives are achieved. In this context, leadership competencies are fundamental for effectively guiding project teams. Wong & Idris (2022) further contend that successful collaboration requires designers to develop strong communication, management, and leadership skills, enabling them to engage constructively with team members and communicate ideas with clarity and confidence. Based on the literature reviewed, the figure below organizes these competencies into three dimensions: knowledge, skills, and attitudes related to collaboration and multidisciplinarity.

Figure 2: Competencies related to collaboration and multidisciplinarity.

KNOWLEDGE, SKILLS, AND ATTITUDES
Competencies for Collaboration and Multidisciplinarity

Knowledge	Skills	Attitudes
Methods and tools to facilitate collaboration and multidisciplinary work. Transdisciplinarity and the integration of diverse perspectives. Management, research, and communication.	Facilitate collaborative processes, particularly in multidisciplinary environments. Act as a mediator among stakeholders (human and non-human). Listen and observe empathetically, analyze data, communicate effectively, and collaborate. Communicate ideas effectively and demonstrate empathy. Coordinate teams to achieve shared goals.	Willingness to act as a facilitator of co-creation. Openness to collaboration and diversity of perspectives. Willingness to deal with ambiguity and uncertainty. Leadership mindset. Assertiveness and empathy.

Source: Developed by the authors (2026).

The knowledge of collaborative approaches, such as co-creation, co-design, and participatory design, as well as of methods and tools that foster multidisciplinarity, is increasingly important for designers operating in complex and diverse contexts. This knowledge supports competencies such as facilitating collective processes, mediating stakeholder interactions, communicating ideas effectively, and coordinating multidisciplinary teams. In terms of attitudes, openness to collaboration, along with a willingness to navigate ambiguity and uncertainty, emerges as particularly important. Moreover, the ability to assume facilitative and leadership roles is essential for guiding collaborative efforts and aligning diverse perspectives.

4.3 Entrepreneurship and Adaptability

Industry transformations require designers not only to respond to market demands but also to shape and anticipate them. This involves understanding broader societal and technological developments, maintaining continuous dialogue with users, and identifying emerging needs and opportunities before they become explicit demands (VITA, 2023, p. 181).

This ability to identify opportunities and develop innovative solutions is closely associated with entrepreneurial competencies (KAO et al., 2023). Matthews et al. (2023) further argue that contemporary job opportunities for designers increasingly require competencies related to management, business-oriented strategic thinking, service design, and innovation. The authors also emphasize the importance of adaptability and cognitive flexibility, enabling designers to respond effectively to change and avoid rigid modes of thinking. Based on the literature reviewed, the figure below organizes these competencies into three dimensions: knowledge, skills, and attitudes related to entrepreneurship and adaptability.

Figure 3: Competencies related to entrepreneurship and adaptability.

KNOWLEDGE, SKILLS, AND ATTITUDES

Competencies for Entrepreneurship and Adaptability

Knowledge	Skills	Attitudes
Strategic thinking focused on business. Service design. Entrepreneurship.	Proactively generate demand rather than merely responding to market needs. Engage in continuous dialogue with users. Adapt quickly to changing conditions. Demonstrate cognitive flexibility. Identify opportunities and develop innovative solutions.	Entrepreneurial mindset to create demand and identify opportunities. Willingness to adapt strategies in response to change.

Source: Developed by the authors (2026).

As the designer's role becomes increasingly diffuse and shifts toward strategic and business-oriented concerns, competencies related to entrepreneurship and adaptability become increasingly important. Knowledge of business strategy, service design, and entrepreneurship enables designers to proactively generate demand, engage with users, respond to changing circumstances, and identify emerging opportunities. In addition, attitudes such as an entrepreneurial mindset, openness to change, and a willingness to adapt strategies are critical for navigating dynamic and uncertain environments.

4.4 System thinking, ethics, and Interdisciplinary Knowledge

Cain & Pino (2023) argue that designers increasingly need to adopt a systemic perspective, understanding how both problems and solutions generate consequences across different contexts, particularly in social and ecological domains. This broader view is closely related to what Zhang (2023, p. 313) describes as the "ethical turn" in design. According to the author, this shift manifests across three dimensions: ontological, epistemological, and methodological. Ontologically, design is concerned with assessing the moral risks associated with technological development. Epistemologically, it focuses on anticipating and intervening in possible futures characterized by uncertainty.

Methodologically, it explores alternative futures and unrealized possibilities as a means of inquiry and action. Together, these dimensions expand the scope of design beyond immediate problem-solving, emphasizing responsibility, foresight, and the ethical implications of intervention.

Within this perspective, Zhang (2023) argues that new forms of design practice are emerging and groups them into three categories: affirmative design, social design, and ethical design. Affirmative design encompasses traditional fields such as graphic, industrial, fashion, interaction, management, and digital design, as well as emerging areas associated with technological innovation, including AI design and biodesign. These practices generally seek to explore and integrate new technologies into design processes, identifying opportunities for their application while remaining attentive to the ethical implications of their use.

The two emerging categories identified by Zhang (2023) - social design and ethical design - are, in contrast, less directly focused on technological development itself. Ethical design seeks to examine the moral implications, challenges, and societal consequences associated with disruptive technologies, often drawing attention to their potential negative impacts on individuals and communities. Social design, by contrast, adopts a more practical and political perspective, using participatory and inclusive approaches to address social issues, incorporate diverse viewpoints, and empower marginalized groups.

Zhang (2023) refers to this classification as a tripartite framework of design practices, emphasizing that these emerging approaches are not intended to replace traditional forms of design but rather to complement and expand them.

Matthews et al. (2023) argue that critical thinking is essential for designers to act responsibly and ethically, reflecting on how their decisions, as well as the actions of technologies and other stakeholders, affect society. Cain & Pino (2023) further emphasize that, as designers increasingly work with personal data used to support the continuous evolution of intelligent systems, ethical conduct becomes imperative. This includes understanding how data are collected, managed, and stored, with the aim of ensuring both user experience and data security.

Integrating these multiple perspectives into the design process requires an interdisciplinary knowledge base. According to Kao et al. (2023), designers must be able to draw upon insights from the natural sciences, humanities, and other fields in order to develop innovative and sustainable solutions that meet "the needs of the present without compromising the future". Wong & Idris (2022) similarly argue that social, cultural, and environmental responsibility, grounded in ethical awareness, is fundamental to contemporary design practice. Based on the literature reviewed, the figure below organizes the competencies associated with systemic thinking, ethics, and interdisciplinary knowledge into three dimensions: knowledge, skills, and attitudes.

Figure 4: Competencies related to systemic vision, ethics, and interdisciplinary knowledge

KNOWLEDGE, SKILLS AND ATTITUDES

Competences for systemic thinking, ethics, and interdisciplinary knowledge

Knowledge	Skills	Attitudes
Understand how problems and solutions impact different contexts through a systemic perspective. Interdisciplinary knowledge to create sustainable solutions. Ethical considerations regarding the use of technologies. Critical thinking. Understand how and which data will be collected and stored.	Analyze the social, environmental, and technological impacts of solutions. Integrate ethical and social perspectives into design decisions. Ensure the best user experience and safety.	Ethical and social responsibility, considering social, cultural, and environmental impacts. Openness to interdisciplinarity. Ethics in the use of data and technologies.

Source: Developed by the authors (2026).

As the use of data and technologies such as artificial intelligence becomes increasingly prevalent, competencies related to ethics, interdisciplinary knowledge, and systemic thinking become essential for addressing complex design challenges. Designers must understand the impacts that both problems and solutions generate across different contexts, while critically examining the ethical implications of data and technology use. Such competencies enable them to assess potential consequences, integrate diverse perspectives, and develop solutions that promote positive user experiences and safety. In terms of attitudes, ethical and social responsibility, together with openness to interdisciplinary perspectives, emerge as fundamental dispositions for contemporary design practice.

4.5 Traditional Competencies

Mortati (2023) argues that, despite the growing importance of emerging competencies, designers must continue to cultivate traditional skills that help bridge the relationship between people and new systems. Similarly, Wong & Idris (2022) found that operational competencies related to the creation of visually compelling artifacts remain highly valued and expected in professional practice. Furthermore, although the field is increasingly oriented toward the conceptualization, development, and implementation of innovative ideas, it should not lose sight of its operational foundations. As a result, designers are required not only to develop new competencies but also to preserve and strengthen the artistic sensibility that has long been central to the discipline.

Among the traditional competencies identified by the authors as essential for preserving the core foundations of design, visual intelligence stands out. Grounded in the construction of models through sketches and other visual representations, this competency enables designers to translate ideas into artifacts and to “share knowledge” (MORTATI, 2023, p. 33). In an era in which machines are expected to assume a greater role in problem-solving activities, human contributions are likely to become increasingly concentrated in the early stages of the design process. As Verganti et al. (2020) argue, humans will remain primarily responsible for defining problems and constructing meaning. Consequently, visual thinking becomes even more valuable as a means of interpreting complex challenges and translating abstract concepts into forms that can be explored, communicated, and developed (MORTATI, 2023).

Springer (2023) argues that, despite the paradigm shift and the growing emphasis on digital technologies in contemporary society, the ability to visually externalize thoughts and concepts through tools such as sketching remains essential for communication and cognitive development. These ideation practices can foster creativity, support the visual exploration of problems, and facilitate the communication of ideas and meanings, thereby making complex concepts more accessible and understandable. This capacity to represent intricate issues visually becomes even more relevant in a context of increasing cultural mobility and diversity. Furthermore, the materialization of abstract concepts contributes to the construction and refinement of designers’ knowledge.

4.6 Implications for Education

Matthews et al. (2023) emphasize the importance of higher education institutions keeping pace with industry developments so that design curricula evolve alongside professional practice. In a similar vein, Kao et al. (2023) contend that design education should place greater emphasis on interdisciplinarity in order to develop the competencies required by future professionals. Wang & Wang (2024) further highlight the need for curricular reform, particularly with regard to the integration of computational thinking into design education.

Wong & Idris (2022) evaluated the competency levels of final-year graphic design students in Malaysia. Their findings indicate that students perceived themselves as most competent in teamwork and leadership, which received the highest ratings, while business-related knowledge and skills were identified as areas of lower preparedness. Based on these results, the authors emphasize the importance of interdisciplinarity, arguing that emerging design professionals must develop knowledge and competencies that extend beyond the traditional boundaries of the discipline.

Springer (2023) similarly argues that higher education institutions must prepare future professionals for a world characterized by continuous sociocultural change, increasing access to information, and the rapid dissemination of ideas, all of which contribute to greater complexity and uncertainty. The author emphasizes the importance of teaching design students to use ideation tools, such as sketching, to represent and materialize abstract concepts. Through these practices, the ability to visually communicate and explore complex ideas can support the understanding and resolution of future challenges, which increasingly require the integration of knowledge from multiple disciplines.

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5. Conclusion

This systematic literature review aimed to examine recent literature on the evolving competencies and roles of designers in the context of emerging technologies, thereby contributing to the adaptation of both professional practice and design education.

The literature reviewed highlights the societal transformations brought about by emerging technologies. According to the authors analyzed, this period - often described as the Fourth Industrial Revolution or Digital Revolution - is characterized by continuous and rapid change, resulting in increasingly complex challenges for designers.

The findings indicate that designers need to broaden their range of competencies beyond those traditionally associated with the field. Among the competencies identified as essential in this new phase of design are the ability to work in a transdisciplinary and collaborative manner with humans, machines, and other organisms; the ability to understand and leverage the potential of machines and large volumes of data; the ability to integrate interdisciplinary knowledge to develop a systemic and ethical perspective on the impact of design on society; and the ability to demonstrate entrepreneurship and adaptability. Furthermore, the authors emphasize that traditional competencies, such as the ability to visually communicate and represent ideas, remain important.

It is important to note that, although we live in an increasingly globalized world, the competencies required of designers may vary across countries and industries. Therefore, future research should investigate these competencies in different contexts. Moreover, given the dynamic nature of contemporary society and technological change, designers' competencies should be understood as continuously evolving, requiring ongoing review and refinement.

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05

Two epistemologies of co-creation in experience design: distinguishing experience and representation

Juliana Eisenhardt Escaleira

Abstract

Co-creation has become a central concept in experience design, emphasizing the active role of users in the construction of value. However, the concept remains marked by conceptual ambiguity, as it is used to describe different forms of user participation that occur at distinct moments of the design and experience processes. In particular, the literature lacks clear analytical distinctions between participation that occurs during the lived experience and participation mediated through representations that inform future design. Building on the initial distinction identified by Escaleira (2024), this article proposes the Two Epistemologies of Co-creation in Experience Design Framework, which differentiates two modalities: Co-creation in Experience and Co-creation for Experience Design. The study argues that these modalities operate under distinct epistemological conditions, leading to different forms of knowledge production and different implications for design practice and evaluation. By clarifying this distinction, the article contributes to a more precise conceptualization of co-creation and proposes an epistemological framework for understanding how different forms of participation generate different forms of knowledge in experience design.

Keywords: Co-Creation; Experience Design; User Participation; User Experience; Human-Centered Innovation.

1. Introduction

Over the past decades, experience design has emerged as an interdisciplinary field dedicated to the intentional design of experiences that transcend the mere delivery of products or services (SHEDROFF, 2020; ROSSMAN; DUERDEN, 2019). Within this perspective, value is not understood as something embedded in an offering and subsequently consumed, but rather as a phenomenon that emerges through the interaction between the individual, the context, and the design proposition (PINE; GILMORE, 1999; VARGO; LUSCH, 2004). Consequently, user participation moves from a peripheral role to becoming a central element in the constitution of experience.

In this context, co-creation has become one of the most influential concepts for understanding user participation in processes of value generation and experience construction. Different theoretical traditions have employed the concept to describe various forms of participant involvement. In the participatory design and co-design literature, co-creation is frequently associated with users' participation in idea generation, solution development, and design processes (SANDERS, 1999; SANDERS; STAPPERS, 2008). Within approaches derived from Service-Dominant Logic, the concept is used to describe the joint creation of value through interactions between organizations and users (PRAHALAD; RAMASWAMY, 2004; VARGO; LUSCH, 2004). In the field of experience design, co-creation is often associated with individuals' active participation during the lived experience itself, influencing how the experience is constructed and perceived (PINE; GILMORE, 1999; ROSSMAN; DUERDEN, 2019).

While this diversity of interpretations contributes to the richness of the concept, it also generates ambiguity. Within experience design, distinct forms of participation are often grouped under the same conceptual label despite involving different processes, objectives and outcomes. In particular, there remains a lack of clear distinction between participation that occurs during the lived experience and participation that occurs through mechanisms for collecting, interpreting and utilizing information about the experience to inform design decisions. Although both are frequently described as forms of co-creation, they operate according to different logics and produce different forms of knowledge. This lack of distinction hinders comparisons across studies, reduces the analytical precision of the concept and limits the development of more consistent design approaches.

Escaleira (2024) observed that user participation in experiences can take distinct forms, associated both with the lived experience itself and with its use for design purposes. Building upon this observation, the present article argues that these forms of participation correspond to two distinct modes of Co-creation in Experience design: Co-creation in Experience and Co-creation for Experience Design. More specifically, it is proposed that the primary distinction between these modes lies not in the timing of participation, but in the nature of the knowledge they produce and the function they perform within the design process.

The central contribution of this article is the proposition of an analytical framework that distinguishes these two modes of co-creation based on their epistemological nature. It is argued that Co-creation in Experience operates at the level of lived experience, producing tacit, situated, and embodied knowledge, whereas Co-creation for Experience Design operates at the level of representation, producing explicit forms of knowledge

that can be communicated, analyzed, and incorporated into the design process. By making this distinction explicit, the article seeks to provide greater conceptual precision for understanding user participation in experiences, contributing both to the theoretical advancement of the field and to the development of more consistent design practices.
Methodologically, this study is a conceptual theoretical investigation developed through a narrative literature review and critical analysis of contributions from the fields of experience design, Service-Dominant Logic, participatory design, co-design, experience psychology, and knowledge studies. Through the articulation of these perspectives, the article proposes a conceptual framework aimed at differentiating and integrating the co-creation modes discussed.

The remainder of the study is organized as follows. Section 2 presents the methodological procedures adopted in the study. Section 3 discusses the theoretical foundations of experience design and co-creation, identifying the conceptual gap that motivates the research. Sections 4 and 5 analyze, respectively, Co-creation in Experience and Co-creation for Experience Design. Section 6 develops a comparative analysis of both modes and presents the Framework of the Two Epistemologies of Co-creation. Section 7 proposes an integrative perspective based on the articulation between lived experience and representation. Finally, Section 8 presents the study's concluding remarks, discussing its contributions, limitations, and opportunities for future research.

2. Methological Procedures

This article is characterized as a theoretical study developed through a narrative and interpretive literature review. It constitutes a form of conceptual research aimed at articulating and systematizing relevant theoretical contributions to support the development of an analytical distinction within the field of experience design.

The review was conducted through searches in academic databases, including Scopus, Web of Science, and Google Scholar, as well as specialized journals in the fields of design and service research, such as Design Studies, Strategic Design Research Journal, and CoDesign. Search terms included "co-creation", "experience design", "participatory design", "user participation" and "co-design", in both English and Portuguese.

The selection criteria included: (a) thematic relevance to the study of Co-creation in Experience design; (b) academic recognition of the works, considering their impact and influence within the fields of design, management, and service studies; (c) their potential contribution to the construction of a coherent theoretical argument. Priority was given to seminal works, as well as to more recent contributions that extend or challenge contemporary debates.

Unlike systematic literature reviews aimed at exhaustively mapping a body of literature, the approach adopted in this study emphasizes the critical articulation of selected references with the purpose of developing a theoretical proposition. Accordingly, the study is grounded in the interpretation, comparison, and integration of different perspectives, seeking to advance conceptual precision within the field.

3. Experience Design and Co-creation

3.1 The Construction of Experiences as a Design Domain

Experience design emerged from the recognition that value is not exhausted in products or services but is realized through the experiences that emerge from the interaction between individuals and their contexts (PINE & GILMORE, 1999; SHEDROFF, 2020). Unlike traditional offerings - such as commodities, goods, and services - which remain external to the individual, experiences are inherently personal, taking shape through perception and meaning-making processes (CARÙ & COVA, 2007; HASSENZAHL, 2010).

From this perspective, experience design can be understood as the practice of configuring conditions for the emergence of meaningful experiences through the orchestration of environmental, interactive, narrative, and sensory elements (ROSSMAN & DUERDEN, 2019; FORLIZZI & BATTARBEE, 2004). Rather than determining outcomes, it involves structuring possibilities for interaction, recognizing that experience emerges through the encounter between a design proposition and participant action.

This shift implies a repositioning of the user's role. Since experience is realized in use (VARGO & LUSCH, 2004), users do not merely interpret experiences; they participate in their constitution, acting as agents in the production of value and meaning (HELKKULA, 2011).

3.2 Value Co-creation and User Participation

The notion of co-creation has been mobilized across different fields to describe users' active involvement in value creation. However, authors who employ the concept often refer to distinct forms of participation without explicitly clarifying their differences.

In the field of strategy, Prahalad & Ramaswamy (2004) define co-creation as an interactive process between companies and consumers in which value emerges through points of interaction. Similarly, Service-Dominant Logic (VARGO & LUSCH, 2004, 2008) argues that value is realized in use through the integration of resources among multiple actors.

Within the field of design, co-creation is frequently associated with user participation in the design process itself. Sanders (1999) and Sanders & Stappers (2008) position users as co-designers, while service design approaches (PAYNE; STORBACKA & FROW, 2008; STICKDORN & SCHNEIDER, 2011) structure participation as part of organized development processes.

These authors do not explicitly distinguish the ontological levels at which different forms of participation operate (SANDERS & STAPPERS, 2008): whether user contributions occur within the experience itself or about the experience after it has been lived (PRAHALAD & RAMASWAMY, 2004); whether value emerging in use is constituted by participants in real time or inferred by designers through subsequent representations (VARGO & LUSCH, 2004); whether participation structured through co-design processes produces the experience itself or merely informs its design (STICKDORN & SCHNEIDER, 2011; SANDERS, 1999); or whether the active engagement that generates meaning and

memorability occurs during the lived experience or can be substituted by accounts of that experience (PINE & GILMORE, 1999; ROSSMAN & DUERDEN, 2019).
As a result, the same term – "co-creation" - comes to designate substantially different phenomena, such as a co-design workshop aimed at generating insights for future projects and an improvisational theatre performance in which the audience actively shapes the narrative in real time. These approaches demonstrate that the concept of co-creation has been used to describe diverse phenomena without a clear analytical distinction between the forms of participation involved.

3.3 A Necessary Distinction

It is from this conceptual gap that the distinction proposed by Escaleira (2024, p. 66) emerges. The issue is not merely terminological but concerns the level at which participation occurs: participating in an experience and participating in the design of an experience constitute epistemologically distinct acts that mobilize different forms of knowledge and imply different design approaches.

This distinction makes it possible to identify two modes of co-creation in experience design, associated respectively with lived experience and its representation. By making these modes analytically distinguishable, it becomes possible to understand more precisely the implications of each for design practice, experience evaluation and the advancement of the field.

4. Co-creation in Experience

"Co-creation in Experience" - a term adopted in this article based on Escaleira (2024) - is grounded in a fundamental ontological premise: a designed experience remains only a potential experience. No matter how carefully a design is developed, it remains a potentiality - a set of conditions and intentions awaiting the participant in order to come into existence. It is the participant's active presence, with their emotions, memories, interpretations and unique responses, that transforms a design into a lived experience. Without such participation, there is only the infrastructure for a possible experience.

This premise is supported by two complementary lines of argument. The first is a design-oriented argument, derived from Sanders (1999), according to which it is impossible to fully design an experience because experiencing is a constructive activity that depends on the individual who lives it. The second is an ontological argument, developed by Vargo & Lusch (2004) and Rossman & Duerden (2019), according to which value and experience are realized only at the moment of use and lived engagement, never beforehand. "Co-creation in Experience" is therefore the moment in which design becomes experience - and it is at this moment that the participant acts as a co-author, not of the design itself, but of the experience.

Based on this premise, three constitutive characteristics of this mode of co-creation can be identified. The first is synchronicity: participation occurs during the lived experience, in real time and cannot be separated from the moment in which the experience unfolds. The second is the predominance of tacit knowledge: what participants produce while living the experience is embodied, situated and difficult to articulate through language - what Polanyi (1966) describes as "knowing more than we can tell". The third is the uniqueness of the outcome: because it emerges from the interaction between participant, context, and design proposition, each instance of experience is unique. Carù & Cova (2007) capture this dimension by describing immersion as a shift from being a spectator to becoming a constitutive agent of the experience.

From a design perspective, recognizing "Co-creation in Experience" as a constitutive condition of experience implies a reorientation of the design process. The question ceases to be how to determine outcomes and becomes how to configure conditions that allow meaningful experiences to emerge. This requires less specification and more structured openness - what Shedroff (2020) characterizes as the constitutive tension within experience design between design intention and the indeterminacy of lived experience, and what Rossman & Duerden (2019) operationalize through the concept of experience design as the orchestration of elements that create opportunities for participation without determining their outcomes.

Figure 1 summarizes the logic of "Co-creation in Experience" as a mode of participation grounded in users' situated involvement during the lived experience. From this perspective, experience is constituted in real time through the interaction between participant, context, and design proposition, producing knowledge that is predominantly tacit and embodied within the experience itself.

Figure 1 – Temporal scope of Co-creation in Experience

Co-creation FOR Experience Design
Knowledge generated: representation of experience (explicit knowledge)
Function: informing and guiding design

TIMING	Before	During	After
FUNCTION	Exploration	Monitoring	Evaluation
EXAMPLES	• User research • Interviews • Co-design workshops	• Real-time data collection • Analytics	• Feedback • NPS • Reviews

Source: Developed by the author (2026).

4.1 Participation and Experiential Intensity

Pine & Gilmore (1999) already recognized participation as a fundamental dimension of experience by proposing a spectrum that ranges from passive to active participation and from absorption to immersion. The present article extends this understanding by arguing that participation is not merely a variable characteristic of experience, but the very condition through which experience is realized as a lived phenomenon.

Different configurations of participation may nevertheless produce qualitatively distinct experiences in terms of intensity, meaning, and memorability. Within the field of experience design, Pine & Gilmore (1999) argue that more memorable experiences tend to involve more intense forms of participation and immersion. The authors distinguish experiences characterized primarily by absorption from those marked by the participant's active immersion in the experiential context, suggesting that the depth of participation directly influences the intensity and memorability of the experience. From a convergent perspective, Carù & Cova (2007) observe that experiences become more meaningful as participants subjectively appropriate the lived situation, moving from a merely observational position to a constitutive role in the production of the experience.

This understanding aligns with Csikszentmihalyi's (1990) theory of flow, according to which particularly intense experiences emerge when there is a balance between challenge, action, and individual competence. Flow states are characterized by deep absorption, intrinsic motivation, and altered perceptions of time, indicating that experiential intensity is associated with the degree of participant involvement in the lived situation. Complementing this perspective, Deci & Ryan (2000) argue that experiences supporting autonomy, competence, and relatedness tend to generate deeper forms of subjective engagement, reinforcing the relationship between participation, agency, and experiential intensity.

From a sociological perspective, Habermas (1984) contributes by conceptualizing social interaction as a communicative process oriented toward the construction of mutual understanding among individuals. Within this view, shared experiences cannot be reduced to the individual reception of stimuli but are constituted as intersubjective processes produced through the dynamics of interaction itself. The intensity and meaning of experience are therefore related to the forms of communication, participation, and meaning-making enabled by the experiential context.

Taken together, these contributions help explain how different configurations of participation influence the intensity, meaning, and memorability of experience by deepening the participant's subjective involvement in the lived experience.

4.2 Challenges and Limitations

Co-creation in Experience presents significant challenges for experience design precisely because lived experience cannot be fully predicted, controlled, or standardized. Although designers may structure contexts, stimuli, and opportunities for interaction, experiential outcomes ultimately depend on how each participant engages with the lived situation.

A first challenge concerns the unpredictability of engagement. States of flow, immersion, or deep involvement cannot be guaranteed through design, as they depend on the relationship between context, action, and the participant's subjective disposition (CSIKSZENTMIHALYI, 1990). The same experiential environment may generate different levels of engagement depending on factors such as individual background, attention, motivation, emotional state, and social dynamics (DECI & RYAN, 2000; ROSSMAN & DUERDEN, 2019).

This variability imposes limits on the predictability and scalability of experiences. Even when the designed structure remains stable, small differences in interactions and contextual conditions may lead to qualitatively different experiences (ROSSMAN & DUERDEN, 2019). In contexts oriented toward standardization, this creates tensions between operational consistency and openness to user participation.

Another important limitation concerns inclusion. Strategies that assume a high degree of participation may privilege individuals who are more comfortable with exposure, social interaction, or particular cultural repertoires. As argued by Mace (1997), design must consider the diversity of users' physical, cognitive, and social abilities, while Sanders & Stappers (2008) observe that participatory approaches may inadvertently exclude participants who are less willing or less able to engage actively.

Additional challenges arise in relation to experience evaluation. Because a significant portion of lived experience involves tacit, embodied, and situated knowledge, not all aspects of experience can be fully externalized or transformed into analyzable representations (POLANYI, 1966). Part of what is experienced remains at the level of sensation, perception, and subjective interpretation, imposing limitations on traditional approaches to documenting and measuring experience.

These challenges demonstrate that Co-creation in Experience requires design approaches capable of operating under conditions of variability, indeterminacy, and representational limits. At the same time, they reinforce the importance of complementary modes of knowledge production about experience, which are discussed in the following section.

5.0 Co-creation for Experience Design

"Co-creation for Experience Design" - a term likewise adopted from Escaleira (2024) - refers to the processes through which participants' lived experiences are converted into knowledge that can be used for design. In this mode, participation does not constitute the experience itself but rather produces forms of knowledge about the experience that can be analyzed, communicated, and incorporated into future design decisions. Participants' contributions are therefore necessarily mediated by time, language, recording artifacts, and interpretive processes that transform lived experience into information.

Unlike "Co-creation in Experience", in which participation operates at the level of lived experience, "Co-creation for Experience Design" operates at the level of representation. Designers do not access participants' experiences directly but rather their externalizations: narratives, evaluations, observations, behavioral records, metrics, and other forms of expression capable of making lived experience communicable.

Consequently, the knowledge produced in this mode is predominantly explicit and analyzable, enabling its use in processes of design conception, adaptation and refinement.

This mode is closely connected to traditions of user research, human-centered design, and design thinking. Authors such as Norman (2013) and Kolko (2011) argue that understanding users is a fundamental condition for developing relevant and meaningful solutions. Such understanding, however, is not achieved through direct access to experience but through processes of investigation, interpretation, and translation that render aspects of participants' lived experiences communicable.

Brown (2009) aligns with this perspective by conceiving design thinking as an iterative learning process driven by the continuous interpretation of user experiences. Within this approach, observations, feedback, and interactions are transformed into design knowledge that guides successive cycles of prototyping, testing, and refinement. Experience is not accessed directly but through records and interpretations that enable its analysis and incorporation into the design process.

From this perspective, "Co-creation for Experience Design" can be understood as the set of mechanisms through which designers and organizations seek to access, interpret, and incorporate represented forms of users' lived experiences. It establishes a connection between realized experiences and the design of future experiences, although this connection is necessarily partial, since what can be communicated, recorded, or analyzed never corresponds entirely to what was actually lived (POLANYI, 1966).

5.1 Mediation and Knowledge Production

"Co-creation for Experience Design" materializes through a variety of user research methods and practices that are well established in human-centered design, participatory design, and service design (SANDERS & STAPPERS, 2008; STICKDORN & SCHNEIDER, 2011). Although these approaches differ in objectives, formats, and data collection techniques, they share a fundamental characteristic: they do not operate on experience itself, but on representations of experience that can be communicated, interpreted and incorporated into the design process.

Interviews, surveys, contextual observation, participatory workshops, behavioral metrics, analytics, and other techniques constitute mechanisms through which aspects of lived experience are externalized and transformed into knowledge that can be used for design. What differentiates these methods is not the epistemological nature of the knowledge they produce, but the degree of fidelity, depth, and granularity with which they capture and represent participants' experiences.

Within participatory design, Sanders & Stappers (2008) conceptualize co-creation as a process in which users and other stakeholders contribute to the generation of ideas, interpretations, and design directions. Similarly, service design approaches structure user participation throughout service conception and improvement processes (STICKDORN & SCHNEIDER, 2011). In both cases, participants contribute not through the constitution of experience in real time, but through the production of knowledge that informs future design decisions.

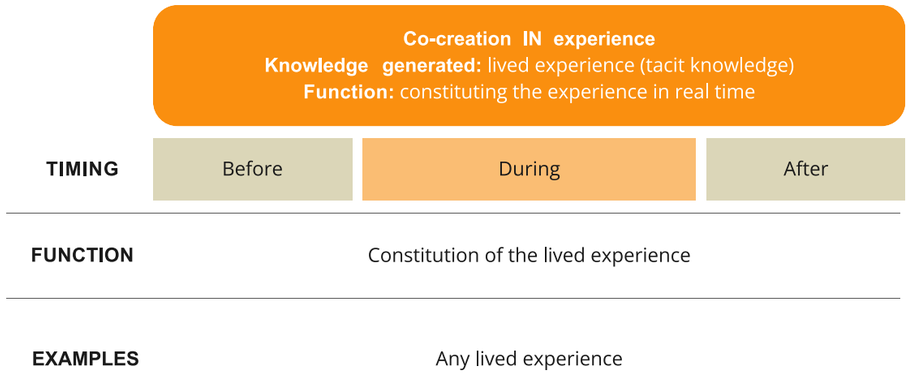
This distinction becomes particularly relevant in situations where information is collected during the experience itself. Methods such as contextual observation (shadowing), behavioral monitoring, real-time analytics, and digital tracking systems may appear similar to "Co-creation in Experience" because they occur simultaneously with the lived experience. From an epistemological perspective, however, they remain within the logic of "Co-creation for Experience Design". What is captured is not experience as a lived phenomenon, but records, indicators, and representations derived from it.

The timing of data collection is therefore not a sufficient criterion for distinguishing the modes of co-creation proposed in this article. Information gathered before, during, or after an experience may belong to the same epistemological mode when it operates through representations of lived experience and aims to produce knowledge for design. The fundamental distinction lies less in the moment of participation than in the nature of the knowledge generated and the function that such knowledge performs.

From this perspective, "Co-creation for Experience Design" can be understood as a continuous process of translating experience into explicit knowledge. Although methods vary in their proximity to lived experience, they all depend on processes of externalization, interpretation, and analysis that make this knowledge transferable among users, researchers, designers, and organizations. The result is not the experience itself, but a representation sufficiently communicable to inform future design decisions.

Figure 2 summarizes this logic of knowledge production. Although user participation may occur before, during, or after an experience, all these forms of contribution share the same epistemological function: transforming aspects of lived experience into analyzable representations capable of informing design decisions. The fundamental distinction lies not in the timing of data collection, but in the nature of the knowledge produced and its use in guiding the development of future experiences.

Figure 2 – Temporal scope of Co-creation for Experience Design



Source: Developed by the author (2026).

5.3 Challenges and Limitations

The primary limitation of "Co-creation for Experience Design" stems from the very nature of the knowledge it produces. Although this mode enables participants' experiences to be transformed into information that can be used for design, what reaches the designer is never the experience itself, but rather representations of experience. Narratives, evaluations, interviews, behavioral metrics, and observational records constitute attempts to make lived experience communicable, but they are not equivalent to the original experience.

This limitation is grounded in Polanyi's (1966) distinction between tacit and explicit knowledge. A significant portion of experience remains embedded in action, perception, and situated interpretation, resisting complete externalization. People frequently know more than they can express, meaning that what is communicated represents only a fraction of what was actually experienced.

The difficulty of representation arises not only from the tacit nature of knowledge but also from the reconstructive character of memory. Kahneman (2011) distinguishes between the experiencing self - which lives the experience as it unfolds - and the remembering self - which subsequently interprets, organizes, and recounts it. As a result, participants' accounts do not constitute faithful reproductions of lived experience, but retrospective reconstructions shaped by memory, interpretation and meanings attributed to events after they occur.

The nature of experience itself imposes additional limits on its representation. As argued by McCarthy & Wright (2004), experiences involve emotional, sensory, embodied, temporal and interpretive dimensions that interact in complex and contextual ways. Part of this phenomenological richness is inevitably lost when experience is translated into analytical categories, indicators, or narratives that can be utilized within design processes. The strength of representation lies precisely in its ability to make experience communicable; its limitation lies in the simplification required for such communication to occur.

Beyond these epistemological limitations, challenges also arise regarding the quality and representativeness of collected information. Users who respond to satisfaction surveys or participate in focus groups are not necessarily representative of the broader user population (MORGAN, 1997). In digital environments, this bias tends to be amplified by the dynamics of feedback channels themselves, where evaluations are often produced by individuals who have had exceptionally positive or negative experiences, while those whose experiences were more ordinary remain underrepresented (SANDERS & STAPPERS, 2008). The uncritical use of such data may lead to distorted representations of user experiences and compromise the quality of design decisions.

Another limitation concerns what may be described as the participation paradox. When consulted about future experiences, participants tend to formulate suggestions based on existing repertoires, references, and solutions with which they are already familiar. As observed by Von Hippel (1986), Christensen (1997), and Norman (2013), users are generally more effective at identifying problems and opportunities for improvement than at proposing radically novel alternatives. Verganti (2009) extends this argument by suggesting that meaning-driven innovations rarely emerge from directly listening to users.

"Co-creation for Experience Design" is therefore particularly powerful for processes of refinement, adaptation, and incremental improvement, but presents limitations when used as the sole source of radical innovation.

Taken together, these challenges demonstrate that "Co-creation for Experience Design" should not be understood as direct access to participants' experiences, but rather as a process of producing and interpreting representations of experience. Its strength lies precisely in its ability to make lived experience communicable and usable for design. Its fundamental limitation, however, lies in the fact that what can be communicated, recorded, or analyzed never corresponds entirely to what was actually lived (MCCARTHY & WRIGHT, 2004).

6. Comparative Analysis of the Two Modes

The proposed framework is based on two fundamental premises. The first is that experience should not be conflated with the design that precedes it: experience is realized only through the interaction between participant, context, and design proposition. The second is that representations of experience should not be conflated with lived experience itself: narratives, evaluations and behavioral data provide indirect access to experience, but do not reproduce it. From these premises emerge two epistemologies of "Co-creation in Experience Design": one oriented toward lived experience and the other toward representation.

The distinction between these epistemologies does not lie primarily in the timing of participation, but in the nature of the knowledge they produce. Although frequently treated under the same conceptual label, Co-creation in Experience and "Co-creation for Experience Design" operate according to distinct epistemological logics, mobilizing different forms of participation, knowledge and relationships with the design process.

In "Co-creation in Experience", participation operates at the level of lived experience. Participants do not contribute information about the experience; rather, they participate directly in its constitution. Experience emerges through the interaction between participant, context, and design proposition, meaning that participation is not an additional resource but the very condition through which experience is realized as a lived phenomenon. The knowledge mobilized in this mode is predominantly tacit, situated, and embodied in action, manifesting itself in the course of the experience and resisting complete externalization (POLANYI, 1966; ESCALEIRA, 2024).

In "Co-creation for Experience Design", by contrast, participation operates at the level of representation. What is produced is not the lived experience itself, but forms of knowledge about experience that can be communicated, analyzed, and incorporated into the design process. Narratives, evaluations, observations, behavioral metrics and other forms of documentation constitute externalizations of lived experience that enable designers to access, albeit only partially, what participants have experienced. The knowledge mobilized in this mode assumes a predominantly explicit and analyzable form, oriented toward organizational learning and design decision-making (POLANYI, 1966; KAHNEMAN, 2011).

This distinction makes it possible to move beyond interpretations that associate "Co-creation in Experience" exclusively with real-time participation and "Co-creation for Experience Design" with post-experience participation. Although the timing of participation may vary across modes, it does not constitute their fundamental criterion of differentiation. Information collected before, during, or after a lived experience belongs to "Co-creation for Experience Design" whenever it operates through representations of lived experience and aims to generate knowledge for design. The distinguishing element is therefore not the moment of participation, but the function it performs and the nature of the knowledge it produces.

Figure 3 synthesizes the Framework of the Two Epistemologies of "Co-creation in Experience Design", illustrating how the two modes differ in terms of their fundamental premises, epistemological orientation, forms of participation, and implications for design. More than temporal or methodological categories, these two modes represent distinct ways of understanding the relationship between experience, knowledge, and design.

Figure 3 – Comparison between the two epistemologies of Co-creation in Experience Design

	Co-creation IN Experience	Co-creation FOR Experience Design
EPISTEMOLOGY	Lived Experience	Representation
NATURE OF KNOWLEDGE	Tacit, situated and embodied	Explicit, articulated and analyzable
PRIMARY FUNCTION	Constituting the experience	Production of knowledge for design
MAIN LIMITATION	Difficulty of externalizing lived experience	Represents only part of the lived experience
ROLE OF THE DESIGNER	Orchestrator of experiential conditions	Translator of representations of experience
FUNDAMENTAL PREMISE	Experience is not the design	Representation is not the experience

Source: Developed by the author (2026).

7. Combining the Two Modes: an Integrative Perspective

Figure 4 highlights two central aspects of the distinction proposed in this article. The first concerns the temporality of the two modes of Co-creation. As illustrated in Figures 1 and 2, "Co-creation in Experience" is concentrated in the moment of lived experience, when the interaction between participant, context, and design proposition constitutes the experience itself. "Co-creation for Experience Design", by contrast, may occur before, during, and after the lived experience, manifesting through user research activities, behavioral monitoring, feedback mechanisms, and evaluation processes.

The second aspect concerns the relationship between the two modes. The distinction between "Co-creation in Experience" and "Co-creation for Experience Design" does not imply that they operate in isolation or independently from one another. On the contrary, they constitute complementary dimensions of the same experience design process. While the former is related to the constitution of lived experience, the latter is related to the production of knowledge about that experience. Experience design depends simultaneously on both: without lived experience, there is no experience to be understood; without the production of representations of experience, there is no learning capable of guiding its evolution.

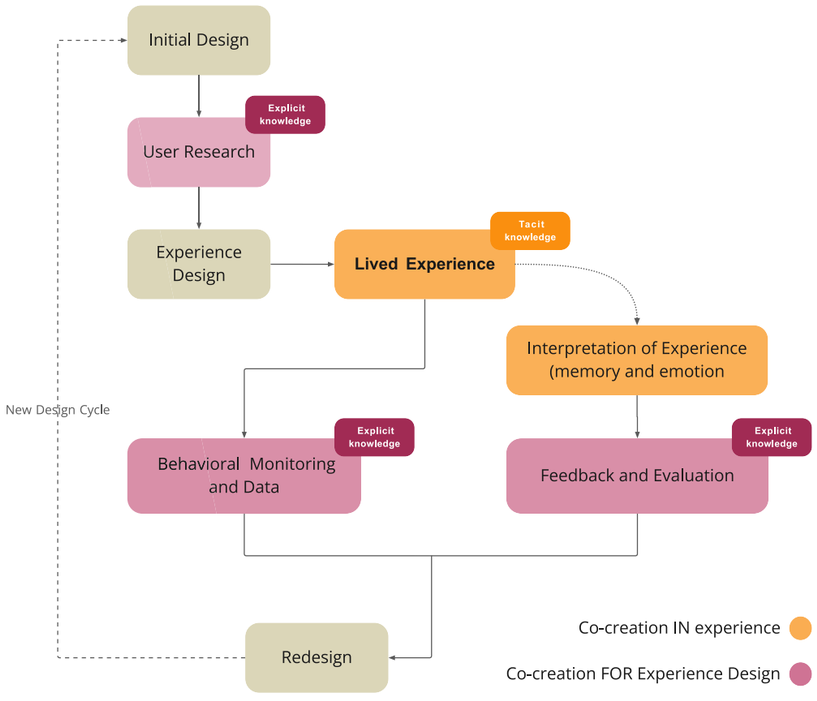
This relationship can be understood as a continuous cycle of conversion between lived experience and representation. The process begins with a design intention materialized in an initial experience proposition. This proposition is refined through user research activities that generate explicit knowledge capable of informing design decisions and guiding the configuration of the experience. The result of this process is the experience design itself, understood not as the experience per se, but as the designed structure that creates the conditions for its realization.

It is only through the interaction between participants, context, and design proposition that experience effectively occurs. At this moment, "Co-creation in Experience" manifests itself through the production of tacit, situated, and embodied knowledge. Lived experience generates meanings, emotions, interpretations, and individual responses that emerge from participants' actions in real time and cannot be fully anticipated through design.

Part of this lived experience remains embodied within the experience itself, while another part is converted into representations. This externalization may occur through different mechanisms. During the experience, monitoring systems may record behaviors, interactions, and patterns of use, generating behavioral data that can be analyzed. After the experience, processes of memory and interpretation give rise to feedback, evaluations, narratives, and other forms of representation of what was lived. In both cases, what is produced is not the experience itself, but explicit knowledge about the experience.
These representations feed processes of interpretation, learning, and redesign. Collected data and participant feedback become resources for identifying opportunities for improvement, validating assumptions, and refining design decisions. The knowledge produced through "Co-creation for Experience Design" is then reincorporated into the design process, giving rise to new cycles of design and experience.

Figure 4 synthesizes this movement by representing the continuous transformation between lived experience and representations of experience. The proposed framework demonstrates that learning in experience design does not occur directly from lived experience itself, but from the representations produced about it. At the same time, no representation can fully substitute for the lived experience from which it originates. The cycle between “Co-creation in Experience” and “Co-creation for Experience Design” expresses precisely this mutual dependence between experience, knowledge and design.

Figure 4 – Cycle of articulation between Co-creation in Experience and Co-creation for Experience Design



Source: Developed by the author (2026).

7.1 Implications for the role of the Designer

The distinction between the two modes implies different forms of designer involvement throughout the experience design process. When the focus is on “Co-creation in Experience”, design activity centers on configuring contexts, interactions, and participation mechanisms capable of supporting meaningful experiences. The designer’s role is to structure conditions that foster particular forms of lived experience without assuming direct control over the meanings produced by participants (ROSSMAN & DUERDEN, 2019; SHEDROFF, 2020).

In “Co-creation for Experience Design”, by contrast, designers primarily operate through the learning and adaptation mechanisms of the design system. The challenge lies in transforming user contributions into knowledge that is relevant for decision-making by selecting, interpreting, and synthesizing information from multiple sources. From this perspective, the quality of design depends not only on data collection but also on the ability to convert data into hypotheses, opportunities, and coherent design directions (BROWN, 2009; NORMAN, 2013; OSTERWALDER et al., 2014).

This distinction also has implications for the competencies required of design professionals. While “Co-creation in Experience” demands skills related to the design of interactions, environments, and participation conditions, “Co-creation for Experience Design” requires competencies in investigation, analysis, synthesis, and interpretation. In one case, the focus is on configuring experience; in the other, on producing knowledge for its evolution.

From this perspective, the proposed framework suggests that experience designers perform complementary roles throughout the design process. They act simultaneously as orchestrators of experiential conditions and interpreters of the representations produced by participants. The contribution of the framework does not lie in replacing one role with the other, but in making explicit that both respond to distinct logics and require equally important competencies for contemporary experience design.

Conclusion

This study began from the observation that the concept of Co-creation has been used to describe distinct forms of user participation in experience design, often without explicitly addressing their differences. In response to this gap, the Framework of the Two Epistemologies of Co-creation in Experience Design was proposed, distinguishing two epistemologically distinct and functionally complementary modes: “Co-creation in Experience” and “Co-creation for Experience Design”.

It was argued that these modes differ not primarily in the timing of participation, but in the nature of the knowledge they produce. “Co-creation in Experience” operates at the level of lived experience, constituting the experience itself and producing tacit, situated, and embodied knowledge. “Co-creation for Experience Design” operates at the level of representation, producing explicit forms of knowledge that can be communicated, analyzed, and incorporated into the design process.

The proposed distinction advances the understanding of user participation in experience design by demonstrating that lived experience and representations of experience constitute epistemologically distinct phenomena. This differentiation contributes greater

conceptual precision to the use of the term co-creation and provides an analytical basis for selecting methods, participation strategies and evaluation approaches that are more compatible with the objectives of different design processes.

At the same time, the study demonstrated that these modes do not operate in isolation. Drawing on the integrative perspective presented in Figure 4, it was argued that experience design can be understood as a continuous cycle between lived experience and representation. Lived experience produces representations; representations inform design; and design creates conditions for new experiences. The contribution of the framework does not lie in privileging one mode over the other, but in making explicit their complementarity and their respective roles in the production of knowledge for design.

As a limitation, this study is predominantly theoretical and conceptual in nature. Although the framework was developed through the articulation of established contributions from the literature, its analytical and practical utility still requires empirical investigation across different experience design contexts. Future research may examine how the two modes manifest themselves in real-world projects, as well as explore methods capable of bringing designers closer to lived experience without reducing it entirely to its representations.

In summary, this article argues that "Co-creation in Experience Design" does not constitute a single phenomenon, but rather two epistemologically distinct and functionally complementary modes. By distinguishing "Co-creation in Experience" from "Co-creation for Experience Design", the proposed framework contributes to a more precise understanding of the relationship between experience, participation, and knowledge production, providing new conceptual foundations for both research and practice in experience design.

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06

Interpreting UX metrics in design education: the CXM-Edu for observing collaboration and learning experience

Bárbara Sanson de Lima
Júlio Carlos Souza van der Linden

Abstract

Collaboration is a central pedagogical condition in design education, particularly in project-based and studio-oriented learning environments. However, assessing collaborative learning remains challenging because teamwork, engagement, cognitive effort, and knowledge transfer are complex experiential phenomena that cannot be directly captured through isolated quantitative indicators. At the same time, digitally mediated learning environments generate interaction data commonly associated with user experience evaluation, such as task completion, satisfaction, time on task, usability scores, and participation rates. This creates a risk of interpreting UX metrics as direct measures of educational quality, rather than as contextual indicators that require pedagogical interpretation. This study asks: how can UX metrics be structured to support the observation of collaboration and learning experience in design education? Grounded in Design Science Research, the study develops the Collaboration Experience Metrics Model for Education, CXM-Edu, as a conceptual artifact that organizes UX metrics into five experiential dimensions: effectiveness, efficiency, satisfaction, engagement, and belonging. The model positions these dimensions as interpretative lenses for observing educational activities at different levels, including assignments, project-based courses, studio-based learning experiences, and collaborative team processes. Rather than proposing a universal measurement instrument, CXM-Edu structures UX metrics as contextualized proxies that may help educators and researchers identify patterns related to learning achievement, cognitive effort, sustained participation, subjective appraisal, and collaborative inclusion. The contribution of the paper lies in clarifying how UX metrics can be translated into an educational evaluation logic without reducing learning and collaboration to purely operational measures. The model also provides a foundation for future empirical studies aimed at testing and refining its hypotheses across design education contexts.

Keywords: Design and Engineering Education; UX Metrics; Collaborative Learning; Learning Experience; Design Science Research; Educational Assessment.

1. Introduction

Design education is strongly shaped by project-based, studio-oriented, and collaborative learning practices. In these contexts, students do not learn only by receiving content or completing individual tasks, but by framing problems, negotiating ideas, making design decisions, producing artifacts, receiving feedback, and reflecting on the consequences of their choices throughout the design process. This understanding is consistent with traditions of reflective practice in design, in which learning emerges through action, reflection, and iterative engagement with uncertain situations (SCHÖN, 1983). It is also aligned with studio-based approaches, where critique, dialogue, iteration, and artifact development constitute central pedagogical mechanisms (BROCATO, 2009; MCCLEAN & HOURIGAN, 2013). Collaboration, therefore, is not a secondary aspect of learning in design education, but one of the conditions through which learning takes place.

Assessing collaborative learning in design education remains challenging because the quality of an educational experience depends not only on final outputs, but also on participation patterns, cognitive effort, engagement, peer interaction, and the capacity to transfer knowledge across design situations. Collaborative learning involves forms of interaction in which learners are expected to coordinate, negotiate, and construct meaning together, although the mere arrangement of students in groups does not guarantee meaningful collaboration (DILLENBOURG, 1999). This distinction is especially important in design education, where a final project deliverable may conceal unequal contribution, limited participation, ineffective coordination, or lack of individual understanding.

The increasing mediation of design education by digital platforms, online studios, collaborative tools, learning management systems, and hybrid teaching formats has intensified the relevance of user experience as part of the educational environment. Interaction quality may influence how students access information, coordinate teamwork, perceive feedback, manage cognitive effort, and remain engaged in project activities. As design education becomes increasingly mediated by digital platforms and collaborative tools, learning activities generate observable traces that may support reflection on how students interact with tasks, peers, tools and project processes. Metrics commonly associated with user experience evaluation, such as task completion, time on task, satisfaction, usability scores, error frequency, and participation rates, may offer useful evidence for observing aspects of the learning experience.

However, the use of UX metrics in educational contexts also introduces an important interpretative problem. Metrics originally designed to evaluate digital products cannot be directly transferred to design education as if they were neutral measures of learning quality or collaborative effectiveness. In usability and UX evaluation, effectiveness, efficiency and satisfaction are traditionally associated with the extent to which users achieve goals in a specified context of use (ISO, 2018). Yet, in educational settings, effort, ambiguity, uncertainty and difficulty may be pedagogically productive rather than necessarily negative. A longer time on task, for instance, may indicate confusion, inefficient interaction, or cognitive overload, but it may also indicate deeper engagement with a complex design challenge. Similarly, high satisfaction may suggest a positive learning experience, but it does not necessarily demonstrate knowledge consolidation, critical reflection, or transfer of learning.

This study addresses the following research question: how can UX metrics be structured to support the observation of collaboration and learning experience in design education? To answer this question, the study proposes the Collaboration Experience Metrics Model for Education (CXM-Edu), a conceptual artifact that organizes UX metrics as contextualized proxies for observing educational experience. Rather than treating metrics as direct evidence of learning or collaboration, the model positions them as interpretative indicators that may help educators and researchers identify patterns related to learning achievement, cognitive effort, satisfaction, engagement, and belonging.

The objective of the paper is to develop a structured model that supports the interpretation of UX metrics in design education, especially in project-based and collaborative learning contexts. More specifically, the study aims to: identify relevant experiential dimensions for observing collaboration and learning experience; organize UX metrics according to their educational interpretative function; clarify how these metrics may operate as proxies rather than direct measures; and propose analytically derived hypotheses that can guide future empirical studies. The contribution of the paper lies in translating UX evaluation logic into an educational framework that preserves the complexity of collaborative design learning instead of reducing it to isolated quantitative indicators.

Methodologically, the study is grounded in Design Science Research, since its main outcome is the development of a conceptual artifact intended to address a practical and theoretical problem in design education. Design Science Research is appropriate when knowledge is produced through the construction and evaluation of artifacts designed to respond to relevant problems in a given field (HEVNER et al., 2004; DRESCH, LACERDA & ANTUNES JÚNIOR, 2015). In this study, the artifact was developed through a process of problem framing, theoretical synthesis, abstraction of experiential dimensions, translation of UX metrics into educational indicators, and analytical formulation of testable hypotheses. Its evaluation in this paper is descriptive and conceptual, focusing on the internal coherence of the model and on its potential use in future empirical research.

The paper is structured as follows. Section 2 describes the methodological procedures and the design rationale behind the development of the CXM-Edu model. Section 3 presents the theoretical framework, focusing on collaborative learning in design education and on the interpretation of UX metrics as proxies for educational experience. Section 4 presents the artifact, its dimensions, proxy indicators, evidence sources, pedagogical interpretations, analytical hypotheses, and guidance for reading and using the model. Section 5 discusses the contribution of the study, its limitations and directions for future empirical research.

2. Methological Procedures

This study adopts Design Science Research as its methodological foundation, since its main contribution is the development of a conceptual artifact designed to address a relevant problem in design education. Design Science Research is appropriate for studies in which knowledge is generated through the construction, articulation, and evaluation of artifacts intended to respond to practical and theoretical problems (HEVNER et al., 2004; DRESCH, LACERDA & ANTUNES JÚNIOR, 2015). In this paper, the artifact responds to the need for a structured way of interpreting UX metrics in collaborative design learning environments.

The development of the CXM-Edu model followed five analytical stages. The first stage consisted of problem framing. Based on the literature on design education, collaborative learning, UX evaluation and cognitive load, the study identified a gap between the increasing availability of interaction data in educational environments and the lack of conceptual structures capable of interpreting these data in relation to collaboration and learning experience. This gap is particularly relevant in design education, where learning is situated, iterative, collaborative, and often mediated by digital tools.

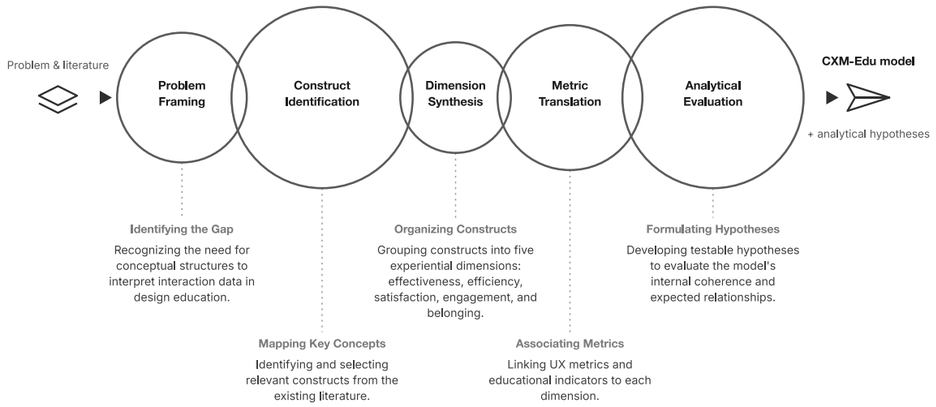
The second stage involved the identification of relevant constructs. Concepts recurrent in the literature were mapped, including effectiveness, efficiency, satisfaction, engagement, cognitive effort, participation, collaboration, transfer, and belonging. Effectiveness, efficiency, and satisfaction were retained from established usability and UX evaluation traditions, where they are used to describe goal achievement, resource expenditure, and subjective appraisal in a specific context of use (ISO, 2018). Engagement and belonging were added because collaborative design education requires attention not only to task performance and usability, but also to sustained participation, interaction reciprocity, perceived inclusion and social integration within learning groups.

The third stage consisted of dimension synthesis. The identified constructs were organized into five experiential dimensions: effectiveness, efficiency, satisfaction, engagement and belonging. These dimensions were not defined as independent or exhaustive categories, but as interpretative lenses through which different aspects of learning experience can be observed. Effectiveness relates to evidence of achievement, retention and transfer. Efficiency relates to cognitive effort, task fluency and avoidable friction. Satisfaction relates to learners' subjective perception of the educational experience. Engagement relates to continuity of participation and sustained involvement. Belonging relates to collaborative inclusion, reciprocity and contribution balance.

The fourth stage involved metric translation. In this stage, UX metrics and educational indicators were associated with each dimension according to their interpretative function. For example, task completion stability, retention evidence, and transfer evidence were associated with effectiveness, while perceived mental effort, error recurrence, and task time variability were associated with efficiency. Similarly, usability scores and post-task perception were associated with satisfaction, while participation frequency, continuity of contribution, and interaction patterns were associated with engagement and belonging. The aim was not to define a universal measurement instrument, but to clarify how different indicators may function as contextualized proxies for educational phenomena.

The fifth stage consisted of analytical evaluation through the formulation of testable hypotheses. Since this paper presents a conceptual artifact rather than an empirical validation study, the evaluation focuses on the internal coherence of the model and on the articulation of expected relationships between dimensions, indicators and educational phenomena. Each operational proposition of the artifact is therefore associated with a hypothesis that may be examined in future empirical studies. This approach allows the model to remain conceptually grounded while also establishing a path for later validation in assignments, studio-based learning experiences, project-based courses and collaborative design activities. Figure 1 synthesises the methodological phases.

Figure 1 - Five Stages of CXM-Edu Model Development



Source: Developed by the authors (2026).

The methodological contribution of this process lies in making explicit the rationale behind the artifact. The CXM-Edu model was not developed as a checklist of metrics, but as an interpretative structure that connects UX evaluation concepts to educational assessment concerns. By organizing metrics as proxies, the model acknowledges that collaboration and learning experience cannot be fully captured by isolated indicators, but can be observed through patterns that combine behavioral traces, self-reported perceptions, task outcomes, and evidence of interaction.

3. Theorical Framework

The theoretical framework of this study connects research on collaborative learning, design education, user experience evaluation, cognitive load and educational assessment. Its purpose is not to provide a broad review of UX in education, but to establish the conceptual basis for interpreting UX metrics as contextualized proxies for collaboration and learning experience. This framing is particularly relevant to design education, where learning often occurs through projects, studio activities, peer critique, iterative making, and collective decision-making.

3.1 Collaborative Learning and Assessment in Design Education

Design education is commonly organized around experiential, project-based, and studio-based pedagogies, in which students learn by framing problems, developing alternatives, prototyping, receiving critique, and refining their decisions over time. Schön's notion of reflective practice remains important in this discussion because it frames design learning as a process of reflection-in-action, in which practitioners make sense of uncertain situations while acting within them (SCHÖN, 1983). Studio-based learning extends this logic by placing critique, iteration, dialogue, and artifact development at the center of the educational experience (BROCATO, 2009; MCCLEAN & HOURIGAN, 2013).

In this context, learning is not restricted to the acquisition of content, but emerges through situated action, reflection, negotiation, and interaction with peers, instructors, materials, and artifacts. This understanding is supported by reflective practice and studio-based learning traditions, which emphasize learning as an iterative process shaped by action, feedback, critique and revision (SCHÖN, 1983; BROCATO, 2009; MCCLEAN & HOURIGAN, 2013). Studio-based and project-oriented learning environments therefore require forms of assessment capable of considering both the outcomes produced by students and the processes through which those outcomes are developed. This is particularly relevant because design work often involves ambiguity, incomplete information, multiple possible solutions, and progressive refinement through feedback (SCHÖN, 1983; MCCLEAN & HOURIGAN, 2013).

Collaboration plays a central role in this process. In design learning, students frequently work in teams, distribute responsibilities, negotiate criteria, make collective decisions, and respond to feedback throughout the development of a project. Collaborative learning research emphasizes that learning depends not only on grouping students

together, but on the quality of interaction, negotiation and shared meaning-making that emerges among participants (DILLENBOURG, 1999; ROSCHELLE & TEASLEY, 1995). These activities create opportunities for peer learning, but they also introduce assessment challenges, especially when collaborative processes are evaluated mainly through final deliverables.

A final project deliverable may conceal unequal contribution, limited participation, ineffective coordination or lack of individual understanding. Conversely, a team that produces an imperfect artifact may still demonstrate meaningful learning through reflection, iteration, critique, and transfer of concepts to new design situations. This interpretation is consistent with the view of design learning as a reflective and processual activity, rather than only as the production of finished outcomes (SCHÖN, 1983; BROCATO, 2009). For this reason, collaboration in design education cannot be evaluated only through final outputs or isolated performance indicators. It requires attention to participation patterns, interaction quality, contribution balance, perceived inclusion and continuity of engagement over time.

This challenge is intensified by the increasing use of digital platforms and collaborative tools in design education. Learning management systems, online whiteboards, prototyping tools, shared documents and communication platforms generate traces of student activity that may appear useful for evaluation. However, these traces do not explain learning by themselves. Participation frequency, task completion, number of comments or time spent in a platform only become meaningful when interpreted in relation to the pedagogical structure of the course, the nature of the design task and the expected learning outcomes. This interpretation is aligned with the broader caution that collaborative learning depends on the quality of interaction and shared construction of meaning, not only on the observable presence of activity or participation (DILLENBOURG, 1999; ROSCHELLE & TEASLEY, 1995). Thus, the evaluation of collaborative learning in design education depends on an interpretative framework that connects observable indicators to educational constructs.

3.2 UX Metrics as Proxies for Learning Experience

User experience evaluation provides a relevant vocabulary for observing how people interact with systems, tasks, and environments. In usability evaluation, effectiveness, efficiency, and satisfaction are commonly used to describe whether users achieve specified goals, how many resources are required and how the experience is subjectively perceived within a context of use (ISO, 2018). UX research has also emphasized that experience measurement is complex because experiential qualities are situated, multidimensional and difficult to operationalize through isolated measures (VERMEEREN et al., 2010; LAW, VAN SCHAIK & ROTO, 2014).

In educational contexts, these dimensions may offer useful insights, but they cannot be transferred without adaptation. A learning environment is not only a system to be used efficiently, but a pedagogical setting in which effort, difficulty, uncertainty and reflection may be necessary parts of the experience. This distinction is especially important in design education, where learning often involves ambiguity, iteration, critique and experimentation, as discussed in reflective practice and studio-based learning approaches (SCHÖN, 1983; BROCATO, 2009; MCCLEAN & HOURIGAN, 2013). Time on task, for example, may indicate inefficient interaction, but it may also indicate sustained engagement with a complex design problem. Error frequency may reveal usability problems, but it may also reflect experimentation during prototyping. Satisfaction may indicate that students perceived the experience positively, but according to its definition in usability evaluation, it refers to subjective appraisal of use rather than direct evidence of learning, retention, or transfer (ISO, 2018; LAW, VAN SCHAIK & ROTO, 2014).

For this reason, this study treats UX metrics as proxies rather than direct measures of learning or collaboration. In this paper, a proxy is understood as an indirect indicator that approximates a phenomenon that cannot be fully observed or measured in itself. This interpretation is consistent with the broader challenge of measuring user experience, since UX constructs are situated and multidimensional, and with the complexity of collaborative learning, which depends on interaction, negotiation, and shared meaning-making rather than on isolated performance indicators (DILLENBOURG, 1999; VERMEEREN et al., 2010; LAW, VAN SCHAIK & ROTO, 2014). Learning achievement, cognitive effort, engagement, and belonging are not directly captured by a single metric, but they may be inferred through patterns that combine behavioral data, self-reported perceptions, task outcomes, and interaction evidence. The value of UX metrics in design education therefore lies not in their ability to prove learning, but in their capacity to support structured observation and interpretation.

Cognitive load theory is particularly relevant to this discussion because it distinguishes between forms of mental effort that support learning and forms of effort generated by unnecessary complexity. Cognitive load theory argues that instructional design should direct cognitive resources toward learning-relevant activities rather than toward unnecessary processing demands (SWELLER et al., 1990; SWELLER, 1994; SCHNOTZ & KÜRSCHNER, 2007). In design education, students are expected to deal with ambiguity, complexity, and iteration, since design learning often involves reflection-in-action, critique, and progressive refinement of artifacts (SCHÖN, 1983; BROCATO, 2009; MCCLEAN & HOURIGAN, 2013). However, when interaction with tools, instructions, or collaborative systems becomes unnecessarily confusing, cognitive resources may be diverted away from the design task itself, producing forms of extraneous load that interfere with learning-relevant activity (SWELLER et al., 1990; SWELLER, 1994). Metrics related to perceived effort, error recurrence, task time variability, and usability may therefore function as indirect signals of whether students are investing effort in learning activities or struggling with avoidable friction in the learning environment.

Engagement and belonging extend this interpretation beyond individual interaction. Design education depends on sustained participation, peer exchange, critique, and shared responsibility, especially in studio-based and collaborative learning environments (BROCATO, 2009; MCCLEAN & HOURIGAN, 2013). Collaborative learning research also emphasizes that meaningful collaboration depends on interaction, negotiation, and the construction of shared understanding among participants (DILLENBOURG, 1999; ROSCHELLE & TEASLEY, 1995). Indicators such as continuity of contribution, reciprocity of interaction, participation distribution, and perceived inclusion may therefore help

approximate the social quality of collaborative learning. These indicators should not be read as definitive evidence of collaboration, but as signals that support reflection about how students participate in and experience collective design processes.

From this perspective, UX metrics become educationally meaningful only when organized within a coherent evaluative structure. Effectiveness, efficiency, satisfaction, engagement and belonging are therefore adopted in this study as interpretative dimensions that connect observable indicators to learning experience. Effectiveness refers to evidence of task achievement, retention, and transfer. Efficiency refers to the relationship between cognitive effort, interaction fluency and unnecessary friction. Satisfaction refers to learners' subjective appraisal of the educational experience. Engagement refers to sustained participation and continuity of involvement. Belonging refers to perceived inclusion, reciprocity, and collaborative integration within learning groups. Together, these dimensions provide the conceptual foundation for the CXM-Edu artifact presented in the following sections.

4. The CXM-Edu Model

The main result of this study is the Collaboration Experience Metrics Model for Education, CXM-Edu, a conceptual artifact designed to support the structured interpretation of UX metrics in design education. The model is intended for educational contexts in which learning occurs through projects, studio-based activities, collaborative assignments, peer critique, and iterative design processes. Its purpose is to help educators and researchers organize observable indicators in relation to relevant dimensions of learning experience.

The model is based on the premise that collaboration and learning experience cannot be directly measured through isolated UX metrics. Instead, they may be observed through patterns that combine behavioral traces, self-reported perceptions, task outcomes and interaction evidence. For this reason, CXM-Edu treats metrics as contextualized proxies. A proxy provides indirect evidence that may support interpretation when considered alongside the pedagogical goals and structure of the learning activity.

The artifact is organized into five experiential dimensions: effectiveness, efficiency, satisfaction, engagement and belonging. These dimensions function as interpretative lenses. Effectiveness focuses on whether students demonstrate achievement, retention, or transfer of knowledge across design activities. Efficiency focuses on the relationship between cognitive effort, interaction fluency, and unnecessary friction in the learning environment. Satisfaction focuses on students' subjective appraisal of the learning experience. Engagement focuses on sustained participation and continuity of involvement over time. Belonging focuses on collaborative inclusion, reciprocity, and contribution balance within learning groups.

In practical terms, CXM-Edu may be used at different educational levels. At the assignment level, it may help observe how students complete a specific design task, respond to instructions, or experience the use of a digital tool. At the project level, it may support the observation of participation patterns, contribution continuity, and cognitive effort across different stages of a design process. At the course level, it may help educators identify broader patterns related to engagement, collaboration, satisfaction, and learning transfer across multiple activities. The model may also be used at different moments of the learning experience: before an activity, to define what should be observed; during an activity, to monitor participation and friction; and after an activity, to interpret evidence of learning, transfer, satisfaction, and collaborative inclusion.

Table 1 presents the CXM-Edu artifact as an interpretative structure for organizing UX metrics in design education. Each row corresponds to an operational proposition of the model, connecting an experiential dimension to an educational focus, a proxy indicator, a possible evidence source and a pedagogical interpretation. The column "educational focus" clarifies which aspect of the learning experience is being approximated, such as transfer, cognitive effort, participation, or collaborative inclusion. The column "proxy indicator" identifies the metric or observable signal that may support interpretation. The column "evidence source" indicates where this signal may be observed, including student reflections, platform logs, peer interaction records, project documentation or instructor observation. Finally, the column "pedagogical interpretation" explains how the evidence may be read in relation to the educational context, avoiding the assumption that any single metric can directly measure learning or collaboration.

Table 1 - CXM-Edu Model: dimensions, proxy indicators, evidence source and pedagogical interpretation logic.

ID	Dimension	Educational Focus	Proxy Indicator	Evidence Source	Pedagogical Interpretation
A1	Effectiveness	Task achievement	Task completion stability	Assignment records, project milestones, instructor observation	Stable completion across comparable design activities may suggest that students are progressively able to perform expected tasks with greater consistency
A2	Effectiveness	Retention	Follow-up recall or reuse of concepts	Reflections, critiques, subsequent assignments, project documentation	Recurrent use of previously addressed concepts may indicate that learning is being sustained beyond the initial activity
A3	Effectiveness	Transfer	Application of methods in new contexts	Project deliverables, design rationale, process documentation	Reuse of design methods or principles in a different brief, project phase, or problem situation may suggest knowledge transfer
A4	Efficiency	Cognitive effort	Self-reported mental effort	Post-task forms, reflection journals, short surveys	High perceived effort may indicate productive challenge or excessive cognitive load, depending on whether the difficulty comes from the design task or from avoidable friction

A5	Efficiency	Interaction fluency	Task time variability	Platform logs, activity records, classroom observation	Wide variation in completion time may signal unclear instructions, tool friction, or different levels of task understanding
A6	Efficiency	Avoidable friction	Error recurrence	Tool logs, help requests, instructor notes, usability observations	Repeated navigation errors, misunderstandings, or tool-use difficulties may indicate extraneous cognitive load generated by the learning environment
A7	Satisfaction	Subjective appraisal	Usability or experience rating	Post-activity questionnaires, usability scales, course feedback	Positive ratings may indicate perceived clarity and usability, but should not be interpreted as direct evidence of learning
A8	Satisfaction	Perceived educational value	Post-task reflection	Reflection journals, open-ended feedback, critique sessions	Student reflections may reveal whether the activity was perceived as meaningful, relevant, or connected to learning goals
A9	Engagement	Participation	Participation frequency	Platform activity, attendance records, interaction logs, instructor observation	Regular participation may indicate sustained involvement, but should be interpreted together with contribution quality and continuity
A10	Engagement	Persistence	Continuity of contribution	Version history, project documentation, activity timelines	Contributions distributed over time may suggest ongoing engagement rather than participation concentrated near deadlines
A11	Engagement	Design process involvement	Iteration evidence	Prototype versions, critique records, design journals, portfolio documentation	Repeated revision, critique response, and artifact development may indicate active engagement with the design process
A12	Belonging	Contribution balance	Distribution of contributions	Peer assessment, version history, team records, instructor observation	Strong imbalance may suggest unequal participation, reduced collaborative inclusion, or concentration of decision-making within the group
A13	Belonging	Interaction reciprocity	Initiated and received interactions	Peer feedback records, communication logs, critique participation	Reciprocal exchanges may indicate stronger collaborative dynamics, shared responsibility, and mutual recognition among students
A14	Belonging	Perceived inclusion	Inclusion or belonging rating	Self-reports, peer feedback, reflective forms, group retrospectives	Positive inclusion ratings, when aligned with balanced participation, may suggest a stronger sense of belonging in collaborative design activities

Source: Developed by the authors (2026) based on Schön (1983), Dillenbourg (1999), Brocato (2009), Vermeeren et al. (2010), Law, van Schaik and Roto (2014), ISO (2018), and Dresch, Lacerda and Antunes Júnior (2015).

The revised structure of the artifact emphasizes that UX metrics only become educationally meaningful when connected to evidence sources and pedagogical interpretation. For example, participation frequency may indicate sustained engagement, but it may also conceal superficial interaction if not analyzed alongside continuity of contribution, iteration evidence and interaction reciprocity. Similarly, high satisfaction ratings may indicate that students perceived an activity positively, but they do not demonstrate learning unless considered together with evidence of retention, transfer or task achievement. The model therefore encourages educators and researchers to interpret indicators relationally, considering how different forms of evidence combine across dimensions.

This structure also clarifies the practical use of CXM-Edu in design education. In a short assignment, educators may focus on task achievement, cognitive effort, subjective appraisal and perceived educational value. In a studio-based project, the model may support the observation of iteration, contribution continuity, peer critique, and transfer across project phases. In collaborative team activities, belonging-related indicators may help identify whether participation is balanced, reciprocal, and inclusive. In all cases, the model is not intended to prescribe a fixed set of metrics, but to guide the selection and interpretation of indicators according to the pedagogical purpose of the activity.

4.1 Analytical Hypotheses Derived from CXM-Edu

Because this study presents a conceptual artifact rather than an empirical validation, the evaluation of CXM-Edu is analytical and proposition-based. The hypotheses presented in Table 2 derive from the internal logic of the model and indicate how its dimensions, proxy indicators, evidence sources, and pedagogical interpretations may be examined in future empirical studies. They should not be understood as confirmed relationships, but as testable propositions that connect observable evidence to educational phenomena in design learning contexts.

The purpose of these hypotheses is twofold. First, they clarify the expected relationship between each proxy indicator and the educational focus it approximates. Second, they make explicit the interpretative caution required when using UX metrics in educational contexts. A proxy indicator may suggest a pattern, but it does not provide direct proof of learning, collaboration, engagement or belonging. For this reason, each hypothesis should be examined in relation to the pedagogical goals of the activity, the evidence source from which the indicator is derived and other complementary indicators within the model.

Table 2 - Analytical hypotheses derived from the CXM-Edu model.

ID	Dimension	Educational Focus	Analytical Hypothesis	Possible Evidence	Interpretative Caution
A1	Effectiveness	Task achievement	Stable task completion across comparable design activities is associated with progressive task achievement	Assignment records, project milestones, instructor observation	Completion alone does not indicate conceptual understanding or design quality
A2	Effectiveness	Retention	Recurrent use of previously addressed concepts is associated with retention over time	Reflections, critiques, subsequent assignments, project documentation	Concept reuse may be superficial if not connected to adequate reasoning or contextual adaptation
A3	Effectiveness	Transfer	Application of design methods in new contexts is associated with learning transfer	Project deliverables, design rationale, process documentation	Transfer should be distinguished from mere repetition of procedures without adaptation
A4	Efficiency	Cognitive effort	High perceived mental effort is associated with cognitive load during design learning activities	Post-task forms, reflection journals, short surveys	High effort may indicate either productive challenge or excessive cognitive burden
A5	Efficiency	Interaction fluency	High variability in task completion time is associated with interaction or instructional inefficiency	Platform logs, activity records, classroom observation	Time variation may also reflect different design strategies, exploration depth, or prior knowledge
A6	Efficiency	Avoidable friction	Recurrent interaction errors are associated with extraneous cognitive load generated by the learning environment	Tool logs, help requests, instructor notes, usability observations	Errors may also reflect experimentation, prototyping behavior or deliberate exploration

A7	Satisfaction	Subjective appraisal	Positive usability or experience ratings are associated with favorable subjective appraisal of the learning environment	Post-activity questionnaires, usability scales, course feedback	Satisfaction does not demonstrate learning, retention or transfer by itself
A8	Satisfaction	Perceived educational value	Meaningful post-task reflections are associated with perceived educational value	Reflection journals, open-ended feedback, critique sessions	Positive perception may reflect enjoyment or preference rather than educational effectiveness
A9	Engagement	Participation	Regular participation is associated with sustained involvement in the learning activity	Platform activity, attendance records, interaction logs, instructor observation	Frequency of participation does not necessarily indicate depth or quality of engagement
A10	Engagement	Persistence	Continuity of contribution over time is associated with persistence in project-based learning	Version history, project documentation, activity timelines	Continuous contribution may still be fragmented, low-quality or disconnected from learning goals
A11	Engagement	Design process involvement	Iteration evidence is associated with active engagement in the design process	Prototype versions, critique records, design journals, portfolio documentation	Iteration should be assessed by its reflective quality, not only by the number of versions
A12	Belonging	Contribution balance	Strong imbalance in contribution distribution is associated with reduced collaborative inclusion	Peer assessment, version history, team records, instructor observation	Unequal contribution may also reflect negotiated roles, expertise or task distribution
A13	Belonging	Interaction reciprocity	Reciprocal interaction is associated with stronger collaborative dynamics and shared responsibility	Peer feedback records, communication logs, critique participation	Reciprocity should be interpreted with attention to the relevance and quality of exchanges
A14	Belonging	Perceveid inclusion	Positive inclusion ratings are associated with a stronger sense of belonging in collaborative design activities	Self-reports, peer feedback, reflective forms, group retrospectives	Inclusion ratings may be affected by social desirability or reluctance to report conflict

Source: Developed by the authors (2026) based on the CXM-Edu model and the analytical evaluation logic of Design Science Research.

The hypotheses reinforce the interpretative nature of the model. For example, A9 does not assume that participation frequency alone proves engagement. It proposes that regular participation may support the interpretation of engagement when analyzed together with contribution continuity, iteration evidence, and the pedagogical goals of the activity. Similarly, A12 does not assume that contribution imbalance automatically indicates poor collaboration. Instead, it suggests that imbalance should be examined as a possible signal of reduced inclusion, especially when combined with low reciprocity, weak perceived inclusion, or limited participation in group decisions.

This analytical structure also clarifies how CXM-Edu may guide future empirical research. Educators and researchers may select a limited set of hypotheses according to the learning goals, duration and collaborative structure of the educational activity. A short individual assignment, for instance, may emphasize task achievement, cognitive effort, satisfaction and perceived educational value. A semester-long studio project may require greater attention to transfer, iteration, persistence, and engagement. A collaborative team activity may prioritize contribution balance, interaction reciprocity and perceived inclusion. In this sense, the hypotheses do not prescribe a fixed evaluation protocol, but provide a theoretically grounded basis for designing future studies and interpreting evidence in design education contexts.

4.2 Reading and using the CXM-Edu artifact

The CXM-Edu artifact is intended to be read as an integrated interpretative structure rather than as a checklist of independent metrics. Table 1 and Table 2 should therefore be used together. Table 1 presents the operational layer of the model, connecting each experiential dimension to an educational focus, a proxy indicator, possible evidence sources and a pedagogical interpretation. Table 2 complements this structure by translating each operational proposition into an analytical hypothesis that can guide future empirical investigation.

Table 1 helps educators and researchers identify what kind of evidence may be observed in a design learning activity. For example, if the pedagogical concern is whether students are sustaining engagement throughout a project, the artifact directs attention to participation frequency, continuity of contribution and evidence of iteration. If the concern is collaborative inclusion, the model suggests observing contribution balance, interaction reciprocity, and perceived inclusion. In this sense, Table 1 supports the selection of relevant indicators according to the educational purpose of the activity.

Table 2 helps clarify how these indicators may be examined and interpreted. Each hypothesis expresses an expected relationship between a proxy indicator and an educational phenomenon, while also indicating the caution required when interpreting that relationship. For example, frequent participation may suggest engagement, but it does not necessarily indicate depth of involvement. Similarly, contribution imbalance may suggest reduced collaborative inclusion, but it may also reflect negotiated roles or task distribution within a team. By making these cautions explicit, Table 2 reduces the risk of treating metrics as direct or self-explanatory measures.

Together, Table 1 and Table 2 can support three forms of use in design education. First, they may be used before an activity to help instructors define which dimensions and indicators are most relevant to the learning objectives. Second, they may be used during an activity to observe patterns of participation, friction, iteration, and collaboration as they emerge. Third, they may be used after an activity to interpret evidence of learning experience, including retention, transfer, satisfaction, engagement and belonging.

The model can also be adapted to different educational scales. In a short assignment, educators may select a limited set of indicators, such as task achievement, cognitive effort and perceived educational value. In a studio-based project, the model may support the observation of critique response, iteration evidence, contribution continuity and transfer across project phases. In collaborative team activities, belonging-related indicators may help identify whether students experience participation as balanced, reciprocal and inclusive. Therefore, CXM-Edu does not prescribe a fixed evaluation protocol. Its role is to help educators and researchers select, combine, and interpret indicators in relation to the pedagogical context.

5. Conclusion

This study addressed the following research question: how can UX metrics be structured to support the observation of collaboration and learning experience in design education? The question was answered through the development of the Collaboration Experience Metrics Model for Education, CXM-Edu, a conceptual artifact that organizes UX metrics as contextualized proxies for interpreting educational experience in collaborative design learning contexts.

The main contribution of the paper lies in reframing UX metrics as interpretative indicators rather than direct measures of learning or collaboration. In design education, learning is frequently situated, iterative, social and project-based. For this reason, isolated indicators such as time on task, satisfaction, participation frequency, or task completion cannot explain educational quality by themselves. CXM-Edu responds to this limitation by organizing metrics into five experiential dimensions: effectiveness, efficiency, satisfaction, engagement and belonging. These dimensions allow educators and researchers to relate observable evidence to pedagogical concerns such as task achievement, retention, transfer, cognitive effort, participation continuity, and collaborative inclusion.

The model also contributes by clarifying the educational use of UX metrics across different design learning situations. In short assignments, CXM-Edu may help educators observe whether students understand task requirements, experience unnecessary friction, or perceive the activity as meaningful. In studio-based projects, it may support the interpretation of iteration evidence, critique response, design rationale and transfer across project phases. In collaborative team activities, the model may help identify whether participation is balanced, reciprocal, and inclusive. In this sense, CXM-Edu does not prescribe a fixed evaluation protocol, but provides a structure for selecting and interpreting indicators according to the pedagogical purpose of each activity.

The proposed analytical hypotheses extend this contribution by making explicit how each dimension may be examined in future studies. Rather than presenting the model as empirically validated, the hypotheses define possible relationships between proxy indicators, evidence sources and educational phenomena. This is consistent with the Design Science Research framing adopted in the paper, in which the present contribution consists of the construction and analytical articulation of an artifact. The hypotheses therefore create a bridge between the conceptual model and future empirical investigation.

The study has some limitations. First, CXM-Edu is a conceptual artifact and has not yet been empirically validated with students, instructors or educational institutions. Its current contribution is analytical rather than experimental. Second, the proposed indicators should not be interpreted as universal or context-independent measures. The same metric may have different meanings depending on the learning activity, course structure, design brief, collaborative arrangement and pedagogical objectives. Third, although the model seeks to preserve the complexity of collaborative design learning, any metric-based approach involves a risk of reduction if indicators are used without qualitative interpretation. For this reason, CXM-Edu should be applied together with pedagogical judgment, student reflection, peer feedback and analysis of design artifacts.

Future research should empirically examine the model in different design education contexts, including short assignments, studio-based courses, online collaborative projects and hybrid learning environments. Further studies may test selected hypotheses, compare how different evidence sources support interpretation and investigate how instructors use the model to make pedagogical decisions. Future work may also refine the dimensions and indicators of CXM-Edu based on empirical data, expanding its applicability while maintaining its central principle: UX metrics can support the observation of collaboration and learning experience when they are treated as contextualized proxies rather than direct measures of educational quality.

In conclusion, CXM-Edu offers a structured way to connect UX evaluation and educational assessment in design education. By organizing metrics around experiential dimensions and linking them to evidence sources, pedagogical interpretation, and analytical hypotheses, the model supports a more explicit and reflective use of indicators in collaborative learning contexts. Its value lies not in quantifying learning as a fixed outcome, but in helping educators and researchers observe patterns that may reveal how students experience, sustain and negotiate learning through design activity.

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07

Applying creative process techniques in educational environment: biomimetics, morphological matrix and prototyping

Allan G. Santos
Manuella M. Santos
Tania M. M. Rossetto
Fabiano V. Scherer
Fabio P. Silva
Júlio C. van der Linden

Abstract

The aim of this article is to demonstrate creative process tools through Bionics, Morphological Matrix, and Prototyping techniques, using them in an educational environment within design methodologies with collaborative mini-stages for design activities and their processes, integrating them with traditional and three-dimensional (3D) modeling. A literature review is presented as well, with a description of the techniques, the application process, and the context applied within the design domain. As a result, the information that can be obtained after practical application in the Creative Processes in Design postgraduate course is presented. The hypothesis is that the suitability of idealized products or objects is something for the classroom, it can become straightforward yet meaningful in visualization, stimulated by the creative process. The conclusions of the didactic experience analysis applying the tools in a learning environment are presented. It was observed that an idea can become tangible and shape the product through Prototyping such as: lighting, carpet, and modular tables, through visual exploration and the application of tools like the Morphological Matrix and Bionics. These techniques, focused on questions, also serve as a means of communication with other parties involved, including testers, clients, or the designer themselves. It also enables the introduction of 3D technology through the use of a 3D pen.

Keywords: Bionics; Creative Processes; Morphological Matrix; Prototyping; 3D Modeling.

1. Introduction

Creativity plays a fundamental role in the conception of new ideas. Imagination and creative processes are essential resources for innovation and for transforming ideas into practice. Human cognitive capacity to accumulate information is shaped by perception, experience, beliefs, and other factors. In design, creative techniques expand and establish new relationships between thinking, creating, and making, leading to innovative outcomes. Creative processes involve cognitive subprocesses such as perception, analysis, synthesis, associative thinking, and analogy, culminating in reflection. This reflection on thinking and making is referred to as metacognition. According to Thienen et al. (2023), metacognition often manifests as reflections and beliefs about past, present, or potential future actions, supporting decision-making in product development.

Flavell (1987) describes individuals who develop metacognition as those who think extensively, are prone to errors, must explain and justify their reasoning, plan ahead, critically evaluate alternatives, and make carefully considered decisions. These characteristics are inherent to professionals engaged in creative processes and design problem-solving.

Creative thinking enables the formation of new connections between ideas and is further enhanced through collaborative work, where ideas are built through shared communication (PEREIRA, 2016). The use of creative tools aligns with the PGDESIGN program's research lines, particularly in 3D technology and Design and Education.

Each tool contributes uniquely: the Morphological Matrix fosters combinations and associations; Biomimetics draws inspiration from natural systems; and Prototyping materializes ideas, enabling validation. This research focuses on understanding these three creative processes through theoretical investigation and practical group application, integrating theory and practice to encourage collaboration, reflection, and problem-solving from multiple perspectives.

Kaufmann (2004) distinguishes between proactive and reactive creativity, as well as novelty in stimuli versus outcomes. Innovation may arise from either the task or the response, reinforcing the dynamic nature of creative processes.

The main objective of this article is to apply the creative techniques of Biomimetics, Morphological Matrix, and Prototyping in an educational environment, analyzing how and why these tools support and accelerate the generation of creative solutions when used collaboratively.

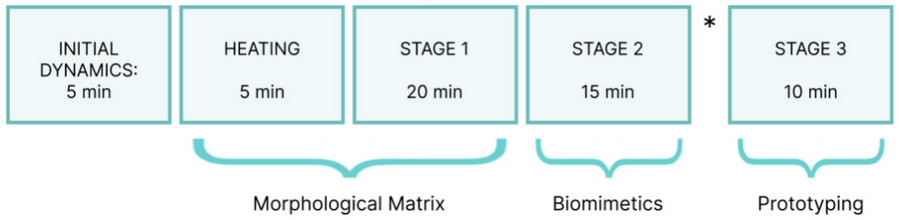
Specific objectives include: understanding the origin and function of these tools; exploring their application in a classroom setting; developing a design product based on the theme "fun"; analyzing the results produced by student groups; and documenting the findings within the context of a postgraduate design course.

2. Methodological Procedures

To understand the tools, a theoretical framework was developed, identifying concepts and classic examples from the literature to aid in the construction of the theoretical-practical seminar and to obtain references for this article.

The teaching practice was developed at different times in order to present the tools and apply their use to a hypothetical design problem. For this purpose, the theme "classroom environment with fun" was chosen, explored through the production of morphological matrices and the support of biomimetics. Between the workshop stages, oral presentations were held, supported by images to illustrate the use of the creative tools under study. Samples of elements of nature, such as plant, animal, and mineral resources, were made available to the groups during the Biomimetics stage integrated with the morphological matrix, in search of analogies to develop the proposed problem/theme. In the prototyping stage, the artifact helps to visualize and build a dialogue about the product. The prototyping technique using modeling clay was employed for visualization, and the 3D pen was introduced as an innovative material. The development of the practice will be described in the Teaching Practice section. The steps and times are divided as shown in Figure 1.

Teaching Practice section. The steps and times are divided as shown in Figure 1.



Source: Developed by the authors (2026).

This study began with a literature review and the definition of research objectives, establishing the case study methodology because it deals with a wide variety of evidence: documents, artifacts, and observations. Applied to groups of people, it is possible to collect different supporting documentation, according to Yin (2010).

This case study presents a multiple-case version of the single-case study, as defined by Yin (2010): "This type of multiple-case report will contain multiple narratives, covering each of the isolated cases" (YIN, 2010, p. 201). Based on information collected through direct observation, participant observation, and physical artifacts such as team productions, photographs, and videos, an analysis of the cases was conducted, which will be addressed in a specific session, as well as the presentation of the generated results, as indicated in the description of this research method.

3. Morphological Matrix, Biommimetics anda Prototyping

The theoretical approach underpins the concepts that emphasize the importance of using the tools Morphological Matrix, Biomimetics, and Prototyping, which aim to foster creativity in the pursuit of innovation. These theoretical foundations were essential to present the tools and to prepare and develop the didactic practice, as described below.

Creativity was once conceived as a divine gift, or as a talent reserved for a few, such as artists. Over time, with the advancement of studies, it came to be understood that "creativity is an inherent human potential, and the realization of this potential is one of its needs," as stated by the artist Ostrower (1986) in her book Creativity and Creative Processes.

According to the Systemic Model of Creativity developed by Csikszentmihalyi (1996), creativity is:

> "the result of the interaction between the sociocultural context and an individual's thinking. Thus, creativity should be understood as a systemic process that depends on the individual's personality traits and personal experiences, the field or social system in which they are embedded—including all those who evaluate whether a new idea or product is creative—and the domain, that is, the area encompassing the accumulated, structured, transmitted, and shared knowledge within a society" (CSIKSZENTMIHALYI, 1996, p. 23).

According to Pereira (2016), an individual's creative thinking—through cognitive operations and stored knowledge—enables the formation of new connections between ideas and is further stimulated and influenced in group work. Creative thinking also underlies well-known design products, which share the ability to solve problems in a remarkable way and often lead to transformative impacts, as noted by Lawson (2006).

The creative process in design, according to Pereira (2016), encompasses both the individual's cognitive processes and the processes of creation, design development, and communication. Through these cognitive operations and accumulated knowledge, new idea connections are continuously generated.

The following sections present the theoretical framework of each tool studied - Morphological Matrix, Biomimetic, Prototyping - and how they contribute to the development of the creative process when applied as design methodologies in an educational context.

3.1 Morphological Matrix

The morphological method originated from the work of astronomer Fritz Zwicky in the 1940s as a systematic way of visualizing stars. From this astronomical approach, morphological analysis emerged in 1969, also known as the Zwicky Box, Morphological Box, or Morphology.

According to Zwicky (1948), the morphological matrix is a non-quantitative technique used to structure and evaluate the set of relationships inherent in a complex multidimensional problem. It serves to identify, index, quantify, and parameterize all possible alternatives to achieve a given objective. It is based on the principle that creative solutions are often found through new combinations of objects or ideas.

The term morphology refers to the study of form structure. Morphological analysis is a systematic approach to examining the structure of a form, idea, product, system, or process (YAN, 1998). Initially applied in the military field, it quickly spread and became widely used for solving various types of problems.

The morphological matrix is an analytical and combinatorial method used as a design tool. It is widely applied in product design, as well as in graphic and digital design, and can be used by individuals or teams. Its objective, according to Pazmino (2015), is to explore new solutions through combinations of alternative possibilities. By combining elements such as form, color, and function, it enables the visualization of innovative solutions.

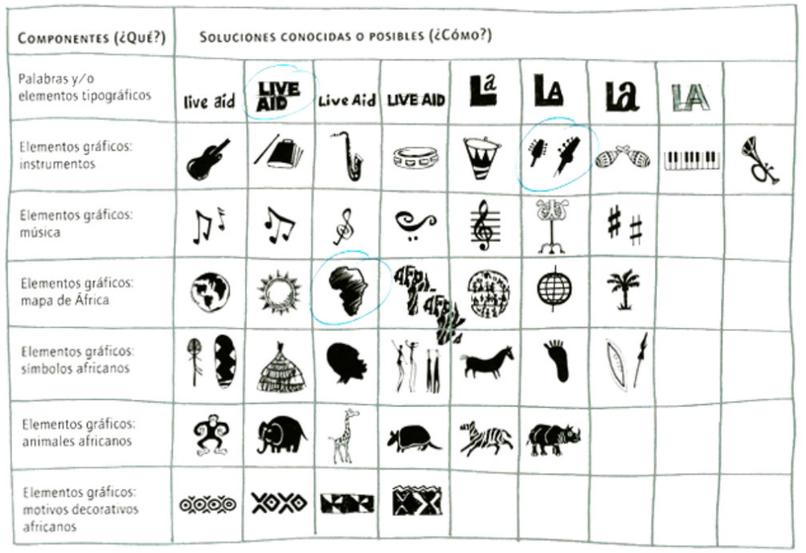
According to Bonsiepe (1984), the morphological matrix is used to understand the formal structure of a product and its components by analyzing aspects such as symmetry, harmony, balance, and element positioning. This analysis helps to understand geometric design principles, transitions and connections, compatibility, surface treatments, and color finishes.

Pazmino (2015) also highlights that the morphological matrix can be applied in both the analysis and synthesis phases of a project. The analysis phase involves data collection and questioning of properties and conventions, while the synthesis phase uses the acquired knowledge to generate creative and innovative solutions once the context and briefing are clearly defined.

For Stindt et al. (2016), the initial diagram of a morphological matrix applied to sustainable product development should include four stages: identification of relevant factors and states, cross-analysis of information, compatibility evaluation, and finally, the development of a model to obtain results. These steps highlight the importance of clearly defining the problem before exploring possible solutions.

The structure of the morphological matrix consists of two axes: functions (or variables) and solutions. The number of rows and columns may vary depending on the project, and a greater number of cells results in a higher number of possible combinations. In formal analysis, functions or variables - such as color, form, texture, and style - are placed in the first column. Each empty cell represents an opportunity for innovation, where alternative solutions are generated. As a tool for expanding ideas, the matrix benefits from the use of images and colors to enhance visualization. Figure 2 presents an example of a morphological matrix developed to create the logo for the Live Aid music festival, aimed at combating famine in Ethiopia in 1985.

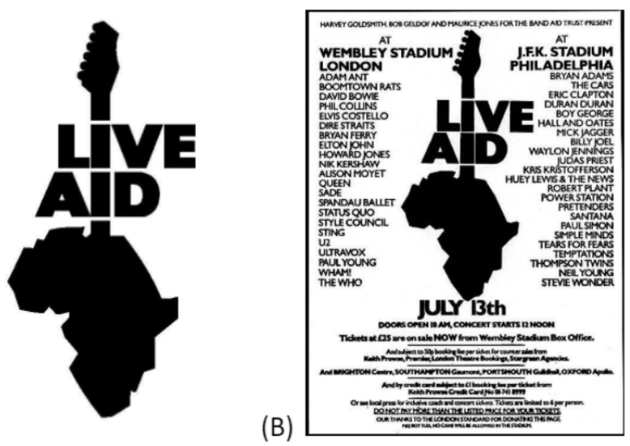
Figure 2 - Morphological Matrix for the Live Aid festival logo



Source: Developed by the authors (2026).

In the morphological matrix shown in Figure 2, the two axes (rows and columns) can be observed: the components and the possible solutions for each function distributed across the remaining cells. After constructing the matrix, "the solutions must be evaluated based on feasibility criteria, and ideas that do not meet the project requirements or the briefing should be eliminated" (PAZMINO, 2015, p. 207). Some cells in the matrix are marked with circles, indicating the best solutions. These selected solutions were used in the development of the Live Aid logo, as illustrated in the promotional poster shown in Figure 3.

Figure 3 - Live Aid logo (A) and promotional poster (B).



Source: Gonçalves (2015).

In Figure 3, the final logo solution and its application on the poster can be observed. Black was used for both the logo and the text, applied over the white background of the promotional poster.

According to Pazmino (2015), the morphological matrix should be assembled on a board or a large sheet, allowing the product to be visualized in a deconstructed form, where each component can be modified independently by one or more team members. This process enables the exploration of combinations and the visualization of solutions that would not emerge without such recombination. Not all cells need to be filled in during the search for solutions. The literature also indicates that the ideal solution may not necessarily be found within a single matrix. Therefore, it is recommended to analyze the generated ideas, select the most promising ones, and construct a new matrix based on this selection, enabling further exploration and refinement toward the best solution for the design problem.

3.2 Bionics anda Biommimetics

The related term bionics intersects with biomimetics and, despite their differences, will be used interchangeably here. These terms emerged in the 1950, when different branches of science began investigating relationships between human activities and principles found in nature, especially in the biomedical field. These studies are based on the creation of mechanisms similar to natural systems (BHUSHAN, 2009). Jack Ellwood Steele defined biomimetics as: “the science of systems whose functioning is based on natural systems, or that exhibit specific characteristics of natural systems, or are analogous to them” (ARRUDA, 1994).

Janine Benyus (1997) highlights the importance of biomimetics in creating more efficient and sustainable designs, arguing that nature offers solutions already tested by evolution over millennia. The principles of biomimetics, when applied to design, can result in more sustainable products and systems, both in terms of efficiency and economy, as well as environmental impact.

One of the major contributors to the study of this field is the German zoologist Werner Nachtigall (1934-2019), a pioneer and precursor of bionics. In the 1990s, he created the discipline “Technical Biology and Bionics” and founded a society with the same name. According to Nachtigall (1998), bionics means that everything is technically transferable, including the most complex technologies of nature, all without violating the laws of nature. Bionics does not seek to prescribe anything to the engineer, but to place them in front of the ‘mirror of nature’ and thus demand their best. The zoologist further states: “Bionics is not a universal remedy, nor a creed. It constitutes a tool that should neither be misused nor neglected, like any other tool” (NACHTIGALL, 1998, cited by Rosendahl, 2006, p. 90).

In Figure 4, examples can be observed of natural technologies serving as sources of inspiration and their application in design products.

Figure 4 - Elements of nature applied in design products: (A) bamboo, (B) necklace, (C) armadillo and (D) lid.



Source: Adapted from Arruda (1994).

There are several ways to use elements from nature as creative resources. Soares & Arruda (2018) discuss some types of possible analogies, including morphological analogy, functional analogy and symbolic analogy (SOARES & ARRUDA, 2018).

Morphological analogy is a fundamental concept in bionics, as outlined by Arruda (1994). It is based on the observation and analysis of morphological structures found in nature to inspire technological solutions. In this context, morphological analogy involves seeking parallels between the forms, structures, and functions found in living organisms and the design or engineering challenges that need to be solved. By identifying morphological similarities, designers and engineers can adapt and apply principles from nature in their innovations, creating more efficient and effective solutions.

Functional analogy, on the other hand, focuses on observing and adapting the functions performed by living beings to solve technological and engineering problems. In this approach, researchers identify the biological functions carried out by certain systems

or organisms in nature and seek to apply similar functional principles in human solutions. For example, by studying how a bird flies and remains airborne, engineers can apply similar aerodynamic principles in aircraft design. Functional analogy allows biomimetics to take advantage of evolutionary processes tested by nature to create technological innovations that are more efficient and effective, reflecting the understanding that nature often offers functional solutions that can be adapted to meet human needs.

Finally, symbolic analogy consists of interpreting and adapting patterns, codes, and symbols found in nature to address design challenges. It involves observing and understanding how natural systems communicate information through visual, auditory, or other symbolic codes. Researchers identify these patterns and replicate them in human systems, such as in the design of communication systems and sensors. Symbolic analogy demonstrates how nature creates complex systems for encoding and decoding information, which can enhance the effectiveness of communication and interaction with technology.

Biomimetics gained recognition with the development of technologies inspired by nature, commonly applied in the medical field, such as the design of improved prosthetics and vision systems based on biological models. Since then, biomimetics has evolved into an interdisciplinary field that combines biology, engineering, design, and computer science, driving significant advances in various areas, including medicine, robotics, aeronautics, and architecture. The history of biomimetics is a narrative of continuous learning from nature, seeking innovative solutions to technological and design challenges, and it stands as a testament to the inexhaustible potential of inspiration that nature provides (RAMOS, 1993).

Biomimetics also plays a fundamental role in the creative process, encouraging designers to observe and learn from nature. Inspiration drawn from biomimetics can lead to innovative solutions, fostering creativity and problem-solving in original ways. Through the analysis of natural structures, patterns, and processes, designers can discover new approaches to challenges, promoting sustainability and efficiency in their creations (PAWLYN, 2011).

Therefore, biomimetics plays a significant role in improving design, driving innovation, and encouraging creative approaches to complex problems. As more designers incorporate bionics principles into their projects, it is expected that innovations will emerge across various fields, from architecture and product design to engineering solutions, with potential benefits for society and the environment.

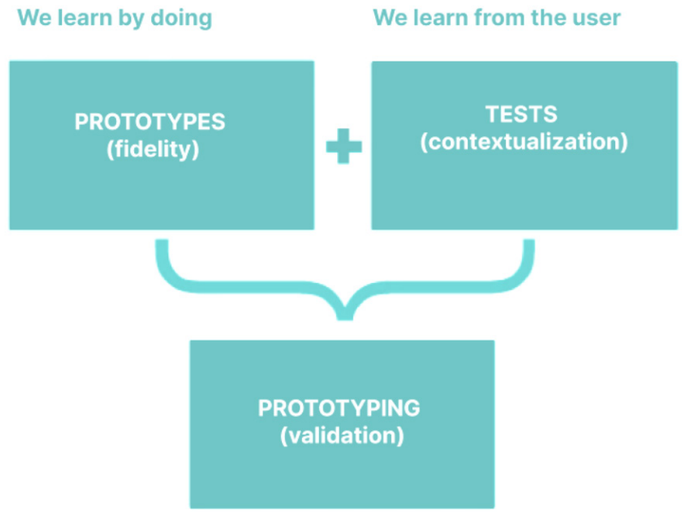
3. Prototyping

According to Kumar (2012), prototyping involves the development of a representation of the product, not necessarily using the final materials. In the words of Vianna et al. (2012, p. 13), it is “the act of making an idea tangible, the transition from the abstract to the physical in order to represent reality - even if in a simplified way - and enable validation”.

This highlights the importance of representing and validating ideas, as well as anticipating problems and considering different points of view, especially when working in teams with distinct perspectives. It can be used in various stages, up to the minimum viable delivery for participant evaluation.

Figure 5 presents a scheme that helps to understand why prototyping is important. By creating a prototype, one reflects on details, learns by doing, and contextualizes the product while testing it, in order to validate it with users.

Figure 5 - Why prototype?

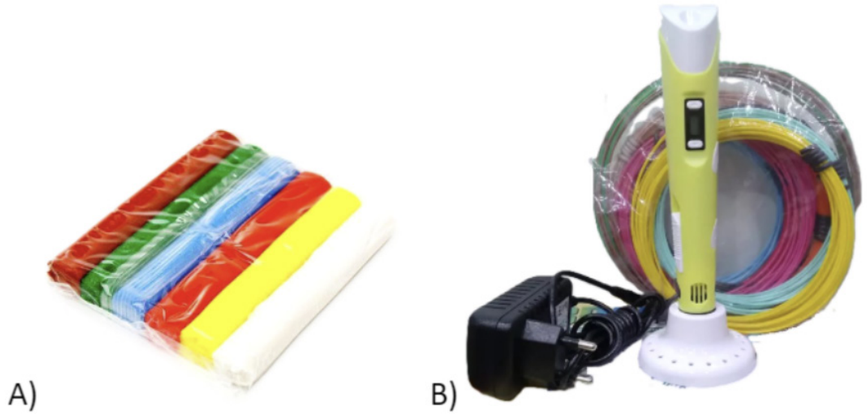


Source: MJV (2016).

The literature presents various techniques and different materials for prototyping. Figure 6A shows a modeling clay and Figure 6B shows a 3D pen + ABS filaments, both used in this study. Traditional modeling with clay allows the material to be shaped using fingers and hands, giving form to imagined ideas, while also enabling the use of additional tools to enrich the form with textures or details. The created form communicates the idea, demonstrating and sharing it with colleagues.

The 3D pen, as a newer prototyping technology, allows people to create objects in an easy and accessible way, and is also feasible for implementation in regular education as well as in specialized educational settings.

Figure 6 - Modeling clay (A); 3D pen + ABS filaments (B).



Source: Developed by the authors (2026).

The 3D pen was invented by Maxwell Bogue, Peter Dilworth, and Daniel Cowen in 2012, based on the idea of a device capable of enabling simple and accessible 3D printing. In 2013, the 3D pen was introduced by the American company WobbleWorks under the name “3Doodler” (3DFila, 2023). The 3D pen is relevant due to its agility in materializing the creative process, allowing imagined three-dimensional objects to be represented with improved visualization of these elements.

With a format similar to a conventional pen, it operates as a 3D printing mechanism that enables three-dimensional constructions at a lower cost compared to a 3D printer, and it does not require computational modeling, as it depends solely on user manipulation. The ABS (acrylonitrile butadiene styrene) or PLA (polylactic acid) filament functions as the “ink” of the pen, being deposited in layers. The nozzle, made of metal or ceramic depending on the model, reaches temperatures between 180 °C and 240 °C, melting the filament and extruding the material in a semi-fluid state (SANTOS & CAVALCANTE, 2023).

The use of the 3D pen in education enables interactive learning, encouraging students to take an active role in the process. According to Silveira et al. (2019, p.1), the advantages of using the pen include “the immediate construction of representations, enabling greater flexibility in classroom activities, as well as its simple and safe use and the production of surfaces with easily identifiable tactile relief”. The Figure 7 demonstrates prototyping using a 3D pen with green ABS filament, enabling the development of prototypes with formal modifications.

Figure 7 - Prototypes with a 3D pen.



Source: Developed by the authors (2026).

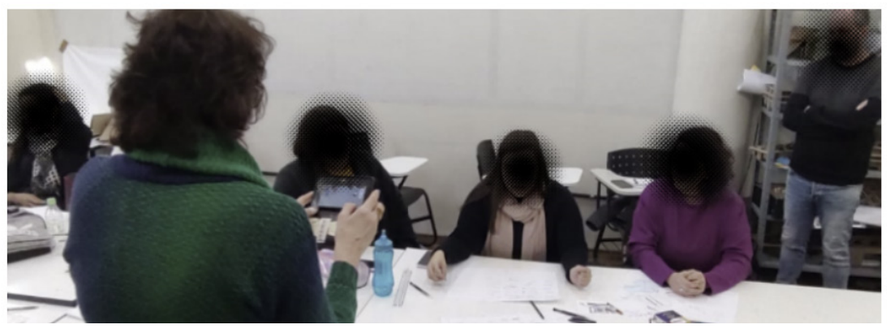
It can be concluded that creative processes are tools that support the connection of ideas in the pursuit of increasingly innovative outcomes.

4. Teaching Pratice and Creative Techniques

The activity under study was developed in the format of a theoretical-practical seminar on Biomimetics, Morphological Matrix and Prototyping. It was applied over a period of 3 credits, in a class of 22 students from the Postgraduate Program at UFRGS, composed of designers, architects, teachers and IT analysts, in the Creative Processes discipline, under the guidance of Professor Fabiano Scherer.

On the day of the seminar, there were 14 students present, in addition to the 3 facilitators who conducted the seminar and the professor of the subject. The three techniques of the creative process under study were presented, one at a time, with their respective theoretical references. The Figure 8 provides an overview of the mediation and monitoring of the seminar by the group and the course professor.

Figure 8 - Mediation and records of the group process.



Source: Developed by the authors (2026).

From the beginning of the seminar, the aim was to motivate participants with verbal (speech), pictorial (images) and physical (selected elements of nature, introspection) stimuli, since, according to Pereira (2016), these stimuli are sources that contribute to the creative process in the application of the tools, enabling the emergence of individual and team creative potential.

The learning space can be seen in Figure 9, where a series of tables have been grouped in the center of the room and the students are arranged around them, leaving the end of the table closest to the blackboard free in order to have visibility of both the blackboard and the projection screen.

Figure 9 - Classroom Layout and Initial Practice.



Source: Developed by the authors (2026).

Still in Figure 9, we see the initial experience: a dynamic in which each participant had the opportunity to close their eyes and recall from their affective memories a situation related to the word “Fun”. After the allotted time, they were asked to select one or two objects in order to graphically record them on a sheet of A5-sized sulfite paper.

Memory supports cognitive and emotional processes, according to Ximendes (2010), and makes us distinct individuals. “Higher-order cognition depends on the ability to recall information from memory and retain it in mind to guide future behavior” (XIMENDES, 2010, p. 53). Retrieving memories is a way to bring the best of individual experiences into the work process. The theme of “fun” was suggested to later become part of the work process, as well as the object of study.

3.4 Stage 1: Morphological Matrix

Subsequently, the Morphological Matrix was presented, including its origin, characteristics, structure, and its use as a design tool. Three types of morphological matrices were analyzed. The first was developed by a student who was researching solutions for a cup object. The student constructed the morphological matrix by drawing the parts of the cup, analyzing them, and “obtained 137 alternatives for the cup’s form” (PEREIRA et al., 2014, p. 6).

The second example refers to the creation of a logo symbol for the Live Aid musical event, a music festival aimed at combating hunger in Ethiopia in 1985. To construct the morphological matrix, elements from culture, location, and music were used (PRICKEN, 2002, p. 207). The developed matrix was presented with the three selected elements used in the composition of the event’s logo, along with the final logo and its application on promotional posters and on the event stage.

The third and final example of a morphological matrix was composed of elements cut and pasted from virtual references (Figure 10). It was used in a Mechanical Engineering project to “list the main functions and solution principles of the product (...). Based on the product’s functions, it was possible to develop a retractable mechanism system, a component to accommodate seated individuals, and a component to provide impact protection.” (LOURENÇO & FETTERMANN, 2021).

Figure 10 - Explaining the third example of the Morphological Matrix.



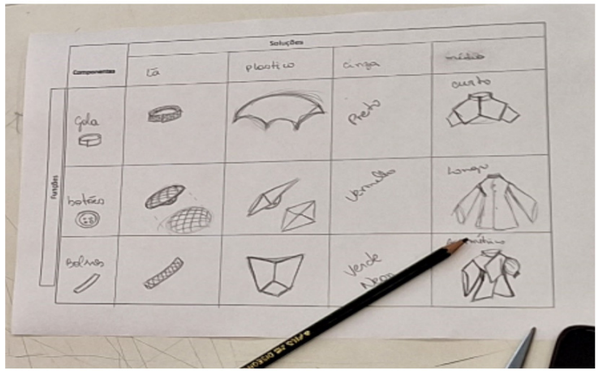
Source: Developed by the authors (2026).

After the explanation and visualization of the cases presented above, time was opened for questions and clarifications regarding the examples. The first activity was then introduced.

The first proposed practical activity was to create a morphological matrix based on an object brought from the participants’ affective memories, linked to their initial experience. The exercise was carried out individually, using a pre-drawn and printed structure provided on a worksheet. The objective was to understand how to construct the morphological matrix using its two defining axes: functions or variables and solutions.

To achieve this, each student received a sheet with the matrix printed and, using the object retrieved from their affective memory as a reference, began the analysis by filling in the matrix. In the first column, the elements corresponding to the object’s functions or variables were described, and along the rows, the solutions were listed - these being ideas that could serve as possible options for each function. An example of a morphological matrix developed in this exercise can be seen in Figure 11.

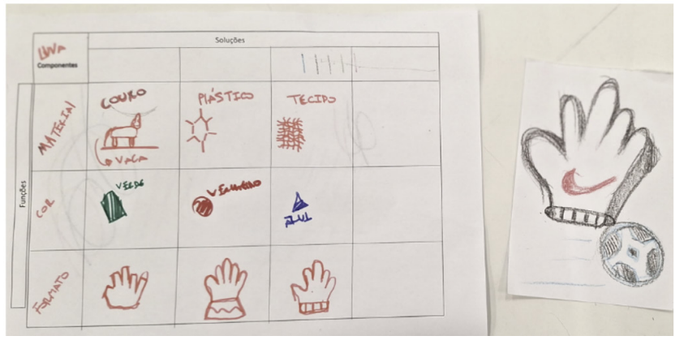
Figure 11 - Exercise on constructing the morphological matrix.



Source: Developed by the authors (2026).

In this matrix, the motivating element was a personal object, a coat. The identification of the initial axes can be observed, along with the development composed of words and drawings sketched in pencil. Other examples of morphological matrices obtained are shown in Figure 12.

Figure 12 - Morphological Matrix: football glove.



Source: Developed by the authors (2026).

In Figure 12, it can be observed that the morphological matrix was filled in using words and drawings with some use of color. It is also noticeable that, on the right side of the matrix, there is a drawing of the object recorded in the initial experience, the soccer glove. In it, a recurring color is used, which also predominates in the morphological matrix.

The individually carried out exercise was monitored, supporting the construction of the matrix and addressing questions. After this stage of understanding the matrix, a theoretical explanation on Biomimetics was presented.

3.5 Stage 2: Biomimetics

The biomimetics activity consists of analyzing natural systems with the aim of identifying solution principles that, when properly adapted, can contribute to solving technical problems (RAMOS, 1993). The concept of Biomimetics was presented (Figure 13) and illustrated with selected images highlighting details from nature.

Figure 13 - Explanation of biomimetics.



Source: Developed by the authors (2026).

The following design problem was proposed: to create a playful product for the classroom environment, with the objective of increasing students' well-being and breaking away from the traditional concept of school space, incorporating the theme of "fun." This theme was proposed considering how much the classroom environment can influence the teaching–learning process.

To support the groups in their creative process, a variety of natural elements were made available (Figure 14). Among the options were plant-based resources such as leaves, stems, flowers, fruits, and seeds; mineral resources such as shells and rocks; and animal-based resources such as corals, fur, leather, and feathers. As discussed in the biomimetics explanation, these visual and tangible elements from nature could serve as sources of inspiration through their form, structure, texture, functionality, among other aspects.

Figure 14 - Students developing the project using the morphological matrix and natural elements as inspiration.



Source: Developed by the authors (2026).

The activity was carried out in groups organized by the students: three groups of three students and one group of five students. Since the morphological matrix is used in the creation phase and is operational in nature, it needed to be applied initially to structure the solution to the design problem. The development process is presented below.

As shown in Figure 15, during the activities, the seminar mediating group documented the moments through photographs and continued to monitor the participants working in groups, while they exchanged knowledge and experiences and presented collaborative ideas.

Figure 15 - Development of group activities with mediator support.



Source: Developed by the authors (2026).

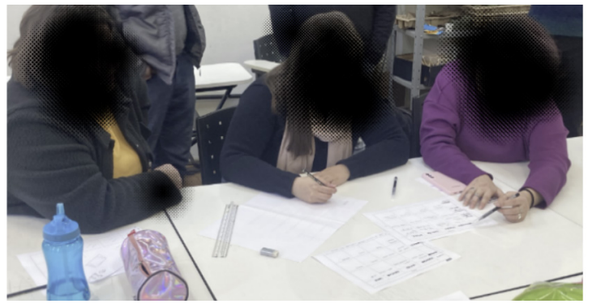
Monitoring the development of the work process and providing support to students is a way to ensure productivity. Some individuals, regardless of rewards, remain persistent and focused on the proposed challenge, while others require recognition to continue, avoiding stagnation, frustration or a negative experience.

Two groups selected plant-based resources, such as leaves and dried fruits. One group chose a shell, and the fourth group selected an animal-based resource - the bioluminescence of the firefly - which was not physically present, but was introduced as an idea and used as inspiration for the project. The natural resources showed a wide range of representation in the groups' choices, as they included plant, animal, and mineral elements.

Interactions with external stimulating elements generate reactive creativity (KAUFMANN, 2004), a condition in which inspiration is expected to emerge, while care must be taken to avoid anxiety or frustration from not immediately finding a solution.

According to Csikszentmihalyi (2006), an experience is similar to the notion of "flow", where the creator is overtaken by pleasure and fascination, becoming fully engaged in the process, and essentially, what drives this movement comes from something that calls for action. The Figure 16 shows a group in the process of developing the morphological matrix.

Figure 16 - Process of creating the morphological matrix.



Source: Developed by the authors (2026).

After the presentation of the Morphological Matrix, an individual practice was carried out to familiarize participants with the tool, followed by a set of activities in small teams aimed at solving the proposed design problem, integrating biomimetics and the morphological matrix. Subsequently, each team explained their work process and presented their results.

Gradually, the matrix was structured and analyzed, giving shape to creative solutions for the proposed design problem. After the allotted time, with responses developed and recorded in graphic projects, the participants verbally reported on the process and the solutions found. These will be described, visualized, and analyzed in the next section of this article.

3.6 Stage 3: Prototyping

Subsequently, Prototyping was explained using visual resources and modeling clay was provided to enable a hands-on experience in modeling and prototyping the product generated in the previous stage (Figure 17).

Figure 17 - Explanation of prototyping.

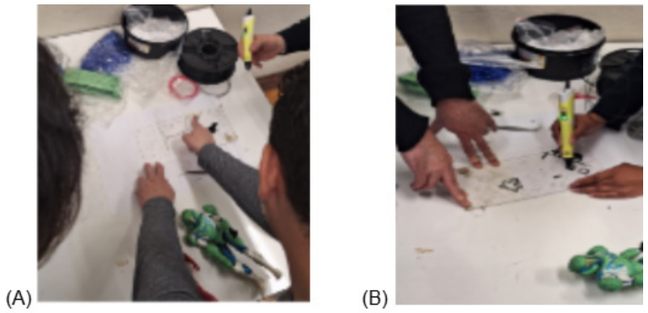


Source: Developed by the authors (2026).

Next, prototyping was explained. The activity began with modeling clay, and the technique was then applied to prototype the object designed by each team, now using the 3D pen. This allowed each group to experience a new approach and obtain their created object. At this stage, the functionalities of the pen were presented, briefly describing its operation, followed by a practical demonstration on an acrylic base, highlighting the importance of first-layer adhesion. It also demonstrated the possibility of drawing in two dimensions, removing the flat drawing, and positioning it perpendicularly.

As an additional prototyping option, an experience with the 3D pen was explained and offered, a material still little known as a classroom practice. The experimentation with the 3D pen was then proposed and accompanied by a mediator, who provided explanations to each group, clarified doubts about the material, and guided safe handling, using acrylic surfaces and tweezers for thermal protection. While students experimented with the process of tracing the heated lines and creating forms and textures, layering them to achieve three-dimensional results related to their projects. In Figure 18, students can be seen observing instructions on how to use the 3D pen while handling prototype examples.

Figure 18 - Students receiving explanations about the 3D pen (A); handling it while creating their prototypes (B).



Source: Developed by the authors (2026).

Curiosity about the new material motivated the teams to handle the 3D pen, and through creativity, each group was able to prototype their product. To support this process, a video demonstrating the application of this tool in solving various tasks was also provided.

It is evident that students show strong interest in exploring elements beyond those they usually work with. With the mediator's explanation of components, such as types and colors of filaments, characteristics of the pen tip, operation, and necessary safety precautions, it becomes possible to achieve effective results. Presenting examples with prototypes tested and developed by the mediator made the experimentation highly engaging and stimulating.

The classroom proves to be a favorable environment for group work, the sharing of ideas, experiences, and materials. It encourages experimentation, the construction of analysis and synthesis, and fosters metacognition and empathetic relationships among participants. Images of the prototypes produced with the 3D pen will be presented in the following section, where the results of the process are discussed.

4. Analysis of Group Processes

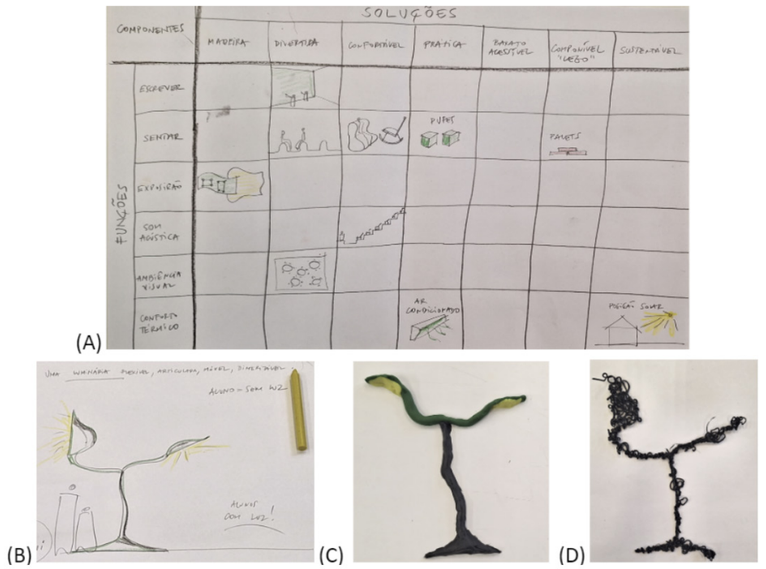
The techniques of the creative process are motivating and address the design problem in order to find the best solutions for the established problem, within the available time, with great creativity. The proposed design problem involved creating something fun for the classroom environment in groups formed by the students. It was observed that empathy was an important element in the formation of the groups. The results of applying the Morphological Matrix, Biomimetics and Prototyping techniques in the learning environment will be described below. The Figures 19 to 22 illustrate the work process of the 4 groups.

4.1 Group 1 Product: Lighting Fixture

The Group 1 was formed with three participants. They structured the morphological matrix with its two axes, function x solution, without any initial idea but gradually, using the theme of fun in a classroom environment, and then, they built the morphological matrix. In the morphological matrix, the Group 1 raised solutions and generated analysis, obtaining the result by applying words, images, and some colors. It was observed that some cells remained blank, which is recorded in the literature as something possible (PAZZMINO, 2015).

The Group 1 successfully prototyped using modeling clay, applying a specific color to the lamp's structure and another to indicate the lighting part, as can be seen in Figure 19C, that shows the various functions of the elements and the prototyping, and also in Figure 19D, using the 3D pen.

Figure 19 - Group 1 Product: Lighting Fixture - morphological matrix (A); project (B); modeling clay (C); 3D pen (D).



Source: Developed by the authors (2026).

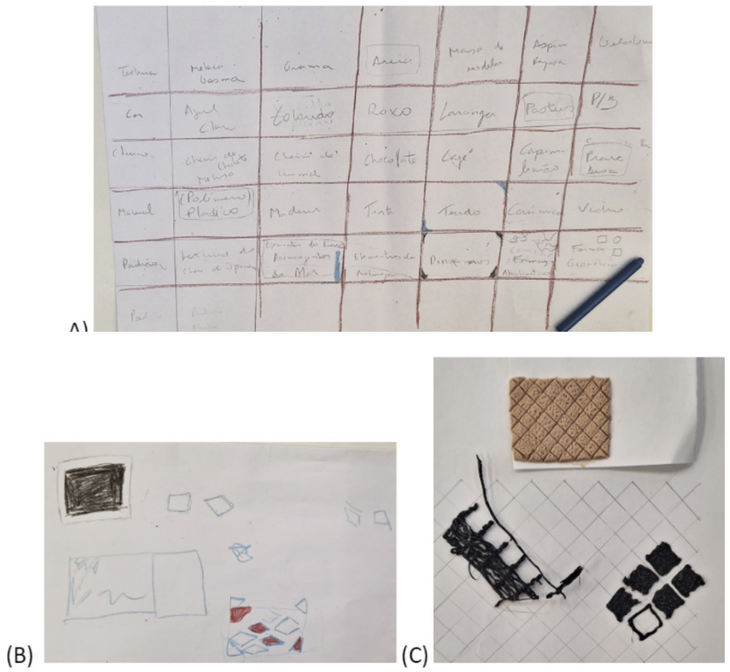
As an inspiring element of nature, the group selected a plant, a small branch with two dried seeds. From this, the group designed an object for the classroom: a lamp, finding a solution to the design problem outside the morphological matrix. This solution is also supported by the literature as a possibility.

4.2 Grouop 2 Product: Rug

The Group 2, also formed with three participants, constructed the morphological matrix emphasizing the structural points of their product. They structured the vertical axis of the matrix with the words: texture, color, smell, material and pattern. They also chose to explore sensory resources, such as smell, selecting scent options that could generate a pleasant experience for the user. With this, they selected the following options from the matrix, as shown in Figure 20 (texture: sand; color: pastel; smell: beach; material: polymer; pattern: marine animals).

After the presentation on biomimetics and the observation of natural elements, they chose the texture and pattern of shells available to finalize the design of the final product: a rug. They carried out prototyping in modeling clay, creating texture on the representative block of a rug, and with a 3D pen, managing to represent the desired texture and patterns.

Figure 20 - Group 2 Product: Rug - morphological matrix(A); project details (B); prototyping with modeling clay (the beige rectangle) and with a 3D pen (the black grid) (C).

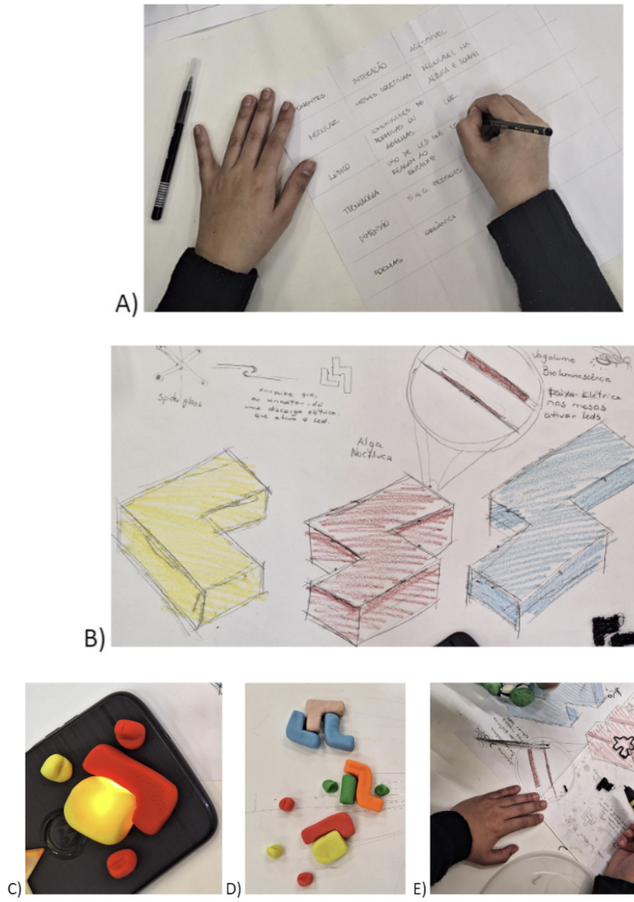


Source: Developed by the authors (2026).

4.3 Group 3 Product: Stackable Tables

The three participants from Group 3 structured the morphological matrix for two possible products. Then, they created a third morphological matrix using the following elements for analysis: Modular: collective tables; Playful Reference: the community of ants and bees; Color: colorful; Technology: use of LEDs that react when fitted; Size: for 5 to 6 people; Shape: organic. In the end, they found an ideal solution that surprised them, as verbalized in the presentation, bringing the idea of LEDs based on the luminescence of fireflies. The group also used the flashlight of their cell phone to give the idea of the lighting in their project - shown in Figure 21C. See Figure 21 for the group's process.

Figure 21 – Group 3 Product: Stackable Tables - morphological matrix (A); project details (B); luminescent prototyping (C): the group used a cell phone flashlight to illuminate their project; prototyping (D) with colorful modeling clay; prototyping (D) with a 3D Pen.



Source: Developed by the authors (2026).

4.4 Group 4 Product: Stackable Table

The Group 4 was formed by five participants, and they structured the morphological matrix based on a plant element, after observing various elements of nature and establishing dialogues and reflections. The Figure 22B shows the natural references selected and analyzed by Group 4. Among them are several plant elements such as: a dry leaf, tree bark, a part of another plant, a seed, a rolled-up seed husk and an animal element (a piece of leather). Based on the reflection and selection of characteristics of the natural elements, they constructed the morphological matrix, on the vertical axis: the form, materials, color, and surface texture, as can be seen in the Figure 22F. On the horizontal axis, they explored various possibilities to arrive at the ideal result for the design problem, using words, shapes, and some colors for characterization.

Figure 22 – Group 4 Product: Stackable tables - morphological matrix (A); initial ideas (B); elements of nature researched (C); stackable table design (D); sketch with the 3D pen(E); prototyping with modeling clay and the 3D pen fitted together (F).



Source: Developed by the authors (2026).

5. Discussion

The elements highlighted by the four groups (Groups 1 to 4) are presented in Table 1. The first column indicates the group number; the second column corresponds to the Morphological Matrix; the third column identifies the natural element highlighted as the source of inspiration for Biomimetics; the fourth column indicates the biomimetic approach; and the fifth column presents the generated product.

Table 1 - Highlighted elements for each group.

Groups	Morphological Matrix	Natural Element	Biomimetics	Generated Product
Group 1	Thermal comfort and sun exposure	Dried fruit	Structure/	Lighting Fixture
Group 2	Texture, material, pattern and smell	Shell	Format	Rug
Group 3	Modular, technology and interaction	Insect	Texture	Stackable table
Group 4	Interaction and furniture	Plant leaf	Functionality	Stackable table

Source: Developed by the authors (2026).

Groups 1 and 4 used the visual characteristics of the natural elements they selected, creating objects with structures inspired by the shapes of a dried fruit and a plant leaf, respectively.

Group 2 also chose a structural perspective for their natural element, but focused on the sensory aspect, the texture of the material. In biomimetics, it is possible to explore different facets of natural elements, and structure is perhaps the most visible aspect and directly related to the possible characteristics to be replicated in other contexts (RAMOS, 1993).

Group 3 used a different approach. They had already created a matrix exploring concepts of “beehive”, “collective work” and “connection” among other keywords that led them to think of the generated product as a table that connects in different ways, and also each connection generates a beam of light on the sides of the table. This concept reminded Group 3 of the bioluminescence of fireflies. It is important to emphasize that biomimetics fulfills both the role of proposing solutions for a project already underway

and that of being the inspiring agent for an idea yet to be developed (BENYUS, 1997).
Group 1, during the construction of the morphological matrix, explored different components of a classroom and their respective possibilities. After analyzing the matrix, the group identified thermal comfort as a relevant aspect, which led them to consider issues related to sun exposure and lighting. The participants commented that observing the branch with the dried fruit facilitated the creative process. They related its shape by similarity to a lamp. From there, they found the necessary insight for the solution. It is worth noting that the morphological matrix is an instrument that allows investigating the perspectives of a theme, initially generating a broad range of ideas, and subsequently delimiting the focus of the creation. In this case, since the specific objective of creating the product was to be an element for the classroom, the aspect of classroom lighting was chosen. However, the more specific the objective, the more the morphological matrix helps to find the most appropriate solution. Sometimes, the morphological matrix assumes the function of stimulating the generation of ideas, but the solution does not always emerge within the same matrix, as Pazmino (2015) points out, as observed in the solution found by Group 1.

Group 2 created a matrix emphasizing the aesthetics and synesthesia of materials, thus resulting in a final product with the fundamental principle of promoting sensory comfort. The morphological matrix is a resource where the choice of components is particularly critical and requires considerable reflection in adopting selection criteria. Choices are imperative in identifying key components according to Kilian (2009). This was evident when observing that, despite the products being created for the same purpose, there was diversity in their conceptions, resulting from the variety of elements used in the morphological matrix. The same proposal is explored from different perspectives, allowing for different outcomes.

As observed during the work process proposed in this study, the students used associative thinking and analogies to arrive at satisfactory solutions to the proposed problem through individual and/or team reflection: creating a fun product for the classroom environment. It was also observed that something intangible like an idea, through visual exploration and the application of tools such as the Morphological Matrix and Biomimetics, can become tangible and take the form of a product through Prototyping.

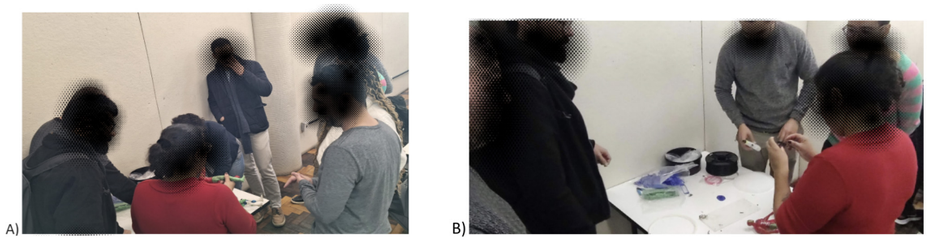
The goal of Prototyping is feedback. The prototype is an artifact geared towards questions, a means of communication with other people involved, whether those who perform tests, clients, or yourself. In the educational context, the difficulty of including 3D printers is noticeable, but the 3D pen is a more accessible technology that generates results and can be introduced in the classroom for small experiments, such as the prototyping discussed in this article.

6. Conclusion

The learning environment fostered discussions and generated an excellent teaching experience, promoting motivation for questioning and information exchange, as well as problem-solving from different perspectives and with much reflection. Collaborative work was valued throughout the entire process, with teamwork, debate, and reflection on solutions to design exercises and problems.

Questions were asked about the use of the 3D pen technique, and directions were given to facilitate its use, as it can be seen in the Figure 23A. The participants were surprised by their unfamiliarity with the instrument, but also by the ease with which they learned to use it.

Figure 23 – Assistance with the 3D pen (A); Prototyping activity (B).



Source: Developed by the authors (2026).

The Figure 23B shows the participants' engagement in using and reproducing a given piece is evident. Some students found it easier, while others needed more time, but in the end, all groups were able to perform the tests with the 3D pen with assistance. A lack of familiarity with technological resources is always a challenge. The main obstacle to using the 3D pen in the classroom is perhaps the lack of knowledge on how to operate the equipment, but by providing support, it is possible to achieve the desired results, as demonstrated by the experience with the four groups that successfully completed their creations. Positive feedback was received at the end of the activity, especially regarding the use of 3D technology, which was an innovation.

The three authors involved in the mediation were able to apply their research lines to this discipline, making the work relevant to the academic experience. Future work could address how to develop the approach of the three techniques of the creative process, and the 3D pen in its use in the school setting. The 3D pen can also serve as an introduction to 3D printing technology.

This challenge was carried out by integrating the study and expository presentation of methods, visualization of illustrative images of how they were applied by professionals; carrying out real exercises for individual and group experimentation for later practical application in order to solve the proposed design problem: creating a fun product for the classroom environment, as well as experimenting with prototyping using a 3D pen to complement the practice, revealing an innovative material that can be used in the classroom.

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08

Design-driven innovation in collaborative educational environments: a methodological proposal for project-based learning

Daniel Ventura

Abstract

This chapter presents the evolution of a design-based problem-solving method whose original logic was grounded in a specific territory, with the inhabitant of the microenvironment as the main actor, carrying a culture built through their own lived experiences within that territory, and with design acting as a catalyst for innovation capable of transforming the way problems are solved, making solutions renewable and replicable. The new method, restructured and presented in this chapter, does not replace the earlier one but rather expands it. What changes is its scale and applicability, the composition of the actors involved, and the nature of the method itself: from descriptive, it becomes prescriptive, no longer simply showing a solution obtained through design as a problem-solving tool, but structuring the action at the moment design, as a method, meets the educational territory, engaging students, teachers, and the world of work. Previously an individual approach, the method is now presented collectively, articulated with the Senac Pedagogical Model (Modelo Pedagógico Senac – MPS), making the student the main actor and protagonist, mediated by teaching action. The student's formative experience becomes pedagogical within the proposed method, which is structured and organized into stages that emphasize and foster, through strategic design, design thinking, and design as a catalyst for innovation, problem-solving and project development within the educational environment. Finally, the territory where the original method was developed, the Mário Quintana neighborhood in Porto Alegre, remains a reference for validating this new proposal, being confronted by its own microenvironment while aiming at future expansion to other educational territories.

Keywords: **design-driven innovation; design as a catalyst; project-based learning**.

1. Introduction

Current transformations, intensified by rapid and dynamic digitalization and by network culture, are leading educational institutions to rethink their teaching and learning practices. Castells (2003) points out that today's society, increasingly organized as a network and largely digitalized through participatory culture, makes the use of collaborative, user-centered methodologies extremely necessary. Against this backdrop, design takes on a leading role, capable of articulating and mediating the actions that will drive innovation with a human-centered focus (BROWN, 2009).

Given this scenario, and in order to expand the real reach and the impact on the world of work of the projects developed by students in the classroom, this methodological proposal aims to develop not merely a space for collaborative, design-driven innovation projects, but a structured method for carrying out such actions — one that is also aligned with the principles of the Senac Pedagogical Model (MPS), which guides teaching practices across the Institution's educational units.

According to Manzini (2015), design today acts as an agent of social transformation, designing small-scale collaborative contexts of innovation that nonetheless carry immense social impact — a view shared by Ehn (2008), who shows how participatory design operates within the creative process, turning the design of artifacts into a learning exercise.

As a nationally recognized reference institution across multiple levels of education, SENAC remains attentive to these changes, developing methodologies aimed at driving forward its students' projects through inter- and multidisciplinary experimentation inspired by creative labs, described by Björgvinsson et al. (2012).

These resolutions also reflect the application of design as a driver of innovation and the replication of the experimental method across all of the state's educational units, which differ in structure and capacity. These applications aim to develop solutions for systematizing collaborative practices that, above all, promote educational innovation in a continuous and replicable way.

This proposal also discusses the development of a collaborative environment, a mediation lab: a space dedicated to research and experimentation where multi- and interdisciplinary teams from different fields come together to seek solutions to collective problems, making use of Information and Communication Technologies (ICTs). Its objective is not directly tied to media in the sense the term is commonly known and promoted, but rather to mediation — a space encompassing areas such as culture, human–machine relations, the development and fostering of research and projects, and the mediation of project teams (PINTO; BALDESSAR, 2020).

Experimentation labs, which develop actions that bridge cultural human expression and technology, are characterized by a broad conception of media, and are therefore able to build effective actions for the community's most varied problems (NUNES, 2020). Labs with technical specialization are already widespread, and according to Hassan (2014, p. 2), communities need social labs capable of developing urgently needed solutions — organizations of this kind have already proven to be an efficient response to the problems faced by society. These are solutions not only for society but also for industry, through the generation of products and services via innovation that foster research and experimentation.

They are multi-use spaces that develop effective solutions to the problems faced by the local community, taking into account both commercial concerns and social benefit, materializing as practical solutions through collaboration.

The method restructured here originates from a process developed by Ventura (2023) between 2021 and 2022 in the Mário Quintana neighborhood, in the northern zone of Porto Alegre (Brazil) — an area with one of the lowest Municipal Human Development Indices (IDHM) in the city, facing a context of violence tied to territorial disputes between factions (OBSERVAPOA, 2022). Even so, the neighborhood sustains a consistent associative fabric, of which the Nature, Citizenship, and Peace Community Space Association (NACIPAZ) is part — founded in 2003 by community leaders with the goal of promoting social inclusion through environmental, cultural, and educational activities. This was not an arbitrarily chosen territory, but rather the very neighborhood where the author has lived experience, which has, from the outset, oriented an action-research conducted from within the community rather than as external observation.

It was together with this Association that Ventura (2023) developed the original design-based problem-solving method, beginning with an initial contact with another neighborhood initiative, the Vila Safira Community Bakery, and deepening through interviews with local leaders until the research came to focus on NACIPAZ itself. This engagement gave rise to the NACIPAZ Computer Lab, a space rebuilt and re-equipped with computers donated by the company Thoughtworks, aimed at building skills for the world of work and structured around design as the organizing principle of the training offered.

This original method, individual in nature and confined to a single territory, is the starting point for the expansion proposed in this chapter, which focuses on its transformation into a collective, institutional method articulated with the Senac Pedagogical Model (MPS). This articulation stems from the author's own work as a teacher in Senac courses, which opens up the possibility of applications within the context of professional education.

The connection between the original method and the MPS did not arise from a theoretical transposition, but from a concrete teaching experience reported by Ventura (2023). At the invitation of the research supervisor, the author, in 2022, worked within the undergraduate course Collaborative Design and Innovation at UFRGS (Universidade Federal do Rio Grande do Sul, Porto Alegre), bringing the very project developed with NACIPAZ into the classroom. Design, product design, and computer science students then began working directly on the Association's real-world problem, ranging from visual identity to the institutional website, with each team responding according to its own expertise while submitting its output to the class's collective discussion. The course produced concrete deliverables incorporated by NACIPAZ, such as a media kit with visual communication and signage materials and the Association's own official website — tangible evidence of what the combination of collaborative design and community experience can produce.

It was in this shift — from the designer working alone in the territory to the student mediated by the teacher within a real project — that the original method, until then merely descriptive, began to show potential for becoming replicable in a teaching environment. It is this experience that the present chapter formalizes and expands upon, addressing the passage from the individual method to the collective method structured around the MPS, which is the object of this proposal.

2. Methodology

This study is characterized as qualitative research of a theoretical-exploratory nature, aiming to propose a learning method based on design as a driver of innovation, applied to educational settings. It focuses on combining design thinking, co-design, and project-based learning in order to identify the principles and structures that guide pedagogical learning practices.

Although it draws on action research in terms of the involvement of the actors concerned, the present study is not presented as a direct application, but rather as a conceptual proposition to be validated in educational settings involving all of the actors. According to Thiollent (1985), this relationship between the researcher and the other people involved in the research, whether direct or indirect actors, requires a high degree of close, private interaction among all parties so that the values of truth, reciprocity, and mutuality remain effectively present throughout every stage of the research.

> Action research is a type of social research conceived and carried out in close association with an action or with the resolution of a collective problem, in which researchers and participants representative of the situation under investigation are involved cooperatively and participatorily (THIOLLENT, 1985, p. 14).

As a form of inquiry, action research strives above all to foster approaches that not only understand the reality existing within a given social space but that actually transform that reality through their processes. It draws on agile methodologies such as design thinking, agile, and lean in order to design artifacts incrementally and continuously. Design thinking, developed by IDEO, is geared toward creating concepts and products with the user at the center (BROWN, 2010), while lean is based mainly on developing the project team to build a prototype or final product at the end of the design process, so that the user can also provide feedback on the project (MIDDLETON, 2001)

3. Theoretical Framework

Design has played a fundamental role in different crises at particular moments in history. At the turn of the twenty-first century, it necessarily began to restructure itself and take on a more prominent role, empowering itself and taking on a commitment to facilitating innovation. It generates creativity and change across commercial, social, and cultural contexts through tools for socioeconomic development. More broadly, the meaning of design, like that of culture, takes on different definitions depending on the context, but in essence both point to an idea of growth and nurturing. When combined, the two terms can take on further meanings: for instance, the guiding idealism behind design is tied to distinct values, and these same cross-cultural values reveal an underlying tension. Ultimately, the existence of one does not preclude the other, since the visual and material language of any given product is always grounded in the cultural structure of a group. "If the culture of consumption makes design necessary, technological progress makes it possible" (SPARKE, 2013, p. 13).

This debate concerns design aimed at solving problems, whose defining attributes are not the products and services that design yields, but rather the tools used to achieve that outcome. These effects — environmental, economic, and social — arising from design thinking, in turn point to the fact that there is still no discussion of the weight culture carries, one that keeps it from fully materializing as an agent of change in these respects.

Sparke (2013), further reflects on emergent design and its composition, arguing that the methods and tools used determine its complexity in ways that make it authentic and useful to society. He notes, however, that design is not simply the outcome of methods, tools, and how they are used — nor can the designer's role be dismissed as insignificant in this equation. Rather than being merely a way of carrying out a task, design takes on different facets depending on its purpose, serving as an instrument of critical analysis and reflection through which specialists generate knowledge, vision, and judgment and turn them into actionable proposals. Accordingly, designers must also know, understand, and incorporate design culture as their primary design artifact. Culture in design — or, more broadly, culture with design — encompasses values, knowledge, and quality criteria that emerge through the practice of design and remain fully open to explicit intervention by cultural agents and actors. Julier (2006) raises an initial question: "…What relationship does design culture actually have with the practice of design itself?" Much has been said about design education in universities, where it is argued that, from the 1990s onward, disciplines aimed at graphic instruction, among others, carry a heavier knowledge load involving methods drawn from visual culture — methods that end up producing a mistaken understanding of what design culture actually means.

The author also notes that design culture as a practice is shaped by context, referring to the way geographic context does or does not influence design practice. Several geographic factors can be cited, such as the technology present in a given region, the materials and substrates available for production, and the cultural factors surrounding the commercialization of these artifacts. Seen through the lens of design culture with an organizational or attitudinal focus, this remains within the scope of design producers who provide models for human resources within the industry. Creative or innovation-driving enterprises in this market thus serve as paradigms for broader organizational change, both internally and externally.

Design-based methodologies focused on innovation, research, and the structuring of new projects propose environments conducive to such projects, with a particular focus on the user of that space, thereby shifting the focus of the design process toward the human being (MILLS; WAGEMANS, 2021, p. 1). Structurally and organizationally, this model aims at designing new forms of revenue and investment, developing and fostering new expertise around methods, transforming the local community, and generating direct social impact, while respecting the community's own limits and boundaries (NUNES, 2020).

When we compare design-focused methods across their various structures, grounded in the social reality of a community, the academic world and commerce are connected through shifts toward new markets, new entrepreneurial attitudes on the part of participants, the development of a space for innovation, and the design of a learning environment fostered by innovation (NUNES, 2020).

From the perspective of design culture as an agency, it is understood as a powerful tool for maximizing an organization's position in its market — and, just as importantly,

for directing design practices toward social and environmental benefit. This model also emphasizes design culture as a way of doing design, a method in itself. Finally, the debate turns to the expression "design culture" itself, which carries a double meaning depending on how it is applied: the first concerns the evaluation of multiple contexts regarding form and expression, while the second concerns the stance from which design is practiced.

Addressing the shortcomings of design culture involves considering visual culture in design, its relationship with design artifacts, users, and values across the whole process, taking into account its main domains — object or artifact, space or medium, and image or project — and the degree to which each of these aspects interferes with the others.

Design and technology, taken together, are seen as two of the main drivers of social innovation. Even though new technologies might seem to work against the development and evolution of social innovation, design, through its approaches and tools, undoubtedly plays a role that yields multiple benefits and positive outcomes for social innovation's potential (LI; BACETE, 2022). Social innovation can be characterized by three distinct aspects: social innovation aims to address social change through changes in social practices. According to Schwarz (2010), the term innovation occupies a broad space in organizational discussions, yet its results are often shallow and of minimal impact, while few other innovations achieve a high impact on technology and society. Innovations are interwoven into societies in ways that drive their development, but require a scientific basis to do so — which is what distinguishes social innovations tied to social matters from innovations grounded in market-oriented technologies pursued for strictly commercial ends by organizations (LI; BACETE, 2022).

For an innovation to be considered and understood as social innovation, it is necessary to understand that innovation is not found solely in designed products or services. At the level of social practice, it can be described as a combination or adaptation of particular social practices within areas of social action, which are in turn driven by specific actors within that context, aiming for better outcomes for the problems of that environment. To be considered social, it need not be profitable for its developers — the real gain lies in the change it generates. As with any other kind of innovation, innovating does not necessarily mean doing something good or well done, but rather what is socially desirable within that context (LI; BACETE, 2022).

The second aspect, put forward by Edwards-Schachter and Wallace (2017), maps out the various elements involved in analyzing a given innovation in order to determine whether it truly qualifies as one: processes of social change underlying social innovation (society, processes, changes, actions, social practices, problems, needs, social relations); development (centrality combined with value, knowledge, ideas, technological innovations, products, government); and the services sector (society, market, social need, business, challenges, new ideas and products, quality of life).

Design itself becomes a strong methodological contributor to social innovation across its various dimensions, precisely because it generates meaning, significance, and sociocultural differentiation for these projects. The orientation required for such change and for the development of social innovation ends up relying primarily on technological innovations. The secondary aspect of this equation, in turn, concerns who innovates, which group innovates, which society and microenvironment innovates, and under what circumstances and for what reasons.

Verganti and Dell'Era (2014) likewise identify design as a driver of design-led social innovation, particularly through its capacity to construct meaning — what they call "making sense" — a determination that remains under construction as organizations adopt the term design-driven innovation. Organizations, in this view, depend on design to achieve a radical form of innovation capable of giving new meaning to their goods and services for users. "Design-driven innovation is not an answer but a dialogue and a modification of the market" (VERGANTI, 2008).

For Verganti (2016), design-driven innovation can be assessed at two different levels: incremental improvements and new directions. At the level of improvements, the emphasis falls on new solutions that better address existing, widely recognized notions of value in the market. At the second level, the approach is tied directly to what consumers themselves choose as value. Traditional innovation methods thus lose some of their value here, since instead of sharpening a brief and reaching out to external actors, innovation proceeds from the organization's internal actors, who in this case stand in for consumers. Design tools that place the user at the center of problem-solving can generate high value for incremental innovation, since they draw on the user's own observations and insights. In radical innovation, however, this same practice can produce the opposite result, since the goal is primarily to develop new solutions that users of the same product or service are unable to articulate themselves. The middle ground between these two models reveals a particularly important approach: design-led innovation, which can be defined as an approach that allows organizations to consider and evaluate new proposals from multiple perspectives, while always keeping the user at the center of the problem to be solved.

It is a model, a methodology, and a set of tools grounded in the articulation and connection of all stakeholders around new proposals, condensing technologies that allow the designer to consider and evaluate their own project against the needs and models the business must recognize, with the user placed at the center. These proposals are then better defined through the continuous involvement of all parties, with the integrated product/service concept emerging as the solution (VERGANTI, 2008; DELL'ERA et al., 2010).

Design as a catalyst for innovation, as described by Wrigley and Bucolo (2012), refers to changes within an organization in which certain roles carry facilitation and strategic responsibilities across every aspect of the company in order to change its business model. Wrigley (2013) further notes that when design acts as a catalyst for innovation, the designer, as the main actor, necessarily needs the competence to design solutions that confront the organization's constraints, navigating the barriers this actor encounters when engaging with organizations and their real needs according to their particular circumstances.

An important observation regarding design as a key asset in the innovation process is that it is not merely a tool for quick problem-solving, but a primary instrument of business-level transformation, in which design-based collaboration becomes a bridge centered mainly on validating these processes. The catalyst's role is to analyze and synthesize data in order to reach conclusions that are valid for academia; once published, these findings contribute directly to the field of research. In industry, by contrast, "teaching" involves presenting ideas to the company itself through activities and the development of design-driven innovation tools. Several characteristics and capabilities

of the design-driven innovation catalyst can be highlighted: (I) the designer's knowledge and skills; (II) knowledge and understanding of the organization's business; (III) cognitive knowledge centered on the client; (IV) personal skills and qualities; and (V) grounding in research. The first characteristic relates mainly to problem-solving. The second implies that the professional must have at least a general understanding of business, its applications, strategies, and business model. The third concerns the competence for disruptive and original thinking, enabling designers to apply creative skills to problem-solving. The fourth, centering clients within the problems themselves, is a key factor, since organizations often fail to place the user at the center of their problem-solving efforts. The fifth factor concerns the skills and knowledge needed to understand client and user needs, so that, following co-design facilitation, the catalyst becomes engaged with the user's problems. The last factor concerns providing design-based innovation knowledge, which above all requires facilitating and assisting organizations in remaining relevant for their future.

Above all, this methodology creates spaces for building solutions that involve both people and technology, since its practices are embedded in human relationships and participants' design work becomes effective. The solutions developed sit alongside the problems of a given social group, working not merely for that group but together with it, so that the inquiry itself becomes an asset. These are spaces that offer an environment of continuous learning and exchange among participants, to the point of becoming one of the main centers for innovation, development, and design focused on transforming realities (FONSECA, 2014).

This approach, carried out through media labs, plays out across a range of actions — where and in what area the project will operate, what development model the lab builds, and its direct or indirect relationship with media sources. Labs are thus designed to perform specific, objective functions with a focus on the local community of a given region (PINTO, 2020).

These environments operate under the idea of open innovation as put forward by Chesbrough (2003), which broadens the exchange among institutions, academic communities, and individuals, building direct and continuous flows of ideas and practical solutions.

For Manzini (2015), social design also involves developing collaborative situations and strengthening communities capable of innovating in a distributed, sustainable way — a view echoed by Zurlo (2010), who argues that the designer's role broadly lies in developing artifacts and methods that generate value and make a real contribution to society.

As multidisciplinary centers constantly engaged in co-creation, labs also play a social role in pursuing new solutions arising from the needs of industry itself (HAASE, 2000). Mills and Wagemans (2021) point out that labs focus on user-driven innovation but are unable to achieve effective scalability, since they are directly shaped by local cultures and environments. For development to be broadened and turned into something that can be replicated and expanded, then, the use of design as a driver of project development and innovation is called for.

In addressing aspects of culture and innovation grounded in design as their driver, or as the main force fostering innovation within labs, Schwarz (2010) points out that innovation in a social setting gives rise to discussions that put into practice technology-based innovations aimed at industry and the market. Edwards-Schachter and Wallace (2017) argue that social innovation requires well-defined purposes in order to achieve the expected results, including the actors involved and the setting, so that the learning process becomes interactive and co-creative.

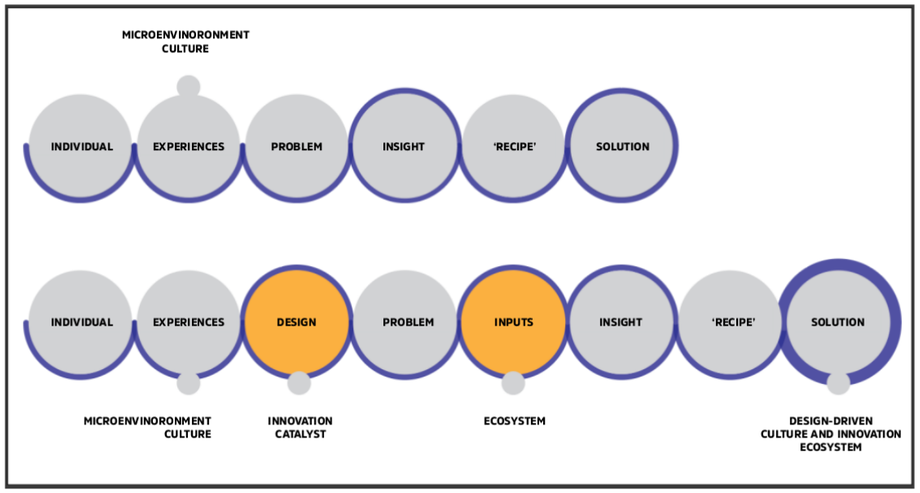
Wrigley and Bucolo (2012) point out that when design serves as the main tool for innovation development, the designer's role carries the responsibility of facilitating mediation and strategy within the business model, as well as economic development and, consequently, greater competition in the market and industry. This use of design as a catalyst for innovation spans both industry and academia, learning and teaching, drawing on research and development methodologies and integrating them to promote results through methods and actions.

When used as the main driver of the innovation process, design should be understood as a link between problem-solving and the development of innovation projects, serving mainly as a user-centered approach to solving problems that directly affect social life, both in industry and in the market. Classifying design as the primary tool in this sense unfolds through the aspects of design work itself — planning and development — so that innovation becomes the main outcome.

Co-design, as a methodological practice, stands as one of the pillars underpinning the proposed method, insofar as it positions the actors involved — students, teachers, and the world of work — as active participants who share responsibility for the creative process. Ehn (2008) argues that participatory design turns the design of artifacts into a collective learning exercise, in which the process itself carries as much value as the final outcome. In this sense, co-design is not limited to producing solutions but structures an environment of exchange in which students' individual experiences become collective inputs for problem-solving. Manzini (2015) reinforces this view, arguing that social design is built precisely on strengthening communities capable of innovating in a distributed, collaborative way. Applied to the educational context, co-design operates as the link between the student's formative experience and the collective construction of solutions, integrating the pedagogical, design, and collaborative dimensions that characterize the method proposed here.

Ventura (2023) proposes, as shown in Figure 1, a design-mediated problem-solving model grounded in the culture of the microenvironment, in which the solutions developed are replicated cyclically. As the process shifts to take into account the user based on their lived experiences, moving from input insights that shape a method, the focus turns to how design becomes the articulator of these actions.

Figure 1 - Problem-solving through design



Source: Ventura (2023).

Building on the concepts reviewed, the following section presents the proposed method, which translates this theoretical foundation into a structure applicable to the Senac-RS Mediation Labs.

4. The proposed method

Building on this view and drawing on the MPS, which calls for active, contextualized teaching and learning practices that place the student as protagonist, mediated by teachers, the role that was previously that of the user becomes that of the student, moving through every stage of the process developed by the author.

The user becomes the student, who, drawing on prior experience and personal repertoire, comes to occupy the "being and knowing" space corresponding to the MPS. Design as a catalyst for innovation unfolds in the "doing." Inputs become "living together" through the students' collective contributions, just as the problem — previously the insight — becomes "knowing and doing" in line with the MPS. Finally, the solution rests on the development and prototyping of projects, integrating all four dimensions.

The methodology proposes an integration between the Senac Pedagogical Model and design as a driver of development through its own design methods. Grounded in the MPS and based on design, it fosters active learning in classroom practice, envisioning a networked design process in which the student is the protagonist, centered on the action-reflection-action cycle and focused on experimentation and collaboration for problem-solving, with design as the method of innovation.

The diagram illustrating this method is based on different stages involving distinct actors and their forms of participation. It begins with the student as protagonist, recognized for their specific, individual experience directly tied to student protagonism, in which the learner is an active agent of transformation within their own context (SENAC, 2013). Once design is introduced as a mediator in the methodological process, its role is to translate the student's experiences into design challenges that they will soon face.

Design also becomes a tool for reflection and, subsequently, for action, enabling students to understand, reflect, and act, in line with the inquiry proposed for project development.

Once the student brings these processes forward, the teacher takes on the role of mediator, contextualizing the project's real needs, setting goals and deadlines in line with the Integrating Project methodology, and encouraging articulation across curricular units while promoting interdisciplinarity alongside the practical application of acquired knowledge. The development stage, guided by experimentation, is designed around the action-reflection-action cycle and the design of products and artifacts, allowing learning to unfold on the basis of critical thinking and creation, with strategic design and design thinking guiding the design of the solutions adopted.

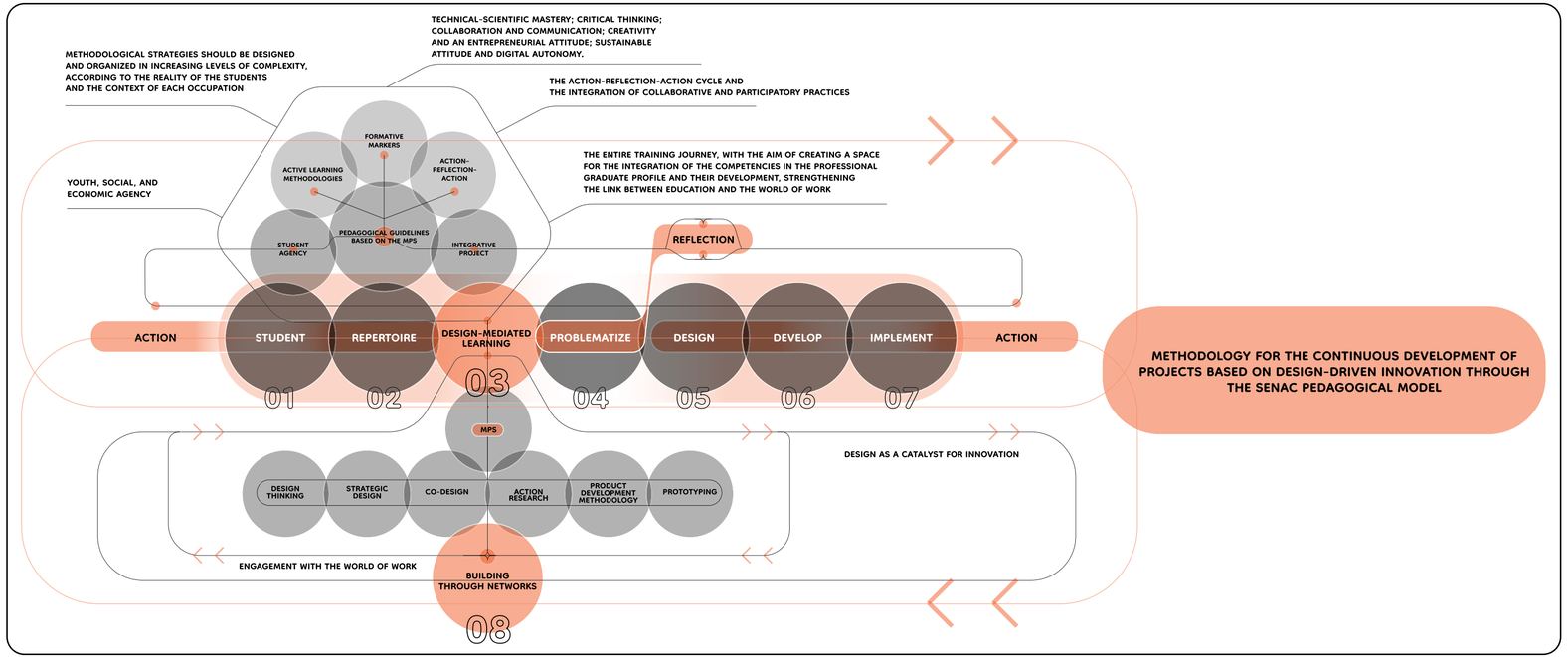
Finally, the solution stage encompasses learning and its practical application; more than a final solution, what is expected is the material representation of the learning process the student went through in the lab, guided by their own experiences and carried out according to the methods developed, mediated by teachers. What the solution stage truly reflects is learning and practical application — first developed within the academic world and then applied to the world of work. It translates into the development of products, processes, and even sociocultural interventions that trace back to the student and the teacher and their developmental process, with the cycle now repeating itself in the ongoing construction of solutions.

At the lower base of the method are the foundations that structurally underpin methodologies such as strategic design, design thinking, co-design, and action research, consolidating the sets of approaches that allow the student to understand and apply the methods adopted, in keeping with the methodological rigor required for the interplay between design and education.

Structured in this way, the proposed methodology centers on networked design, symbolizing the distributed nature of exchange among the various actors involved — students, teachers, pedagogues, and, above all, the world of work — thereby generating a shared learning ecosystem that fosters the exchange of knowledge among Senac-RS's educational units.

In summary, the Project Development Methodology for the Senac-RS Mediation Labs proposes a scalable, replicable method grounded in the integration of pedagogy, design, and project work, as shown in Figure 2. Building on the Senac Pedagogical Model, it establishes concrete actions that emphasize doing and educational development based on design and the construction of innovative projects as instruments of transformation.

Figure 2 - Project Methodology



Source: Ventura (2026).

5. Discussion

Considering that methods play a social role in addition to a design one, since new solutions must also remain aligned with society and the world of work (MILLS; WAGEMANS, 2021), the proposed methodology positions design as a central actor in mediating these learning processes, from collaboration to experimentation and problem-solving, in the connection between educational institutions and the world of work.

This mediation has already proven concrete in the experience that gave rise to the method. Of the courses offered at the NACIPAZ Computer Lab, community demand fell short of what had been planned, but the 12 available places per cohort were filled and the first cohort graduated (VENTURA, 2023). This outcome, modest as it is in scale, reinforces the challenge identified by Mills and Wagemans (2021): user-centered initiatives face scalability constraints when they depend on a local, personal context — which is precisely what justifies institutionalizing the method through the MPS, extending its reach beyond a single territory.

According to Mills and Wagemans (2021), innovation-oriented initiatives that are user-centered — here, student-centered — face numerous challenges: scalability, and local, personal, and professional contexts among them. For development to be broadened and turned into something that can be replicated and expanded, then, design is called upon as a driver of project development and innovation.

This approach also speaks to design's new role as a catalyst for innovation. Schwarz (2010) notes that innovation within a social setting generates discussions that put into practice technology-based innovations for industry and the market. Edwards-Schachter and Wallace (2017) argue that social innovation requires well-defined purposes to achieve the expected results, including the actors involved and the setting, so that the learning process becomes interactive and co-creative.

Wrigley and Bucolo (2012) point out that when design serves as the main tool for innovation development, the designer's role carries the responsibility of facilitating mediation and strategy within the business model, as well as economic development and, consequently, greater competition in the market and industry. This use of design as a catalyst for innovation spans both industry and academia, learning and teaching, drawing on research and development methodologies and integrating them to promote results through methods and actions.

In this way, design takes on a learning-mediation function once structured as a method, providing a connection between student training and problem-solving in real, more dynamic projects directly applied to innovation.

6. Final considerations and future perspectives

This chapter proposes a project development methodology based on design as a driver of innovation through the Senac Pedagogical Model. It has examined the active, contemporary transformations of educational processes, with a direct focus on student and teacher protagonism, thereby preparing a more effective connection with the world of work.

Drawing on the literature review and grounded in distinct yet interconnected stages, it proposes a cyclical process of experimentation, reflection, and development — the action-reflection-action cycle. Its main contribution is a model geared toward replication and adaptation across the most varied educational contexts, supporting the development of solutions for the goods, trade, and services sectors, and thereby expanding projects that generate real-world solutions.

As a limitation, the method's full empirical application is still under development and calls for future research into its applicability and the measurement of its results. Nevertheless, its main contribution lies in a replicable, sustainable methodological structure adaptable to different educational contexts, which significantly expands the possibilities for integrating teaching, practice, and the development of competencies aligned with the MPS and grounded in the world of work.

This limitation had already surfaced in the very experience that gave rise to the method: even with a ready-made structure and planned training sessions, community uptake in the Mário Quintana neighborhood fell short of expectations. It is precisely this fragility of scale, typical of initiatives anchored in a single territory, that the proposed expansion into the Senac environment seeks to overcome.

Furthermore, unlike approaches that treat design merely as a one-off or supplementary tool, the method proposed here positions and structures the organization of the learning process and the way in which the student's output can be further qualified, integrating pedagogical, design, and collaborative dimensions.

By fostering problem-solving learning together with collective construction within the action-reflection-action cycle, grounded in and driven by design, the method contributes directly to critical thinking, autonomy, and the capacity for networked action in complex and dynamic scenarios, aiming in the future at a genuine, full-scale application of the methodology.

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About the Autors

Allan Giovanni dos Santos

Engenheiro de Produção, com especialização em engenharia HVAC pela Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS) e Mestre em Design pela Universidade Federal do Rio Grande do Sul (UFRGS). Atualmente, é empreendedor na área de fabricação digital e polímeros, atuando como escultor digital e ceramista, além de graduando em Design de Produto (UFRGS). Trabalha com desenvolvimento de produtos, gestão de projetos (CAD/BIM) e produção artística, integrando engenharia, design e tecnologias digitais. Desenvolve pesquisas relacionadas à Inovação (PD&I), seleção de materiais, processos de fabricação, prototipagem, modelagem, digitalização e impressão 3D, com aplicação em biônica e patrimônio cultural.

Production Engineer, with a specialization in HVAC engineering from the Pontifical Catholic University of Rio Grande do Sul (PUCRS) and a Master's degree in Design from the Federal University of Rio Grande do Sul (UFRGS). He is currently an entrepreneur in the field of digital manufacturing and polymers, working as a digital sculptor and ceramic artist, and is also pursuing a bachelor's degree in Product Design (UFRGS). He works in product development, project management (CAD/BIM), and artistic production, integrating engineering, design, and digital technologies. He conducts research related to innovation (R&D&I), material selection, manufacturing processes, prototyping, modeling, digitization, and 3D printing, with applications in bionics and cultural heritage.
E-mail: allan.santos@ufrgs.br

Bárbara Sanson de Lima

Arquiteta e Urbanista pela PUCRS e Mestranda em Design pela UFRGS, atua na área de Experiência do Usuário no desenvolvimento de soluções digitais. Focando na interseção entre design, tecnologia e inovação, concilia a prática acadêmica com a profissional como Lead Product Designer. Com atuação em desenvolvimento de Produtos Digitais e Design Centrado no Usuário, foca na colaboração entre equipes multidisciplinares e projetos de inovação.

An architect and urban planner with a degree from PUCRS and a master's candidate in Design at UFRGS, she works in the field of User Experience in the development of digital solutions. Focusing on the intersection of design, technology, and innovation, she balances her academic and professional practices as a Lead Product Designer. With experience in digital product development and user-centered design, she focuses on collaboration among multidisciplinary teams and innovation projects.
E-mail: it.barbaraz@gmail.com

Claudia Adriana Oliboni Nichetti

Graduada em Design, mestre pelo Programa de Pós-Graduação em Planejamento Urbano e Regional (PROPUR) da Universidade Federal do Rio Grande do Sul (UFRGS), com ênfase na linha de pesquisa Percepção e Análise do Espaço Urbano e na área de estudos Ambiente e Comportamento, e doutora em Design pelo Programa de Pós-Graduação em Design da UFRGS. Atua como professora adjunta no Departamento de Design e Expressão Gráfica (DEG) da Faculdade de Arquitetura da UFRGS, ministrando disciplinas nos cursos de graduação em Design de Produto e Design Visual. Pesquisadora do Laboratório de Design, Cultura e Inovação (LDCI) da UFRGS, onde desenvolve projetos de pesquisa teórica e aplicada voltados ao design como ferramenta para a revitalização urbana por meio da inovação. Suas pesquisas concentram-se em temas como pensamento sistêmico, processos e métodos projetuais, além da interdisciplinaridade entre design e urbanismo - Design e Urbanidade.

Holds a Bachelor's degree in Design, a Master's degree in Urban and Regional Planning from the Federal University of Rio Grande do Sul (UFRGS), with a research focus on Urban Space Perception and Analysis and Environment and Behavior Studies, and a Ph.D. in Design from UFRGS. She is an Assistant Professor in the Department of Design and Graphic Expression at the School of Architecture, UFRGS, where she teaches undergraduate courses in Product Design and Visual Design. She is also a researcher at the Laboratory of Design, Culture and Innovation (LDCI), conducting theoretical and applied research on design-driven urban revitalization through innovation. Her research interests include systems thinking, design methods and processes, design for innovation, and the interdisciplinary relationship between design and urbanism, with a particular emphasis on Design and Urbanity.

E-mail: claudia.nichetti@ufrgs.br

Daniel Ventura

Professor, Mestre em Design pela Universidade Federal do Rio Grande do Sul (UFRGS), na área de Design e Tecnologia, especialista em User Experience e em Docência na Educação Profissional, e bacharel em Design Gráfico. Atua como professor de Design, com experiência nas áreas de design gráfico, identidade visual, branding, produção gráfica, experiência do usuário e processos de inovação. É pesquisador vinculado ao Laboratório de Design, Cultura e Inovação (LDCI) da UFRGS, onde desenvolve estudos relacionados ao design como catalisador de inovação e à aplicação de métodos de design na compreensão e resolução de problemas em diferentes contextos sociais e culturais. Suas pesquisas concentram-se em temas como processos e métodos de design, cultura, inovação, design e educação, metodologias colaborativas e relações entre design, território e sociedade, com interesse particular na atuação do design em contextos de vulnerabilidade socioeconômica e na formação de novos agentes e repertórios para a inovação. É sócio-fundador da POMA Design, atuando também em projetos de branding e experiência do usuário.

Professor, Holds a Master's degree in Design from the Federal University of Rio Grande do Sul (UFRGS), with a research focus on Design and Technology, as well as postgraduate specializations in User Experience and Professional Education, and a Bachelor's degree in Graphic Design. He works as a Design professor, with professional and academic experience in graphic design, visual identity, branding, graphic production, user experience, and innovation processes. He is a researcher at the Laboratory of Design, Culture and Innovation (LDCI) at UFRGS, where he develops studies on design as a catalyst for innovation and on the application of design methods to understand and address problems in different social and cultural contexts. His research interests include design processes and methods, culture, innovation, design education, collaborative methodologies, and the relationship between design, territory, and society, with particular emphasis on the role of design in contexts of socioeconomic vulnerability and in the development of new agents and repertoires for innovation. He is also a co-founder of POMA Design, working on branding and user experience projects.

E-mail: danielventtura@gmail.com

Davi Franco Viegas Pereira

Graduando em Design de Produto na Universidade Federal do Rio Grande do Sul (UFRGS). Aluno pesquisador no Laboratório de Design, Cultura e Inovação (LDCI); na linha de pesquisa Design para Urbanidade que tem por objeto a inserção do design no processo de revitalização de cidades por meio da inovação. Tem interesse em design estratégico e design para experiência, com ênfase na área de design e planejamento urbano.

Undergraduate student in Product Design at the Federal University of Rio Grande do Sul (UFRGS). Research student at the Design, Culture, and Innovation Laboratory (LDCI) in the "Design for Urbanity" research area, which focuses on integrating design into the process of urban revitalization through innovation. He is interested in strategic design and experience design, with an emphasis on urban design and planning.
E-mail: viegasdviegas@gmail.com

Fabiano de Vargas Scherer

Arquiteto, graduado pela Universidade Federal do Rio Grande do Sul (UFRGS), com mestrado em Planejamento Urbano e Regional pelo PROPUR/UFRGS e doutorado em Design e Tecnologia pelo PGDESIGN/UFRGS. Professor adjunto do Departamento de Design e Expressão Gráfica (DEG), na Faculdade de Arquitetura da UFRGS, onde atua nos cursos de graduação em Design de Produto e Design Visual; e Coordenador e Professor Permanente do PGDesign/UFRGS. É coordenador da especialização em Design Gráfico UFRGS e do Laboratório de Experiência do Usuário (e.lab). Pesquisa e orienta trabalhos de doutorado e mestrado nos temas de Inserção do Usuário no Processo de projeto e Processos criativos em Design.

Architect, with a bachelor's degree from the Federal University of Rio Grande do Sul (UFRGS), a master's degree in Urban and Regional Planning from PROPUR/UFRGS, and a Ph.D. in Design and Technology from PGDESIGN/UFRGS. Adjunct professor in the Department of Design and Graphic Expression (DEG) at the UFRGS School of Architecture, where he teaches in the undergraduate programs in Product Design and Visual Design; and Coordinator and Tenured Professor at PGDesign/UFRGS. He is the coordinator of the UFRGS specialization program in Graphic Design and of the User Experience Laboratory (e.lab). He conducts research and advises doctoral and master's theses on the topics of User Involvement in the Design Process and Creative Processes in Design.
E-mail: fabiano.scherer@ufrgs.br

Fabio Pinto da Silva

Engenheiro Mecânico, graduado pela UFRGS, com mestrado e doutorado em Engenharia, com ênfase em Ciência e Tecnologia de Materiais, pela mesma instituição. É Professor do Departamento de Design e Expressão Gráfica (DEG), na Faculdade de Arquitetura, e do Programa de Pós-Graduação em Design (PGDESIGN), ambos da UFRGS. É coordenador do Laboratório de Design e Seleção de Materiais (LDSM), atuando em temas relacionados a Tecnologias 3D: Digitalização Tridimensional, Impressão 3D, Usinagem CNC, Corte a laser, Fabricação Digital, Inspeção Digital, Realidade Virtual e Aumentada. Atua ainda na aplicação de Tecnologias 3D em projetos envolvendo Preservação do Patrimônio Cultural e Tecnologia Assistiva.

Mechanical Engineer, with a bachelor's degree from UFRGS, and a master's and doctorate in Engineering, with an emphasis on Materials Science and Technology, from the same institution. He is a professor in the Department of Design and Graphic Expression (DEG) at the School of Architecture and in the Graduate Program in Design (PGDESIGN), both at UFRGS. He is the coordinator of the Design and Materials Selection Laboratory (LDSM), working on topics related to 3D technologies: 3D scanning, 3D printing, CNC machining, laser cutting, digital fabrication, digital inspection, and virtual and augmented reality. He also works on the application of 3D technologies in projects involving cultural heritage preservation and assistive technology.
E-mail: fabio.silva@ufrgs.br

Fernando Souza Ferreira

É graduado em Design pela Universidade Federal do Rio Grande do Sul (UFRGS), mestre em Design pela mesma instituição e atualmente doutorando em Design. É pesquisador do Laboratório de Design, Cultura e Inovação (LDCI). Atua como Head de Produtos e sócio da EvcomX, onde lidera o desenvolvimento de soluções de dados e inteligência artificial para ambientes industriais complexos, com projetos nos setores de energia, siderurgia, mineração e logística. Pesquisa e desenvolve projetos relacionados à inovação orientada pelo design, estratégia de produtos e modelos de negócio orientados por significado. É também cofundador da Faísca Design Júnior, empresa júnior do curso de Design da UFRGS.

He holds a bachelor's degree in Design from the Federal University of Rio Grande do Sul (UFRGS), a master's degree in Design from the same institution, and is currently a Ph.D. candidate in Design. He is a researcher at the Design, Culture and Innovation Laboratory (LDCI). He serves as Head of Products and partner at EvcomX, where he leads the development of data and artificial intelligence solutions for complex industrial settings, with projects in the energy, steel, mining, and logistics sectors. He researches and develops projects on design-driven innovation, product strategy, and meaning-driven business models. He is also co-founder of Faísca Design Júnior, the junior enterprise of UFRGS's Design program.
E-mail: souzaferreiraphd@gmail.com

Gabriela de Oliveira Dutra

É designer analista de políticas públicas e gestão governamental no Estado do Rio Grande do Sul na Assessoria de Comunicação da Secretaria Estadual da Saúde. Graduada em Design Gráfico pela Universidade de Passo Fundo e Especialista em Audiovisual e Convergência de Mídias pela Unisinos. Atualmente, mestranda no Programa de Pós-Graduação em Design pela Universidade Federal do Rio Grande do Sul

She is a designer specializing in public policy and government management in the state of Rio Grande do Sul, working in the Communications Office of the State Department of Health. She holds a bachelor's degree in Graphic Design from the University of Passo Fundo and a specialist degree in Audiovisual and Media Convergence from Unisinos. She is currently pursuing a master's degree in the Graduate Program in Design at the Federal University of Rio Grande do Sul.
E-mail: gabrieladutra13@gmail.com

Gilberto Consoni

É graduado em Comunicação pela Universidade Católica de Pelotas (UCPel), especialista em Ciências da Comunicação pela mesma instituição e mestre e doutor em Comunicação e Informação pela Universidade Federal do Rio Grande do Sul (UFRGS). É Professor Associado e Chefe do Departamento de Design e Expressão Gráfica (DEG) da UFRGS, além de Professor Colaborador do Programa de Pós-Graduação em Design da UFRGS. Coordena o Laboratório de Experiência do Usuário (e.lab/UFRGS). Desenvolve pesquisas nas áreas de experiência do usuário, design de interação, design de interfaces, arquitetura da informação, inteligência artificial e objetos de aprendizagem aplicados ao desenho técnico.

He holds a bachelor's degree in Communication from the Catholic University of Pelotas (UCPel), a specialization in Communication Sciences from the same institution, and a master's and Ph.D. in Communication and Information from the Federal University of Rio Grande do Sul (UFRGS). He is an Associate Professor and Head of the Department of Design and Graphic Expression (DEG) at UFRGS, and a Collaborating Professor in the Graduate Program in Design at UFRGS. He coordinates the User Experience Laboratory (e.lab/UFRGS). He conducts research on user experience, interaction design, interface design, information architecture, artificial intelligence, and learning objects applied to technical drawing.
E-mail: gilberto.consoni@gmail.com

Juliana Eisenhardt Escaleira

Engenheira civil de formação pela Universidade Federal do Rio Grande do Sul (UFRGS), mestre em Design pela mesma instituição e pós-graduada em Comunicação e Marketing Estratégico. É fundadora da Gaudi Studio, onde atua nas áreas de design estratégico, branding, design de embalagens, design de serviços e experiência do cliente. Pesquisa, desenvolve e aplica o Design de Experiências como abordagem para fortalecer marcas, gerar valor e criar conexões significativas entre pessoas e organizações. Busca continuamente ampliar seu repertório por meio da vivência de diferentes culturas, negócios, serviços e contextos, transformando essas experiências em conhecimento aplicado ao design.

She holds a bachelor's degree in Civil Engineering from the Federal University of Rio Grande do Sul (UFRGS), a master's degree in Design from the same institution, and a postgraduate degree in Communication and Strategic Marketing. She is the founder of Gaudi Studio, where she works in the areas of strategic design, branding, packaging design, service design, and customer experience. She researches, develops, and applies Experience Design as an approach to strengthen brands, generate value, and create meaningful connections between people and organizations. She continually seeks to expand her repertoire by immersing herself in different cultures, businesses, services, and contexts, transforming these experiences into knowledge applied to design.
E-mail: juliana.escaleira@hotmail.com

Júlio Carlos de Souza van der Linden

Designer, graduado pela Universidade Federal de Pernambuco (UFPE), com mestrado, doutorado e pós-doutorado em Engenharia de Produção pela Universidade Federal do Rio Grande do Sul (UFRGS). É Professor Titular do Departamento de Design e Expressão Gráfica (DEG), na Faculdade de Arquitetura da UFRGS, onde atua nos cursos de graduação em Design de Produto e Design Visual; é Professor Permanente do Programa de Pós-Graduação em Design da UFRGS. É coordenador do Laboratório de Design, Cultura e Inovação (LDCI). Pesquisa e orienta trabalhos de doutorado e de mestrado nos temas de Competências de Designer, Inovação pelo Design e Educação pelo Design.

Designer, with a bachelor's degree from the Federal University of Pernambuco (UFPE), and a master's, doctorate, and postdoctoral degree in Production Engineering from the Federal University of Rio Grande do Sul (UFRGS). He is a Full Professor in the Department of Design and Graphic Expression (DEG) at the UFRGS School of Architecture, where he teaches in the undergraduate programs in Product Design and Visual Design; he is also a Tenured Professor in the UFRGS Graduate Program in Design. He serves as coordinator of the Laboratory of Design, Culture, and Innovation (LDCI). He conducts research and advises doctoral and master's theses on the topics of Designer Competencies, Innovation through Design, and Education through Design.
E-mail: julio.linden@ufrgs.br

Luciene Machado

Designer de Moda e Imagem. Doutora em Design (UFRGS-RS) com tese sobre competências atitudinais, empreendedorismo e inovação por meio do design. Mestra em Design Estratégico (Unisinos-RS). Especialista em Design de Moda (Esamc-SP). Bacharel em Arquitetura (UniSantos-SP). Atua como designer com foco em gestão da Imagem Pessoal Estratégica através da moda, estilo, colorimetria e visagismo, desenvolvimento de competências empreendedoras, criatividade e inovação. Pesquisadora no Laboratório de Design, Cultura e Inovação (LDCI/UFRGS) com experiência em competências atitudinais do designer, processos criativos, design thinking e estratégico, projetos educacionais e docência.

Fashion and Image Designer. Ph.D. in Design (Federal University of Rio Grande do Sul – UFRGS, Brazil), with a doctoral dissertation on entrepreneurial attitudinal competencies and innovation through design. M.Sc. in Strategic Design (Unisinos, Brazil). Specialist in Fashion Design (ESAMC, Brazil). Bachelor's degree in Architecture and Urbanism (UniSantos, Brazil). Works as a designer specializing in Strategic Personal Image Management through fashion, style, personal color analysis, and visagism, as well as the development of entrepreneurial competencies, creativity, and innovation. Researcher at the Design, Culture and Innovation Laboratory (LDCI/UFRGS), with experience in designers' attitudinal competencies, creative processes, design thinking, strategic design, educational projects, and higher education teaching.
E-mail: luka_mac@hotmail.com

Manuella Mattos dos Santos

Professora, graduada pela Universidade Federal do Rio Grande do Sul, com mestrado em Educação em Ciências (UFRGS) e doutoranda em Design (UFRGS). Professora da educação básica, atualmente técnica pedagógica na Secretaria de Educação de Santa Catarina. Pesquisadora na área de design e educação, junto ao Projeto MADiT (Mobility in Art and Design in Teacher Education), com foco em design na educação básica e literacia em design.

Professor, with a bachelor's degree from the Federal University of Rio Grande do Sul, a master's degree in Science Education (UFRGS), and currently a doctoral candidate in Design (UFRGS). A teacher in elementary and secondary education, she currently serves as an educational specialist at the Santa Catarina Department of Education. She is a researcher in the field of design and education, working with the MADiT Project (Mobility in Art and Design in Teacher Education), with a focus on design in elementary and secondary education and design literacy.
E-mail: manuella.mds@hotmail.com

Neilton Feliciano Costa

Bacharel em Design e Administração de Empresas pela Universidade Federal do Ceará (UFC), especialista em Administração Pública contemporânea e mestre em Design pela Universidade Federal do Rio Grande do Sul (UFRGS). Atua como especialista em regulação no setor audiovisual, com experiência em planejamento governamental, inovação no setor público e políticas públicas para a cultura. Seus interesses situam-se na interseção entre design, inovação pública, gestão pública e regulação.

Holds a Bachelor's degree in Design and Business Administration from the Federal University of Ceará (UFC), a specialization in Contemporary Public Administration, and a Master's degree in Design from the Federal University of Rio Grande do Sul (UFRGS). Works as an audiovisual sector regulation specialist, with experience in government planning, public sector innovation, and public policies for culture. His research interests lie at the intersection of design, public innovation, public management, and regulation.
E-mail: neiltonfeliciano@gmail.com

Silvia Trein Heimfarth Dapper

Designer, graduada com ênfase em Ergonomia pela Universidade Feevale (2010), com mestrado em Design pela UFRGS (2013) e doutorado em Engenharia Civil pela mesma instituição (2019). Atualmente cursa segundo doutorado em Design na UFRGS, com foco em metodologias de pesquisa com usuários para inovação em startups de base tecnológica. Tem mais de 13 anos de experiência docente no ensino superior (Univates e PUCRS), atuando principalmente nos temas: biomimética, materiais e processos de fabricação, ergonomia, design centrado no humano e sistemas produto-serviço. Também atuou em consultoria corporativa e no ecossistema de inovação da PUCRS. Recentemente, desenvolveu pesquisas sobre design-driven innovation e metodologias ágeis aplicadas ao ensino de design.

Designer, with a bachelor's degree in Ergonomics from Feevale University (2010), a master's degree in Design from UFRGS (2013), and a Ph.D. in Civil Engineering from the same institution (2019). She is currently pursuing a second Ph.D. in Design at UFRGS, focusing on user research methodologies for innovation in technology-based startups. She has over 13 years of teaching experience in higher education (Univates and PUCRS), focusing primarily on the following topics: biomimetics, materials and manufacturing processes, ergonomics, human-centered design, and product-service systems. She has also worked in corporate consulting and within the PUCRS innovation ecosystem. Recently, he has conducted research on design-driven innovation and agile methodologies applied to design education.
E-mail: silviadesign@gmail.com

Tânia Mara Mattiello Rossetto

Arte-educadora, graduada pela Universidade de Caxias do Sul (UCS); Mestre em Design pela Universidade Federal do Rio Grande do Sul (UFRGS), ênfase em Design e Educação; Artista Visual; Arteterapeuta. Especializações em Artes Plásticas: Suportes Científicos e Práxis (PUC/RS); Arteterapia no Contexto Social e Institucional (INFAPA/RS); Residência Integrada em Saúde, ênfase em Saúde Mental (ESP/SUS/HPSP). Possui ampla experiência no uso de processos criativos em ambientes de aprendizagem; em atelier terapêutico com portadores de diagnósticos e em atelier livre. Integra redes e associações profissionais no Brasil e no Exterior. Promove projetos sociais e ações comunitárias.

Art educator, with a bachelor's degree from the University of Caxias do Sul (UCS); Master's degree in Design from the Federal University of Rio Grande do Sul (UFRGS), with an emphasis on Design and Education; Visual Artist; Art Therapist. Specializations in Fine Arts: Scientific Foundations and Practice (PUC/RS); Art Therapy in Social and Institutional Contexts (INFAPA/RS); Integrated Residency in Health, with an emphasis on Mental Health (ESP/SUS/HPSP). She has extensive experience using creative processes in learning environments; in therapeutic art studios with individuals with specific diagnoses; and in open art studios. She is a member of professional networks and associations in Brazil and abroad. She promotes social projects and community initiatives.

E-mail: comtaniarossetto@gmail.com

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PGDESIGN UFRGS
LDCI Lab Design Cultura Inovação
CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico
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synopsis

How can Design transform cities, give new meaning to experiences, drive innovation, and contribute to building possible futures? It is through these reflections that Design, Culture and Innovation invites the reader to explore the multiple dimensions of Design and its role in the transformation of society. In its fifth volume, this collection brings together eight chapters resulting from research conducted within the Postgraduate Program in Design at UFRGS. Organized into three thematic axes, the work explores Design as an agent of social, urban, and public transformation; experiences and interactions mediated by emerging technologies, including artificial intelligence agents; and the methods, creative processes, collaborative practices, and learning involved in the production of knowledge in the field of Design. More than just presenting research findings, this work proposes new ways of understanding Design, its scope of practice, and its potential for impact. By bringing together diverse approaches, the volume encourages reflection, broadens perspectives on the complexity of contemporary Design, paves the way for future inquiry, and invites the reader to explore—including through the collection's previous volumes—the richness of a field in constant transformation.

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