MECHANICAL ENGINEERING | PHYSICS | PRESERVATION OF THE ARCHITECTURAL HERITAGE | STRUCTURAL, SEISMIC AND GEOTECHNICAL ENGINEERING | URBAN PLANNING, DESIGN AND POLICY | AEROSPACE ENGINEERING | ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING | ARCHITECTURAL, URBAN AND INTERIOR DESIGN | BIOENGINEERING | DATA ANALYTICS AND DECISION SCIENCES | DESIGN | ELECTRICAL ENGINEERING | ENERGY AND NUCLEAR SCIENCE AND TECHNOLOGY | ENVIRONMENTAL AND INFRASTRUCTURE ENGINEERING | INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING | INFORMATION TECHNOLOGY | MANAGEMENT ENGINEERING | MATERIALS ENGINEERING | MATHEMATICAL MODELS AND METHODS IN ENGINEERING

PhD Yearbook | 2023

Chair:
Prof. Lucia Rosa Elena Rampino

DOCTORAL PROGRAM IN DESIGN

Field of study
The Politecnico di Milano established a PhD programme in the field of design already in 1990. Based on this tradition, the current PhD programme in Design was established in 2008, resulting from a substantial review of how design was researched at a doctoral level. The overall aim of the PhD programme in Design is to develop skills to carry out high quality research, reflecting on the overall nature of design, with its aesthetic, performance and meaning values as well as its capability of being an agent of social change.

The PhD programme in Design deals with various research strands, each of them carried out by a given research team within the Department of Design. All the teams cluster around three Sections:
- Design and Cultures
- Products, Strategies and Services
- Design for Environments, Landscape and Mobility

The programme aims at educating researchers who will contribute original knowledge to the field of design as an established academic field by tackling the problems and identifying the potential of contemporary society. Their contribution may be brought to bear in:
- creating designs, visions, and proposals (research through design);
- developing tools and methods for putting these into practice (research for design);
- developing critical analysis of design and its application domain (research on design).

The Programme develops project and analytical abilities, proposes different methodologies of research, promotes the attitude to collaborate, and offers working opportunities in universities and research centres, design enterprises and public corporate bodies.

Mission and goals
The programme develops design skills and analytical abilities, proposes various research methodologies and promotes a collaborative disposition.

The main academic field is Design. Other academic fields partially covered are: Philosophy; Language Theory; Sociology of Cultural Processes; History of Art; Science and Technology of Materials; Industrial Engineering.
The achievement of the PhD qualification in Design requires a study and research activity equivalent to at least three years of full-time study. During this period, both educational and research activities are provided. At the beginning of the programme, candidates become effective members of a research team, within which they develop an original research topic: this activity is the core of the learning process. Parallel to this, candidates are involved in training and specialist activities.
Moreover, the activities of the PhD in Design include participation in conferences (as listeners or speakers) and writing of research papers and/or journal articles. The programme offers doctoral candidates the following opportunities:
- to develop an original theme of research, becoming an effective member of a research team;
- to attend courses and seminars on design research and on research in general, developing skills concerning the discipline of design and the profession of the researcher;
- to attend courses and seminars referred to a specific field of research, developing high-level specialist skills and acquiring knowledge and tools for the development of their own research;
- to develop the ability to clearly and effectively present the contents of their own work;
- to spend a period abroad as visiting researcher in a research centre to verify the assumptions, the methodologies and the results of their doctoral work.

Qualifications
The PhD program in Design intends to educate a flexible figure: a designer who knows how to carry out research and a researcher who uses design tools. At the same time, she is also an expert in knowledge management, in constructive interaction among different actors and in the sharing of ideas and proposals.
The combination of these skills is useful in a variety of work environments. Specifically: in institutions expressly dedicated to the development of design research, such as universities and research centres; in design agencies and in design-oriented companies; in public corporate bodies and in organizations for territorial development which, increasingly, are faced with complex problems, which the designer-researcher can effectively address, analyse and contribute to resolve.

DOCTORAL PROGRAM BOARD

Lucia Rosa Elena Rampino
Bertola Paola
Caratti Elena
Celi Manuela
Feraboli Maria Teresa
Lupo Eleonora
Quaggiotto Marco
Riccò Dina
Spagnoli Alessandra
Bertolo Maresa
Cautela Cabirio
Conti Giovanni
Ferraro Venere
Maffei Stefano
Mortati Marzia
Vezzoli Carlo Arnaldo
Villari Beatrice
Anzani Anna
Canina Maria Rita
Ferrara Maria Rita
Guerrini Luca
Maffeis Rodolfo
Mazzanti Anna
Rognoli Valentina
Rossi Michela
Rossi Maurizio
Spallazzo Davide

DESIGN METHODS FOR PUBLIC POLICY FORMULATION. A STUDY OF DESIGN PRACTICES APPLIED BY PUBLIC SECTOR INNOVATION UNITS IN PUBLIC POLICY FORMULATION PROCESSES

Villa Alvarez - Supervisor: Marzia Mortati

Co-Supervisor: Valentina Auricchio

The emerging design practice in the public sector has become a subject of study for the design discipline and the political sciences. In this field, scholars observe a potential contribution of design to the traditional policy practices to stimulate collaboration (e.g., involving various actors in analysing a public issue, co-creation, co-design), to address public challenges (e.g., design methods for researching, representing and testing ideas), and to shape policy delivery (e.g., public services) (Bason, 2014a; Blomkamp, 2018; Kimbell, 2015; Kimbell & Bailey, 2017; Mager, 2016; Van Buuren, Lewis, Peters, & Voorberg, 2020). While they suggest that design's significant contribution to policy occurs in the implementation of public services and programmes, they also call for a deeper understanding of the nature of design practices at a more strategic level, particularly for developing policy proposals and reforms (Figure 1) (Bason & Schneider, 2014; Lewis, McGann, & Blomkamp, 2020; McGann, Blomkamp, & Lewis, 2018).

This doctoral research seeks to understand the design practices of public sector innovation (PSI) units in public policy formulation processes. After building a research sample, it selects five cases to study PSI units' participation in policy formulation processes, their design activities and methods, and contributions to these processes. The research adopts a policy cycle model, particularly the policy formulation stage and design processes and methods' inventories. Building the research sample led to collecting a list of 475 PSI units worldwide and mapping design activities and methods of 46 PSI units in stages of the policy cycle (Villa Alvarez, Auricchio, & Mortati, 2022). It also identified 13 PSI units working in the policy formulation stage, from which 11 were validated through interviews. Among these PSI units working in policy formulation processes, this research studied five cases at a national or state level in Argentina, Colombia, The Netherlands, Latvia, and the State of Victoria in Australia (Figure 2).

Case studies described PSI units' design activities and methods applied in various policy formulation processes, and validated hypotheses of design contributions in these processes. These cases suggest that among the four phases of a policy formulation process, PSI units' design activities concentrate mainly on the Appraisal and Dialogue phases, while they are less frequent in the Formulation and Consolidation phases.

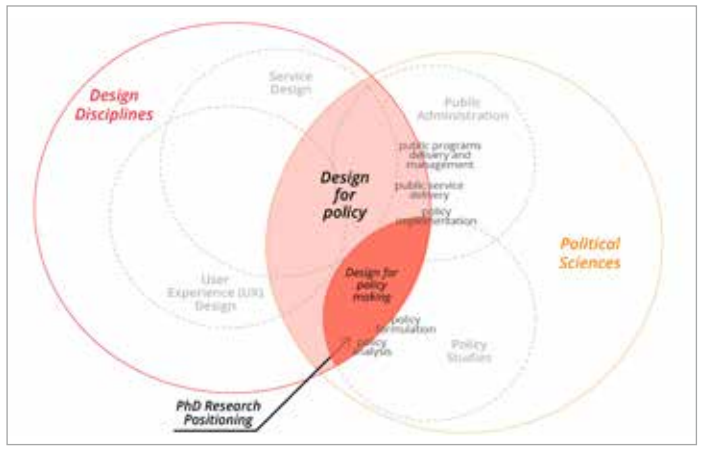

Fig. 1 - Positioning map of the PhD research in the design for policy field, in the intersection of design and policy studies.

Remarkably, the two internal PSI units working in Formulation were not responsible for writing the policy document drafts but a team of policy-makers. Also, the one PSI unit in Consolidation mainly facilitated negotiation among decision-makers. Findings suggest that PSI units' multidisciplinary staff influence the methodological approach for collaborating with policy-makers in policy formulation and produce a hybridisation of processes and methods from the diverse expertise of PSI units' staff. This research corroborates that design contributes to policy formulation processes by considering policy users in different phases, improving policy problem understanding and reframing, and changing policy-makers mindsets. Findings also evidence benefits of systematising and supporting policy-makers discussions with actors, prioritising policy problems and solutions, increasing efficiency in policy formulation processes, and broadening the scope and detail of the policy.

This research creates a fertile ground for future investigations and design work in the design for policy field. Researchers may complement findings in policy formulation processes and explore design practices emerging in other policy cycle stages such as agenda-setting and policy evaluation, uncovering their contributions and connections to policy formulation. For design practitioners, design activities and methods become a source of reference to support policy formulation, while emerging design practices and gaps in design work in the policy cycle suggest potential opportunities for developing future design services. Over more, this research also opens to further studies in design work in policy processes of PSI units and other types of innovation units (e.g., social innovation labs, living labs, non-profit organisations, think thanks). This research observes the increasing relevance of critically examining users' consultation or participation and design impact in policy formulation processes. The Design for Policy field will also benefit by discovering the roots and characterising the evolving design methods complementary to traditional policy-making methods. Within the education in this field, future programmes may aid designers in gaining knowledge in policy processes, political contexts, and data literacy, among various skills valued in the Design for Policy field.

Fig.2 - Overview of the location of the case studies.

IF EYES COULD BREATHE. THE ATMOSPHERIC DIMENSION IN HISTORIC TEMPORARY EXHIBITION SPACES

Marta Elisa Cecchi - Supervisor: Giampiero Bosoni

Entering a 'quality' space means immediately perceiving the particular, vibrant elements of atmosphere that surround and characterise it. Although apparently explicit in its definition, the concept of the atmosphere has been misused and extremely vague in describing spatial qualities. The concept of atmosphere resides in spatial disciplines, such as architecture, interior design, landscape, and urban design, as a reality that has existed but has not yet been decoded and sufficiently deepened. In fact, the specific characteristics and traits that trigger the atmosphere in a space are not yet clearly defined, but it is always possible to perceive and feel them when encountered.

The concept of the atmosphere has recently become one of the most important in the German neo-phenomenological debate. It has been employed in aesthetics, particularly by the philosopher Gernot Böhme, the foremost exponent of this "atmospheric renaissance". The spheres of investigation of the atmosphere are vast, including nature, art, design, visual arts, music and literature, which no longer have a marginal place.

Even if the contemporary landscape of design and arts have lost the criteria of recognisability, blurring in a thin medium as an aesthetic ether, the concept of atmosphere can provide a different perspective in aesthetic domains where the value of 'staging' prevails over the object by determining attention to the environmental qualities of spaces and landscapes. Therefore, the concept of the atmosphere is a new category or 'hermeneutic approach' to understanding spaces, case studies, histories and past/current events.

Furthermore, the need to effectively translate and communicate this concept in the design of the built space is becoming particularly relevant in the specific context of temporary exhibitions. This is especially pertinent to the exhibition design since it establishes a narrative and emotional engagement between visitors and the subject matter and visitors and the set-up space. Furthermore, the research intends to highlight that exhibition design should be conceived as a field of creating atmospheres, potentially building temporary ambiences and milieu. In becoming "atmospheric", exhibition design tests its *mediating power*: its capacity to touch the body, transmit sensations, and become the spatial bearer of moods.

To this extent, integrating the concept of atmosphere into this specific discipline allows a different perspective on exhibition design, which investigates the perception of the temporary space and its expressive-sensorial characteristics with even greater sensitivity.

This doctoral research aims to understand and decode this particular *spatial dimension* through an exploratory approach and to develop an interpretation of the atmospheric phenomenon in the specific field of temporary exhibitions. The research also draws from theories developed in the humanistic field of aesthetics and contemporary philosophy. Furthermore, the philosophical angle from which this research took its first stages proved to be of great importance in approaching the understanding of our relationship with space from a perceptive and cognitive point of view, involving a different sensitivity.

The investigation is developed mainly through a historical perspective, critically analysing past examples of exhibition spaces in the Italian and international contexts, termed as *outcomes* of a design process. The phenomenological approach to the theme will provide a foundation to investigate the curating of exhibition spaces, defined as *processes* of 'invisible' complexity, to stimulate different bodily and mental perceptions. Furthermore, the research title "If eyes could breathe" intends to investigate the concept of atmosphere in the specific field of temporary exhibition spaces through images and documents as the only historical evidence able to revive the environmental atmosphere that would have been experienced in those installations. The sentence comes from Elias Canetti's third autobiographical book, *The Play of the Eyes.* It is taken as a starting point and inspiration to imagine a different way of looking at both the historical heritage of design culture (through different materials such as images and texts) and of conceiving (interpreting and designing) the spaces of the contemporary age with a different viewpoint, more sensitive to the invisible and impalpable aspects that characterise them.

The main objective of this research is to acknowledge the concept of atmosphere as a qualitative spatial characteristic to be integrated into the design practice of temporary exhibition spaces and to build a reference lexicon, establishing a better understanding of the exhibition space from the atmospheric perspective. The main result of this research is the atmospheric dimension, which can be summarised as a *set of coordinates* (natures, qualities, elements, and approach) to conceive the atmosphere in interpreting historical and lived space and exhibition space design. The main inputs of the research are:

- Defined spatial macro-categories, or macro-areas, of the atmosphere that allow for understanding any designed space, declined in an atmospheric view. The macro-categories are the following: atmosphere as air, bubble, fog, diaphragm, net, hues&tones and void.
- Built and structured an anthology of historical case studies of temporary exhibition spaces in the Italian context, subdivided into categories and individually re-read in the atmospheric perspective. This anthology represents a starting point for future contemporary atmospheric reinterpretations of exhibition culture and design. The atmospheric categories in the anthology are the following: dynamic / active, echoing / balanced, enveloping / permeable, solid / dense, framed / netted, tinted / lit, free / alive. Plus, two preliminary categories are spaces and structures of transition and connection.
- It has defined the atmospheric lexicon that can be used to understand and design the exhibition space. This lexicon becomes a primary tool to solicit the atmospheric sensitivity of conceiving the designed space.
- Contribute to adding a practical example, i.e. the ADI Design Museum exhibition *// Cucchiaio e la Città,* of how it is possible to use a tuning tool within an exhibition space in an atmospheric sense and understand the exhibition as research as a method to reflect on the practice of exhibition design and its aesthetics.

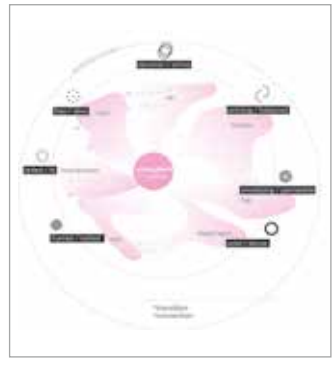

Fig. 1 - Definition of atmospheric categories in the field of temporary exhibition spaces

Lastly, the evolution of our understanding and sensitivity to the atmospheric matter could help us implement our aesthetic abilities, through which we 'breathe' the places we encounter in new or revised ways. This research attempted to describe the contemporary aspects of this profound reflection on a mutual relationship that will hopefully continue to support the discipline of exhibit design over time.

DRIVING SUSTAINABILITY IN FASHION THROUGH DESIGN: EXPERIMENTING WITH THE ROLE OF DESIGN IN THE DEVELOPMENT OF A CIRCULAR FASHION SUPPLY CHAIN MODEL

Erminia D'Itria - Supervisor: Chiara Colombi
Co-Supervisor: Federica Vacca

In recent years, sustainability has emerged as the focus of global debate on environmental, social, economic, and cultural issues. Considering current uncertainty and unexpected emergencies related to climate change and the globalization phenomena of an increasingly anthropocentric system, companies in the fashion industry are in a moment of crucial change in their sustainable vocations and practices. These changes are determined by the environments in which these companies are immersed: society, the market, and the ecosystem.
In sustainability, the study of different dynamics within the fashion industry crosses from scientists' work and social and economic philosophers to politics. Furthermore, the interconnectedness of the environmental, economic, social, and cultural parameters demonstrates the power dynamics at play in societies worldwide.
Fashion Design for Sustainability (FDfS) refers to an umbrella theme of Design, production, retail, and purchasing that holistically considers unsustainable issues such as production patterns, resource exploitation, workers' status and quality of life, fair trade, and social innovation.
The presented doctoral research reports evidence that an emphasis on circularity is relevant to the global fashion industry but still has a limited impact on the circular cycle. It shows how fashion companies need to concentrate on their sustainable goals, approach them holistically, and consider systemically all business processes to implement sustainable development strategies. In this way, they could start to close the circularity loop fully.
In this scenario, the focus of the proposed doctoral research is the role of Design in guiding possible directions for the future development of the FDfS industry. Investigating the shift through a holistic paradigm that, considering the supply chain as a continuum, can envision a design-led transformation.
Design could enable the adoption of approaches to develop an alternative and circular model of the fashion supply chain.
Specifically, the research objectives are related to defining, elaborating, and testing design-led strategies for supporting fashion actors in changing their mindset for moving from the business-as-usual approach toward a circular one. This could happen by exploiting the knowledge and tools produced by the research and embedding such methods in the company's practices.
The research results aim to be an enabler, through the theory and practice of Design, to translate the complexity of sustainability. The vector for such a translation process is the research-designed tool – the Circular Strategy Toolkit - that supports fashion actors in self-assessing and implementing their knowledge through a systems approach based on the pillars of sustainability. It might guide them in adopting a holistic approach or focusing vertically on specific circularity aspects. In this way, companies could systematize the available knowledge to set priorities and future goals and define what they want to achieve in transforming their practices and, consequently, their supply chain, aiming for a sectorial transition.

DESIGNING MNEMOTOPES. PHOTOTEXTUAL PRACTICES FOR THE GEOLOCALIZED MEMORY OF PLACES

Clorinda Sissi Galasso – Supervisor: Giovanni Baule

The research *Designing Mnemotopes. Phototextual Practices for the Geolocalized Memory of Places* has three main objectives: it aims to lexically transfer the concept mnemotope to the field of design; it outlines, through the phototextual analysis of case studies, a mnemotopic theoretical framework based on different categories and specific variables; it describes the *mnemotope* as a performative design principle. The research is embedded in the field of Communication Design for the Territory, a discipline that has taken up the territorial theme as its own specific dimension, through geolocalization and cartographic paradigms, in conjunction with Memory Studies, an academic field that investigates memory as an integrated interdisciplinary system that combines the physiological dimension with the sociocultural one. Since there is no standard definition of mnemotope, research moves towards a mnemotopic taxonomy and the development of a plural definition consisting of interdependent parameters. The most significant parameters are:

- Place: in dealing with mnemotopes, the signifier – place – assumes a special value, is itself an object of attention because of its status, recognizable and distinct from undifferentiated space. Mnemotopes are not historical transportable markers, but they can be considered as mnestic containers and condensers.
- Narratives: mnemotopes contain stories. Whether visible or latent, the narrative layer is an essential component of the mnemotope and its subsequent dissemination. Mnemotopes have their own communicative value, which may be hidden but remains intrinsic may be hidden but remains intrinsic as they move from the individual to the collective.
- Movements: mnemotopes can trigger movements on the territory. They can attract our steps and thoughts. When we recognize a place as a mnemotope, we can feel the desire to reach it, to see the memory it preserves, and to feel its genius. Mnemotopes can open new paths of territorial exploration away from traditional routes.
- Emotion: Mnemotopes can evoke strong emotions in visitors. To traverse a mnemotope is to meet its emotional apparatus; it is to immerse oneself in the flow and resurgence of a collective psychogeography that intersects with the personal one. We can understand mnemotopes as real emotional haptic devices: to experience a mnemotope is to engage in an exchange of energies and emotions between the body and the mnestic site.

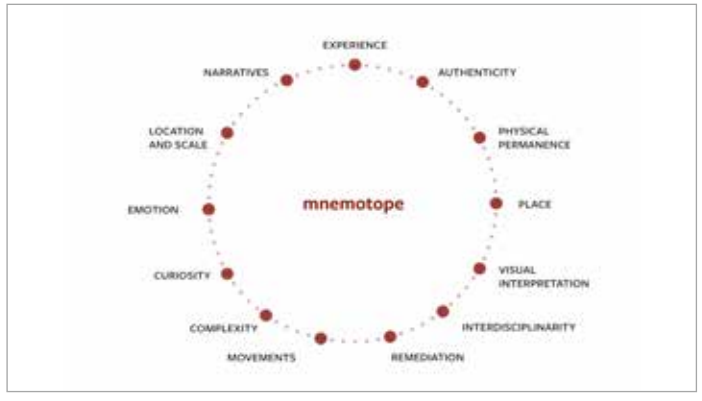

Fig. 1 - Mnemotopic plural definition with parameters, 2021.

The methodological strategy underlines the need to develop a specific tool to support the research hypotheses and activities and to analyze the different mnemotopic typologies. The elaboration of the reports refers to the case study research configured as a mode of investigation, an empirical method that studies a contemporary phenomenon – the case – in its real context. To this research framework was added the photo-textual model, more specifically the *auto-photobiotext*. Starting from the idea of photography as a trace and externalization of memory, but also as its preservation site, the autobiographical photo-text apparatus offers the connection of the photograph, no longer understood in its mimetic value, but as a tool to represent a subjective vision of oneself and the surrounding reality, with the original and personal textual account of one's experience in the world. In this context, then, the semiotic and memory-enhancing power of images emerges, which, together with the narrative, constitute a third object of identity mediation. In the specific field of mnemotopic research, which understands memory in its relation to the physicality of places, the concept of the auto-photobiotext has been associated with the *travelogue*, a narrative genre that is part of the broader field of travel literature, which collects fictions describing a journey to a foreign place, and which today encompasses several disciplines such as geography, history, sociology, and anthropology.

This experimental fusion gave birth to the *mnemotopic phototextual* report, which is based on the three-part emblem form (*inscriptio, subscriptio, pictura*) and consists of:

- Header – inscriptio: informative apparatus that acts as the title of the entire phototext and reports data on: Title/ Name; Location; Coordinates; Year; State of preservation; Mnemotopic category; Mnemotopic typology; Website.
- Textual apparatus – subscriptio: commentary and narrative level of the phototext consisting of two complementary parts: Description, analytical report of the mnemotope; Mnemotopic relevance and remediation, autobiographic mnemotopic storytelling, acting as a travelogue remediation of the non-structured notes derived from the territorial exploration.
- Photographic apparatus – pictura: visual level of the phototext consisting of two original pictures taken from the photographic reportage, with sometimes the insertion of not-self-produced materials but taken from other forms of representation (movies, pictorial works etc.). Action that echoes the photo-textual re-appropriation.

Fig. 2 - Example of the Mnemotopic phototextual report, 2022.

Finally, the various communication projects developed during the years within the Design Department of the Politecnico di Milano show how the promising concept of the mnemotope has become a real productive and performative principle, not only integrated in the design projects, but actively involved in the creation of effective and operational communication prototypes.

EMBALMING AND DISSECTING ARTIFICIAL INTELLIGENCE. VISUAL EXPLANATIONS FOR THE GENERAL PUBLIC

Beatrice Gobbo - Supervisor: Paolo Ciuccarelli

Artificial Intelligence (AI) algorithms – and data that feed them – are increasingly imbued with agency and impact and are empowered to make decisions in our lives in a wide variety of domains: from search engines, information filtering, political campaigns, health to the prediction of criminal recidivism or loan repayment. Indeed, algorithms are difficult to understand. Explaining how they exercise their power and influence and how a given input (whether or not consciously released) is transformed into output is an ambitious goal. In the Computer Science field, Explainable Artificial Intelligence (XAI) techniques have been developed to disclose and study AI algorithms to let expert users, domain experts, and newcomers explore their inner workings and understand the nature of their outputs. Moreover, understanding the mechanisms of the algorithms that control AI machines is an issue that has also affected humanistic fields such as Social Sciences and Science and Technology Studies that have focused chiefly on the effect that these emerging technologies have on society. Visual communication, especially Data Visualization and Visual Analytics for XAI, have proven to be practical tools to represent and explain the mechanisms of algorithms or justify their results through explanatory processes. However, current research on XAI is not addressing the needs of people affected by them. To meet this need, the visual inheritance of communication design allowed to observe XAI from a novel perspective, focusing on the representation of the social context and on the reproduction of algorithmic settings as pivotal elements for explaining AI to the general public. Specifically, while considering the permeability of the involved fields and operating translation acts, the dissertation proposes embalming and dissecting as valuable visual communication tactics to expand the XAI field of action toward the general public.

Methodology

The research was conducted by exploiting a mixed methodology, predominantly guided by Research through Design processes complemented by qualitative and quantitative approaches from the social science tradition and Human-Computer Interaction. Although the thesis followed a mixed methodology, the main methods are derived from research through design and constructive research. However, since the dissertation has a multidisciplinary breath, I had to take inspiration from various domains alongside design tradition. For example, I will present both quantitative methods associated with qualitative ones. Actually, the dissertation structure hides the methodology. Chapters 1, 2, and 3 are devoted to the literature review. Chapter 4, which contains the first design experiment and whose results represent a key contribution of this research, represent the watershed of the dissertation. Indeed, it condenses knowledge and experiences through a constructive design approach from the previous stages. Chapter 5 and 6 describe two projects developed during the doctoral path to support and enrich the discourse about communication tactics. Chapter 7 and 8 describe the theoretical findings, namely the proposed communication tactics.

Thesis Structure

Firstly, the dissertation provides a historical overview of visual explanations of artificial machines, arguing that the ancestors of visual explanations for AI are the Renaissance representations of the "Theater of the Machines". Historical examples, gathered through a process of desk research allowed me to observe and analyze how graphic and visual choices helped to contextualize artificial machines in everyday social environments. Chapter 2, whose core is a visual survey of case studies gathered from the scientific literature, gathers examples from the well-grounded XAI field. The chapter ends with considering the users who are part of the XAI stakeholder system, identifying the need to include the general public. Consequently, Chapter 3 offers a social perspective on the issue, presenting the algorithmic situations as the backdrop for designing AI visual explanations addressed to the general public. Here I focus on the definition Chapter 4 represents the watershed of the discourse. Here, I describe the Explainable Artificial Intelligence Primer (XAI Primer): a wide-ranging visual survey of visual explanations for AI across different fields developed in collaboration with scholars from Computer Science and HCI. Drawing on the experience sedimented up to this stage, the second section of the dissertation is dedicated to "research through design experiment". Chapter 5 describes the Algocount project, the first design experiment carried on in collaboration with social scientists from the University of Milano. Chapter 6 describes the second experiment, carried on during a learn-by-doing process with a group of master students. These chapters (§6 and §7) represent two different ways of addressing visual explanation to the general public: the Algocount project follows the communication tactic of embalming, while the second exercise follows the dissection tactic. Chapter 7 resumes the lesson learned by describing the design tactics of embalming and dissecting as suitable solutions for addressing visual explanation to the general public and providing guidelines and suggestions for future research. Chapter 8 closes the dissertation, encapsulating insights from each chapter and envisioning future research directions.

DESIGN AS A CRITICAL CATALYST INTERROGATING FUTURES BY DESIGN: CONTEXT, RATIONALE AND MOTIVATION.

Ammer Harb - Supervisor: Manuela Celi

Context

It is inevitable that major ecological challenges such as climate change, resources depletion, and food scarcity will have an impact on humanity's future. In this context, Design must succeed in facing these challenges with a greater sense of responsibility and awareness. This PhD research starts with a critical stance toward design. It adopts a position that designers should look critically at the future. It explores and investigates design as a future problematiser/complicator and medium for enquiry rather than design as an affirmative practice that confirms the status quo. This doesn't mean that design should be pessimistic but rather responsible and aware. This research discusses design as a transformative tool for achieving sustainable futures. It introduces design as a vehicle for the future that should aim at a) mitigating the consequences and implications of today's actions, b) enacting social and behavioural change, and c) democratising the visions of the futures through participation and inclusion of the public. In this thesis, design as futures enquiry is shifting from discussions about market and corporate-driven enquiry toward participatory, democratic, and sustainable futures enquiry. It is not about expanding the profit we gain from design but rather questioning the price we will pay in the future following today's actions.

The critical turn

In the recent decades, several directions in design have emerged to counter the negative impacts humans have had on the environment and to redirect the actions we take today with the aim of transforming the status quo towards more sustainable futures. These directions could be defined as (Critical Design practises). Some of these directions are specifically concerned with exploring alternative future visions, aiming to problematise the implications and consequences of the actions we take today. In this thesis, the concept of Critical Design Futures (CDF) is examined, contextualised, and problematised to answer the central research questions through the literature review, expert interviews, analysis of case studies, and design workshops. The thesis introduces a thorough definition of CDF supported by a ten-pillar framework.

Research Gap

Although there is a plethora of examples for CDF, their nature is still little theorised, and their interpretation often remains uncertain and unclear regarding their methodological approach. It is evident that the intentions of critical practises in design are purely for social good, as they aim to achieve sustainable transformation and change. However, there are many contradictions and challenges within these practises themselves. The big question that is often asked in the criticism for CDF practises is the "How?" The answer to this question is very complicated because of many reasons. Yet, it could be concluded in one main problematic aspect that this research aims to investigate is the weakness in the methodological account and lack of concrete theoretical frameworks for CDF.

Methodology

To address the research gap, the research follows a qualitative inductive methodology. The researcher starts by gathering data and analysing the Critical Design practises, elements, context, and rationale in order to develop the definition and foundational theoretical framework for "CDF". Primary research activities included sixteen expert interviews with highly significant academics in the field of Critical Design and CDF. Along with the expert interviews, the researcher analysed cases from the literature and in-depth cases by interviewing influential CDF practitioners. Following these two primary research activities, the researcher conducted design workshops to test and validate the applied outcome of the thesis. Besides primary activities, the researcher conducted secondary research activities including both a literature review of the key concepts and topical issues within Design Futures, Critical Design, and Futures Studies as well as the Critical Theory and relations to design.

The main research question of this research is "What does it mean to be 'critical' about Design Futures, conceptually and performatively?" This question is tackled in the research on two levels: a) the conceptual level, aiming to identify the motivation, context, rationale, philosophical and ideological frameworks of CDF; (b) the performative level, which tackles the main research gap which is the methodological account of CDF. The applied outcome of this thesis is the Critical Catalyst which helps designers and design researchers to critically explore alternative futures with the aim to mitigate design's negative consequences, expose their implications, and facilitate design-driven transformations.

The Critical Catalyst

The Critical Catalyst (CC) (fig.1) is a set of reflexive design activities, tactics and devices developed to fill the gap in the methodological approach of CDF. The CC works as the initiator of critical debates in Design Futures and a catalyst to facilitate designers' reflections towards future challenges. The CC started as an outsourced lexicon of methods, approaches, concepts, and techniques coming from the literature review, from case studies analysis and backed by the interviews. Then, the CC was refined through cycles of validation with expert interviewees and through observing and developing the validation experiments. The CC is a catalyst, support, and facilitator rather than a guide. It facilitates the process by providing the practitioners and researchers with tactics to problematise a future challenge and look at the hidden and intangible sides of it.

a) Facilitate triggering critical enactments in the futures-oriented design process
b) Work as a self-reflexive tool for practitioners and researchers
c) Catalyse critical thinking, analysis, and decisions along the process
d) Support participatory processes by supporting practitioners to prompt, challenge and trigger dilemmas and controversies and to provoke the intended audience.

The CC works to support the methodological flexibility needed for CDF by offering the critical triggers all over the process without imposing a particular sequential or linear process. It's a means to offer wide and flexible choices of critical triggers that a practitioner can select from. The CC was validated and developed through conducting several design workshops with design students, professionals, and experts to test its impact and functionality (fig.2).

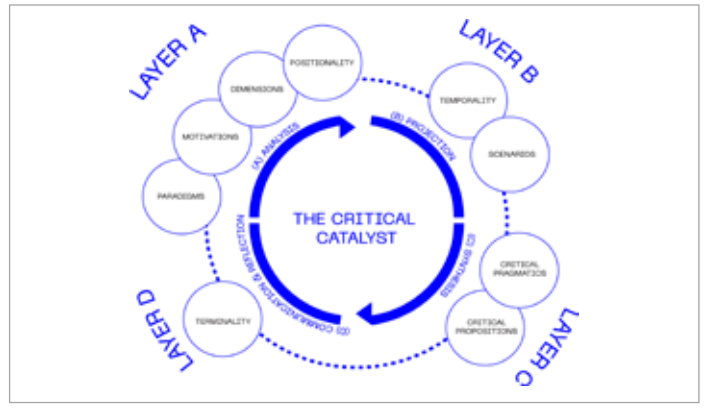

Fig. 1 - The Critical Catalyst framework, by author (2022)

Fig. 2 -A design workshop conducted at the design department of Politecnico di Milano to test the Critical Catalyst in April 2022, image by author (2022)

CO-CREATING A CIRCULAR CITY: A COLLECTIVE AND REFLECTIVE JOURNEY

Li-Ting Huang - Supervisor: Beatrice Villari

Since the significant promotion of the green transition in the EU, a growing number of city authorities have begun embedding sustainable development goals (SDGs) and circular economy (CE) principles into their regional strategies to foster the transition towards circular cities. As a result, the co-creation approach is now entering the vocabulary of government decision-making processes. This indicates that authorities are actively collaborating with stakeholders, including the private sector and civic society, to realise circular cities.

Although co-creation has been applied to engage city authorities and stakeholders in strengthening public service provision and public problem-solving, the approach is still developing. For instance, there remains a research gap from a practical point of view in terms of knowing how co-creation can be used to achieve innovative solutions and how public value is co-created in circular cities. This is particularly true when the municipality has been able to make effective use of the design approach. This thesis presents a methodological framework that applies co-creation to realise circular cities, through the support of both service and systemic design.

Through qualitative research, case studies were undertaken in a two-stage process. The first stage comprised semi-structured interviews with public employees of four European frontrunner circular cities. Data were analysed using the grounded theory (GT) method to deepen our understanding of the value that co-creation brings to circular cities. The output of this stage was a conceptual model. The second stage involved desk research of varied sources such as official reports and documents showcasing EU projects. The output of the second stage was a prescriptive model. From these two models, a preliminary framework was outlined and further assessed by city practitioners.

The final research output – the 'circular city co-creation framework' – with three instructive levels – provides typologies of co-creation practices, stakeholders, and engaging platforms. Such a strategic framework offers municipalities a more systematic way to co-create with confidence and imagination. The framework has been found to be effective as a guideline to facilitate innovation.

Keywords: circular economy (CE), circular city, sustainable development goal (SDG), co-creation, value co-creation, co-design, service design, systemic design

Fig. 1 - The circular city co-creation framework

DESIGNING IN DATA-CENTRIC POLICYMAKING. AN EXPLORATION OF DATA FOR POLICY AND POLICY LEARNING IN DATA ECOSYSTEMS

Francesco Leoni - Supervisor: Stefano Maffei
Co-Supervisor: Grazia Concilio

A considerable part of the contemporary scientific and political debate sees the digitalisation and digitisation of today's sociotechnical systems as an unprecedented possibility to create innovation from digital data. In this view, the relationship between data and innovation is mainly based on a paradigm of extracting value from data. Under this paradigm, national governments worldwide appear committed to making digital data a central element of their innovation agendas by proposing data-driven innovation to improve governance, public services, and policymaking. Accordingly, several governments are incentivising the leveraging and appropriate sharing of currently under-utilised public sector data. For example, several national and supra-national governments addressed the lack of legal and policy frameworks for public data governance by publishing official Data Strategies.

Within the literature considering data-driven innovation in the public sector and policymaking, several authors agree that the innovative, game-changing factor of data-driven innovation for policy would rely on *building policy knowledge from digital data not originally intended as evidence for policy decision-making*. This would allow the exploration of policy problems from a vast collection of heterogeneous *non-traditional* data sources. Unlike the traditional data — usually collected for an extended period by actors with an official mandate to build evidence for public decisions (e.g., statistical offices, policy analysts, think tanks) — non-traditional data might be collected and updated faster and on a granular level. A clear example is administrative data (i.e., data collected as part of public administration functions), which could provide quickly updated information on citizens' interaction with public services at the individual level.

The non-traditional data perspective suggests that data-driven innovation in policymaking implies challenges in government analytical capacities, evidence-building processes, data governance, and data sharing across public organisations. This account contrasts with a decade of "big data" narrative that emphasised technological factors above the others. Since they are already bombarded with information, policymakers hardly need to leverage large quantities of data but should be provided with insights from "appropriate", trustable sources. Hence, the innovation locus of data-driven innovation for policymaking should conceptually be searched outside a reified conception of technology and within the complex policy processes where data might be collected and used.

These value propositions have been progressively examined in an emerging field of discussion called "data for policy". In this field, some authors noted that the value of data for policymaking could not be discussed with the same logic of efficiency that has characterised the general debate on data. Policymaking is, in fact, a process that implies a normative and partial view of public issues and is therefore connected to mechanisms of political judgement and public acceptability, dimensions that lie outside the logic of efficiency. Rather than in the data itself, for policymaking, there seems to be value in the processes centred on collecting and using these non-traditional data, which can constitute new forms of experimentation and collective learning on policy problems.

From these considerations, the thesis conducted two main studies. Firstly, a qualitative exploration of the current discourse in the emerging "data for policy" field. Secondly, a qualitative comparative analysis of data uses practices within data ecosystems in the public sector in four European countries (Sweden, Italy, Belgium, and the Netherlands). The thesis proposed the concept of data-centric policymaking to conduct the comparative analysis and developed this concept through a theoretical-conceptual framework based on policy learning.

The qualitative exploration of the current discourse in the emerging field of "data for policy" (i.e., the first main study conducted by the doctoral research) seems to feature Data Ethics (i.e., the ethical use of non-traditional data) and Data Culture (i.e., both the capacity of using data in the public sector and the cultural approach to their use) as relevant and recurring themes. This suggests that the "data for policy" discourse, while still largely fragmented, might be acknowledging its specific challenges, which arguably pertain to a value-laden and normative dimension, addressing the right approach and use of non-traditional data for policymaking. At the same time, the field appears still largely fragmented and divided by several interests, of which a large part does not seem concerned with the influence of policymaking on the use of data and technologies but with technological applications and their impact on the public sector and government.

The qualitative comparative analysis of four cases (i.e., the second main study conducted by the doctoral research) shows that actors involved in data-centric policymaking practices perceived greater individual cognitive learning on policy issues. However, there does not seem to have been a fundamental change in their opinions through participation in the process. Overall, the interpretation of findings from qualitative comparative analysis suggests that the learning that happened might have only regarded the gain of new information, depending on the initial knowledge of actors. Experts of the policy problem gained new knowledge and increased their expertise on policy problems; individuals without pre-existing knowledge gained a general increase of what they knew already. This finding might suggest that data-centric policymaking risk becoming a process where existing beliefs are reinforced. Moreover, the conditions for this learning seem to have depended not on structural enabling conditions for data sharing but on factors at organisational and individual levels. These included the presence of a stakeholder with a leadership role and the possibility and time to experiment given by the political support. This notion reinforces how the appropriate use of data for policymaking highly depends on the contextuality of the policy process and its alignment with the goals of the organisation collecting the data.

From the knowledge of these two studies, the thesis proposed three areas of convergence between 'data for policy and 'design for policy', articulating the potential contribution of design in data-centric policymaking: Learning from Data-centric Anticipatory Governance; Learning from local/contextual knowledge; Learning from Data-driven Service Systems.

The three areas presented identify paradigms under which designing practices can merge into data-centric policymaking, with an indication of goals, roles, technologies, and the support of illustrative examples. The thesis has thus contributed to a better understanding of "data for policy" and data practices in the public sector while offering an interpretation of the phenomenon in relation to policymaking and design.

URBAN MINDSCAPES – DESIGN HEALTHIER URBAN PUBLIC SPACES

Emilio Lonardo – Supervisor: Anna Anzani

Cities are both the most complex and the most important human invention. Much of the world as we know it would not exist if cities did not exist. Why do we know so little about the emotional effects of urban living when more than half of the planet's population already resides there? Psychology, which deals most closely with human emotions, is basically absent from urban policy. This is astounding. Increasingly, researchers are looking into creating urban environments and cities where people feel a sense of complete well-being. On the one hand, it appears as if the design world must prepare itself to deal with a paradigm shift that incorporates psychological dictates into the study of public space, on the other hand psychology sees an opportunity to reposition itself at the centre of the debate over the health and form of cities, while also being aware that it must embrace other disciplines and develop new tools in order to deal with this paradigm shift.
This thesis seeks to identify points of contact between the design culture of urban spaces, particularly those defined as Urban Interiors, and the psychological disciplines, exploring their implications for the development of a design culture that aims to improve the psychological health of city dwellers. The main objective is to broaden the knowledge on this topic to outline new and better urban landscapes that aim to recreate the conditions for inhabiting city spaces more healthily. Urban Mindscapes, as a neologism, is inspired by the homonym defined by Vittorio Lingiardi (2017) to "evoke the relationship between psyche and landscape and place us halfway, where we need to be," and is proposed as a transdisciplinary contribution to suggest a point of view still little explored in the field of urban design. It could be considered as the offspring of a tradition wherein, in the development of projects, the prevalence of formal and functionalist aspects is replaced by the adoption of a more gentle approach, which also takes into account immaterial components, the psychological dimension and the intrinsic and systemic relationship that exists between place and inhabitant.
These statements form the core of the research and attempt to address the gap between two fields that, in terms of vocabulary and methodologies, have many common aspects but which often find themselves misunderstanding or ignoring each other on collaborative occasions. The research was inspired by the perception that the role of contemporary design is no longer to build spaces but to form places where the complex intangible system between human beings and the other material and immaterial components of the surroundings are joined. Furthermore, where man is part of this system with his body and psyche, influencing the space and letting himself be influenced. As in breathing, man and environment live in synergy; understanding how the surrounding space modifies our being seems today the only way to inhabit space in a sustainable way for us and for space itself.
The aim is to trace the boundaries of a general common ground of communication, in which the culture of design can enter into dialogue with the knowledge of psychology, so that "the area of study that explores the dynamics of feelings and emotions" (Landry & Murray, 2017) can be helpful in designing better places for the mental well-being of human beings and consequently for ecological well-being. To this end, the research tries to position itself as a filling agent to broaden knowledge about mental well-being in the urban context. It proposes a possible transdisciplinary approach that can connect the methods of the two disciplines and make them able to dialogue with other stakeholders involved in urban public life and generate new knowledge with renewed culture. It also aims to propose solutions to the everyday problems concerning those biases that do not promote the psychological well-being of urban dwellers. In conclusion, it is believed that the influence between the two disciplines, "with the psyche in the landscape and the landscape in the psyche", in the environment of contemporary Western culture, can open up designing paths to address the issue of inhabiting urban public space with a psychological lens. So that space design is more conscious of the influence between man and the environment and is not only an installation action centred on functions and services but is also proactive in promoting the mental health of those who live in the city.
The built environment influences people's mental health (Evans, 2003). Living in cities activates a dual process, since also our mental state impacts on the health of the cities. Light, topology, organisation and use of space, geometry, rhythm, texture and matters, sounds and smells: all these elements, prior separately and then through their integration, concern the physiology of the human sensory system. Therefore, a designer of public spaces has the responsibility to think not only in aesthetic terms, but also to make projects capable of responding to the basic needs of the people who will inhabit them.
In order to do this, it is necessary to tap into the knowledge of other fields, one of which is the psychology sphere. Although the number of studies on how much the built environment impacts on people's mental health has increased in recent years, there still seems to be a gap with design practises aimed to achieve a good quality level for the city spaces. Perhaps this is also due to the lack of a set of guidelines who can lead designers' choices and of indicators that allow to verify the impact of these choices. In this regard, urban psychology can offer a new key through the combination of the knowledge of some psychology branches with the typical ways of designing spaces, with particular attention to those of the city. The aim of the research is to define how urban design can improve city spaces for a better people's mental health. Methods of study and work will be analysed to prefigure future developments so that the figure of the designer of public spaces becomes aware of his role as a pivotal figure in the development of the cities of the future.
The State of the World's Cities 2008/2009: Harmonious Cities of the United Nations predicts that in 2050 more than 70% of the world's population will live in an urbanised context; however, it is only in the past 4% of the human experience (starting with London in 1800) that any human has lived in a large city of 1 million (Takooshian, 2005). This leads to the conclusion that the human species is not psychologically prepared to live in cities, so much so that some studies (Peen et al, 2010; Vassos et al., 2010) show that life in urban contexts is associated with a percentage increase in the development of psyche diseases and disorders such as anxiety, schizophrenia and drug use.
People can become anxious and uncommunicative in places perceived as unpleasant, for example, with endless expanses of asphalt, a persistent noise and smell of cars, sucking up energy; on the other hand, in clean and well-kept places, they can find the feeling that the world is in order or stable and achieve greater psycho-physical well-being. In relation to our environments and in response to health problems, we have issued regulations to improve the quality of the air we breathe. We pay attention to the protection of habitats but we still pay little attention to the effects that our projects have on the mental health of the people who live there.
Because a transdisciplinary approach is encouraged, the actors potentially involved in this type of reasoning, in addition to psychologists, could be policy makers and people belonging to the public sector, and in this sense the role of the designer could also become that of facilitator of connections and interpreter of languages.

ENHANCED CULTURAL EXPERIENCE BASED ON SMART USE OF 3D DIGITIZED CULTURAL HERITAGE ARTIFACTS

Umair Shafqat Malik - Supervisor: Raffaella Trocchianesi
Co-Supervisor: Gabriele Guidi

Three-dimensional (3D) digitization has been intensively applied to cultural heritage (CH) assets during the past two decades. Because of the advancements in 3D tools and technologies, the massive digitization of CH assets is becoming common in museum practices. 3D digitized CH collections can be used with different narration levels through various 3D technologies such as augmented reality (AR), virtual reality (VR), 3D printing, and digital screen displays.
Despite the versatility of 3D digitization projects, they are currently not adequately focused on end-user experience. The massive 3D digitization is still not reaching the fundamental goals of CH valorization, preservation, and promotion. Museums are not solely interested in digitizing their collections to create repositories of replicas, but they are also eager to use these technologies to promote and raise public awareness about the treasures housed in their collections. Therefore, digitization projects should be more directed toward goals such as (i) attracting visitors to the museum to view the physical CH assets and not just to see their virtual replicas online; (ii) preserving the diversity of values that can be attributed to heritage, which does not solely rely on its materials and appearance but also on the integrity of all its components, its intangible qualities, and the narratives attached to it; (iii) assisting specialists of different fields working with CH objects by merging interdisciplinary data on one platform. However, currently, most literature on 3D technologies for CH focus on either the technical aspects or how to enhance the quality to achieve the most realistic aspect. The information stored in massively 3D digitized CH collections is currently disconnected from their usage, both for the specialists (museum professionals, restorers, researchers, and technicians) and the museum visitors. On the one hand, the massive 3D digitization of the cultural heritage assets represents several challenges in process optimization to create high-quality digital models while working in difficult situations. On the other hand, its practical use for CH valorization, and to design narratives and cultural experiences is lacking in most existing practices.
The lack of theoretical foundations before developing and implementing any technology can create problems such as misalignment between different researchers and professionals, slowing down the innovation process, and resulting in a less efficient design of an experience. The attempts made in the past in interactive museum visits made it clear that relying only on the intuition of designers for implementing technologies in a museum can be risky. Analytical tools are needed to foster a more systematic and reflective approach to the design, implementation, and deployment of technology in museums.
To deal with these challenges, the interdisciplinary research presented in this thesis aims to evaluate the use of digitized museum artifacts in significant contexts of designing cultural experiences and narratives. The results of this research are a step toward creating a comprehensive framework using quantitative and qualitative research approaches to evaluate best practices in the digitization of CH and its applicability to museum education, museum presentation, CH valorization, research, conservation, and restoration. The proposed framework evaluates the design of user experience with different modes of interaction between people and cultural assets by studying the perception of art. It also incorporates guidelines to efficiently perform 3D digitization of CH assets for designing user experience and interaction.
In this research different guidelines and evaluation criteria for an enhanced museum experience were theorized by applying empirical mixed methods research. The interdisciplinary methods and techniques employed in this research evaluate experience design for the use of data that are not easily narratable by traditional methods. The proposed theoretical framework suggests various aspects of cultural experience through digital interactions with CH assets and provides possible design choices for such aspects. It is intended to be employed by CH professionals, designers, digital application developers, and researchers to support their decision-making about important criteria for the design, development, and implementation of interactive systems. It will also enable designers and museum professionals to create new forms of exhibition, visitors' engagement, and museum learning.
The research explicitly investigates different modes offered by 3D technologies to merge visual content with varying types of information for designing cultural experiences and creating narratives. The framework proposed in this research aims to evaluate the design of cultural experience to enrich and differentiate the museum visits and assist the professionals in their daily practices. It evaluates the effectiveness of employing 3D technologies to connect narratives with digital models for creating better experiences for museum visitors, researchers, and CH professionals. 3D digitization of museum contents, which has recently become a common practice for complete museum collections, provides the possibility to test the theoretical results of this research in real scenarios.
By combining the disciplines of 3D digitization and museum experience design, the resulted framework could be applied for the improved uses of digitized CH in a way that is comprehensible and attractive because of its meticulous nature and emotional aspects. Instead of only focusing on the modality of content delivery to the audiences, this research evaluates new forms of communication languages for researchers and CH professionals. Thus, this research is not only an evaluation of technological applications for museum visitors but also provides solutions for the exhibition design, museum curation, and CH research. By employing the technology for museum experience design and interactive narrative creation, the research will enable cultural institutions to connect with their audiences, bring together different audiences, attract new visitors, enhance visitors' CH experience, and create new insights into the cultural stories.

PUBLIC INTERIORS: INFRASTRUCTURES OF SEAMLESSNESS

ENHANCING SYNERGIES BETWEEN SPACES AND SERVICES: ENVIRONMENTS AND ACTIVITIES WITHIN PUBLIC ADMINISTRATION.

Claudia Mastrantoni - Supervisor: Peter Arthur Di Sabatino

This thesis contributes to the discussion about the relationship between Spatial and Service Design and how these two disciplines can interact and influence each other to achieve more complexity, capability, and synergy for the specific context of Public Interiors within Public Administration Buildings.
The research traced the actions of a Reflective Practitioner (Schön, 1983) adopting action research of three main field activities located in public administration buildings in the city of Milan. The research also explores best practices by designing a repository of examples and case studies.
Specifically, the study is divided into three parts: the first (Background Knowledge) is theoretical, offering a framework of reference and an introduction to the environments and activities of Public Interiors (PI) traced within Public Administrative Buildings (PAB), such as Registry Offices, Chambers of Commerce, Municipalities, Town Halls, and Courthouses. The study explores the idea of Seamlessness and Permeability as the drivers of a more fluid continuity between the urban context and the interiors mentioned above. It is predicted that the trend of a digital transition stated by the Next Generation EU (NGEU) program, along with a growth in opportunities for public administrations, will produce a reduction in the flow of citizens into public administrative spaces, since administrative activities will be increasingly available digitally, without the need to travel to a physical location. In compliance with these new requirements, this thesis aims to observe what is happening in international best practices within the context of other public administrative spaces and strategic activities, so they may be adopted in the future, and design implemented for this change. Finally, the methodological background will present the relationship between the Designer, Practitioner, and Researcher, and will also introduce the actions of the research through design methodology, and the meaning of Metadesign as a transversal element used to validate the process setting.
The second part of the dissertation (Process Setting) will describe the process setting, outlining problems, challenges, hypotheses, and finally the research questions. This section includes the methodology structure that explains how to conduct research through design, and how to deal with a metadesign framework as a scenario builder. This will help with the comprehension of the research activities results described in the process evaluation.
In the third part, (Process Evaluation) we look at the practical implications of the research. The three years of research were conducted using a combination of different strategies, which can be ascribed to three distinct, but simultaneous, steps in their generation and implementation. Along with the literature review, the study includes a repository of examples and case studies, and a systematic review aimed at defining the state of the art in this topic, combining the primary authors with best practices at the national and international levels (desk research). This developed into building a new classification system, and defining a new taxonomy with the intent to design "family recognition". Particularly relevant in this study is the research through design managed through three pilot projects conducted in the Chamber of Commerce of Milan, Monza Brianza and Lodi, oriented towards different outputs. Since 2018, the Chamber of Commerce and the Politecnico di Milano's Design Department, have established a collaboration within the field of design research, sharing an innovative systemic approach to rethink the offer of services aimed at the world of business, trade, and tourism, and the consequent re-functionalization and enhancement of Chamber of Commerce's spaces.
This enabled research through design practice, generating observations and testing during the process, and including participatory activities with the primary audience. In this section the process is evaluated through the use of the metadesign framework (Scenario Builder), which applied to the research activities that fostered the construction of a set of principles for coherent design solutions, and new approaches to support the designer / researcher / practitioner in enriching their observations and thinking capacities while generating positive outcomes.
In the final part of the dissertation is a second round of interviews with the stakeholders of the public entities that participated in the research activities; this is also part of the study conclusions which address the main hypothesis and research questions of the thesis.

Keywords: Spatial Design, Service Design, Public Interiors, Public Administrations, Infrastructure of Seamlessness, Digital Transition, Metadesign Framework.

O.S.M.O.S.I.S. METHODS AND TOOLS TO REFRAME MATERIAL SELECTION
A COOPERATIVE APPROACH FOR INDUSTRIAL COMPANIES TOWARDS SUSTAINABLE TRANSITION.

Flavia Papile - Supervisor: Barbara Del Curto

Current times are demanding for a rapid, profound change in the economic and productive way-of-doing. In fact, the transition from a linear productive asset to economic models that promote a more careful production, taking care of environment and society before profit is, nowadays, in its maximum expansion. The way we used to deploy prime matter and conceive our products is subject to an intense review, not simply concerning punctual improvements on specific issues, but in a systemic way. The increasing necessity to reduce the amount of prime matter deployed, the energy resources in productive companies, the pollution rates, are only few examples of the intense governmental activity promoted to slow down the run towards the (already happening, for certain topics) irreversible eco-system damages. To tempt industrial companies of different typological nature in adopting more sustainable attitudes, diverse business and economic strategies have been developed. As analysed in CHAPTER 1 of this thesis, the Circular Economy, as well as other similar models, need to find a practical response from the field to achieve the expected results or part of them. Companies need to build core competencies to facilitate product reuse, recycling and cascading. This is not possible if prompt intervention on product design aspects such as material selection, standardisation of components, long-lasting product design, design for easy end-of-life sorting, and others, won't be integrated in the daily practice. Therefore, some changes in the internal dimension of industrial companies are necessary, and these changes need to consider the systemic shifting that market and industrial networks as well will face in the meantime. For what it concerns material selection activity, in this thesis the author tried to map the methodologies and tools already available for productive companies (in CHAPTER 2) and tried to understand the limitations and difficulties encountered by the industrial companies in adopting such great knowledge. It came out that, since the material selection process is becoming more and more complex, (Fig.1), there was necessary to propose a new approach that embraces the new economic models visions in the process, without neglecting necessary, traditional pillars of the material selection practice.

Moreover, direct collaboration with the industrial company Faber S.p.A. has been a plus to directly interface with people managing and practicing product design activities in the everyday life, to understand their relationships and needs in terms of the material selection activity. By adopting a mixed methodology articulated in different methods (CHAPTER 3), the research has been conducted with an intense collaboration with company's employees, in order to ground the activity and blur the confines between academic research and industrial daily practice. In doing this, a novel approach is proposed (CHAPTER 4): material selection activity, to consider different aspects of prime matter (technic, hedonic, ethic) has been threaten as a cooperative approach. This tendency already occurs into industrial companies, but in literature is still not investigated as an organic activity between different departments of a company. Therefore, the proposed methodology and tools represent a starting point for the interpretation of the material selection task as an integrated activity within companies, a starting point to introduce circular concepts in the daily designing activity. Together with the always-increasing amount of tools and information concerning sustainable productive practices, this thesis is thought to emphasise the necessity to increase the dimensions upon which materials are studied and deployed into industrial companies, trying to increase aware-ness on the preciousness of manufactured matter and by-products. In this perspective, the direct involvement of company stakeholders since the initial phase of the O.S.M.O.S.I.S. methodology application is a crucial step to guarantee the confidence, the under-standing and the sharing of objectives in terms of material selection. The stakeholders' involvement is so important, that even tools could be customised to respond the specific needs of the referring industry (Fig.2).

In this methodological application design and the designers play a crucial role: the design discipline is a reference for what it concerns the ideation and realisation of tools that could simplify decisional tasks. Moreover, the designer as a key figure in the presented methodological process has the competences and attitude by education and practice of having a look at the outside, at the consequences and at the novelties. Therefore, to overcome the intrinsic complexity of the material selection, this research tried to offer a new perspective of the process: this task, traditionally confined in technical departments (but affected by external information as well), is here presented as a cooperative approach between all the industrial departments identified in the referring industrial company Faber S.p.A. The experienced trials demonstrated that a collaborative approach to manage several materials aspects affecting the selection are promising. The intention is finding a usable ensemble of tools, enabling the change from the inside, for a better, more aware resources use, thanks to design.

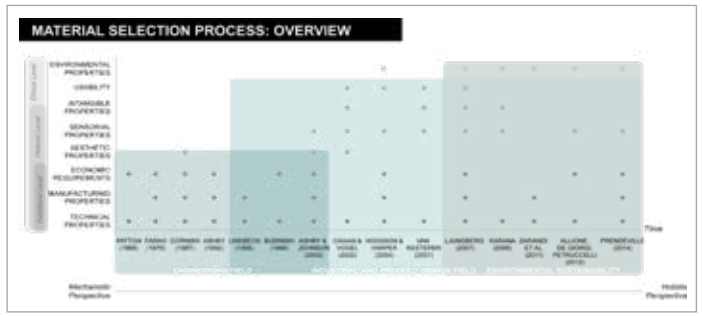

Fig. 1 - Material properties and characteristics taken into account for the material selection process according to the literature review.

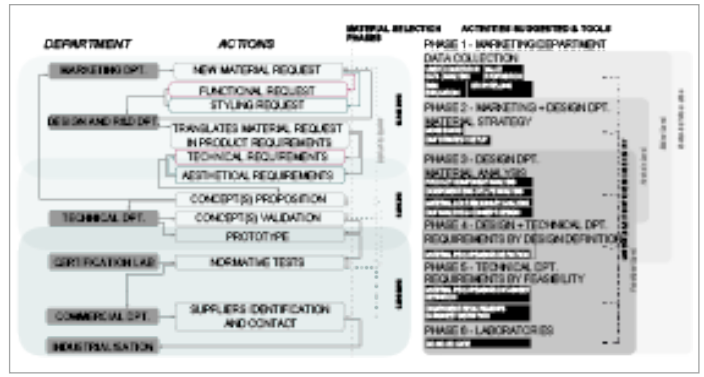

Fig. 2 - Overlapping of material selection flow into industrial company with material selection steps and different levels of material analysis envisioned with the proposed tools.

FACILITATING PARTICIPANT ENGAGEMENT IN REMOTE CO-DESIGN THROUGH GAMIFICATION

Ziheng Zhang - Supervisor: Francesco Zurlo

Rapid-changing innovation environments require more interaction and interchange of knowledge among multi-stakeholders. The co-design approach is increasingly popular on these occasions thanks to its unique and diverse approaches to engaging people in design activities. However, impacted by the covid19 pandemic, the classic in-person co-design event cannot be organized. A challenge has emerged during the lockdown and in the post-pandemic era when working from home becomes the new normal. That is, how to facilitate co-design activities remotely? As the employment of game elements in non-game contexts, the gamification approach has been applied for many serious purposes in online environments. It seems a promising solution to facilitate remote co-design in terms of engagement. However, this is a topic that continues to pose challenges for designers and researchers. How to understand participant engagement? How to facilitate participant engagement in remote co-design through gamification? How to measure participant engagement if a gamification solution is proposed?

The research actions follow the 'research through design' process. Start by formulating several structured design principles and hypotheses built on the review and analysis of literature. Various types of prototypes are continuously designed and developed based on the result of the literature review. Finally, the core hypotheses can be verified through the implementation of experiments or studies in the real field or a context-simulated lab.

In order to gain a comprehensive understanding of participant engagement, we applied a systematic review scan across the design literature. The results suggest a dimensional and attribute-based interpretation, in which engaging participants can be understood as the promotion of intrinsic motivation, involvement, and empowerment. By scanning the literature in game studies and supported by the case studies, we introduced the framework of "game principles," in which fantasy, rules, challenge, meaningful choice, and lusory attitude are considered as the principles to shape gamification for participant engagement in co-design. Based on this, we designed a working prototype, 'ideaGardener ', as the instrument of design knowledge inquiry to test our theories. The ideaGardener metaphorizes gardening as the innovation process, providing an engaging and structured means to "preparing," "seeding," and finally "harvesting" the concepts that address a particular problem/ challenge.

Finally, we adopted ideaGardener in experiments and studies. A comparison experiment has been carried out foremostly. We investigated the effects of applying a gamification approach relative to using a non-game method. Based on the self-report data collected from 47 participants, we find that participants experiencing gamification conditions re-port significantly higher levels of engagement than the baseline group. Moreover, we invited five experts to rate participants' developed concepts regarding creativity. The results show the experts acknowledge more novelty in the concepts developed from the gamification workshops. The experiment confirms the tremendous impact of gamification on engagement in terms of intrinsic motivation, involvement, and empowerment. Afterward, by combining the qualitative data from the experiment and other implementations, we investigated participants' perceptions regarding ideaGardener and the game principles manifested. This in-depth in-sight supports the completion of the framework of game principles as the guideline for designing impactful gamification in remote co-design for participant engagement.

The thesis contributes to the theory of design participation, co-design, and design innovation methods and practice, particularly for the participant engagement during remote or low-contact participation. By introducing and validating the 'game principles,' this thesis extends the boundary of gamification in terms of facilitating and coordinating remote co-design, especially for innovation challenge organizers and facilitators. It also provides avenues for further research in the interaction of design, innovation culture, and gamification.