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

DOCTORAL PROGRAM IN DESIGN

Chair:
Prof. Lucia Rosa Elena Rampino

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.

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AESTHETIC INTERACTIONS. RAISING ETHICAL AWARENESS THROUGH MULTISENSORY SYSTEMS

Gabriele Barzilai - Supervisor: Lucia Rampino

This thesis investigates the relationship between ethics, aesthetics, and emotion in user experience with multisensory interactive systems. In particular, new insights are offered into the aesthetic strategies underlying the communication of conceptually sophisticated messages in user-system interaction. The focus of the research is the question of how users' ethical awareness can be increased through multimodal communication.

Today's massive proliferation of interactive technologies has transformed the lives of millions of people and impacts all dimensions of everyday life. Because of this shift, there is an urgent need to understand how interactive artefacts influence people's beliefs and decisions, particularly when it comes to ethical issues. The role of aesthetic pleasure and emotions in user experience with multimodal intelligent systems has been extensively studied in recent years. However, this does not apply to the relationship between ethics and aesthetics, which represents new territory. What remains unexplored in this regard is the power of the aesthetics of interaction to shape people's beliefs, decisions, and actions by embodying ethical

concepts. The mechanisms underlying this complex form of communication are therefore the main topic of the research work. By elucidating the nature of such mechanisms, the study aims to provide designers with conceptual tools for structuring the communication dimension of interactive artefacts.

The dissertation is organised into three main parts: 1) literature review (theoretical foundation); 2) case study analysis (conceptual framework); 3) research-through-design study (empirical exploration).

An extensive literature review was carried out to better understand the connections between aesthetics of interaction, affective response in use, and ethical awareness in interaction. Such connections were analysed considering the possible pairings between the three dimensions: ethics and aesthetics; aesthetics and emotions; emotions and ethics. From the understanding of this triadic relationship, an argumentative synthesis was developed, which acted both as the theoretical basis for the research and as a knowledge contribution. A descriptive model of aesthetic experience in user-system interaction has been proposed, in which the aesthetic domain is understood as the

result of the interplay of emotion, pleasure, and cognition (Fig.1). The model combines analytical and synthetic perspectives on aesthetics, whose constitutive dimensions are conceptualised as distinct but not separate.

On this theoretical basis, four main dimensions were identified, as part of a conceptual framework of multisensory interactive experiences: psychological; aesthetic; artefactual; and communicational. The framework was initially used as a conceptual structure for detailed case study analysis and later converted into a design tool (Fig.2). Based on secondary data, the in-depth analysis revealed four groups of design strategies, one for each dimension (Fig.3). The strategies hinge on aesthetic communication, a key dimension of multisensory interactive experiences that arises in
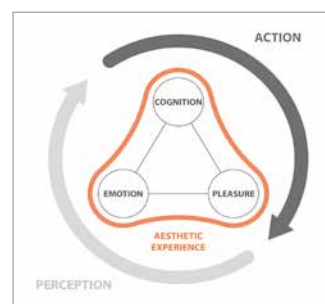
the interaction between user and artefact. Framework and strategies complement each other and are tools that can help designers control the impact of their decisions on the end user's experience. This proves crucial when conveying complex messages aimed at increasing ethical awareness.

As a final stage, an exploratory study was carried out to evaluate the impact of the *Aesthetic Communication-Centred Design Strategies* on the three dimensions of user experience examined — aesthetic, affective, moral. As part of a research-through-design project, some of the strategies were implemented to develop a prototype of a multisensory system for (critical) nutritional monitoring. The research prototype was tested in the laboratory with 28 participants: the artefact acted as a tangible manifestation of a specific conceptual design developed using the strategies. In this sense, the strategies were tested indirectly through the prototype experience. Data were collected on the three dimensions of user experience, combining quantitative and qualitative research methods. The results of the study suggest that the strategies can influence users' moral response, although there

is little evidence that this also applies to affective and aesthetic responses.

Although not free from ambiguity, the results of the prototype experiment indicate that the aesthetic communication-centred design strategies developed in the early stages of the research have the potential to influence users' experience and stir ethical thinking through

aesthetics. This partially underpins the theoretical basis of the research, making it worth examining the strategies further. In this regard, the strategies can be the starting point of a new research direction concerned with the design of interactive experiences in which ethics, aesthetics and emotions are simultaneously stimulated and integrated.
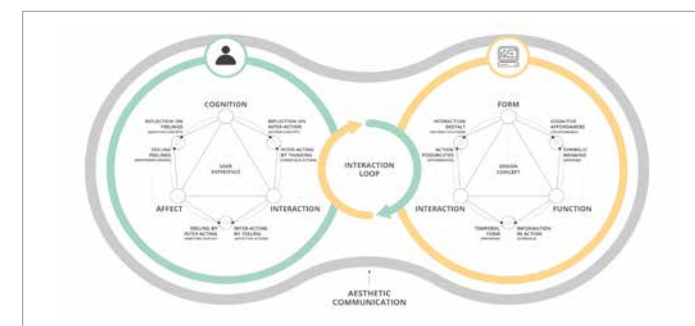

Fig. 1 - Multicomponent model of aesthetic experience in user-system interaction.

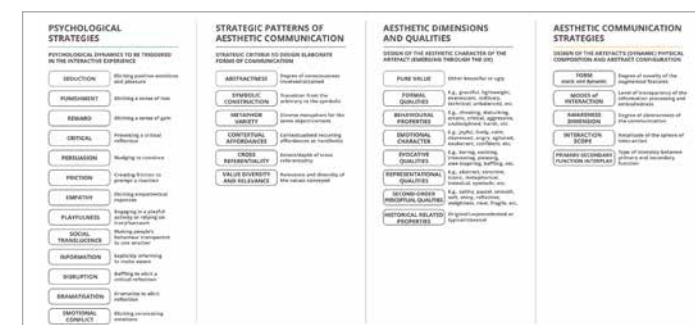Fig. 2 - Aesthetic Communication-Centred Design Framework.

Fig. 3 - Aesthetic Communication-Centred Design Strategies.

OVERCOMING RESISTANCES TO ADOPT DESIGN THINKING: HOW TO SUPPORT PRIVATE ORGANISATIONS IN DESIGN THINKING ADOPTION

Gianluca Carella - Supervisor: Francesco Zurlo

Co-Supervisor: Cabirio Cautela

Private organisations (meaning large-sized for-profit organizations)are showing increasing interest in adopting methods and approaches coming from the design disciplines. They are particularly looking at the application of Design Thinking (DT) for innovation efforts. In recent years, many organisations have decided to adopt Design Thinking as a strategic tool. Very often, however, adoption is only partially achieved through short-term solutions, resulting in design being introduced superficially without influencing organisational culture and structure. This adoption often refers to *partial absorption* of design within the company. Design intervention usually takes place inside an organisation through forms that have *flat engagements with a short-term impact*. Managers still need clarification about how to actually integrate Design Thinking and sometimes even about the results to be expected from its adoption, leading to confusion regarding investment and allocation of resources. Indeed, to get the best out of Design Thinking, the ultimate goal should be to impact business operations by changing processes, values and underlying assumptions

of employees and managers. However, achieving this requires precise, constant and long-term efforts, which companies often fail to undertake and use design only for aesthetics or product-related projects. This dissertation examines the factors that facilitate the introduction of Design Thinking, creating a favourable organisational environment for change. At the same time, the barriers that hinder the introduction of Design Thinking at a deeper level are analysed. The relevant aspect of this work stems from the fact that barriers are very well established in the literature, as there are numerous articles examining this aspect, in contrast to enabling factors, about which there is less information not clearly clustered in the literature – so that it could be defined as being in an embryonic stage.

In this dissertation, a systematic literature review was performed to analyse e cluster of the main barriers available in the literature. Barriers were found in each reviewed article from the literature and then categorized into macro-categories based on how similar they were. In this study, four major categories of macro barriers were found. The literature review approach

identified over 60 barriers, first grouped into 13 blocks and then clusterised into four macro-barriers.

With an empirical approach, touching different disciplines (from the areas of design and management) through qualitative methods, the aim is to understand how the adoption of DT can be facilitated inside large-sized for-profit organizations, being possible to be incorporated inside their daily routines.

In light of this, the conceptual foundation for this thesis was created by combining established studies from several other fields. Literature on technology adoption has been added to the literature from the design and management fields. This is due to the following assumption being made in order to produce this research in the absence of recognized adoption facilitators for Design Thinking in the literature:

Considering the article "Putting Technology in Its Place: Design Thinking's social Technology at Work" published by Jeanne Liedtka where Design Thinking is defined as a social technology, is it possible to apply the facilitators of technology adoption, well consolidated in the literature, rewriting them in a design key? Four facilitators from the

technology adoption literature were extrapolated and included in the conceptual framework to try to see if they could also be valid in the world of Design Thinking. To these four, a well-established element of the Design Thinking literature in adoption processes was added to complete the conceptual framework.

The definition of these facilitators and the related practical actions to be put in place in order to overcome barriers to adoption is the result of the analysis of ten case studies. All large, non-design-driven companies that are at different stages of adoption of Design Thinking were selected. The objective was to understand the main problems these companies faced in adopting Design Thinking and the related facilitators they had to put in place to overcome the barriers they encountered.

To understand whether the assumptions made were correct, it was decided to first use an exploratory analysis and then a qualitative comparative analysis. The choice of the exploratory case study was made because it provides answers to the questions "how" and "what." In the case of this study, it is very appropriate considering the need to understand which facilitators

to employ and how to put them into practice.

Once the different elements have been identified and coded in the exploratory analysis, a qualitative comparative analysis gives the possibility to assess the connection between a result and the sum of several predictors. The choice of qualitative comparative analysis thus provides an insight into whether there are facilitator patterns for adopting Design Thinking. Within this research, it was seen that Design Thinking can be a great way to differentiate the company in the market and develop new solutions that are innovative. However, it emerged how truly absorbing Design Thinking requires great effort and change on the part of companies. The theoretical research and its results have been concretised into a game-based format, named "Implementing Design Thinking", that can help companies identify the barriers to the adoption of Design Thinking that they might encounter and reflect on which facilitators they might implement according to their available resources.

The contribution of this dissertation is precisely to paint a clear picture of what practical actions companies can take to

facilitate the adoption of Design Thinking, leading to full adoption. The research is therefore aimed at private organisations (meaning large-sized for-profit organizations) that would adopt Design Thinking and need both to be aware about how to do it and to be supported during the process. The research also highlights how different facilitators can be employed at different stages of adoption and should not all be considered at the earliest stages of Design Thinking adoption. The results want to both *support and guide private organisations in the process of adopting of Design Thinking inside their operations overcoming most of the already identified obstacles*.

NEW PARADIGMS OF TRAVELLING ON SMART SHIPS. TOWARD A DESIGN FRAMEWORK FOR THE DEVELOPMENT OF SPACES AND SERVICES ON CRUISE SHIPS

Giuseppe Carmosino – Supervisor: Andrea Ratti

Context

The radical transition from "fun ships" to "smart ships" is a recent phenomenon, involving technological, commercial, social, and design aspects that require complex and systemic thinking. In fact, the cruise industry is going through three major changes: the introduction of smart technologies, changing target audiences, and growing awareness of environmental issues. These three major changes are welcomed with great enthusiasm and optimism by cruise lines, but they still lack critical and in-depth analysis. In this context, this paper investigates the smart phenomenon through a partly theoretical and partly empirical research process, supported by field tools and participatory forms of user involvement. The thesis thus aims to give due prominence to design research in the field, especially considering this phenomenon that simultaneously affects technologies, environments and users.

Design and Innovation

Although the market also has a strong influence on design choices, especially in interior design, these seem to be marginal in the design process, thus not reflecting the real condition of the industry. The main reason for this neglect can be attributed to a lack of awareness of its economic value and design's preoccupation with the qualitative aspects of innovation, which are more difficult to measure than traditional quantitative indicators. Today, design has evolved from a single-craft discipline to a multidisciplinary discipline, linked to social environments, products, services, systems and brands, and has demonstrated that it can play a significant role in business and social innovation, producing positive results in tangible ways.

Methodology

The PhD thesis falls between the two categories of "research for design" and "research through design." The research methodology is qualitative and is based on a design-driven approach through the use of the four phases of the Research Unit's innovation process. The setting of this methodological framework is due to the intention of the thesis research to offer a developmental alternative in the cruise industry to current technology- and market-driven approaches. The various phases include various forms of collaboration and feedback with different actors, who serve a specific function, from guidance to co-creation. An innovation process based on design research should start from a clear definition and analysis of the context surrounding the product to strategic knowledge that enables product innovation. Despite the enormous expansion of the cruise industry, the academic literature related to cruises is relatively recent, fragmented, descriptive, and with legacies from the economic and social sciences or engineering. In the absence of a clear understanding of cruise interior design knowledge as it relates to design research, a systematic literature review helped the research reduce the likelihood of bias and ensure a comprehensive body of knowledge on the chosen topic. The systematic literature review was conducted through the grounded theory approach, using an inductive approach to analysis and allowing theory to emerge from the data. The concepts resulting from theoretical background, methods, results, and future research revealed five main lines of research: industry, space and services, users, technology, and sustainability. Despite the number of studies related to Smart Ships in various sectors, the literature review revealed no relevant contributions on the smart phenomenon in the cruise industry, thus prompting the research to systematize the concepts into a multidisciplinary investigation, involving other fields in the tourism context. The conceptual review of the literature was conducted through the grounded theory approach, using an inductive approach to analysis and allowing theory to emerge from the data. The concepts resulting from the analysis categories employed, namely industry, technology, sustainability, space and services, and customers, revealed four main trends in cruise ship development: dynamism, engagement, integration, and systematicity. These different trends are characterized by specific approaches based on economic/social science, design or technology orientation.

A Design Perspective in Cruise Future Studies

In this dissertation, the scenario tool was understood as a real-world narrative based on the current context, with the aim of exploring potential future developments of spaces and services from a design-oriented perspective. Design-oriented scenarios can be defined as a set of motivated and articulated visions that support the generation of a shared vision among a coherent group of actors, so their production is an extraordinarily effective tool for innovation and promotes participatory forms of design. As in the conceptual review of the literature, other tourism areas may offer interesting solutions for the further development of the cruise industry, rooted in the present time and thus easily applicable by cruise lines. The evolution of technologies brings with it opportunities and, at the same time, the emergence of critical factors, such as the management of personal data. These disruptive market conditions require a new direction for cruise ship development, and design has shown that it can play a significant role in innovation, producing positive results in tangible ways by creating value networks between products, services, people, and organizations. The main obstacle in cruise industry research has been public involvement in the research project due to the private nature and lack of transparency of cruise lines. Finally, the strengthening of the link between ships and territory that emerges from the design-oriented scenario points to possible directions for the future exploitation of research in the international, European and departmental spheres.
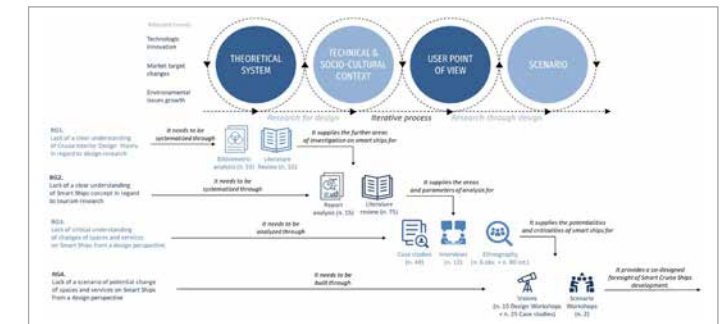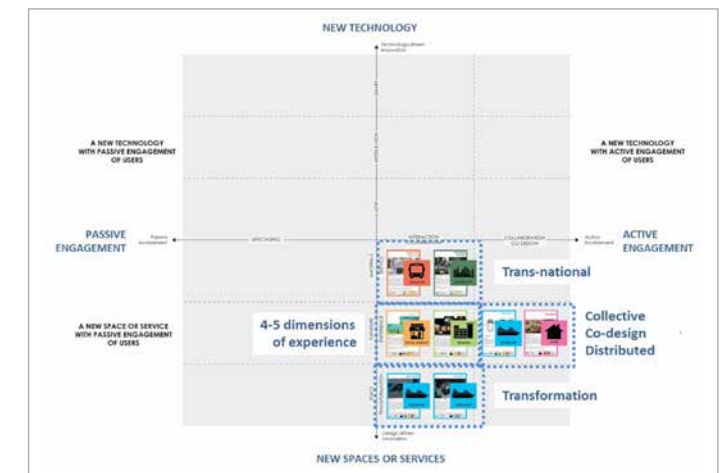

Fig. 1 –Design of research process in four stages.

Fig. 2 - Polarities diagram presenting the core vision of the design-oriented scenario

A SYSTEM OF DE-BIASING PRACTICES FOR FUTURE GENDER-SENSITIVE DESIGNERS.
NAVIGATIONAL TOOLS FOR A STEP-BY-STEP REVOLUTION

Francesca Casnati – Supervisor: Valeria Bucchetti

The research presented in this PhD thesis lies at the intersection of Communication Design and Gender and Feminist Studies, engaging with other related disciplines such as Visual Cultures, Media Studies, Sociology of Media. The core of the research concerns the concept of *gender bias* in relation to communication design practice, or rather the processes that lead communication designers to translate their unconscious gender bias within their design thought and practice, influencing the effect of meaning produced by their own design outputs and their social, cultural and political impact.

Central to the investigation is the premise that every designer acts as a vehicle for gender biases that are translated into design outputs, inevitably perpetuating and reinforcing the dominant perspective which, according to feminist theories, aligns with that of the *white, Western, heterosexual male*, thus excluding the *Other*, anyone who does not correspond to the *norm*. Taking as a given the inherently political dimension of images and the close connection between systems of representation and the

production of meanings and identities, the communication designer has the power, through design choices, to give voice rather than exclude a certain social group. This epistemic and symbolic exclusion «is no abstraction: it translates into ruthless violence for the real-life people who happen to coincide with categories of negative difference» (Braidotti, 2022).

In this framework we as communication designers bear a responsibility that cannot be ignored. It becomes therefore more and more urgent to equip ourselves with the tools and strategies to critically understand the present, foreseeing and preventing the effects of our biased design practice. Tools and strategies that can convey a *gender-sensitive* approach to communication design, but also triggering an avant-garde and activist approach leading to a *step-by-step revolution* towards the dis-mantling of cognitive schemes and mental habitus embodied in the designers and consequently in our design practice, contributing to the definition of new agendas for design.
The issue of gender bias extends beyond individual

designers to encompass the entire design and education systems. As Levick-Parkin (2017) provocatively points out, that part of this weakness «has to be traced back to how designers are trained and how their training does often not go further than competently reproducing aesthetics and concepts which are deemed acceptable within their community of practice», emphasizing the need for structural change.

Drawing from a feminist perspective elaborated from the re-reading of the overlapping areas between visual cultures and feminist studies, the research focuses on the tools, methods and strategies that we as designers/educators can implement to spread a gender-sensitive approach among future designers, leading to the definition of a modular "System of de-biasing practices for future gender-sensitive designers. Navigational tools for a step-by-step revolution". Recognizing that widespread change requires collective commitment, the system aims to activate autonomous de-biasing processes, empower designers to critically engage with present challenges, and

challenge entrenched gender biases inherited from an androcentric and Eurocentric worldview.

The system of de-biasing practices was developed from the results of multiple case studies collection that made possible to identify different models and way of acting, strategies, tools, and methods that can be quite close to what it is meant for 'de-biasing' purposes and selected and reassembled them in order to define new experimental activities. It encompasses therefore a set of gender de-biasing activities that are intended to be applied and practiced across various levels of design education. These activities are designed to activate processes that mitigate bias based on gender and foster a more gender-sensitive approach. Each module of the system corresponds to diverse array of tools, methods, topics, and areas of interest. These components have been carefully curated through the research path, with the primary aim of adapting and utilizing them in a flexible workshop format tailored to design students, contexts, places. The overarching goal is that these workshops, in their implementation, will lead to the development of exemplary practices and attitudes, thus contributing to an incremental transformation towards a more equitable and unbiased paradigm.
An extensive testing phase in national and international

university contexts – that mainly involved design students with heterogeneous levels of expertise and different levels of prior knowledge about gender issues and bias allowed the model to be finalised and systematized.

The PhD thesis is intended as a contribution, a step forward in terms of tools and strategies, to implement long-term activities aimed at a change of attitude, a change of behaviour of designers in approaching the communication project. The title itself, "A system of de-biasing practices for future gender-sensitive designers. Navigational tools for a step-by-step revolution" intends to be both optimistic and provocative, in the awareness that gender biases cannot be completely eradicated overnight but we can only try to mitigate them and devise strategies to circumvent them, hoping that this will help activate virtuous circles. Circles that through a ripple effect could trigger others and others, leading sooner or later to radical change. Baricco writes: *where frontal attack loses, contagiousness wins*. Utopianly speaking, it is therefore hoped that the practices developed within the scope of this thesis may resonate by disseminating and stimulating critical thinking and awareness, making a small contribution to the formation of designers of the future who will gradually rebel against *bad communication*, contributing to building a new and sustainable media

landscape. The peculiarities of the system, namely its flexibility and modularity, allow it to adapt and integrate into various types of communication design curricula with different levels of impact, aiming to reach the widest possible number of future designers. As this thesis propels forward a vision of progressive change, it invites designers to embrace their role as agents of societal transformation, ultimately steering towards a more just and balanced media landscape. In the relentless pursuit of this endeavor, may these navigational tools catalyze a ripple effect of critical consciousness, propelling us towards a future where inclusivity and equity reign supreme.

The research work constitutes a piece of systematised knowledge that fits into a field, that of gender and feminist studies, which has long been investigated and is continually evolving and which needs flexible tools that can be used in the coming years in the training of designers. Furthermore, the implemented methodology constitutes in turn a model on top of the model, providing a rigorous method applicable in the future for the development of similar activities or systems.

HOME-MAKING INTERIOR DESIGN: THE ROLE OF INTERIOR DESIGN IN PROMOTING A SENSE OF HOME FOR PEOPLE WITH DEMENTIA LIVING IN CARE FACILITIES

Jing Chen - Supervisor: Alessandro Biamonti

Research motivation
Following many years of research, it has been determined that the design of care facilities plays a crucial role in providing therapeutic interventions in dementia care. The primary reason is that the physical environment has a "prosthetic" value that can compensate for cognitive deficits (Zeisel & Raia, 2000). Numerous studies have been undertaken to examine the therapeutic effects of care institution design on people with dementia (PwD) (Marquardt et al., 2014). Among these, the non-institutional design with its homelike features has been frequently recommended. The homelike care environment has been shown to improve cognitive function (Verbeek et al., 2010), daily activity performance (Reimer et al., 2004), and social interactions (Lee et al., 2016a; Smit et al., 2012). Indeed, person-centered care (Kitwood, 1997) has transformed conventional medical-style facilities into care facilities that resemble a more homelike environment. The homelike design is currently commonly used for dementia care institutions in various formats and countries (Verbeek et al., 2009), such as Confused and Disturbed Elderly (CADE) units in Australia, Care Housing in Scotland, Domus in the UK, Green Houses in the USA, Group Homes in Japan, Group Living in Sweden, Residential Groups in Germany, and Small-scale Living in the Netherlands/Belgium. With the prevalence of homelike dementia care facilities, it is necessary to discuss how to design a dementia care facility with a sense of home.

Research gap and opportunity
An increasing body of research is currently exploring designing dementia care facilities that effectively cultivate a homelike environment. The current approach for designing a homelike care facility relies on evidence-based design (EBD). EBD is a design approach grounded in utilizing the most reliable and valid evidence derived from credible research (Stichler & Hamilton, 2008). The feeling of home within a care facility can be influenced by various physical environment factors, such as private spaces, (quasi-)public spaces, personal possessions, technological services, aesthetic qualities, and outdoor areas (Rijnaard et al., 2016). These factors serve as evidence to guide the designer in design practice (Eijkelenboom et al., 2017).
However, it is debatable whether design outputs produced using this approach achieve the effect demonstrated by the evidence (Lawson, 2010, 2013; K. D. Moore & Geboy, 2010), specifically for designing care facilities that give PwD a sense of home. On the one hand, it may be difficult for PwD with cognitive impairments to interpret the meaning of an item or environment based on its appearance because they lack sufficient insight to recognize their surroundings (Van Steenwinkel et al., 2014). Therefore, it may be hard to make PwD feel at home just by having physical elements symbolizing home in care facilities. On the other hand, although the sense of home can be understood through physical concepts or associated with specific physical elements (Després, 1991; J. Sixsmith, 1986), home is more than just an artificial object. It is more of a metaphor for the "intimate relationship" between people and space (Mallett, 2004; J. Moore, 2000). Interior design that emphasizes the aesthetic home while ignoring the intrinsic meaning of home (J. Moore, 2000, 2007) only leads to "decorated" living rooms (Fay & Owen, 2012). So, the interior design approach cannot only consider the home-related physical elements while ignoring intrinsic home meaning.

Aim and research questions
Based on the knowledge gap and opportunity described above, the study raises the following main research question:
RQ: How can interior design provide PwD living in care facilities with a sense of home by emphasizing the "intimate relationship" between people and space?
Because the conceptual articulation of this main question is complex, it has been divided into sub-questions that can help clarify the contents to be investigated.
SQ 1: What "intimate relationship" between people and space can express a sense of home after relocating to a care facility?
SQ2: How can PwD develop this "intimate relationship," and what role does the interior environment play in it?
SQ 3: Based on the previous findings, what knowledge and tools can be generated for interior design practice?
SQ 4: How does this innovative interior design approach relate to other stakeholders?

Methodology
This is a qualitative study as well as research for design, and it is divided into four phases: desk research, field research, generation & evaluation, and future development. Each focuses on one sub-question.

The desk research phase responds to SQ1. Based on a narrative literature review, it was determined which "intimate relationship" between people and space can express home feelings after moving to a care facility. It proposes a hypothesis regarding SQ2: How can PwD develop this "intimate relationship?" This hypothesis clarifies the question that must be addressed in the field research phase.

The field research phase responds to SQ2. The ethnographic case study approach is utilized to investigate this sub-question. The findings of this phase inspire the generation of knowledge and tools in the next phase.

The generation & evaluation phase responds to SQ3. Based on the first two phases, it generated a design framework and four main design strategies. Following that, a literature review was conducted to summarize which specific physical elements or features could support these strategies, culminating in design guidelines. Finally, it evaluated the outputs mentioned above by focus group and questionnaire.

The future development phase adopts an action research approach. SQ4 was discussed through two rounds of focus groups with caregivers, institutional staff, and designers: What impact does this new interior design approach have on them, and vice versa?

Contribution to knowledge
A more effective interior design approach
This study proposes a more effective interior design approach for shaping dementia care facilities with a feeling of home. This innovative design approach emphasizes helping PwD feel at home through the intrinsic meaning of home more than existing design approaches. In order to use this innovative design approach more effectively in practice, relevant knowledge and tools have been developed.
A new insight into PwD having a home feeling after relocating to a care facility
This study proposes that a sense of home for PwD in care facilities can be understood as establishing people-place integration through developing habitual activities in the facility. This finding provides new insights into making PwD feel at home in care facilities.
A new insight into about interior design for the habitual activities of PwD
This PhD study also provides some new insights into how interior design can support PwD's habitual activities. This study demonstrates the significance of organizing and managing the interior environment in promoting the development of PwD's habitual activities in a care facility.
A possibility that interior design and other fields are interrelated in contributing to the feeling of home
This PhD study also proposes a model to explain how interior design, care strategies, and institutional policies are interrelated to contribute to a sense of home.

UNDEFINED SELF. DESIGNING WITH AND FOR MULTISTABILITY IN SELF-TRACKING WEARABLES AND DATA REPRESENTATION

Chiara Di Lodovico - Supervisor: Chiara Colombi

Over recent decades, wearable technologies, such as smartwatches and fitness trackers, have garnered considerable attention from individuals, industry, and academia. These devices seamlessly capture bodily signals, like heart rate, and movements, as steps, converting them into digital data streams. The ultimate aim is to construct detailed virtual representations of individuals, aiding informed, data-driven decision-making. An examination of the design of data representations and wearable devices, as well as users' engagement motivations and researchers' interests, reveals a reinforcing cycle of a prevailing paradigm. This paradigm emphasizes designing representations of individuals' physiological and physical phenomena in a seemingly unambiguous and "objective" manner, often manifesting as quantified data presented through graphs, numerical values, and scores. Accompanying these representations are prescriptive recommendations aimed at promoting healthier lifestyles within a framework of behavior change and performance enhancement, underpinned by principles of efficiency and utility. Nevertheless, this research draws upon the philosophy of technology

strand "Postphenomenology" to reveal a more complex reality that challenges the conventional view of technologies as neutral tools for human empowerment. Postphenomenology argues that technologies are inherently ambiguous, capable of being interpreted differently by various individuals and assuming diverse meanings across different contexts, time periods, and socio-cultural settings. It further suggests that the materiality of technology may unexpectedly mediate human experiences and actions, irrespective of designers' intentions, a condition referred to as "Multistability". Despite this intrinsic characteristic of technologies, the prevailing paradigm appears to prioritize normative top-down frameworks over the deeply personal and intimate practice of self-tracking. Therefore, the present doctoral research aims to explore the practical application of multistability in the design of self-tracking wearables and data representation, recognizing its potential as both an analytical tool for understanding technology's ambiguity and a generative resource for creating more open-ended systems.
In seeking to explore the practical integration of multistability into the design of self-tracking wearables,

the current research has identified a significant research gap. This gap pertains to the underutilization of postphenomenology and multistability in design-oriented research, particularly in the context of self-tracking wearables. While philosophical works have explored the mediating influence of wearable technologies through a postphenomenological lens, there is a lack of design-oriented analyses. Additionally, although the potential benefits of incorporating postphenomenology and multistability into design research are recognized, there is a scarcity of studies investigating how these concepts can be utilized as generative resources in design practice.
Therefore, the current doctoral research aims to address the following research question: "How can multistability be leveraged as a generative design resource in the domain of self-tracking wearables and data representation?"
To address this research question, I adopted a threefold methodology following a research-through-design approach characterized by iterative action research cycles. Firstly, I conducted a postphenomenological analysis of self-tracking wearables and data representation combining review of literature and auto-ethnographic research to unveil multistability

in contrast to the dominant design paradigm. Secondly, I conducted a literature review and mapped design approaches that acknowledge and promote multistability, identifying core concepts and reviewing empirical investigations employing them in the design of the self-tracking wearables. Thirdly, I organized a series of design workshops accompanied by participant observation, focus groups, and interviews to explore how multistability could be integrated into the design process of wearables and data representation and its implications.
In response to the research question, several key findings emerge. Firstly, multistability can be generative in initiating the design process by utilizing its analytical outcomes as a foundational aspect. Through the postphenomenological analysis, five overarching tensions and ambivalences were identified: allusion to objectivity and non-neutrality of data, data reductionism and the complexity of lived phenomena, trust in data and reliance on subjective experience, performance and well-being, surveillance and self-surveillance. Acknowledging the tensions in the prevailing paradigm involves recognizing multistability, which permeates interactions between users and self-tracking wearables and data representation as well as the design process itself.
Secondly, multistability can be leveraged as a generative resource adopting a non-solutionist and non-deterministic design approach. This approach may involve reducing designers'

prescriptions to prompt users to complement design gaps or exaggerating prescriptions to stimulate discussions on alternative scenarios. In this context, "ambiguity as a design resource" emerges as a relevant concept connected to multistability within the self-tracking domain. It extends beyond utility and usability, challenging dominant design paradigms and encouraging diverse, personal interpretations and appropriations of technological artefacts by design.
Thirdly, building upon the previously discussed findings, multistability can be leveraged as a generative resource and integrated into the design process of self-tracking wearables and data representations first recognizing the multistability inherent in existing prescriptive self-tracking wearables, and utilizing tensions as a tool to reflect this condition in the design. Subsequently, designers can adopt a design approach aimed at embracing multistability by addressing, reducing, or exaggerating tensions to encourage diverse interpretations and discussions. This involves applying design tactics in the data representation modality through techniques such as abstraction, physicalization, and metaphors, as well as manipulating data and feedback dynamics, playing with unfamiliar human-technology interaction rules, and unbalancing the instructions and information provided to the wearer on the system's functioning dynamics and data interpretation/meaning to enhance multistability in practice.

To translate this knowledge into practical application, the aforementioned principles have been consolidated into a research outcome known as the *Multistability-Driven Framework* and the *Ambiguity Design Toolkit*, specifically tailored for designing with, for, and reflecting upon multistability, leveraging ambiguity as a design resource. It was developed, deployed, and refined through a series of design workshops involving design students, HCI professionals, and HCI researchers. These workshops demonstrated that the framework serves as a counterintuitive catalyst for creativity, facilitating the tangible exploration of tensions through design, and acting as a reflective resource that prompts discussions on the domain and process of designing wearables and data representations, as well as on the design practice itself.
Lastly, a central theme that permeates this doctoral research on various levels is the tension between prescription and openness. This tension manifested not only at the interplay of designers' intentions and inscriptions in the technology materiality but also in the design methods and approaches that underpin the design process. Moreover, this tension extends to design researchers who must negotiate the delicate balance between their ingrained designer mindset when crafting processes and tools to facilitate design and the inherently open-ended nature of research.

DESIGN NARRATIVES AS WORLDMAKING FOR INNOVATION THE DISCURSIVE MECHANISM OF INTERPRETATION AND SENSEMAKING FOR THE COEVOLUTION OF PROBLEM AND SOLUTION

Yasuyuki Hayama - Supervisor: Francesco Zurlo

Context

Narratives have become increasingly prominent in both design and innovation management. As a fundamental aspect of human cognition and a mode of communication, the role of narrative in design and innovation processes has been emphasized. Human beings are recognized as "homo narrans," individuals who learn about, interpret, and engage with the world through stories, guided by what is known as "narrative rationality." The narrative paradigm seeks to unite two aspects of rhetorical theory: the persuasive and argumentative elements, and the aesthetic and literary elements.

Research Gap and Aim

Despite recent studies exploring the roles and characteristics of narratives and storytelling in design and innovation, there remains a gap in understanding how design narratives can influence innovation processes. This doctoral research aims to investigate the fundamental characteristics of design narratives in the design innovation process. By addressing the knowledge gap between design studies and innovation management, identified through both academic and practical reviews, this study seeks to establish a theoretical foundation for Design Narratives in innovation.

Design Narratives: From "semantic turn" to "narrative turn"

To probe this research's central focus, it is beneficial to scrutinize the dynamic between the narrative teller and the audience's role. Zurlo and Cautela's prior investigation introduced the narrator and narratee paradigm to characterize the relationship between companies and designers in innovation processes. Companies establish narrative frames to shape fundamental cognitive perceptions, enhance linguistic understanding, and prompt action. Within the company's articulated design frame, designers position themselves as authentic interpreters capable of deciphering the company's narrative based on their perception. Designers, forming a crucial link between the social-cultural models expressed by consumer communities and the material production models organized by companies, can be viewed as hub-narrators. In this role, designers are tasked with filling in the gaps left by companies as they articulate their stories. Krippendorf's groundbreaking idea - the "semantic turn" - can provide a solid foundation for understanding the role of designers as narrators and their narratives, termed "DNs" in this Ph.D. dissertation. According to Krippendorf, the "semantic turn" in design involves a systematic exploration of how individuals attribute meaning to artifacts and how these meanings influence the creation or alteration of artifacts. This shift also involves examining the terminology and methodology of designing artifacts from the perspective of the meaning they hold for users and stakeholder communities. Therefore, this dissertation constructively explores the central mechanism of DNs within the design innovation processes, framed within the well-established discourse of design studies that align with the "semantic turn", and furthermore, proposes a phenomenological standpoint of design studies' "narrative turn".

Methodology

Initially, the study constructs a conceptual framework to address the central issue. Through interdisciplinary conceptualization among design studies, innovation management, and narrative studies, key premises and assumptions are woven together. Specifically, "Design Narratives as Worldmaking" can facilitate and coordinate the co-evolution of problem and solution spaces in the design innovation process. Subsequently, three dimensions of narratives—typologies, functions, and elements—are constructed to explore different aspects of narrative characteristics, which are fundamental facets argued in narratology. This research employs qualitative and exploratory research methods, grounded in a social constructivist worldview. Methodologically, it adopts a mixed method design, utilizing two qualitative methods: protocol analysis as the core component and a multiple-case study as a supplementary component.

The Design Narrative Worldmaking and Contributions

The outcomes of this study have made significant contributions to both academy and practice in the design community. It has enriched scholarly insights by elucidating the influence of Design Narratives on the innovation process and by constructing a conceptual framework grounded in existing theoretical and empirical knowledge. Furthermore, it fosters interdisciplinary collaboration and dialogue across diverse fields, including design studies, innovation management, and narrative studies. On a practical level, it provides actionable guidance for companies, innovation practitioners, and design professionals seeking to leverage design as a driver of innovation. It introduces a novel perspective on design, portraying it as a practice of worldmaking through narrative and discourse. Additionally, the findings shed fresh light on how design practitioners can effectively act as agents of narrative worldmaking. Beyond academia and practice, this PhD research carries broader societal implications. In light of the myriad complex challenges confronting the world, this study underscores the pivotal role of design narratives in harnessing interdisciplinary expertise to confront these challenges with confidence. Especially for wicked problems characterized by hyper-complexity and ambiguity, the theoretical framework of "Design Narrative Worldmaking (DNW)" emerges as a vital approach for generating and implementing innovative solutions. By unveiling new dimensions of narrative in design, design has the potential to emerge as a central tool in addressing a wide range of increasingly intricate and sophisticated problems.

Keywords: Design Narratives, Narrative Worldmaking, Design Innovation Process, Coevolution of problem and solution, Legitimacy building, Possible worlds
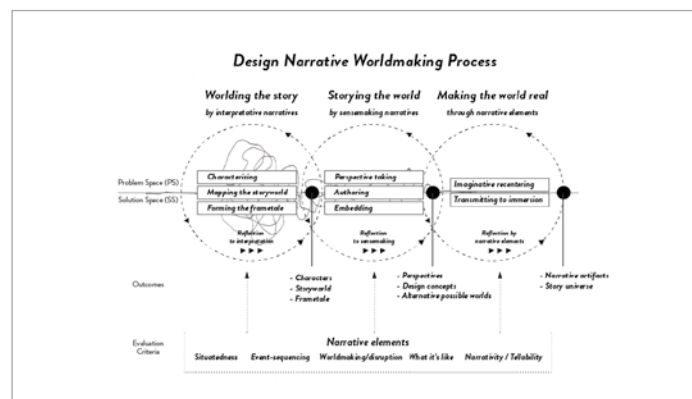

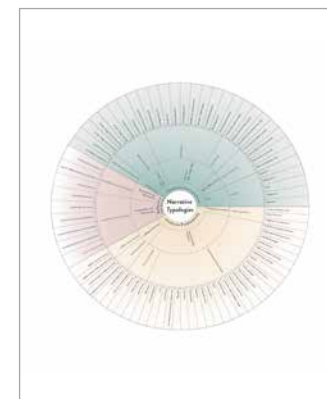Fig. 1 - Process model of design narrative worldmaking

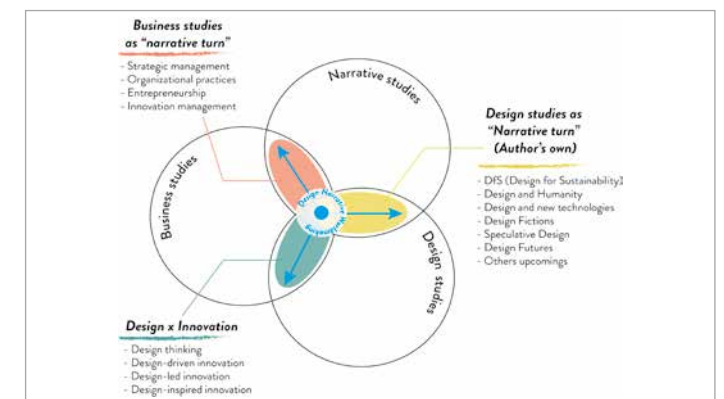Fig. 2- Design Narrative typologies ring

Fig. 3 - Broader potential application of Design Narrative Worldmaking

EXPERIENTIAL COUNTERFACTUALS: SPECULATIVE AND COUNTERFACTUAL AUGMENTED REALITY EXPERIENCES TO ENHANCE AWARENESS CONCERNING MORE-THAN-HUMAN WORLDS

Alessandro Ianniello – Supervisor: Stefania Palmieri

DESIGN

This Ph.D. research stems from a critical stance toward some of the many crises we are currently living as humankind, which are all related to and consequences of what can be defined as the Anthropocene.

We, as Western people, are experiencing a crisis of imagination, which, as Mulgan states, reflects our lack of ability to envisage alternative futures that can act as catalysts and guidelines to achieve a better society, a balanced relationship with natural ecosystems, a human non-centrality in the processes of constructing new meanings, significances, and values.

On a practical level, our systems have reached an extremely high level of complexity, which results in global problems that can be described as wicked, as they present several interdependent factors that make them seem potentially unsolvable: the ecological crisis we are currently facing is an example of this. To contrast the paradigm of Anthropocene, scholars, and practitioners from different fields are producing theories and actions that constitute a pluriversal repository of images and knowledge that can change current mindsets towards non-centric visions able to nurture the

coexistence of multiple and plural perspectives and agencies, which belongs to human beings and to all natural actors.

From an ontological and epistemological perspective, it means embracing and fostering critical approaches that try to diverge from the traditional worldviews that contributed to producing the dichotomies between Nature and humans, responsible for the current environmental, social, and values crisis.

It also means researching and exploiting technology as a tool to enhance awareness and engagement with these concepts, to regenerate or build new relationships with nature, and to constitute new senses and meanings that should contribute to building More-than-Human worldviews. Therefore, technology can help us rediscover forgotten relationships and widen the possible connections between living entities and with a broader variety of natural agencies, becoming a facilitator, a repository, and a communicative means to experience alternative perspectives.

Among the different design domains that actually exist, the research recognised the field of design futures as the

most suitable to foster these epistemological and critical reflections, being strongly aimed at nurturing alternative and speculative visions concerning more responsible, sustainable, and just presents and futures. It also highlighted an inherent gap in this area which is related to a (Western) linear vision and understanding of time which avoid us to grasp the inter relationships between past, present and future, that in turn poses a threat and a barrier to the nurturing and establishment of pluriversal perspectives.

To imagine is a process and imagination is, therefore, a skill. It is a process since it has an origin embodied in memory - individual or collective - in lived experiences, and in perceptions - purely sensory or altered - and it has an *end* in empathy, involvement, and creativity. The word "end" has been deliberately emphasized, since the imaginative process never ends, like a loop in which empathy, involvement, and creativity are transformed into memory, experiences, and perceptions, which, in turn, feed into a new imaginative cycle.

Imagination is a strictly mental faculty, which is abstractly expressed and acts as an enabler of the creative process,

characterized instead by the grounding, the creation, of something new, unseen before. By imagining, one can therefore be creative. Imagination is thus capable of stimulating innovative processes and radical change. If imagination enables the prefiguration of innovation and radical change, then being able to imagine (and bring to the ground what has been imagined) becomes an exercise of power: who imagines and succeeds in disseminating and making acceptable the products of imagination (images), has the possibility of guiding and directing the processes of innovation and radical change, generating involvement towards one's imagery.

Bearing in mind that the imaginative act is mainly generated by an experiential or memory-related trigger and that each of us has a unique personal past and a cultural background determined by a specific space and time, imagination is situated. This implies the fact that there are multiple and plural imaginative products.

Being situated and representing an exercise of power introduces a further aspect of extreme importance: there is a need to decolonize the existing imaginary, pluralizing it through the multitude of images and stories that make up the archives of memories and experiences, situated and existing. It is not possible to embrace and deconstruct the layered and growing complexity while maintaining a universal approach and perspective.

Experience is strongly related to imagination, and it can be defined in different ways.

Clearly, it may be seen as (the process of) learning or acquiring knowledge; but it also can be related to our way of perceiving something, and to our actions. It can, therefore, be stated that an experience requires our actions and perceptions to become such, and to co-form our personal and situated background, mindset, expertise, and so on.

Furthermore, it is linked to our feelings toward a particular moment in our past, and how it affected and affects us. It can be stated that our emotions and memory are, hence, highly influenced and built on our experiences.

If the adjective immersive is added to the word experience, its concept defines those experiences in which the perceptual and cognitive components are highly stimulated: in this sense, analogical processes of storytelling, role play, etc. take on immersive traits, such as digital-based processes, i.e., conveyed by the use of immersive technologies, such as Virtual Reality, Augmented Reality and Mixed Reality.

Thus, this Ph.D. thesis is focused on two main subjects - imagination and immersive experience - which are strongly interlaced with each other, and it is positioned within the area of design futures, with the aim of creating a framework to design AR-based experiences able to enhance awareness towards More-than-Human perspectives.

This technology is acknowledged as an imaginative and experiential tool, that, working by overlapping layers on the real world, can let us experience multiple alternative situations at the same time, making different and preferable timelines (pasts, presents, and futures) collapse on each other. With this perspective, AR acts as an ontological device whose characteristics bring it closer to the paradigms and the aims at the base of the design futures area.

Lastly, the main objective of the research is to design and provide a framework to be integrated within the design futures practices. It consists of a toolkit that can be used in collective design futures processes, aimed at exploiting, and applying imagination to design alternative scenarios and narratives. The second part of the framework consists instead of a set of guidelines to stage the experiential scenario and the narrative through the exploitation of AR technology and to evaluate the audience experience and the potential of AR in enhancing awareness concerning the topic of interest and the proposed and designed alternative. Furthermore, the overall aim of the framework is to increase the knowledge concerning non-human actors and perspectives, thus becoming a potential means, on one side, for critical inquiring and learning and, on the other, for creating and spreading critical transmedia projects.

THE MORE-THAN HUMAN (MTH) MAGNIFIER – A RELATIONAL FRAMEWORK FOR INCORPORATING THE "MTH" ACTORS IN THE PROJECT-BASED DESIGN STUDIO TOWARDS "COLLABORATIVE CITIES" SCENARIO

Jixiang Jiang – Supervisor: Davide Fassi

Contemporary design discourse is increasingly grappling with the challenges posed by anthropocentrism and ecological degradation. In response, there is a growing advocacy for a paradigm shift towards relational design frameworks that acknowledge the agency of more-than-human (MtH) actors. This paper explores design thinking through the lens of relational and object-oriented ontology, with the objective of assisting design practitioners in creating projects rooted in collaboration and coexistence between humans and MtH actors within urban environments.

Drawing on insights from post-humanist theories and participatory democracy, this study presents Collaborative City-Making (CCM) as a transformative model for urban development. CCM seeks to empower marginalized communities and MtH actors, offering them a platform for active participation in shaping urban landscapes. Central to this approach is the redefinition of the role of universities as key drivers of social innovation and interdisciplinary collaboration in CCM projects. Project-based studios emerge as pivotal spaces for integrating MtH perspectives into design pedagogy, with a focus on disciplines such as Service Design (SD) and Product Service System Design (PSSD). Through the development of the MtH Magnifier framework, designers are guided towards a more relational mindset, facilitating the incorporation of MtH considerations throughout the design process.

Grounded in empirical research and informed by grounded theory methodology, the MtH Magnifier framework aims to transcend hierarchical and dualistic thinking, fostering the identification of shared interests between humans and MtH actors. By embracing this holistic approach, designers contribute to the co-creation of inclusive and sustainable urban environments.

This study seeks to catalyze a gradual ontological transformation in city-making practices, fostering grassroots initiatives and revolutionizing design methodologies. Through collaborative efforts and interdisciplinary dialogue, the envisioned paradigm shift holds the promise of a more equitable and harmonious future for urban communities and their more-than-human counterparts.

According to the former considerations, the main research questions for this research are:

RQ1: How do posthumanism theory's view MtH actors, agency, and relationality?

RQ2: What is the framework (include principles, process, methods, and tools) did students adopt to go beyond a human-centered mindset? What limitations might restrict their mindset?

RQ3: How can these theories be transformed into tools that are understandable and usable for designers to help them break through the limitations in their thinking?

Methods

The author's research comprises two primary components aimed at advancing design practice in the context of collaborative urban projects involving MtH actors. Firstly, a design framework is proposed to guide design practitioners in integrating MtH actors' perspectives using relational thinking and design capabilities informed by post-human theories. Secondly, a set of design tools is developed to support practitioners at each stage of the design process, focusing on three key domains: transforming thinking and design capabilities among postgraduate students, the role of design outcomes in fostering connections between human and MtH communities, and understanding MtH actors and their agency through post-human theory. The research methodology draws from Blessing and Chakrabarti's Design Research Methodology (DRM), which facilitates the systematic development and validation of research outcomes. Utilizing DRM's progressive stages, including Research Clarification, Descriptive Studies I and II, and a Prescriptive Study, the author clarifies research questions, conducts literature reviews, analyzes case studies,
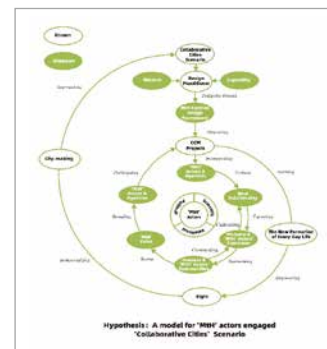

Fig. 1 – Human Centred Model for CC Scenario, Illustrated by the Author

evaluates design principles, and iteratively develops the framework and tools.

This process culminates in the creation of a comprehensive framework and accompanying tools that can be effectively applied in design studios to support MtH-engaged Collaborative City-Making (CCM) projects. Through workshops and feedback sessions, the effectiveness of the framework and tools is evaluated and refined, ultimately contributing to the advancement of design practice in addressing the epistemological challenges posed by posthumanism.

Literature Review:

The author examines the shift in innovation focus from technology to social impact, particularly in the context of social innovation's development amidst the ecological crisis. Recognizing the need for an ontological transformation for true sustainable development, the author explores design's potential contributions. This leads to the development of a CCM model informed by post-human theory.

Case Studies:

Five case studies are analyzed to understand how design practitioners incorporate MtH actors into CCM projects. These cases, sourced from various universities worldwide, offer insights into the evolving capabilities and thinking of designers facing MtH challenges. Focus group interviews and desk research provide primary data for analysis.

Grounded theory:

Grounded theory is employed to analyze interview data and develop theoretical models. This bottom-up approach results in a design framework for CCM projects integrating MtH actors' perspectives. The framework is iteratively refined based on insights from the case studies.

Tools Design and Testing through workshops:

Limitations in the initial framework are addressed through further iterations informed by relational thinking.

Post-human theories are translated into design tools to aid designers in overcoming anthropocentric limitations. Workshops are conducted to verify the framework's effectiveness, resulting in a social innovation project based on PSSD produced through continuous iterative efforts.

Through this process, the research contributes to advancing design practice in addressing the challenges posed by post-humanism and the ecological crisis, particularly in the context of CCM projects incorporating MtH actors.

Contribution

This study presents a transformative model called CCM within contemporary design discourse, advocating for a paradigm shift towards relational design frameworks that acknowledge the agency of MtH actors in urban development. Through the development of the MtH framework and accompanying design tools, grounded in empirical research and informed by grounded theory methodology, it offers a systematic approach for design practitioners to integrate MtH perspectives and to think relationally in their projects. By highlighting the role of project-based studios and addressing limitations through iterative testing, this research contributes to advancing design practice in addressing the challenges posed by post-humanism and the ecological crisis, ultimately fostering the shared urban commons with MtH actors.

Discussion

This study investigates a significant shift in design philosophy, moving away from anthropocentrism towards a comprehensive perspective that recognizes the influence of MtH actors in shaping urban landscapes. Through rigorous theoretical exploration, empirical case studies, and grounded theory analysis, the researcher presents the innovative MtH Magnifier framework.

This framework, grounded in relational ontology and post-human theory, enables designers to integrate MtH perspectives into CCM projects, promoting inclusivity and sustainability in urban development. Despite facing challenges such as disruptions caused by the pandemic, the research sets the stage for future initiatives, including workshops and partnerships aimed at establishing centers for pioneering design practices and advancing interdisciplinary research in ecological conservation. Through these endeavors, the study makes a substantial contribution to the ongoing discourse surrounding design, social innovation, and the harmonious coexistence of human and non-human actors within urban contexts. Additionally, a practical social innovation project is currently underway in the Quanzhou region of China, stemming from the outcomes of the test workshops. It aims to leverage the rich marine culture of the area through social innovation design centered around SD and PSSD. The goal is to transform local marine culture into a driving force for encouraging people to engage in oyster reef conservation actions and promote awareness shifts.
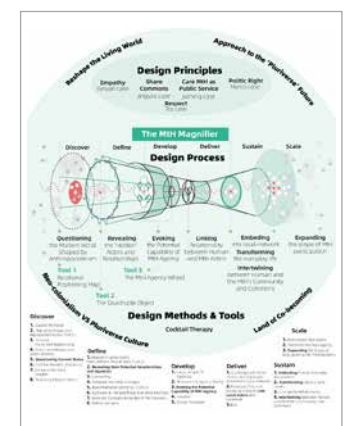

Fig. 2 – The More-than human (MtH) Magnifier – A relational framework for incorporating the "MtH" actors in the project-based design studio towards "Collaborative Cities" scenario

CIVIC DESIGN.
DEVELOPING A THEORETICAL FRAMEWORK TO FOSTER CIVIC PROJECTS WITHIN PUBLIC ADMINISTRATION DOMAINS

Vanessa Monna – Supervisor: Valentina Auricchio

The recent crises have accelerated and highlighted a decline in democracy, driven by a phenomenon known by the names "democratic backsliding" and "autocratisation". This phenomenon is characterised by a change in governance towards a more arbitrary and repressive exercise of political power, restricting the space of political participation and public contestation in the process of governing. The crisis of democracy translates into low participation in public affairs, leading to widespread disinterest and a loss of civic sense. The democratic recession and its long-term impact are affecting an increasing number of countries, with sometimes devastating costs for entire populations. International and regional human rights organisations underline the importance of protecting and promoting human rights, civic sense, and democracy.

This PhD research approaches these issues through the **exploration of the meaning of "Civic Design".**
The research focuses on the exploration of the notion of "Civic Design" towards the definition of a **theoretical framework** grounded in the systematised perspective of Civic Design experts.

The **emergence of design practices** addressing multiple interpretations of Civic Design, and **the insufficient theoretical contribution** of the concept of Civic Design in Design literature call for an **explorative study** about this notion, not only within the Design discipline, but also delving into **humanistic** disciplines dealing with related themes. The motivation for exploring the topic of Civic Design has been the need for the development of a systematisation of how Civic Design is shaping itself as an emerging practice, drawing forth the qualities, values, formats, expressions, and distinctions from other forms of design.

This investigation was sparked by a research question, which was supported by a sub-question:
RQ1. What does the concept of Civic Design refer to in Design research?
RSQ1.1. What are the conceptual building blocks of Civic Design?

This exploration aims at building a common understanding of what "Civic Design" is, and how it can be framed by describing **what defines it** and **how it relates to current design fields and approaches**, ultimately generating fresh understandings about patterned relationships between concepts emerging from data, to create a theoretical explanatory schema.
Through a literature review and a grounded theory method, this research contributes to design discourses around communities, common good and communal realms by developing a **systematisation of the body of knowledge** currently existing on Civic Design, and a **theoretical framework** appropriate for Civic Design.
Civic Design knowledge has been systematised in a theoretical framework comprising six dimensions: the **scope**, describing what drives a Civic Design project; the **space of action**, describing the context of Civic Design projects; the actors, portraying the participants in Civic Design projects; the **modes of action**, describing the attitudes and approaches endorsed by the actors of Civic Design; the **methodologies**, describing methods, processes, techniques, and practices applied in Civic Design projects; and the **impacts**, relating to Civic Design outputs, outcomes and impacts.

Leveraging the grounded theory, the PhD research reveals that the notion of Civic Design in Design research refers to an approach being **value-rational; embedding** design processes; nurturing processes of **commoning**; working in and for the **space of togetherness**; doing the work of **agonism**; construing through the **lenses of power, ownership, and representation; forming publics**; while **learning together**.
This research questions **what design *is*, *does*, and *makes*** by casting light on the essential nature of Civic Design, which addresses **issues while simultaneously presenting a critique through the proposed outcomes**.

Although this thesis is far from comprehensive, it makes a significant contribution by organising extremely unstructured knowledge that is still in its early days. The doctoral thesis constitutes a first attempt to give an answer grounded in Civic Design experts' knowledge that doesn't result in a definition of Civic Design (some already exist, as reported in the thesis), but in a set of Civic Design building blocks, the combination of which can result in civic projects.
Through a theoretical systematisation of Civic design— its concepts, its contents, its practices, and its stakeholders— this research is able not only to include in the theory a phenomenon which is developing outside of academic institutions in an undisciplined manner, but also to deepen the Design discourse around communal realms, the common good, and communities, framing the shift of attention from design outcomes as products towards processes and practices.
Constructing a theory about the meaning of combining the words 'civic' and 'design' is not a simple matter. To say that a theory around "Civic ensign" is developing means that it is establishing a philosophy, pedagogy, and ontology. Drawing a theory of Civic Design implies that the term defines its set of principles and system of values, elicits wisdom and knowledge, has its own form of teaching and learning, and has a unique way of being. This may be a bold assertion. Framing Civic Design may produce a pluralistic, messy, and disputable result. Nonetheless, this dissertation hopefully lends credence to the existence of an emerging practice further supporting people in addressing significant contemporary societal issues. Besides, the research calls into question what design "is", "does," "makes," and "does", "makes", and can "be(come)", owing to two fundamental traits of Civic Design, which are, first, the ambivalent ability to address issues while simultaneously bringing forth a critique through the proposed outcomes, having identified the meta-problems underlying an issue; second, the focus on bringing all citizens, beyond their rights, to participate in processes of democracy, not just to participate in processes of design.
These constitute a shift in how design might be understood and practiced, redefining its challenges, its focus, and its contributions.

To conclude, the title of this thesis, "Civic Design. Developing a theoretical framework to foster civic projects within Public Administration domains", wants to be an invitation to keep developing this approach; it's a door that is kept open for researchers and practitioners to come in, experiment with the framework and its components, go on the field, and work with people and non-humans, fostering civicness and building up the critical mass to start changing public administrations from within.
I mention that "a meta-role for Civic Design might be to explore the meanings of doing politics and being a political agent." This statement is like a research compass, directing us to questions we could ask next.

HEALING MATERIALITIES FROM A BIODESIGN PERSPECTIVE FRAMING BIODESIGNED MATERIALS AND ARTEFACTS FOR THE SUSTAINABILITY TRANSITION

Barbara Pollini - Supervisor: Valentina Rognoli

The rediscovered potential of "growing" instead of "making" is driving the emergence of new materialities, leading to innovative scenarios in biotechnologies and Biodesign, deeply interconnected and both depicted as game changers in the sustainability discourse. Biofabrication is undergoing a fervent research stage, with few viable material solutions already on the market, but a growing trend of investments for basic research and scaling-up opportunities. Biodesign, an emerging approach drawn on biological components, is also getting increasing attention. Currently, the first design courses and labs are pioneering a transdisciplinary educational path bridging design and science. The novelty of these fields inevitably accounts for many research gaps; among the most urgent issues is the need to understand whether the hypothesis about biogenerated materials and products sustainability is founded or not. Furthermore, Biodesign's expressive potential, definitions and methodologies still need to be explored in the design field. The main objective of this research is to grasp a picture of the rapidly evolving phenomenon of Biodesign, mainly focusing on its potential for a sustainability

transition, addressing (i) the state of the art and the contributions that living variables can bring in the sustainable transition; (ii) the new emerging features of biodesigned materials and artefacts, including their potential in design; (iii) the role of biodesigners and designers-in-lab as new professional figures emerging from the field, and their tools and methods. The study is carried out through a mixed methods approach. Knowledge foundations are based on literature review, case studies analysis and expert interviews; moreover, a phase of Research Through Design significantly contributed to the findings and outcomes of the doctoral study. Biofabricated materials have been considered through current sustainability metrics (e.g. LCA), highlighting their crucial role in the circular economy and some overlooked process-dependent environmental burdens. In parallel, many biodesigned materials and artefacts stand out for the possibility of overcoming the concept of sustainability as currently intended, embracing Regenerative Design for those restorative and regenerative features in living and bioreceptive materials. These main findings led to a conceptual framework, defined as Healing Materialities

- clarifying the dual nature of Biodesign, pushing both inner and outer sustainability through practical and speculative approaches and material outcomes. The still blurred figure of the biodesigner has been further outlined through the definition of the peculiar activity of biotinkering, based on a co-design with the living. New tools, mainly worksheets and checklists, have been proposed to facilitate designers approaching the field, creating bridges between Biodesign, Green Chemistry, and Sustainable Design strategies. A significant contribution to the research also came from four Research Through Design projects, which saw the candidate working on different materials in the role of a biodesigner and a designer-in-lab, activating collaborations with various universities and research groups and better validating the contributions that designers can have in scientific environments of different transdisciplinary intensity. The study highlights Biodesign's contribution in supporting a radical ecological transition and further encourages the use of regenerative materials and processes capable of balancing in the long run human and non-human needs.

Keywords
Biodesign, biofabrication, bioreceptive design, regenerative design, biotinkering, more-than-human design, nature-based solutions.

CIRCULARITY BY DESIGN, MATERIALS, AND ADDITIVE MANUFACTURING: FOSTERING SUSTAINABLE AND CIRCULAR MATERIALITIES ENABLED BY ADDITIVE MANUFACTURING

Alessia Romani - Supervisor: Marinella Levi

Co-Supervisor: Valentina Rognoli

New sustainable production models are gaining increasing attention to reduce the human impact on Earth in the next few years. Design practices, materials, and digital fabrication tools, i.e., additive manufacturing, play a crucial role in this change at local and global scales. A comprehensive range of circular materials and design strategies can be implemented to foster the development of new products and applications following the principles of circular economy in the next years. Nevertheless, their current exploitation in practical contexts is still challenging. Designers, engineers, and practitioners are not always aware of the new possibilities allowed by these materials and how to use them in real projects. At the same time, the potential applications of these materials and their experiential or non-tacit aspects are scarcely considered in the conventional materials development process. In contrast, new production and consumption patterns based on additive manufacturing arise from local communities and distributed networks, shaping new sustainable production and consumption models.
This Ph.D. research explores the interconnections between design, materials, additive manufacturing, and circular economy. The goal is to stimulate the use of new circular materials and strategies in real contexts by investigating possible materials and applications. At a later stage, the aim is to foster knowledge building and transfer on these topics by developing new accessible and participative experiential tools for designers, professionals, and students. The study follows a transdisciplinary approach that merges the materials engineering and design disciplines, mainly product design and engineering design. The methodology relies on case study analysis, materials characterization, design experimentation (Research through Design), product development, and reflective practice. The research path focuses on two case studies, both dealing with specific secondary raw materials and investigating new circular materials, additive manufacturing technologies, plausible design strategies, and applications in collaboration with professionals, industries, and labs. The first case study was carried out within the Horizon 2020 European project FiberEUse. It is linked to recycled glass and carbon fiber-reinforced polymers, mainly thermosetting, for small-format 3D printers, including custom-modified apparatuses (Figure 1a). The second case study, RepMat, focused on bottom-up experimentations in collaboration with international industrial and academic partners. It deals with recycled thermoplastics and biomass scraps or by-products in large-format 3D printing systems, also working with modified and self-made apparatuses (Figure 1b). The experimental activities resulted in a set of new circular materials, modified 3D printing systems, and potential applications, ranging from furniture to technical sectors, e.g., automotive and sports. The two case studies led to develop and release two materials libraries: the FiberEUse library (Figure 2a, virtual part at: https://fibereuselibrary.com) and the RepMat library (Figure 2b, virtual part at: https://repmatlibrary.github.io/).
Thanks to the two case studies, a novel, accessible, and replicative experiential tool based on the concept of materials libraries named "Materials Library System" was developed to share and build new knowledge on circular materials for additive manufacturing.

This open source tool is made of a physical and virtual part, aiming to stimulate distributed participative practices. It can be used to showcase new materials (divulgative use) or replicated to guide the investigation of emerging materials and technologies in different contexts, i.e., labs, makerspaces, and studios (experimental use). Its use wants to foster a collaborative distributed network focused on sustainable and circular practices and make emerging materials and technologies more accessible to real-world contexts. The practical experimentations led to outlining the adaptive contribution of specific design professionals, i.e., materials designers and engineering designers, to exploit circular materials for additive manufacturing in real contexts. Finally, the research redefines the role of materials libraries in the current scenario, contributing to the democratization process of materials and technological knowledge for and through design.
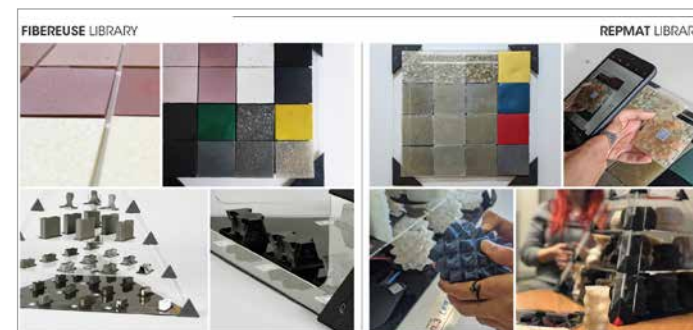

Fig. 1 - Part of the experimentation with additive manufacturing and circular materials carried out during the Ph.D. research: (a) FiberEUse project (first case study) and (b) RepMat project (second case study).
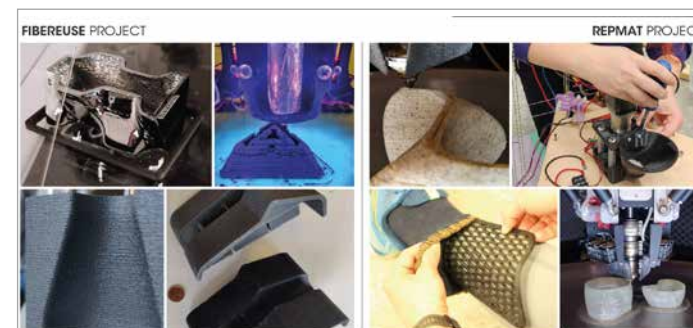

Fig. 2 - Materials library systems developed during the Ph.D. research: (a) FiberEUse library (first case study) and (b) RepMat library (second case study).
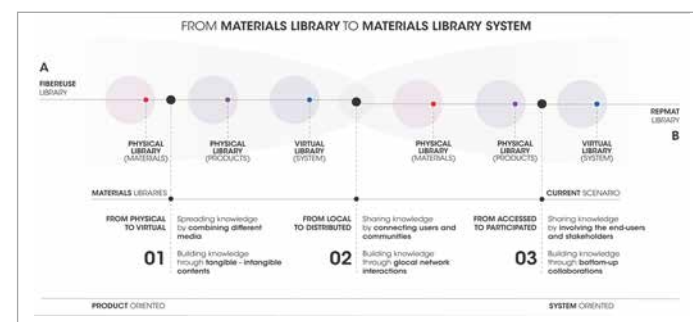

Fig. 3 - Analysis of the uses and roles of materials libraries in the current scenario from the Ph.D. research.

MACHINE LEARNING (FOR) DESIGN. TOWARDS DESIGNERLY WAYS TO TRANSLATE ML FOR DESIGN EDUCATION.

Martina Sciannamè - Supervisor: Davide Spallazzo
Co-Supervisor: Mauro Ceconello

Artificial intelligence (AI) is not a discovery of our time. It dates back to the 1940s, and ever since, it has experienced exciting periods of disruptive visions coming to life, and winters in which innovative ideas could not be materialized, bringing the hype around this technology back to a silent state.

Recent technological developments have dramatically increased computational power and the possibility to retrieve and store data, creating the perfect conditions for machine learning (ML) to thrive, becoming the most important subset of AI and opening up new possibilities. This powerful technology is going to affect numerous aspects of life on Earth in ways that we cannot yet fully anticipate, and with a revolutionary force comparable to electricity. However, with power comes responsibility. Currently, the development of products and services integrating ML is led by technical experts, often moved by the urge to unlock new technological capabilities or following the marketing objectives of their funders while missing the broader perspectives rooted in the socio-technical nature of these systems. The problem is acknowledged in both computer science and ethics fields, and many initiatives and guidelines emerged to counter the dangers of the reckless advancement of AI and ML, moved by experts from the public and private sectors. Among the most commonly suggested measures to responsibly manage such an influential technology that is still being studied, diversity in development teams is strongly encouraged.

However, in this domain, designers are still marginally or not involved, even though the recent history of the evolution of personal computers and the Internet shows that their empathy, system-level thinking, and transformative influence would allow them to bring beneficial contributions to the ML field and society at large. They have the potential to make sense of ML in innovative and more sensitive ways and to find new interpretations of what can be valuable to people through the conceptualization and materialization of meaningful solutions integrating ML systems. Though, designers are not yet prepared for this objective and have difficulties recognizing ML as a new material to include in their projects. Indeed, they lack ML-related knowledge, language, competencies, tools, and methods to deal with it.

Therefore, design education appears to be a perfect context of intervention to start filling this gap and contribute to steering the development of ML towards beneficial impacts, a pressing matter that is still under-explored in the design discipline. This is also consistent with the strategic vision of the European Commission to disseminate AI knowledge and promote trustworthy results and with the principles that should drive design education for the 21st century. Specifically, interdisciplinary approaches that draw on technological knowledge are strongly encouraged, as this is a critical asset to cope with our changing environment.

In order to enable (future) designers to exploit ML as a resource for their designerly interventions and to help them envision meaningful applications for this technology, the research aims to identify and translate ML basic knowledge to raise design students' awareness (main research question). On the one side, it focuses on making it accessible and operationalizable to them, understanding how this technology works, its possibilities, and limitations from a theoretical standpoint.

On the other, it includes ethical concerns to enhance a responsible approach, reinforce and augment the **systemic and holistic** perspective of design students when addressing a problem, maintaining human life and its ecosystems at the center. Because of these premises, the doctoral research is positioned at the intersection of UX/interaction design, ML, HCI, and computer ethics.

Specifically, the investigation starts from the foundations of the ML discipline and related ethics to infer what are the essential concepts that can and must be translated to design in order to favor their comprehension and implementation (RQ1). Then, it concentrates on the modalities, forms, and language to actually transfer knowledge (RQ2), and it synthesizes the preliminary hypothesis into theoretical assumptions and constructs. To accomplish the translation, the research envisions, develops, and validates flexible and modular models and tools for different design educational contexts (RQ3). Finally, based on the experimental experiences and gained insights, it formulates a possible structure for an educational method to merge technical, ethical, and designerly knowledge and support the conceptualization of meaningful ML-infused solutions (RQ4).

In pursuit of these objectives, the investigation produced original contributions to knowledge at different levels. From a theoretical point of view, it resulted in the systematization of essential ML knowledge to bridge technical and human-centered perspectives on its implementation (*ML Designerly Taxonomy*) and in the identification and procedural framing of the foundational elements for a responsible ML design process (*Responsible Cycle for ML Design*). To apply these concepts in a hands-on educational environment, some tools were developed to transfer basic knowledge (*ML Agents*) and give procedural support and inspiration for envisioning meaningful ML-infused artifacts (*Concept Building Blocks* and *VALUable by Design Expansion*). Educational models and an overarching method have been outlined to test and frame them. Hopefully, the research outputs represent starting points to enhance interdisciplinary communication and collaboration toward addressing relevant challenges and impacts.

Due to the uncharted territory under investigation (at least from a designerly perspective), the research is highly exploratory. It moves across ML and ethics to gain a better understanding of the subject matter and to identify the key ingredients to empower (future) designers to handle this technology as one of their design materials.

With no solid foundations to lean on, the research follows an action-research process. It starts from wide-ranging qualitative inquiries and leverages field research methods to test and investigate hypotheses from direct observation and participation. To infer actionable information, though, a significant role is played by reflective and interpretative activities. Indeed, it is highly iterative, and its development unfolds with a cyclic structure. The research questions are addressed in a constructive progression: each is characterized by four phases (planning, acting, observing, and reflecting) and creates the premises on which the next can be built. They are increasingly comprehensive in scope, moving from basic aspects of the translation to broader and more articulated constructs and, in the end, all the findings (tools, models, and theoretical assumptions) converge in the definition of an educational method merging design, ML, and ethics for design students to learn how to integrate and take advantage of ML capabilities to envision responsible and meaningful solutions.

Overall, it can be said that the investigation assumes a research-through-design spirit as this kind of research process actually corresponds to a design process.

HUMAN-AI CO-CREATIVITY. UNDERSTANDING THE RELATIONSHIP BETWEEN DESIGNERS AND AI SYSTEMS IN THE FIELD OF INTERACTIVE DIGITAL NARRATIVE

Anca Serbanescu - Supervisor: Francesca Piredda

Co–Supervisor: Maresa Bertolo

The research topic of this thesis, titled *Human-AI co-creativity. Understanding the relationship between designers and AI systems in the field of Interactive Digital Narrative*, revolves around the collaborative and complementary relationship between designers and Artificial Intelligence (AI) systems within the domain of Interactive Digital Narratives (IDN). IDN is commonly understood as a digital product that blends storytelling with interactivity, enabling end-users to influence the plot's outcome and explore various pathways within the narrative. For instance, an IDN might be a story established by an end-user on a computer interface, where the plot unfolds based on the end-user's chosen actions with the provided material.

This thesis aims to define a theoretical framework highlighting co-creativity dynamics emerging from the interaction between the human creator, herein referred to as a designer, and the AI system as a support tool in the *IDN design process*. This interaction ultimately culminates in creating *narrative design products*, including *IDN design artefacts*. This thesis is theoretical and outlines from the perspective of a communication designer an *AI4IDN framework*, which allows designers to familiarise themselves with the AI support systems with which to create *narrative design products* to communicate their design project effectively. It highlights that designers often lack a basic understanding of AI systems, especially when they come from humanistic backgrounds and have little exposure to computer engineering fields like Human-Computer Interaction (HCI). The proliferation of AI systems aimed at facilitating the creation of *narrative design products* has created a context in which IDN theory faces challenges in keeping pace with the systematisation of existing and new knowledge. This resulted in foundational theoretical research guided by a methodological approach known as qualitative multimethod, which systematically merged the knowledge of three relevant fields, i.e. Design, HCI, and Narrative Studies. This led to a case study analysis, the development of a theoretical framework, and subsequent evaluation through semi-structured interviews, adopting a cross-sectional critical-reflexive approach.

The original contribution of this thesis is threefold. First, it provides a multifaceted and systematic overview of AI systems knowledge capable of supporting the creation of *narrative design products*. Second, the *AI4IDN framework* emerges as a proposal for simplified comprehension of content related to AI support systems for narrative design product creation within the Design community. The intention is to equip designers with the necessary awareness and the ability to choose the most suitable AI tool for their IDN creation needs and to familiarise themselves with the chosen AI system before delving into the *IDN design process*. Third, the study concludes by identifying polarities and tensions in addressing the human–AI co-creativity topic, highlighting the open issue related to the classification of creativity within human–AI collaboration.
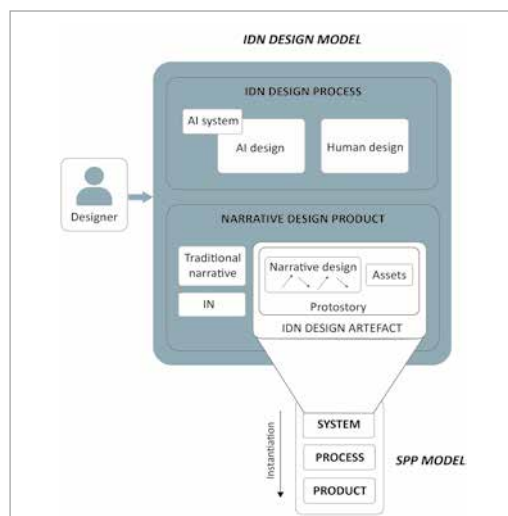

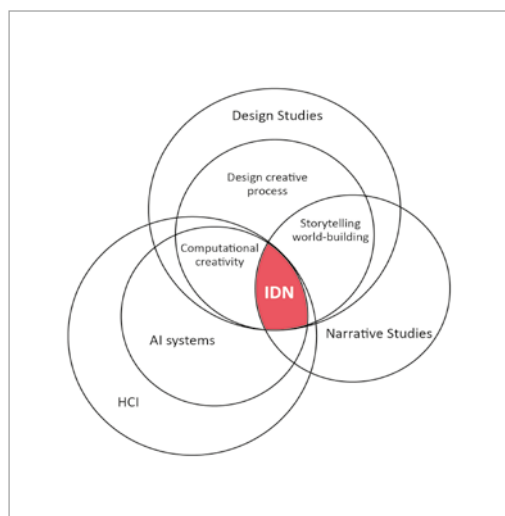Fig. 1 - IDN design model, extended version of SPP model

Fig. 2 - Research field map

CAREER DEVELOPMENT LEARNING FOR SERVICE DESIGN – DEVELOPING AN INSTRUCTIONAL DESIGN MODEL TO ENABLE THE TRANSITION FROM STUDENT TO PRACTITIONER

Andrea Taverna - Supervisor: Anna Meroni

Co-Supervisor: Daniela Sangiorgi

This doctoral research investigates the transition process of Service Design (SD) students from their academic journey into professional practice. The investigation aims to comprehend how SD programs can facilitate the transition process to the workplace by developing an instructional design model that supports SD students' career development processes and therefore prepares better practitioners.

Indeed, in the last decades, SD gained recognition both in terms of research field and professional practice. Nevertheless, the distance between these two sides of SD can negatively impact the education of a new generation of service designers, affecting the university-to-work transition, which is already a delicate and complex process. Considering the fast-paced evolution of SD, many students struggle to position themselves on the job market in the initial phase of their careers. According to Career Development theories, leverage on self-efficacy can positively impact on career performance. Thus, this study proposes integrating career development learning initiatives to improve SD students' self-efficacy during the transition to professional practice.

A series of theoretical bodies indeed inform the doctoral investigation (Figure 1). The context of the research in which the problem and the research gap emerge is SD. In particular, focusing on the transition, it is relevant to comprehend the evolution of the figures of service designers both from a research perspective and a practice perspective. Thus, observing the education field as a bridge between these two spheres of SD. Career Development studies have been analyzed and used as a theoretical lens to comprehend transition phenomena and provide a theoretical framework to design interventions. Last, moving within the educational context, the Research through Design process has been

informed by the genre of studies of Educational Design Research to provide an argumentative grammar to the investigation. The distance between academic education and the job market is a known issue that has increased since the rapid advances of technologies, constantly bringing new demands for new skills. Moreover, in the last decades, several transformations affected how we work, and new professions emerged. Additionally, the transition moment between the university and the workplace can be conceived as a liminal space during which the students undergo a process of self-definition. Students experiencing the transition to a workplace encounter a change of role from
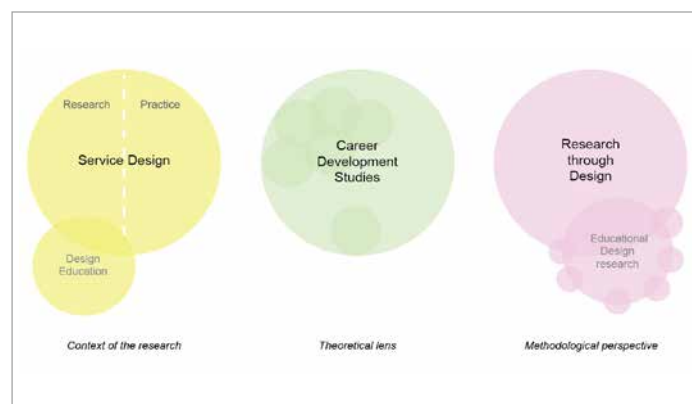

Fig. 1 - Theoretical bodies that are informing the research

students to practitioners, often characterized by disorientation, uncertainty, and lack of information. Career theories try to tackle these problems by providing a model that describes or supports career development. Among the most-known theories, the Social Cognitive Career Theory aims to integrate and build conceptual linkages of previous career development-related theories. It is informed by the Social Cognitive Learning Theory of Albert Bandura. It sees learning experience as elements of leverage on self-efficacy and outcome expectation that influence the self-definition of practitioners. Within the context mentioned above, SD constitutes an interesting case to investigate. The shift from a product-based economy to a service economy has promoted an approach that puts consumers at the centre of the experience. Hence, increasingly, businesses have been moving toward service-centric thinking from a product-centric one. Thus, the demand for SD practices in the job market has increased in recent decades. The adoption of SD practices has been developing along many dimensions. On one side, it has proven its diversity of application within different service sectors. On the other, it has expanded the areas where service design is considered valuable, including designing for service innovation, designing the public sector, and design for social innovation. However, if the demand for service designers has grown, and their role is diversified across organizations and contexts, it

is not fully clear how designers develop their professional identities.

The research has the objective at one side to comprehend which learning dynamics support their transition process in the current offer of initiatives for service designers and on the other to define an actionable model for the SD program to build career development interventions. The research is developed using a Research through Design approach to achieve these two objectives. The doctoral study is divided into two phases. The first phase consisted of observing the current panorama of initiatives in the SD field to comprehend on which occasions students encounter professional practice during their studies and to understand the role played by universities. The second one comprises a series of interventions aimed at comprehending how to support students in their career development journey. These interventions have been "designerly experiments" in the form of didactical activities for students. The empirical interventions have been carried out in the Italian context within the M.Sc. of Product Service System Design of Politecnico di Milano; in addition, a validation intervention has been carried out with the M.Sc. of Service System Design at Aalborg University. As a result of these initiatives, a series of design principles for career development initiatives have been defined. Thus, based on the derived principles, the study proposes an instructional

design model. This actionable model contributes originally and creatively to provide SD university's programmes with an instrument to create career development learning initiatives which can support students in becoming professionals by increasing their self-efficacy. Therefore, the research targets are SD Educators, especially those in the position of coordinating SD programs. Considering the research methodology, the research might also interest researchers in education and career development fields. The design approach through educational interventions toward career development might inspire these scholars.

In addition to this, the benefits of the research are not only affecting the programs of SD but as well impacting learners who are building their careers in the SD area by supporting their process of self-reflection and thus their career development; and companies that include service designers, by having profiles more aligned with their business value.

PLANTS AS STAKEHOLDERS
GRANTING THEIR INVOLVEMENT IN PARTICIPATORY
DESIGN PROCESSES OF PUBLIC URBAN SPACES

Francesco Vergani - Supervisor: Davide Fassi

In recent years, the field of Design has been quietly engaged in reframing its role in a world that is increasingly acknowledging interdependence among various lifeforms. This paradigm shift extends beyond human-centred perspectives and actively involves non-human actors, such as plants, in the design process. Empirical data on plant intelligence are revealing extraordinary complexities of thought, action, and interaction of vegetal beings, opening a vibrant discussion about the plant realm and its skills, and fostering a shift in considering plants as "active and political" actors rather than "silent and passive" resources. However, effectively handling the information arising from novel discoveries in plant intelligence proves to be a challenging task, mainly due to the specialized and continuously evolving nature of data derived from Plant Neurobiology. Reimagining plants as active actors - or *agents* - expands the possibilities to be explored and envisioned within the field of Design. This calls for a critical thinking of the efficacy of Design in understanding the potential implications for non-human life forms, which possess distinctive alternative modes and behavioral patterns. In a similar way, broadening

the consideration of plants as purposeful actors (and, by extension, capable of *designing* in their own way) directly impacts the perception of plants in urban environments, as they emerge as stakeholders that must be taken into account. Design approaches and biodiversity strategies are constantly flourishing in urban contexts, as well as in the design guidelines of many municipal administrations, promoting an image of ecological sustainability by re-introducing plants and their entanglement with other non-human lifeforms. However, these design practices - though significant for the biodiversity of urban ecosystems - seem to be driven by a purely anthropocentric need to improve the physical and mental well-being of human citizens, leaving little room for embracing the emerging knowledge on plants as agents. Most of the spatial settings of urban contexts still produce a large number of stressors on a daily basis - such as pollution, hot temperatures and limited space for growth - affecting both plants and other lifeforms (including humans). In this framework, plants are significantly affected by the toxicity of anthropocentric behaviours, even though they play a crucial role in fostering the wellbeing of urban ecosystem.

Given that plants evolve within, shape, and inhabit the shared spaces of urban environments, there is an emerging willingness to recognize their status as stakeholders worthy of consideration. By adopting a multispecies perspective, it becomes evident that participatory design processes for public urban spaces often fall short in acknowledging the agency of plants. Despite the apparent lack of consideration by municipal administrations and other public and private entities, the implementation of Participatory Design processes of public urban spaces emerges as a suitable framework for raising awareness in civil society about the importance of recognizing the agency of plants, yielding mutual benefits for both human and non-human agents. Within this framework, the thesis aims to promote a multispecies dimension for Design, surpassing the anthropocentrism of the current human-centered approach by raising awareness of plants as stakeholders. Building upon these foundational assumptions, which recognize *designing* as a multispecies endeavor involving various agents - albeit with uncertain forms - the research explores the realm of "Critical Plant Studies" to

understand if and how plants can be regarded as stakeholders in Participatory Design processes of public urban spaces. This exploration consists of three main research activities, employing diverse methods and tools to comprehend the collected data and generate insights about the speculative role of plants in Design. By gathering data through Desk Research and Experts Interviews, the first research activity (*Acknowledging plants as stakeholders*) mainly explores the active role of plants in urban ecosystems. This investigation involves collecting emerging insights from diverse disciplinary domains, including Biology, Botany, and Plant Neurobiology, which are not inherently associated with Design. By consolidating this data into a *Plant-centered Atlas*, the research speculates various strategies used by plants to engage with other agents within urban contexts. The second research activity (*Investigating plants in urban contexts*) aims to highlight issues related to the current design of public urban spaces concerning plants as well as problematizing the current role given to plants by municipal administrations. This problemoriented inquiry combines Ethnographic and

Desk Research by taking visual materials and studying official documentation from municipal administrations in two specific case studies (the cities of Milan and New York). Drawing upon the insights collected in the previous research activities, the third one (*Envisioning coexistence scenarios*) focuses on a specific case study involving a Participatory Design project in the Nolo neighbourhood (Milan). The investigation is conducted through a co-design session involving representatives from the local community to envision coexistence scenarios and acknowledge plants as stakeholders within the design process of a public urban space.

DESIGNING SUSTAINABLE FURNITURE SYSTEMS - THE KNOWLEDGE BASE AND KNOW-HOW FOR FURNITURE PRODUCT AND PRODUCT-SERVICE SYSTEM DESIGN FOR ENVIRONMENTAL SUSTAINABILITY

Dongfang Yang - Supervisor: Carlo Vezzoli

Overproduction and overconsumption on the system level (CSIL, 2021), as well as the heavy environmental impacts of a single piece of furniture on the product level (González-García et al., 2019), are among the environmental challenges for the furniture sector which has recently been identified as one of the key sectors that should be addressed and improved to achieve more sustainable development (European Commission, 2020).

Design was recognized as a significant area in the transition to more responsible and sustainable production and consumption models (Bhamra & Hernandez, 2021). To be specific, more than 80% of a product's environmental impact is determined at the design stage (Design Council, 2022; European Commission, 2020). In addition, the focus of Design for Sustainability has expanded the level of innovation from low-impact material and energy selection to product design, to Product-Service System design, to Spatio-Social innovation, and more recently to socio-technical systems innovation (Ceschin & Gaziulusoy, 2019). However, the furniture industry is currently focusing on single-indicator innovation, such as

reducing material content (Ika Rinawati et al., 2018) and selecting resources with lower environmental impacts (Iritani et al., 2015), which are insufficient. Although some furniture product LCD strategies have been proposed (Krystofik et al., 2018), there is a lack of comprehensive furniture-specific approaches, strategies, and guidelines. Regarding furniture S.PSSD, a limited number of studies focus on either environmental sustainability or economic prosperity, with no considerations for win-win economic and environmental benefits (Park et al., 2016). Knowledge base and know-how are required to generate sustainable win-win furniture S.PSS solutions.

In conclusion, the critical importance of design and the emphasis on complementary products and Product-Service Systems innovation are duly recognized. Nevertheless, the established knowledge base and practical know-how of Design for Sustainability (DfS) as applied to the furniture sector remain relatively limited at this time. According to the former considerations, the main research questions for this research are:

RQ1: What are the framework and characteristics of environmentally Sustainable Furniture Systems

(on product and PSS levels)?

RQ2: What new knowledge is needed to design environmentally Sustainable Furniture Systems (on product and PSS levels)?

In essence, this research seeks to unearth a knowledge base (in the form of theoretical frameworks, approaches, guidelines, etc., addressing RQ1) and practical know-how (in the form of methods, tools, etc., addressing RQ2) for sustainable furniture system design, particularly focusing on Furniture LCD and Furniture S.PSSD

Methods

Given the complexity of the research, a Design-Based Research (DBR) methodology framework was chosen to guide the entire process. DBR consists of four primary stages (Barab & Squire, 2004; Brown, 1992; Collins, 1992; Wang & Hannafin, 2005): preliminary research, prototyping, assessing and reflection to produce design principles and enhance solution implementation (Ceschin, 2012; Diehl, 2010; Herrington et al., 2007; Reeves et al., 2005).

preliminary research
This study explores aspects including the innovations and characteristics of environmentally sustainable furniture products and furniture S.PSS: Reviewing the literature

on furniture life cycle activities and other researcher's Life Cycle Assessment (LCA) on furniture, assessing the environmental impact of 25 pieces of furniture through a comprehensive LCA in the study, analyzing best practices, conducting semi-structured interviews. The goals were two folded: to construct a furniture life cycle profile and identify sustainability-oriented interventions and characteristics, and to identify characteristics of furniture S.PSS. Concluding this stage, the conceptual framework for the SFSD was developed, taking into consideration the characteristics of sustainable furniture products and S.PSS furniture offerings, which were utilized in the next stage to formulate furniture-specific design guidelines.

Prototyping
To address RQ 2, building upon the design insights and sustainable characteristics identified in RQ 1, preliminary guidelines for SFSD were developed. This process involved integrating experts' knowledge in furniture design and design for sustainability through two workshops, employing a consolidated method. Subsequently, these guidelines were evaluated by experts for comprehensibility and practical utility. This iterative process facilitated the creation of comprehensive sustainable furniture-specific design guidelines at both the product and Product-Service System (PSS) levels, encompassing three levels of detail: strategy, sub-strategy, and guideline. At the same time, drawing on these design

guidelines, a series of furniture-specific sustainable design tools were created.

Assessing
This research stage was dedicated to iterative processes of empirically applying, evaluating, updating, and redesigning/improving the furniture-specific design method and tools. The primary goal of this stage was to validate the developed knowledge base and know-how for their comprehensibility, usability, and effectiveness. The main methods employed during this stage include a workshop, a focus group, interviews, and questionnaires with 70 participants. Participants were selected based on specific criteria: 1) their involvement in sustainable furniture-related projects; 2) their affiliation with furniture design institutions/studios or their experience in furniture design or other product design; 3) their association with the LeNS network and focus on design for sustainability and/or furniture design. The continuous application and evaluation of these tools resulted in continual improvement.

Contribution

From a theoretical standpoint, this Ph.D. research contributes significantly to: (1) Identifying the comprehensive environmental impact throughout the entire life cycle of furniture and within the furniture production and consumption system. (2) Summarizing the characteristics of sustainable furniture products and Product-Service Systems. (3) Developing an Archetypal

Furniture S.PSS Map. (4) Creating a set of 154 furniture-specific LCD guidelines. (5) Formulating 46 furniture-specific S.PSSD guidelines.

From a practical perspective, this research yields valuable contributions, including the ICSxFurniture toolkit that support the whole process of sustainable furniture LCD, as well as the SDOxFurniture toolkit, an innovation diagram and system map designed to support the whole process of sustainable Furniture Product-Service System design.

Discussion

There are still limitations and opportunities for future work. First, conducting additional testing in different furniture company contexts, especially quantitative ones, would provide valuable insights and help validate the effectiveness of the developed tools and guidelines. Second, ongoing research activities may lead to new eco-design rules and guidelines. It is essential for this research to stay updated to ensure its relevance and applicability. Third, while this research primarily focuses on the application of LCD and S.PSSD in the furniture sector, there are still unexplored DfS approaches within the field that could be further investigated.

Despite these limitations, the knowledge base and know-how generated through this research are made available in an open-access manner. This allows for continuous improvement, modification, and upgrading by potential end-users.