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Chair:
Prof. Lucia Rosa Elena Rampino

DOCTORAL PROGRAM IN DESIGN

Field of study

The Politecnico di Milano established a PhD programme in the field of design already in 1990. Based on this tradition, the current PhD programme in Design was established in 2008, resulting from a substantial review of how design was researched at a doctoral level.
The overall aim of the PhD programme in Design is to develop skills to carry out high quality research, reflecting on the overall nature of design, with its aesthetic, performance and meaning values as well as its capability of being an agent of social change.
The PhD programme in Design deals with various research strands, each of them carried out by a given research team within the Department of Design. All the teams cluster around four Sections:

- Design and Cultures
- Products, Strategies and Services
- Design for Environments, Landscape and Mobility
- Design, Innovation and Sustainability

The programme aims at educating researchers who will contribute original knowledge to the field of design as an established academic field by tackling the problems and identifying the potential of contemporary society. Their contribution may be brought to bear in:

- creating designs, visions, and proposals (research through design);
- developing tools and methods for putting these into practice (research for design);
- developing critical analysis of design and its application domain (research on design).

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

Mission and goals

The programme develops design skills and analytical abilities, proposes various research methodologies and promotes a collaborative disposition.
The main academic field is Design. Other academic fields partially covered are: Philosophy; Language Theory; Sociology of Cultural Processes; History of Art; Science and Technology of Materials; Industrial Engineering.
The achievement of the PhD qualification in Design requires a study and research activity equivalent to at least three years of full-time study. During this period, both educational and research activities are provided.
At the beginning of the programme, candidates become effective members of a research team, within which they develop an original research topic: this activity is the core of the learning process.
Parallel to this, candidates are involved in training and specialist activities.
Moreover, the activities of the PhD in Design include participation in conferences (as listeners or speakers) and writing of research papers and/or journal articles.
The programme offers doctoral candidates the following opportunities:

- to develop an original theme of research, becoming an effective member of a research team;
- to attend courses and seminars on design research and on research in general, developing skills concerning the discipline of design and the profession of the researcher;
- to attend courses and seminars referred to a specific field of research, developing high-level specialist skills and acquiring knowledge and tools for the development of their own research;
- to develop the ability to clearly and effectively present the contents of their own work;
- to spend a period abroad as visiting researcher in a research centre to verify the assumptions, the methodologies and the results of their doctoral work.

Qualifications

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

DOCTORAL PROGRAM BOARD

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INFRASTRUCTURING MULTI-LEVEL STAKEHOLDERS' PARTICIPATION IN DASHBOARD DESIGN PROCESS.

A TWO-CASE-STUDIES ACTION RESEARCH IN THE PUBLIC TOURISM SECTOR

Nicola Besana - Supervisor: Davide Spallazzo

This research addresses a structural paradox within contemporary digital governance: although Public Administrations (PAs) increasingly rely on Big Data infrastructures, the interactive systems designed to translate these data into decision-support tools are often underutilized, misaligned with operational practices, and insufficiently integrated into institutional workflows. In the context of smart tourism, dashboards have become central instruments for processing and visualizing tourism-related data, yet their development frequently follows predominantly data-driven or technically oriented logics. As a result, stakeholder involvement is limited, usability is compromised, and systems fail to reach their full potential as decision-support systems.

Focusing on the regional governance ecosystem of Lombardy, this study investigates how Participatory Design (PD) methods can be strategically oriented and infrastructured to enhance the design of interactive Big Data dashboards within complex, bureaucratic, and multi-level institutional contexts. Rather than treating participation as a supplementary consultation phase, the research proposes reframing it as a structured and sustained component of the dashboard development lifecycle. In doing so, it bridges Interaction Design (ID), which foregrounds usability, clarity, and operability, with Participatory Design, which emphasizes collective sense-making, stakeholder validation, and democratic engagement.

The research adopts a practice-based Research Through Design (RtD) and Participatory Action Research approach. Over more than one year, the researcher operated as an embedded designer-researcher within PoliS Lombardia, the Regional Statistical Institute for Policy Support, collaborating on the development of two dashboards: one processing ISTAT monthly overnight stay data and another based on experimental mobile phone data provided by a telecomunication company. This dual role enabled direct engagement with institutional actors while systematically documenting how participatory and design decisions were negotiated in practice. More than 50 multi-level stakeholders - including municipal councillors, Destination Management Organizations (DMOs), regional policymakers, data analysts, and external consultancies - were involved through a mixed-method strategy that combined desk benchmarking, surveys, semi-structured walkthrough interviews, collaborative prototyping sessions, participatory observation, and focus groups.

The dashboard design process evolved iteratively through multiple stages. Initial phases revealed a strong dependence on dataset structures and technical constraints, resulting in interfaces shaped "by the data" rather than by stakeholder practices. A subsequent redesign phase incorporated standard interaction design principles, but further participatory engagement demonstrated that technical correctness alone was insufficient. Stakeholders consistently emphasized practical usability concerns, such as the need for flexible territorial aggregation, persistent filters across pages, and clear explanations of masking rules. Walkthrough interviews exposed how small interaction details could determine adoption, and focus group discussions highlighted the importance of aligning indicators with territorial realities. The transition from design mock-ups to Business Intelligence implementation (in Tableau) further revealed tensions between design intentions and platform constraints, requiring iterative "design-after-design" adjustments.

Through thematic analysis of both design and participatory processes, the study identifies recurring patterns at three interrelated levels. At the practical (product) level, the most critical usability dimensions for public dashboards were found to be operability, the system's integration into routine workflows, and situational awareness enhancement, the ability to accurately reflect territorial and temporal dynamics. At the operational (process) level, participation proved most effective when phased strategically: early engagement clarified inquiry themes and analytical priorities, while mid-stage prototyping supported validation of data interpretation and interaction logic. At the strategic (institutional) level, participation strengthened trust, enhanced legitimacy, and facilitated cross-institutional alignment, gradually transforming the dashboard from a technical artifact into a boundary object capable of supporting coordinated governance.

Beyond the dashboards themselves, the research documents the emergence of what is conceptualized as "infrastructuring participation." This refers to the ongoing work of establishing and maintaining social, organizational, and technical scaffolds that sustain collaboration over time. Technical infrastructures included shared prototyping platforms and documentation repositories. Organizational infrastructures involved restricted technical task forces, modular development cycles, and routinized feedback mechanisms. Relational infrastructures developed through the cultivation of territorial "antenna" figures - domain experts who provided contextual validation - and the formation of shared vocabularies between designers, analysts, and administrators. These infrastructures enabled participation to withstand institutional discontinuities, such as shifting priorities and administrative constraints.

A key contribution of the study is the articulation of non-exclusive Design (Policy) Briefs structured across practical, operational, and strategic dimensions. These briefs translate empirical insights into actionable guidance for public-sector dashboard projects, offering structured recommendations on when and how to involve stakeholders, how to integrate usability validation into development cycles, and how to align design decisions with governance objectives. Validation interviews with institutional managers emphasized the importance of formalizing such practices within procurement processes, suggesting that stakeholder integration and usability verification should be explicitly embedded in contracts with external providers. This move toward contractualization represents a critical step toward institutionalizing participatory practices beyond individual initiatives.

Ultimately, the research argues that infrastructuring participation is essential not only for building more usable and operable interactive systems, but also for fostering more context-sensitive, transparent, and democratically informed governance cultures. While acknowledging limitations, such as the challenges of sustaining engagement across administrative cycles and the risk of tokenized participation, the study positions public dashboards as living sociotechnical platforms. In this perspective, Interaction Design and Participatory Design are not parallel methodologies but interdependent practices that must co-evolve to ensure that large-scale interactive systems remain resilient, trusted, and aligned with the complex realities of public administration.

USER-CENTRIC DESIGN FOR HEALTH WEARABLES: EXPLORING BLOCKCHAIN ADOPTION FOR DATA PRIVACY AND CONTROL

Polina Bobrova - Supervisor: Paolo Perego

Introduction

The widespread adoption of wearable technologies has generated an unprecedented volume of personal health data. While these devices offer non-intrusive methods for monitoring physiological and behavioural markers, their reliance on centralised data management systems exposes users to significant privacy vulnerabilities and a lack of genuine ownership over their sensitive information. In response, blockchain technology and the emerging Web3 paradigm have been proposed as transformative solutions, offering decentralised architectures that promise immutability, security, and patient-centric data sovereignty.

However, the transition from theoretical promise to practical application is fraught with challenges. The complexity of blockchain interactions such as management of private keys, understanding gas fees, and navigating irreversible transactions, creates a steep usability barrier that frequently deters adoption.

This doctoral research addresses the critical disconnect between the technical potential of blockchain and the realities of user experience and acceptance. It identifies a "Blockchain Paradox": while users demonstrate high conceptual interest in the security and control blockchain offers, they experience significant friction and frustration when interacting with its current interfaces.

Existing research often exacerbates this issue by examining technical implementation, usability, and socio-cognitive acceptance in isolation. This thesis confronts this fragmentation by proposing and validating a holistic, integrated approach to the design and assessment of tangible, blockchain-enabled health devices.

Methodological Framework

The research employs a hybrid methodological framework rooted in a pragmatic epistemology, synchronising Research through Design (RtD) with Research for Design (RfD). This approach creates a virtuous cycle of inquiry: the RtD component generates situated knowledge through the iterative creation of a tangible artifact, while the RfD component distills these findings into transferable, actionable knowledge for the broader design community (Figure 1).

Research Phase 1: Problem-Finding (RtD)

The investigation began with the iterative design and development of "CipherPal," a smart fidget toy (Figure 2) that serves as a tangible interface for collecting health data secured by blockchain. This phase acted as a diagnostic tool. Through mixed-methods user studies including focus groups, anonymous surveys, and interactive prototyping, the study empirically surfaced the central design tensions. Results revealed that while 90% of users perceived improved security with blockchain integration, the "cognitive cost of sovereignty" was high. The friction introduced by wallet connection and transaction confirmation processes threatened to negate the device's therapeutic value, highlighting two distinct gaps: a lack of specific usability guidelines for decentralised systems and a lack of practical tools to address user acceptance factors beyond simple utility.

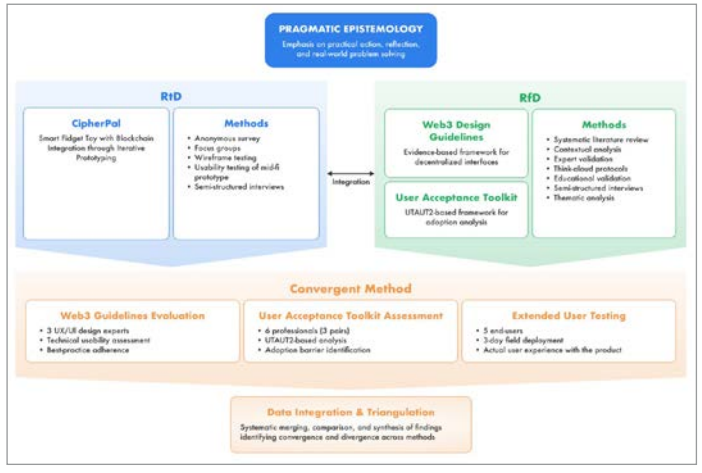

Fig. 1 - Scheme of the Methodological Framework

Research Phase 2: Tool-Building (RfD)

In response to the identified gaps, the second phase focused on developing targeted methodological solutions to support designers in this complex space. First, to address the "Acceptance Gap," the research developed a **User Acceptance Toolkit**. This resource bridges the theory-practice divide by translating the comprehensive Unified Theory of Acceptance and Use of Technology (UTAUT2) into a practical, canvas-based workflow. Validated with industry experts and 45 design students, the toolkit equips practitioners to proactively design for often-overlooked socio-cognitive factors, such as social influence, habit formation, and hedonic motivation, which are critical for the adoption of novel technologies.

Second, to address the "Usability Gap," the research constructed a set of **Web3 Design Guidelines**. Derived from a systematic review of academic and industry sources and refined through heuristic evaluations of 25 decentralised applications, these guidelines provide an empirically grounded framework for creating user-friendly Web3 interfaces. They offer specific principles for managing the unique constraints of blockchain, such as latency, transparency, and transaction irreversibility.

Fig. 2 - Photo of CipherPal (Smart Fidget Toy) Physical Component Prototype

Research Phase 3: Synthesis and Validation

The thesis culminates in a multi-framework evaluation that synthesises all research components. The refined CipherPal prototype was subjected to a holistic assessment triangulating three distinct perspectives: a technical compliance review using the Web3 Design Guidelines, a predictive acceptance analysis using the User Acceptance Toolkit, and an extended, in-the-wild user study. The findings from this capstone study reveal that successful blockchain adoption in health wearables relies on distinguishing between "trustless architectures" and "trustworthy interfaces." While the underlying infrastructure may be trustless (cryptographically secure), the user interface must be trustworthy, legible, predictable, and supportive. The evaluation demonstrated that when technical complexity is not sufficiently abstracted, it disrupts the user's sense of control, turning data sovereignty from a benefit into a burden.

Conclusion and Contributions

Ultimately, this research contributes a validated pathway for designing the next generation of secure health technologies (Figure 3). It moves the discourse beyond technical feasibility to focus on the human experience of decentralisation.

The theoretical contribution lies in defining the "Cognitive Cost of Sovereignty," articulating how self-custody shifts the locus of effort to the user. The methodological contribution is the hybrid RtD-RfD framework, offering a model for investigating complex socio-technical systems. The practical contributions are the artifacts themselves: the CipherPal prototype, the User Acceptance Toolkit, and the Web3 Design Guidelines. Together, these outputs provide designers with the evidence and tools necessary to balance technical security with user-centered principles, ensuring that the future of health data privacy is not only secure but also accessible, usable, and human-centric.

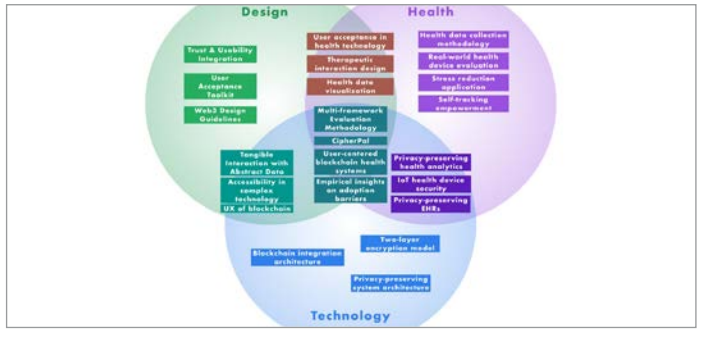

Fig. 3 - Research Contributions Map.

DESIGNING DEVICE OFFERS TO AVOID THE MANIPULATION OF CONSENSUS IN DEMOCRATIC PROCESSES: SMART SUSTAINABLE PRODUCT-SERVICE SYSTEMS DESIGN AGAINST DATA MISUSE

Alessandra Caroline Canfield Petrecca - Supervisor: Carlo Vezzoli

Sustainable Product-Service Systems (S.PSS), also known as product-as-a-service, are a promising offer model across all dimensions of sustainability. More and more smart devices have been integrated into these models, leading to the extraction of extensive data to deliver personalised and responsive products and services — a process often framed as co-creation of value. However, the pervasiveness of personal data collection has been disrupting the social sphere, contributing to the manipulation of users, compromising democratic processes, and negatively impacting the social dimension of sustainability.

Smart devices, from phones and wearables to speakers and other home appliances, function as nodes that capture data without informed or meaningful consent and request permissions beyond functional necessity. This creates a cyclical process: users interact with these devices, producing data; this data trains predictive models that generate personalised, often sponsored, outputs; users consume these outputs, generating more data and reinforcing the loop. In this sense, smart devices may appear user-centred while in practice advancing profiling and mass behavioural modification. Political strategies on digital platforms can range from microtargeting to targeted messaging through personal data and behavioural profiles, disinformation campaigns, deepfakes, and coordinated bot networks, designed to sway public opinion towards personal goals.

This research aimed to understand the role that the design of Smart S.PSS can play in avoiding the misuse of personal data for manipulating consensus in democratic processes. Rather than being neutral tools, these devices and their systems embed design choices that prioritise data-driven influence. These technologies could, however, be designed differently, toward models that do not reinforce such manipulation. To this end, a literature review was conducted to identify the key elements relevant to avoid consensus manipulation and erosion of democratic systems. These elements were then used to analyse cases as examples of better personal data configurations. The results informed a conceptual framework, which was iteratively prototyped and assessed through workshops and interviews with students, professionals, and domain experts. The framework comprises four key elements (Privacy, Transparency, Participation, and Inquiry) that underpin four main strategies: Protection, Guidance, Control, and Collaboration.

Protection and Guidance involve more passive strategies in terms of user control over personal data. For example, privacy-by-default features that minimise data collection, and newsletters on data ethics to educate users. Control and Collaboration, by contrast, support a more active user role, such as refined controls over algorithmic preferences and open-source communities that can suggest platform developments. Meanwhile, Protection and Control act directly on users' personal data, whereas Guidance and Collaboration adopt a broader view of how data is treated collectively. Across the four strategies, the framework includes 13 guidelines comprising 48 features that can serve as examples or sources of inspiration.

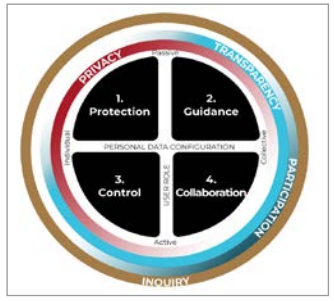

Fig. 1 - e.g. Conceptual framework strategies diagram

The iterations also identified the need for preparatory education before designers can effectively apply strategies. The design community must develop a deeper understanding of digital data configurations and learn to treat data as a controversial design material that demands ethically grounded frameworks. Co-creation of value must move beyond behavioural prediction, with dialogue, transparency, and informed participation in how user data is interpreted and applied. It is important to reverse the contemporary logic of "delivering people to systems" and instead develop genuine "systems for people", as Thackara (2005) argued. The framework thus aims to restrict large-scale data extraction, raise user awareness, and support more participatory practices, contributing to broader debates on how societies can govern digital technologies ethically and sustainably.

REDESIGNING FASHION SUSTAINABLE RETAIL APPROACHES.

SUSTAINABLE INNOVATIVE SERVICE MODELS WITHIN THE RETAIL CONTEXT GUIDED BY THE NEW COMMUNITY-DRIVEN CONSUMPTION DYNAMICS

Gabriela Fabro Cardoso - Supervisor: Alessandra Spagnoli

The global fashion industry is currently characterised by an unsustainable linear model, often referred to as *take-make-dispose*, which has led to significant issues regarding overproduction and overconsumption. While the volume of clothing manufactured has grown exponentially in recent times, the frequency with which people wear their garments has declined significantly. This paradigm is further accelerated by the phenomenon of **fast fashion,** characterized by rapid trend adoption and cost-efficient manufacturing that creates massive amounts of textile waste and a significant financial burden for brands managing overstock. In response to these pressures, the **European Union's Circular Economy Agenda** has introduced rigorous regulatory changes designed to enforce corporate accountability throughout a product's entire lifecycle. Key legislative pillars include **Extended Producer Responsibility (EPR),** which makes brands responsible for post-consumer waste, and the **Digital Product Passport (DPP),** which provides verifiable data on a product's composition and instructions for repair or recycling.

Central to this transition is the adoption of **Collaborative Fashion Consumption (CFC)**, including resale, rental, swapping, and leasing, which redefines the consumer relationship by prioritizing **access over ownership** to extend garment life cycles. Theoretically, these models are grounded in **Product-Service Systems (PSS),** initially defined as a combination of products and services designed to satisfy user needs while reducing environmental pressure. However, research indicates that PSS models do not inherently guarantee sustainability unless they are explicitly designed with Circular Economy goals in mind. For these models to achieve radical gains, they must move beyond transactional services toward **community-driven consumption dynamics**, where consumers act as active co-creators in *social-collaborative loops* rather than passive recipients.

Despite the potential of CFC, its practical impact is frequently hindered by an *intention-action gap*. This phenomenon describes the discrepancy where consumers stated environmental values fail to translate into sustainable practice, as **price, convenience, and routine habits** tend to dominate ethical factors at the point of purchase. Expert perspectives confirm that this *intention-action gap* remains a central obstacle, often leading to a **rebound effect** where reselling items is used to justify further consumption.

Within this context, the Doctoral Research investigates how **Design can serve as a catalyst** to bridge this gap and foster community-driven retail models, particularly for **Small and Medium-sized Enterprises (SMEs),** which act as agile innovators but face significant hurdles in complying with new regulations. Adopting a **Research Through Design (RtD)** methodology, the study positions Design as both the object and process of inquiry to generate novel understanding. The study utilizes a **multi-method qualitative approach**, integrating a **Systematic Literature Review**, a comparative analysis and coding**, Expert Interviews** with industry professionals, a **Focus Group** with young consumers, and a **Participatory Workshop**. Triangulation of these findings allowed for the translation of empirical insights into a standardized language to inform strategic decision-making.

The exploratory research led to the development of two diagnostic classification systems: **seven distinct business archetypes** and **six future-oriented consumer archetypes**. The business archetypes, which include *The Visionary Leader, The Marketing Communicator, The Data-Driven Transformer, The Ecosystem Collaborator, The Local Circular Advocate, The Tech-Driven Optimizer, The Minimal Engager*, classify firms based on their strategic response to circularity, internal operational capabilities, and consumer engagement. Simultaneously, the consumer archetypes, such as *The Conscious Minimalist, The Aspiring Circularist, The Cost-Conscious Pragmatist, The Style-Driven Shopper, The DIY Upcycler, The Ethical Researcher*, capture the nuances of motivations beyond simple demographics. These archetypes address the limitation of *one-size-fits-all* sustainability strategies by offering a **structured perspective** for understanding diverse competencies and evolutionary paths.

An important contribution of this thesis is the development of the **Ecotype Toolkit**, a diagnostic and strategic instrument designed to align business efforts with consumer demand. For businesses, the toolkit provides a systematic self-evaluation across five core operational areas: **Consumer Engagement & Awareness, Circular Business Models & Services, Supply Chain & Infrastructure, Partnerships & Collaboration, and Transparency & Impact Reporting.** By identifying their archetype and matching consumer, businesses can prioritize investments in services with the highest potential for market success, such as repair workshops or take-back schemes. The toolkit effectively translates complex environmental criteria into an **accessible format**, empowering SMEs to build a strategic identity and mitigate the risk of **greenwashing.**

For consumers, the toolkit presents 12 hypothetical everyday scenarios as an interactive means of conceptualizing individual actions. By engaging with these scenarios, consumers identify their primary behavioural profile and are prompted to adopt personal habits that support sustainable business models, such as choosing repair over replacement. The toolkit creates a **shared common ground** between market actors, helping both sides understand how their unique values and strategies intersect. By establishing a **common nomenclature**, the instrument promotes a more collaborative, responsive, and integrated operational design in the fashion system.

The research offers significant **theoretical value** to **Fashion Retail Design** and **PSS literature** by repositioning Retail Design as a strategic tool for systemic change and behaviour shift. It enriches PSS theory through empirical evidence that community involvement is a key variable in the sustainability of fashion models. Practically, the thesis provides a **realized proof-of-concept** for SMEs to innovate beyond traditional product sales toward relational, participatory systems. The findings also offer critical insights for **EU policymakers** engaged in the circular economy agenda, confirming the necessity of system drivers like EPR and the DPP while advocating for **scaled institutional support** for smaller innovators.

Finally, the study acknowledges limitations regarding its geographical focus on Europe and North America and the small size of the consumer samples. **Future research** should focus on the digital transformation of the Ecotype Toolkit to enable automated data analysis, benchmarking, and real-time updates. Recommendations include incorporating **weighted scoring and verifiable performance data** to bridge the gap between reported intent and measurable impact. Additionally, further studies are required to accurately measure the **displacement effect** of CFC models on overproduction through quantitative lifecycle assessments. Ultimately, the Doctoral Research highlights the transformative potential of **Design as an enabler of community-driven retail models,** offering a concrete pathway toward a more sustainable and relational future for the global fashion system.

DESIGNING FOR INTERSECTIONAL AWARENESS:
META-DESIGN FOR SITUATED AND INCREMENTAL CHANGE IN DESIGN EDUCATION

Federica Caruso - Supervisor: Venanzio Arquilla

Design processes often address exclusion too late, reinforcing marginalization and limiting designers' capacity to anticipate harmful consequences.
Traditional accessibility-focused approaches fail to account for broader dimensions of exclusion.
This PhD research draws on Design Justice principles and Intersectionality theory to reposition **awareness as central to design education**.
Coined by Kimberlé Crenshaw in 1989, intersectionality challenged the "single-axis framework" that obscured overlapping forms of oppression, revealing how identity categories (race, gender, class, ability, and others) intersect to produce distinct experiences of privilege and marginalization.
It rejects "either/or" thinking in favour of "both/and" relationality.
Despite its influence across the social sciences and legal research, **intersectionality remains under-integrated in design education**, with limited guidance available for educators.
This research supports educators in fostering students' understanding of privilege and marginalization by repositioning awareness as a meta-design intervention acting on the problem-framing phase of the design process (Fig. 1). Addressing bias and power dynamics early is essential to preventing exclusionary outcomes.
Using participatory action research (PAR), the study co-constructs knowledge with educators and students, treating that knowledge as situated, collaborative, and oriented toward change. Although most closely aligned with Design Justice, the research retains the term "inclusive design" (in lowercase) to refer to design approaches that, despite theoretical differences, share a commitment to equity and participation. This choice reflects two practical considerations: consistency with the initial research phase, and accessibility - many participants were unfamiliar with "design justice" but recognised and worked with "inclusive design."
Three progressive objectives move from theory to practice. The first establishes the **theoretical foundation** by examining the relationship between meta-design and inclusive design, particularly how intersectionality can be integrated into design processes, through a literature review and mapping of design courses, tools, and resources.
The second **observes practice through iterative PAR cycles with educators and students**, exploring how inclusive design and intersectionality are currently addressed. **The third develops actionable contributions by identifying barriers** that prevent educators from meaningfully integrating inclusion and intersectionality into their teaching.
Four interconnected PAR cycles unfolded as follows.
Cycle 0 comprised semi-structured interviews with eighteen educators and a student survey, mapping current practices and surfacing the gap between educator intentions and student understanding.
Cycle 1 involved student reflection workshops and focus groups with early-career educators, correlating perceptions and identifying convergences and divergences.
Cycle 2 entailed classroom collaboration within a meta-design course at Politecnico di Milano, enabling direct observation and student feedback.
Cycle 3 consisted of focused workshops testing refined reflective activities to support critical and reflexive thinking.
The research applies three PAR quality criteria: outcome validity, in which ongoing problem reframing generates new questions; democratic validity, ensuring solutions are appropriate to the local context; and catalytic validity, reorienting both participants and researcher toward transformative understanding. Peer evaluation and the collaborative involvement of educators and students shaped the final outcomes.
Analysis of educators' experiences identifies **three key "Tensions"**: (1) **topic complexity** and inherent uncertainty, including "majority anxiety" and the evolving, contextual nature of inclusivity content; (2) **educator agency**, professional integrity, and the ongoing commitment to self-reflection and learning; and (3) **institutional barriers**, the ways institutions can either enable or delay necessary change.
Educators struggle with where to begin, fear causing harm, and lack institutional support; students, meanwhile, are receptive to intersectionality but perceive the market and curriculum as resistant or indifferent. Awareness alone proves insufficient without multi-level support; nonetheless, small, intentional interventions within existing courses can begin disrupting exclusionary defaults.
The thesis produces three practical outcomes. First, **"Tactics" are actionable strategies** operating across three levels of social complexity, micro (personal), meso (classroom), and macro (institutional), encompassing approaches such as embracing discomfort, rejecting perfectionism, establishing shared language, creating safe learning spaces, and moving beyond isolated interventions. Their value lies in documenting small, feasible moves within existing curricula and institutional structures.
Second, **Reflective Activities** are designed to stimulate students' critical reflection during the meta-design phase, laying the foundation for design projects.
Third, the **"Matrix" is a multi-level diagnostic** framework that systematises the relationships between Tensions, levels of complexity, and Tactics, revealing that these elements are complementary (unable to be addressed in isolation), mutually supportive (each level reinforcing the others), and iterative (enabling ongoing adaptation).
Reflective Activities and curated resources support implementation, and a pilot proposal outlines how these tactics might be embedded into a meta-design course at Politecnico di Milano.
This research demonstrates that students can engage meaningfully with intersectionality when offered reflective activities that foster open discussion. The outcomes **aim to sustain power-sensitive conversations** and maintain productive engagement with tension as an ongoing, evolving process. They emphasise collective action and offer starting points for reflection and adaptation.
Like others working in this area, this research offers a humble contribution to the broader collective effort toward justice in design, a modest part of a larger, shared endeavour to challenge dominant culture. Conceived as a supportive rather than constraining structure, its value lies not in providing definitive answers or proven solutions, but in documenting current conditions and sharing resources for continued work.

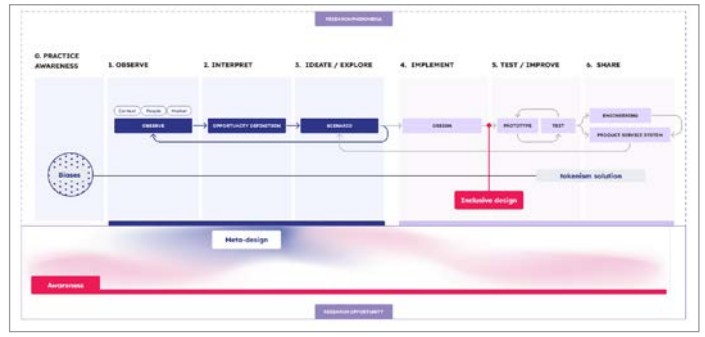

Fig. 1 - Research Phenomena and Opportunity Overview. Evidence from the literature shows that cognitive biases heavily influence problem-framing, while inclusive design is typically introduced only in the final stages of development. Integrating inclusive design principles from the outset - and fostering awareness in the early phases - represents a key opportunity.

IMAGINEERING URBAN SPACES: ENHANCING THE DESIGN PROCESS WITH SPATIAL FUTURES APPROACH FOR SPATIAL EQUITY

Tatiana Efremenko - Supervisor: Marita Canina

Cities are complex and constantly evolving systems shaped by interconnected social, technological, ecological, and economic dynamics. Urbanization – accelerated since the Industrial Revolution – has improved many aspects of human life but has also generated profound environmental and social challenges. Today, cities face multiple intertwined transformations, including climate change, technological development, social inequalities, and political polarization. These processes increase the complexity of urban environments and make it difficult to anticipate how cities and their inhabitants will evolve in the future.

Urban design is inherently a future-oriented practice, as spatial decisions influence cities for decades and often shape the lives of future generations. However, most urban design approaches remain grounded in present-day conditions and rely heavily on forecasting, modelling, and trend-based planning. In such approaches, urban space is frequently treated as a passive outcome of external forces – whether technological, economic, or political. As a result, many urban visions reproduce existing patterns rather than critically imagining alternative futures.

This doctoral research challenges this paradigm by asking: what if urban space itself could become an active driver of future visioning? Instead of beginning with external trends, the research explores how the intrinsic characteristics and potentials of space could guide the imagining of urban futures.

While various principles exist for human-centered urban design—such as soft city principles or guidelines for good urban design – there is still no clearly articulated framework for designing future-driven urban spaces.

At the same time, urban design has historically been shaped by human-centered – and often male-centered – perspectives that overlook the diversity of urban stakeholders. While the concept of spatial equity emphasizes the importance of designing cities that respond to diverse human needs and experiences, the role of non-human actors such as animals, plants, ecosystems, and technologies remains largely absent from spatial design processes. Yet urban environments function as complex ecosystems where multiple forms of life interact and depend on one another.

These challenges highlight the need for new conceptual and methodological approaches capable of integrating futures thinking, spatial design, and inclusive participation. Although futures studies and design futures offer valuable tools for imagining alternative futures, they rarely engage deeply with spatial questions. Conversely, urban planners and designers often pay limited attention to variety of foresight methodologies. This disciplinary divide limits the ability to generate transformative urban visions.

This doctoral research addresses these challenges by proposing a new approach to spatial design that positions space itself as an active driver in the process of imagining urban futures. Instead of beginning with external trends, the research explores how the intrinsic characteristics of space can guide the envisioning of future urban environments.

First, the research introduces the Spatial Futures Model supported by 14 guiding principles, a conceptual framework that integrates principles of design futures with four core dimensions of space: material, functional, interactional, and temporal. Through this framework, space is understood not merely as a container for human activities but as a dynamic environment capable of shaping future imaginaries. The principles are designed to support both designers and citizens in navigating complex urban challenges while embracing multiple temporalities, stakeholders, and potential scenarios.

Second, to broaden the understanding of stakeholders in urban environments, the research also develops a Taxonomy of Spatial Agents, which expands the notion of spatial equity beyond human actors. The taxonomy recognizes a wide range of spatial agents – including humans, non-human species, ecosystems, and technological systems – as legitimate participants in urban design processes.

Finally, a central contribution of the research is the Spatial Futuring process, introduced as a new generative phase in the urban design process. Positioned before traditional analysis and planning stages, Spatial Futuring functions as an "imagination space" where stakeholders collaboratively explore possible futures, reveal local knowledge and needs, and identify opportunities for more inclusive and context-sensitive urban transformation. Spatial Futuring approach with its tools attempted to offer another way to design that integrates multispecies perspectives, imagination, and empathy to enhance spatial equity. By recognizing diverse human and non-human stakeholders, fostering reflective and inclusive practices, and visualizing alternative futures spatial scenarios, it empowers both designers and citizens to rethink how urban spaces are conceived and who they are for.

Spatial Futuring process, based on three phases – Recognize, Envision, Anticipate – is an imagination process of creating spatial scenarios, supported by the Spatial Futures model, its guiding principles, and the design tools created to support it. It includes a set of practical tools designed to activate imagination, inclusivity, and futures thinking in spatial contexts. These tools include Spatial Agent Cards, Design Cards, What-if Cards, the Spatial Futures Wheel, the Mindset Mirror, and the Multispecies Explorer, which support both designers and citizens in collectively exploring alternative urban futures. The proposed framework was developed and refined through eleven field experiments conducted across Europe and China, where participatory workshops tested the application of futures-driven spatial design methods. Spatial Futuring approach with its tools attempted to offer another way to design that integrates multispecies perspectives, imagination, and empathy to enhance spatial equity. By recognizing diverse human and non-human stakeholders, fostering reflective and inclusive practices, and visualizing alternative futures spatial scenarios, it empowers both designers and citizens to rethink how urban spaces are conceived and who they are for.

The research outcomes are consolidated in the Atlas: Spatial Futuring for Spatial Equity (https://spatialfuturing.com/), an open online platform that provides conceptual frameworks, participatory tools, and guidelines for implementing futures-driven spatial design practices. The Atlas also supports a growing community of designers, researchers, and practitioners interested in equitable and future-oriented urban transformation.

By integrating futures thinking directly into spatial design processes, this doctoral research contributes a new theoretical and applied framework for designing urban environments that are inclusive, adaptive, and capable of responding to the complex challenges shaping contemporary cities.

DESIGNING POST-SUSTAINABLE TOURISM.

A MULTISTAKEHOLDER DECISION-MAKING FRAMEWORK FOR SOCIO-CULTURAL TRANSITION IN THE TOURISM SECTOR

Valentina Facoetti - Supervisor: Laura Galluzzo

This doctoral dissertation examines the structural crisis inherent in the contemporary tourism system from a design perspective. The prevailing capitalist growth paradigm has turned tourism into a critical social and environmental issue, characterised by extractive practices that exploit cultural and natural resources for consumption. While the ecological impacts are extensively studied, the social implications, such as the marginalisation of host communities, tourism gentrification, and the loss of the right to the city, remain critically underexplored. Existing literature on Social Innovation often overlooks the necessary strategic and political role of local communities in driving profound systemic transformations in production and consumption.
To address these gaps, this research investigates how Multistakeholder Participatory Design methodologies can support creative experimentation in tourism practices to generate positive social impacts for place-based communities, initiating a shift towards a Post-Sustainable Tourism paradigm. Drawing on Design for Social Innovation and Transformative Design, the thesis advocates the Local Turn, which redefines tourism by placing the local community at the centre of decision-making and emphasising situated and relational practices. This theoretical underpinning is grounded in the strategic proposal of tourism Degrowth: a political transformation aimed at reducing consumption, diversifying the local economy, and rebalancing decision-making power to challenge the logic of infinite expansion.
Situated between academia and industry, the research is part of a PNRR Doctoral Program co-founded by Alpitour World and features extensive ethnographic fieldwork in Mallorca. The study mediates between theory and practice, offering a dualism that provides opportunities for critical reflection on the socio-environmental responsibilities of contemporary tourism. An extensive interdisciplinary literature review frames the complexity of the tourism phenomenon, critically examining it within the capitalist growth paradigm. It discusses the social impacts of massification, overtourism, and touristification on territories and communities, before exploring sustainability discourses and their limitations. By introducing Post-Growth perspectives, Degrowth, and the Local Turn, the research positions Design as a transformative field capable of mediating systemic change, moving from a problem-solving to a problem-posing approach.
The study adopts a qualitative Social Constructive Research through Design (RtD) approach informed by Action Research (AR). The methodology is structured across four iterative phases—*Analysing, Interpreting, Designing, and Implementing*—that integrate literature systematisation, case study exploration, and participatory co-design. Particular attention is dedicated to the role of the researcher as a Designer–Practitioner–Researcher, acknowledging the complexities of subjectivity, reflexivity, and ethical positionality within a public-private collaboration context.
The core research activities follow the methodological framework. The **Analysing phase** systematises the state of the art, resulting in the creation of the ***Tourism Systemic Atlas***. Initially conceived as a visual data-mapping device, the Atlas evolved into an instrument for designer-led inquiry to explore relationships, power dynamics, and systemic interdependencies. It utilizes a rhizomatic, concentric structure that firmly places the local community and territory at the core, mapping how tourists, resources, and the global industry interact with and extract value from the place.
The **Interpreting phase** focuses on the case study analysis of Alpitour World within the insular socio-political ecosystem of Mallorca. Using a multi-level critical framework, it examines corporate sustainability narratives, power asymmetries, and strategic trade-offs, opening a space for critical design reflection. This phase led to the identification of four ***Corporate Strategies for Post-Sustainable Tourism***, strategies that can be applied by corporations to design tourism services and products (SP) from a post-sustainable perspective.
The **Designing phase** presents a system of ***Multistakeholder Participatory Design workshops*** that engaged company professionals, academics, local citizens, and activists. In these sessions, the *Tourism Systemic Atlas* was reactivated as a participatory provotype to facilitate dialogue and collaborative scenario creation. These activities systematically identified a set of ***Drivers of Change*** that constitute a comprehensive framework for the community-led design of alternative tourism futures.
The Implementation phase consolidates the insights generated through the case study and participatory activities into a coherent post-sustainable trajectory. Interpreting the *Drivers of Change* through the strategic areas identified in the Alpitour analysis yielded four ***Future Scenarios for Post-Sustainable Tourism***, representing feasible strategic paths for the transition of corporate actors towards generative tourism models. These scenarios—"Cultivating belongings" (emphasising local hospitality and de-gentrification), "From tourism monoculture to balanced economies" (focusing on local impact fees and participatory budgeting), "Participatory multistakeholder governance" (creating civic-design arenas for shared policy-making), and "Reframing tourism through situated storytelling" (shifting narratives from stereotyped consumption to community-led curation)—demonstrate how systemic transitions can be operationalized. Furthermore, the thesis provides a ***tentative definition of Post-Sustainable Tourism***, synthesising theoretical reflections and empirical findings into a conceptual framework that moves beyond conventional sustainability paradigms.
The study concludes by highlighting the catalytic role of Multistakeholder Participatory Design in creating the social and material conditions necessary for degrowth, positioning communities as active political actors. Ultimately, the research argues that achieving post-sustainable tourism requires a structural commitment to power redistribution, support for common goods-based governance, and the institutionalisation of the value of local knowledge in the vision of a fair and regenerative future.

DESIGNING THROUGH GENERATIVE AI: FRAMING THE DESIGNER-GENAI INTERACTION IN THE DESIGN PROCESS

Fabio Antonio Figoli - Supervisor: Lucia Rampino

Co-Supervisor: Francesca Mattioli

Artificial Intelligence (AI), and in particular generative AI (genAI), is rapidly reshaping design practice. Designers increasingly adopt these systems to generate images, texts, concepts, and prototypes, integrating them into everyday workflows. Yet, while technological capabilities evolve quickly, academic discourse on the topic remains fragmented. A designerly understanding of how genAI is actually appropriated within situated design processes is still emerging.

This dissertation investigates how designers engage with genAI within the design process, grounding the inquiry in practitioners' lived experiences. The research adopts a constructivist grounded theory and bottom-up approach: rather than testing predefined hypotheses, it builds theory iteratively from empirical material collected through in-depth interviews and reflective activities. Through constant comparison and theoretical coding, three interrelated dimensions of engagement emerged: the "what" (the tasks designers perform with genAI), the "how" (the patterns and configurations through which interaction unfolds), and the "so what" (the professional effects that arise from this engagement).

Across these dimensions, the research surfaces and systematises the more human-centred and often implicit aspects of designer-genAI interaction.

With regard to the "what", the study identifies shifts across levels of abstraction—criteria, ideas, concepts, and prototypes—showing how designers externalise intentions through inputs and internalise meaning through generated outputs (Figure 1). These movements are articulated through the Direction–Magnitude framework, which makes visible both the direction of interaction (toward greater abstraction or greater concreteness) and the magnitude of the cognitive leap occurring between input and output. This perspective highlights how genAI can compress intermediate cognitive shifts, introducing discontinuities that reshape the designer's reasoning process.

Concerning the "how", the dissertation introduces the Imagery Modes framework (Figure 2), distinguishing three recurring configurations—before, during, and after imagery—based on the degree of output imagery definition, intended as the clarity of the designer's mental representation of the expected output prior to the interaction, regardless of whether that output is textual, visual, or otherwise. These modes describe how designers position themselves in relation to genAI: from exploratory engagements in which control is partially released, to highly specified interactions aimed at retaining control over execution. Within a single sequence of exchanges, designers may shift fluidly between these modes, revealing the non-linear and reconfigurable nature of genAI-supported design activity. The research further analyses fluctuations between agency and sense of agency, demonstrating how these two dimensions continuously interrelate throughout the interaction.

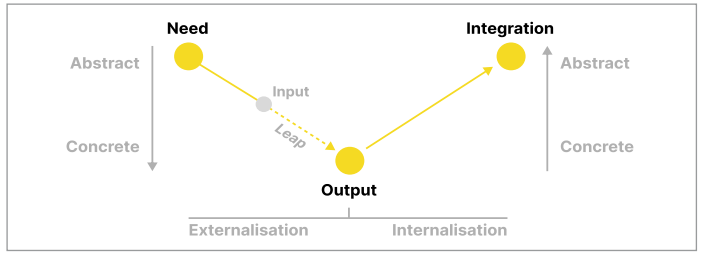

Fig. 1 - Externalisation and internalisation occurring in a designer-genAI interaction cycle

Regarding the "so what", the study examines the professional implications of designer-genAI engagement. It identifies capabilities that expand designers' reach—such as faster iteration and broader exploration—while also recognising the challenges that accompany them, including cognitive overload and difficulties in tracing intention across sequences. Rather than treating these as separate dimensions, the research conceptualises them as capabilities-with-challenges, emphasising that the affordances of genAI and the frictions it introduces are inseparable aspects of the same interaction dynamic. Affective responses—confidence, surprise, frustration, and uncertainty—are shown to be integral to this condition, shaping how designers interpret, navigate, and reposition themselves within the interaction.

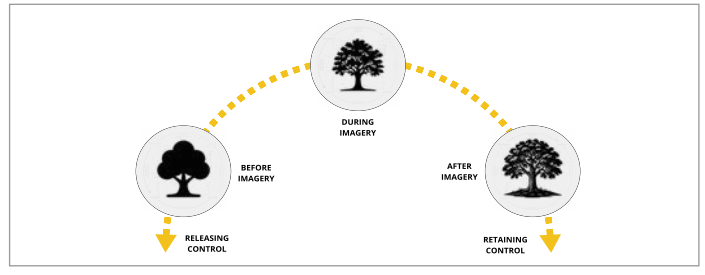

Fig. 2 - The designer-genAI imagery modes (IMs) framework presents the three recurring modes of before imagery, during imagery, and after imagery.

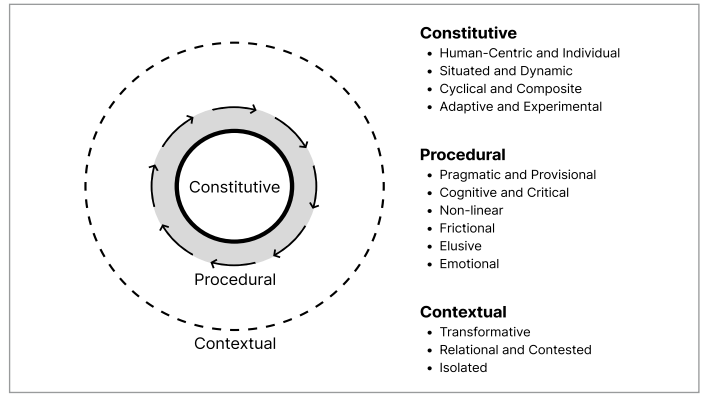

Fig. 3 - The Constitutive, Procedural, and Contextual properties of the designer-genAI interaction.

Building on these theoretical insights, the dissertation translates its findings into two capacity-building practices developed for educational and professional contexts. One practice engages design students in structured reflection through a game-based activity; the other supports professional designers in mapping and discussing their interaction experiences through an analytical canvas. These interventions demonstrate how guided reflection can foster more intentional and critically aware engagement with genAI, while also generating additional empirical insights that further refined the theoretical synthesis.

Taken together, the results provide a descriptive and process-oriented account of the designer–genAI interaction phenomenon. The findings are consolidated into a set of constitutive, procedural, and contextual properties (Figure 3), establishing a shared vocabulary for understanding this dynamic and evolving practice. In doing so, the dissertation complements prevailing notions of designing with genAI by articulating a processual understanding of designing through genAI—foregrounding how interaction reshapes cognition, positioning, and decision-making within the design process. By articulating intermediate-level knowledge—positioned between empirical observation and abstract theorisation—this dissertation advances design research and contributes to the broader discourse on human–AI interaction in creative contexts.

MEANINGFUL WARDROBE. TOOLS AND METHODS FOR ADVANCING SUSTAINABILITY IN THE SPORTSWEAR SECTOR

Lorenzo Goldaniga – Supervisor: Giovanni Maria Conti

This research is situated within the context of UN Sustainable Development Goal 12 (Ensure Sustainable Consumption and Production Patterns); this goal is intricately connected to the discourse of Design, particularly in its emphasis on rethinking consumption patterns. This research stems from the observation that, in contemporary societies, consumers are increasingly exposed to conflicting pressures: while the prevailing economic model relies on the continuous expansion of consumption, growing cultural awareness encourages more responsible and sustainability-oriented behaviours. Within this perspective, the study aligns with approaches that consider design as a discipline capable of connecting different fields of knowledge and facilitating responses to complex societal challenges.

The work begins by analysing how environmental sustainability is not only a material issue related to environmental impact but also a perceptual phenomenon shaped by how individuals interpret their actions and their relationship with the environment. The bibliographic research focused, among other aspects, on the dynamics of fashion consumption, with particular attention to the sportswear sector. The fashion system presents several structural paradoxes related to consumption patterns, symbolic value and product life cycles. Within sportswear these dynamics are further intensified by the technical and functional requirements associated with athletic performance. In this context sustainability rarely represents the primary driver of purchase and is sometimes perceived as potentially conflicting with performance expectations.

To investigate how this tension is addressed by sportswear companies, a field research phase was conducted through the selection and analysis of relevant case studies (see Fig. 1), aimed at understanding how companies reconcile sustainability with consumer expectations, transforming it into a conscious value proposition that strengthens their brand image.

The research was developed in collaboration with the partner company **Freddy S.p.A.**, which served as the operational context for the investigation. An exploratory phase of the study was conducted during an internship period at the company, during which a series of internal interviews were carried out with key departments and personnel in order to gain insight into the organisational structure, product development processes and strategic perspectives of the organisation.

Following the bibliographic review, the exploratory phase conducted within the partner company and the analysis of selected case studies, which together provided the foundation for the research, a methodology was developed and subsequently tested within the company.

The experimental activities were based on Wardrobe Studies, an approach that investigates everyday clothing use through the analysis of individuals' wardrobes. By shifting the focus from purchasing behaviour to everyday use, this perspective allows a deeper understanding of how garments acquire value over time and how consumption patterns are shaped by both functional and symbolic motivations. Based on this approach, the methodological framework combines quantitative and qualitative components. (see Fig. 2).

The first, quantitative phase provides insights into sportswear consumption patterns, while the qualitative phase explores the emotional and symbolic relationships that consumers develop with garments. In particular, interpretative tools such as archaeological stratigraphy and Interpretative Phenomenological Analysis enable the exploration of consumption as a layered and meaningful practice, revealing symbolic dimensions that often remain hidden in conventional consumer research. An adaptation of archaeological stratigraphy (Harris Matrix) was employed to investigate quantitative aspects of sportswear consumption, drawing on the analogy between the stratification of garments within the wardrobe and the layered complexity of the subsoil. Interpretative Phenomenological Analysis (Smith, Flowers and Larkin), rooted in phenomenological psychology and grounded in a hermeneutic tradition, follows an idiographic approach aimed at understanding how individuals make sense of their lived experiences.

The experimental activities were conducted in collaboration with the company through interviews, wardrobe analysis and qualitative investigations involving athletes selected by Freddy S.p.A. The insights collected through wardrobe analysis were brought back into the corporate context through a workshop involving the merchandising and marketing departments. This workshop served to develop a new product collection, and the same insights were also used to inform the communication of the collection, with the objective of preserving as much as possible the original meanings emerging from consumers' voices.

The findings also show how sustainability can be framed not as an additional attribute attached to products, but as a strategic element integrated within corporate Design processes. In this perspective, sustainability becomes part of an identity-based approach that connects product Design and company communication, linking the internal process of corporate identity construction with the external dimension of brand image, and ultimately strengthening the relationship between companies and consumers. The results highlight how the symbolic and emotional dimensions of garments can be strategically activated through design and communication processes, enabling sustainability to be framed not merely as a technical attribute but as a value capable of strengthening brand identity and fostering meaningful connections between companies and consumers. Through this process, the research contributes to the field of Design for sustainability by proposing a framework capable of connecting consumer behaviour, product Design and communication strategy. The Wardrobe Study tool developed within this research demonstrates how Design methodologies can support companies in integrating sustainability into product development while strengthening product storytelling and encouraging longer and more conscious relationships between users and garments. In this sense, sustainability emerges not as a compromise between performance and responsibility, but as a strategic asset capable of enhancing product value and reinforcing meaningful connections between companies, products and consumers.

This doctoral research was developed within the PhD programme in Design at the Politecnico di Milano. During the course of the programme, a visiting research period was undertaken at Aalto University, where part of the theoretical and methodological framework of the study was further developed.

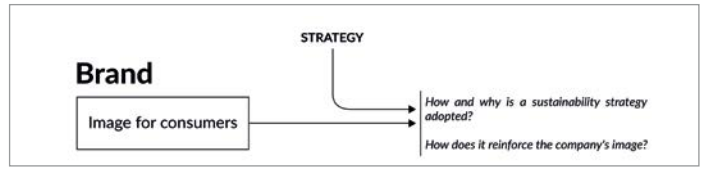

Fig. 1 - The case study analysis was guided by specific research questions aimed at identifying the relationship between brand image and sustainable products, with the objective of understanding why and how certain virtuous companies have successfully capitalized on sustainability as a strategic asset.

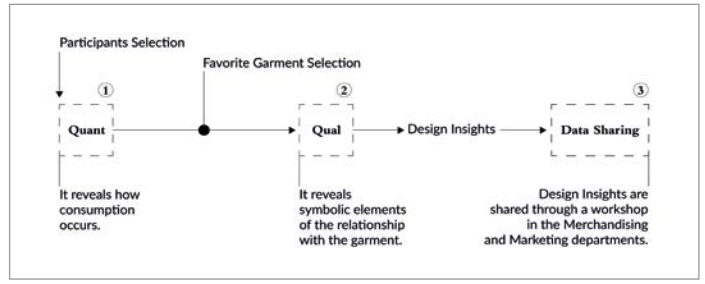

Fig. 2 - This diagram provides a synthetic overview of the main phases of the tool. It includes a quantitative phase aimed at collecting data on how garments are used over time, followed by a qualitative phase designed to explore the reasons behind users' attachment to specific garments. The final phase involves sharing these insights with company departments to inspire the development and communication of a new collection.

INTEGRATION OF LIGHTING AND CMF DESIGN IN BIM PROCESSES: TOOLS, METHODS, AND REAL-TIME VISUALIZATION

Gianluca Guarini – Supervisor: Maurizio Rossi

The thesis investigates how lighting design and Color, Material and Finish (CMF) design can be reliably integrated into Building Information Modeling (BIM) workflows, with a specific focus on real-time and VR-based visualization of architectural projects. The work addresses the fragmentation currently affecting digital design practices, where lighting, material data, and BIM models are often managed in separate, poorly interoperable environments, hindering collaboration and the photometric and perceptual reliability of design decisions.

The research adopts a mixed-methods and pragmatic approach, combining systematic literature review, qualitative interviews with professional lighting designers and software developers, and quantitative case studies conducted in both contemporary and heritage contexts. Design Science Research provides the overarching methodology, guiding the iterative development and evaluation of digital "artifacts" such as workflows, guidelines, and toolkits. Three main research questions structure the inquiry: how to integrate lighting design into BIM and VR, how to improve CMF workflows in BIM and real-time tools, and whether VR and game engines can serve as trustworthy interfaces for BIM-based lighting and CMF design.

The first part of the thesis clarifies the theoretical and regulatory framework of BIM, OpenBIM, and HBIM, and analyses current limitations, with a particular focus on the Italian and European context. It then examines the role of lighting design in the AEC sector, detailing key photometric quantities, the importance of spectral data and correlated color temperature, and the capabilities and constraints of existing lighting CAD software, both as standalone tools and as BIM-integrated plugins. Interviews show that many practitioners still work at BIM "level 2", rely on email and CDE platforms for coordination, and lack confidence in the accuracy and usability of current BIM-based lighting integrations.

Subsequently, the research explores CMF design within BIM, emphasizing how optical, chromatic, and material properties affect perception, comfort and performance in architectural spaces. The thesis discusses color management, device profiling, material acquisition via scanners and cameras, and the configuration of PBR materials and spectral workflows for both offline and real-time rendering. It highlights the scarcity of BIM-ready CMF data from manufacturers and the need for richer, standardized datasets that include spectral properties, reflectance values and colorimetric parameters suitable for digital simulation.

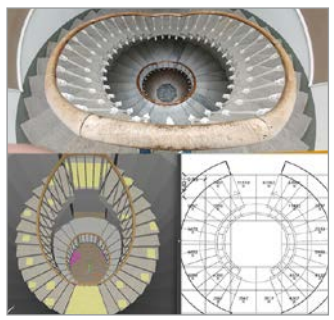

Fig. 1 – Verification of the accuracy of BIM-based lighting integrations

Fig. 2 – Virtual real-time digital simulation of a Classroom with different lighting setup, correct spectral properties and reflectance values

A further section is dedicated to real-time rendering and its integration with BIM. It describes export–import pipelines, scale and texture handling, lighting and camera setup, interactivity and scripting, as well as optimization strategies for "digital sustainability". The thesis evaluates how real-time engines can become bidirectional interfaces for BIM data, enabling immersive VR experiences that support decision-making while remaining performant across multiple devices.

Three major case studies ground the theoretical discussion in practice: the Villa Argentina complex in Mendrisio, a controlled classroom at the Laboratorio Luce of Politecnico di Milano, and the historic "Quarto Camerino" in Villa d'Este, Tivoli. These cases combine in situ measurements, spectral and material surveys, BIM modeling, lighting CAD simulations, and real-time visualization, allowing a critical comparison between real illuminance values, CAD outputs, BIM-based simulations, and game-engine renderings. The results show both the potential and the current discrepancies of digital workflows, particularly in the representation of spectral behaviour, material finishes, and the photometric correctness of VR scenes.

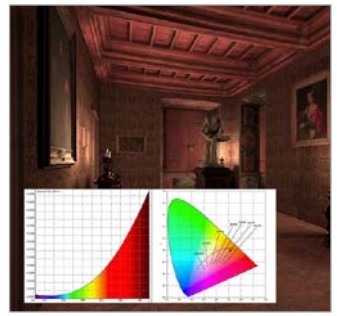

Fig. 3 – Virtual real-time digital simulation of a "Quarto Camerino" in Villa d'Este, with spectral properties of lights converted into RGB triplets

The thesis proposes a set of structured guidelines and toolkits. For lighting, it defines procedures for managing photometric and spectral data within BIM, selecting appropriate file formats, and coordinating between standalone CAD and BIM-integrated tools. For CMF, it outlines best practices for encoding colors, materials, and finishes in BIM objects, configuring PBR shaders, and converting spectral reflectance data into display-ready formats while preserving technical accuracy. For real-time visualization, it delivers workflows to connect BIM models with game engines, ensuring traceable data exchange, controllable visual quality, and performance suitable for interactive design review and client communication.

The original contribution of the research lies in framing lighting, CMF, BIM, and real-time rendering as a unified methodological ecosystem. The proposed toolkits serve as operational bridges between disciplines, enabling more reliable, transparent, and repeatable digital processes that balance quantitative performance metrics and perceptual quality. The study also formulates recommendations for software developers and standardization bodies, advocating for open, interoperable data formats (e.g., enriched IFC schemas for luminaires and materials), better support for spectral information, and embedded validation procedures that compare simulated and measured data.

Finally, the thesis identifies future directions for research and practice, including automation of acquisition and conversion workflows, AI-supported validation of simulations, scalable cross-platform distribution of real-time applications, and targeted training programs that expand designers' skills across BIM, lighting CAD, CMF, and game engines. By consolidating methodological, technical, and perceptual aspects into coherent guidelines, the work aims to support a more mature, interdisciplinary use of BIM-based processes for lighting and CMF design, ultimately improving the reliability and communicative power of digital architectural projects.

FEELING TOGETHER WITH THE CAR: TOWARDS THEORIZING CO-DRIVING PLEASURE FROM A TECHNOLOGICAL MEDIATION PERSPECTIVE

Peng Lu - Supervisors: Fausto Brevi, Venanzio Arquilla

Introduction & Research
Questions Rapid advancements in driving automation technologies are transforming vehicles from tools into active agents. These automated vehicles (AVs) can sense, act, and learn, turning driving into a collaborative "co-driving" practice. While driving pleasure is central to manual driving, research on co-driving pleasure remains scarce. Concerns that automation might diminish enjoyment could hinder technology adoption. Therefore, understanding "co-driving pleasure" within this new paradigm is essential. This research aims to enhance understanding of the co-driving pleasure of non-professional drivers in everyday driving scenarios, with implications for the design of better driving automation systems and for improving the overall co-driving experience. Specifically, three core research questions (RQs) are:
• RQ1: What constitutes co-driving pleasure for non-professional drivers in everyday driving scenarios, and what factors influence its emergence?
• RQ2: How does co-driving pleasure emerge for non-professional drivers, and what is the underlying mechanism that governs its formation in everyday driving scenarios?
• RQ3: What design considerations can be derived from the understanding of codriving pleasure to inform the development of driving automation systems aimed at enhancing the co-driving experience?

Methodology
To answer the first two RQs, this research employs Reflective Lifeworld Research, a phenomenological research approach, and the Trip Experience Sampling method to explore the co-driving phenomenon among non-professional drivers in everyday scenarios. Two interview rounds were conducted: the first provided primary data; the second triangulated and expanded the findings. This research also included a design practitioner talk session, involving nine automotive industry design practitioners, in response to RQ3, based on three design considerations derived from the synthesis of findings and results beforehand.

Findings & Results
Apart from some observations about the current co-driving practice, key results reveal five distinct types (meanings) of co-driving pleasure and five key factors influencing its emergence. Theoretically grounded in Technological Mediation Theory and Pleasure Theories in Design, this study introduces the Human-Vehicle Relation (HVR) conceptual tool—a framework with proposed concepts and tools, such as Technological Granularity (via service design touchpoints), the Dynamic HVR Composition Diagram, the Inscription/ Rendering Model, and Relation Mode to analyze the complex, mediated relationship between humans and increasingly agentic vehicles.
Co-driving pleasure is defined as the positive emotional experience of a human driver in a situated driving context, emerging from the satisfaction of psychological needs during co-driving activities. Crucially, it is conceptualized as an extension, not a replacement, of traditional driving pleasure.

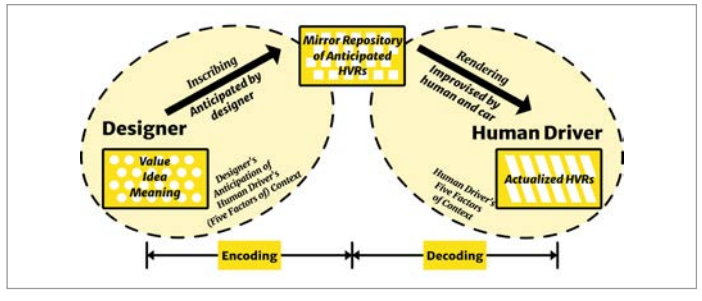

Fig. 1 – The Inscribing/Rendering Process of Human-Vehicle Relations

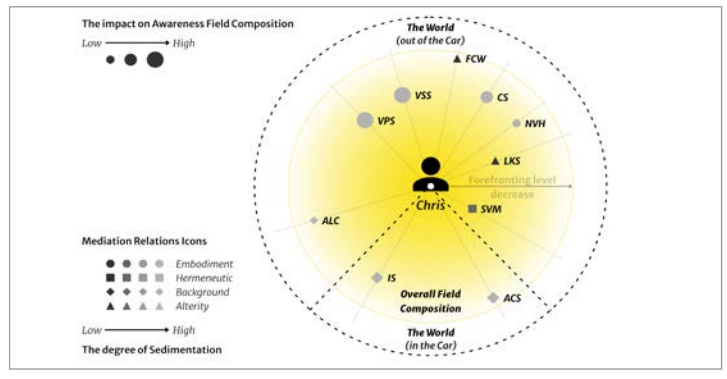

Fig. 2 – The dynamic HVR composition corresponds to a specific co-driving pleasure type.

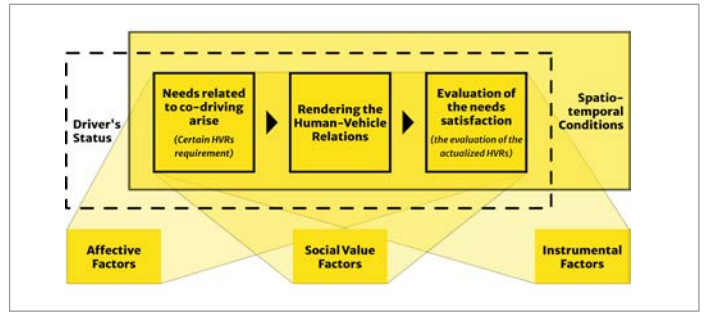

Fig. 3 - The co-driving pleasure model

The developed Co-Driving Pleasure Model elucidates the mechanism by which this pleasure arises: through the driver's positive evaluation of how the actualized HVR addresses their situated needs. These findings and theoretical insights were distilled into three core design considerations— namely, leveraging the five influencing factors, considering driver habits, and adopting HVR constructs. For RQ3, all three design considerations discussed were well recognized by the design practitioners. They unanimously acknowledged their importance in guiding UX design practices for automotive products. However, challenges remain in applying these considerations to real-world practices.

Conclusion
The primary contributions of this PhD thesis are threefold:
1. An analytical framework of the HVR conceptual tool to dissect complex human-vehicle interactions and mediation in the context of driving automation.
2. A systematic conceptualization and model of co-driving pleasure, encompassing its definition, identified sub-types, influencing factors, and the mechanism of its emergence.
3. A set of empirically derived design considerations for fostering co-driving pleasure, which were positively evaluated by nine front-line design practitioners.
These findings provide a theoretical foundation and practical guidance for Human-Computer Interaction (HCI) researchers and practitioners designing future co-driving experiences.

DESIGN IN CONTEST: UNDERSTANDING THE USE AND POTENTIAL OF DESIGN FOR POLICY ENTREPRENEURSHIP

Erin Claire McAuliffe - Supervisor: Stefano Maffei

Design for policy has for the last decade focused on the way that design has been used within governments as and for policy innovation. However, the field has failed to sufficiently engage with the role of design beyond the 'policy cycle', as outlined in theories of the policy process drawn from policy studies. This thesis examines the role that design plays in policy entrepreneurship—the work done by non-government actors to develop and promote policy innovations—and the potential for design in this highly contested, political space. Using a multi methods approach, the thesis draws its theoretical basis from both design and theories of the policy process, and investigates this emerging phenomenon of design for policy entrepreneurship empirically using multi mini case studies, and two critical case studies from the United Kingdom and Denmark. Finding that 'design for policy' as a policy innovation has not diffused in any systematic way beyond its initial typical sites of public sector innovation labs and into wider policy community, the thesis identifies through its analysis of 47 emerging cases five typologies of 'design for policy entrepreneurship': *supporting*, *shifted*, *spectacle*, *subversive*, and *standalone*. The *Supporting* typology sees design applied to develop products and services (largely digital) to support or enable the work of policy entrepreneurship. *Shifted upstream* sees design replicating the logics and practices of design for policy but upstream, and by a non-government actor. In *Spectacle*, design works to raise awareness of a policy issue and critiques the status quo. *Subversive* applies design to contest problem framing and subvert dominant frames to unsettle perceived consensus. Finally, *Standalone* sees design applied to develop products or services that themselves constitute policy entrepreneurship; the policy framing, solution and its implementation is embedded in the product or service, such as by developing products that change the mindsets and practices of public officers directly through their use.

Building from this empirical work, and connecting to existing policy entrepreneurship frameworks, the major contribution of the thesis is a framework suggesting how both designers and other actors within policy communities might use design to pursue policy innovation and policy change. The framework proposes firstly extending 'design for policy' beyond the boundaries of government and into this broader, more political and contested space within the policy process, and secondly identifying key contributions of design to the work of policy entrepreneurship taking place here. The framework is set out in **Figure 1**.

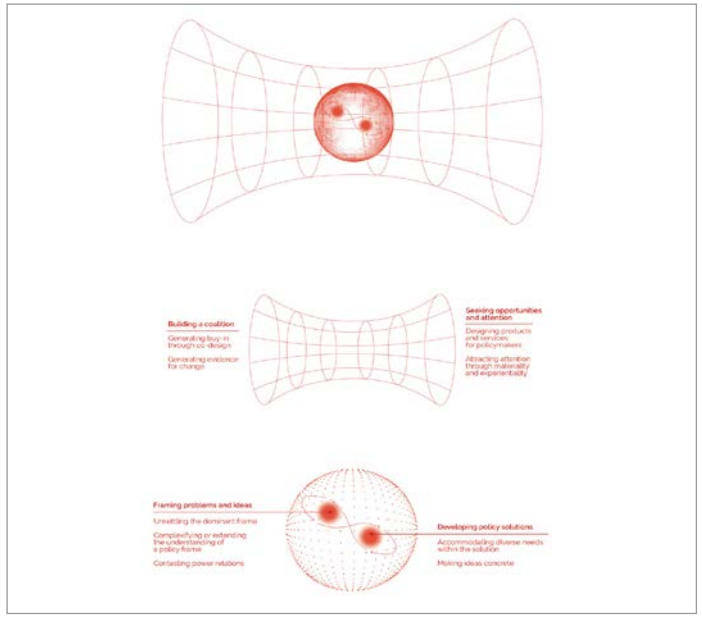

Fig. 1 - A framework for design for policy entrepreneurship

The nucleus of the framework's visualisation is the activities related to framing problems and ideas, and developing policy solutions. This represents the interplay and necessary co-evolution of problem frame and solution. Five relevant design moves to support these activities are suggested. The frame-solution coupling can be seen within a 'wormhole' with, to the left, the building of a coalition—the momentum driving the frame-solution coupling forward. On the right, it seeks opportunities and attention to be realised as policy change. This time, four specific design moves are suggested to support this transit from potential to possible change.

Challenging to represent in two dimensions, though, is the dynamic nature of this process. It is not mechanistic; there is no certainty, that the frame-solution pair will find an opportunity, or that if it does it will be able to capitalise on it. Other frame-solution pairs also compete—within the same policy issue, but also for scarce attention across policy issues. Its course is unpredictable. Any linear models of how change comes about are at best extreme simplifications of this messy, unpredictable unfolding. The framework offers direction to designers engaged in social design and design activism, providing guidance on how they might direct their practice towards and contribute to policy change as part of a policy community. For non-designers engaged in policy entrepreneurship, it offers insight into how design might strengthen their existing efforts, and complement 'traditional' policy entrepreneurship strategies with designerly ones.

Policy entrepreneurship, however, is increasingly recognised as a collective—not individual—endeavour; as such, the framework should be understood as identifying possibilities for design to make a unique contribution to the collective efforts of coalitions within policy communities, rather than policy entrepreneurship being achieved solely through design methods or by designers. Finally, the thesis argues for the adoption of a broader definition of the 'design for policy' field as encompassing both design for policy entrepreneurship and the existing government-centred focus.

*UN*LEARNING X FUTURING.

TOWARDS A POST-ANTHROPOCENTRIC CREATIVE MINDSET TO STAY WITH THE TROUBLE OF THE PRESENT AND DESIGN MORE-THAN-HUMAN FUTURES

Eva Monestier - Supervisor: Marita Canina

Planet Earth is witnessing an era of irreparable transformations, informally defined as the Anthropocene, the epoch whose undisputed protagonist is the ἄνθρωπος (ánthrōpos), the human being. In the Anthropocene, technological disruptions, eco-social emergencies and geopolitical turmoil are destabilizing Western, modern ways of being in the world.
In this unsettling scenario, the ecological crisis represents the overarching one. Extreme pollution and rising temperatures are causing irreversible ecosystem alterations primarily due to human pressures, which must now be considered the major destructive forces. Despite the numerous critiques that the term has collected in recent times, the Anthropocene demands a critical reexamination of humans' position within the *web of life* and the ways in which human systems and processes have reshaped life on the planet. Critically, adopting an imaginative and creative mindset becomes therefore essential to deconstruct the existing conventional norms of behavior and drive meaningful future-oriented action for human and planetary thriving. These norms of behavior are grounded in Eurocentric, anthropocentric, and humanistic premises that emphasize the binary separation of nature from culture by elevating humans as sole bearers of inherent value, thereby dictating the way we should live in relation to the natural world and deeply forging Western epistemologies.
Unsurprisingly, this theoretical framing of reality has permeated every discipline or practice, not least design, historically ingrained in euro-modern capitalistic logics. Design, indeed, has long been shaped by and in turn replicates the unsustainable *status quo* it operates within. Reconsidering current dominant human-centered approaches to design embracing a more-than-human perspective is now timely for ensuring planetary futures. Research in this direction is increasingly gaining momentum both in and outside academia.
Given its transformative power to stimulate collective reflections and imaginaries of preferable alternatives, design can and should be leveraged to craft visions of multispecies futures in which humans and more-than-humans not only coexist but also prosper in reciprocally sustaining relationships. In this endeavor, there is an urgent need for a radical *post-anthropocentric turn* in design practice and education. Designers must go through inner transformation processes to recognize human-nonhuman *interconnectedness* and *interdependence* and nurture a deeper *sense of care* for others and the surrounding more-than-human world. Since design is inherently a form of thinking that generates concrete action, it should be grounded in a critical and speculative kind of inquiry that could disrupt dominant anthropocentric development models and sustain planetary life. These considerations compel the creation of new design methodologies, frameworks, and alternative *designerly ways of thinking* to engage with the world more profoundly by adopting a relational perspective and sensitivity towards humans and more-than-humans.

Against this backdrop, a post-anthropocentric reframing of creativity becomes necessary to provide designers with new approaches and tools to envision futures in which humans coexist with the more-than-human world in a just and equitable way. Debates on how to extend creativity research to consider complex and hybrid creative processes with diverse actors are becoming central in design research and practice. Stemming from the need to clarify how *post-anthropocentric creativity* can be defined and what its implications might be, the thesis investigates existing literature merging posthuman theories with studies on creativity. It proposes a critical reading of what a *post-anthropocentric creativity* might mean for designers to respond to the impelling need for a radical paradigm shift necessary to facilitate the transformation of design itself from being the perpetuator of unsustainability to becoming a means for *futuring*.
The act of imagining and designing collective futures should now encompass the enlargement of our human-centered perspectives to embrace the plurality and openness of more-than-human life. Since our modern, Euro-centric underlying assumptions reflect our internal priorities and in turn influence how designers shape the external world, it is urgent to critically question the inherited worldviews, values, and beliefs that mold our designs.

Building upon this, the doctoral thesis argues that a **post-anthropocentric creative mindset** could infuse design *futuring* practices with an acquired sensibility towards the more-than-human world, thereby evolving them to practices that value and uphold the intricacies and interconnectedness of planetary life through the creation of alternative counter-narratives.
In fact, a post-anthropocentric shift in the creative mindset of designers would require them to account for all forms of life employing a *process of unlearning* the Cartesian dualistic categories and traditional binary worldviews to narrativize and/or materialize new ways of relating with the more-than-human world, eventually envisioning radically alternative futures. Through the nourishment of a caring and post-anthropocentric creative mindset, the act of designing has the potential to turn from a practice of *defuturing* to a practice of *multispecies worlding*.

New educational experiences might be key in providing young designers with the opportunity to *unlearn* entrenched paradigms and develop such a creative, critical and post-anthropocentric mindset. These new educational experiences might also be crucial in encouraging design students to leverage design as a means to restore our lost connection with the planet and its nonhuman inhabitants. Following a *'research through design'* approach, the doctoral project encompassed a range of methods and activities involving professors, lecturers, researchers, and experts in more-than-human design, posthuman design, multispecies design, pluriversal design, and design futures from various parts of the world. Participants were engaged through semi-structured interviews, informal conversations, a focus group, and a co-design workshop. In addition, the research led to the development of two design experiments – an affective *walkshop* and an interactive installation - involving both expert and non-expert audiences.

The thesis introduces the ***Un*learning x Futuring (UxF) Compass** developed to orient design educators in creating (un)learning experiences to challenge assumptions and imagine alternative multispecies futures, leveraging posthuman theories and embracing a more-than-human design approach.
The metaphorical denomination of *compass* highlights the tool's neither normative nor prescriptive nature, which is intended as a supportive *apparatus* for educators to conduct students through a process of inner transformation, helping them develop a post-anthropocentric creative mindset that fosters worldviews of care for the more-than-human world.
The UxF Compass unfolds along three interconnected and interdependent dimensions - called the *thinking-feeling-doing continuum* - and its associated acts of *noticing (thinking), sensing (feeling)* and *anticipating (doing)* more-than-human relations. These intertwined and co-constitutive acts outline a form of post-anthropocentric creative action pivoting around the notion of *care* and open up spaces for designers to (i) problematize anthropocentric presents and Euro-modern, capitalistic norms behavior, (ii) develop an affective understanding of human-nonhuman interconnectedness, and (iii) create alternative counter-narratives to inspire visions of more-than-human futures. Furthermore, the compass includes a set of *Tips for Educators* along with a collection of *Practices* that emerged from interactions with experts during the research activities and that were included in the compass to offer practical suggestions for educators seeking to create (un) learning experiences.

TOWARDS SMART AND CIRCULAR WATERBORNE PASSENGER MOBILITY ECOSYSTEMS: A SYSTEMIC AND STRATEGIC APPROACH

Laura Pirrone - Supervisor: Andrea Ratti

The transition toward sustainable urban mobility and the reduction of transport-related emissions are critical challenges for cities worldwide. Waterways represent a promising alternative, offering the potential to alleviate congestion, reduce air and noise pollution, and enhance urban quality of life. Waterborne Passenger Mobility (WPM) services, integrating vessels such as ferries and waterbuses into broader urban transport networks, provide flexible and resource-efficient mobility solutions.

Despite their advantages, WPM systems still face challenges concerning emissions, resource use, and waste management. Although the sector is progressively transitioning toward sustainability, partly driven by EU targets, knowledge remains limited and fragmented, lacking the holistic perspective necessary to support long-term and systemic transformation. Existing research predominantly adopts a vertical, product-centred approach, focusing mainly on vessels or propulsion technologies, often overlooking the broader systemic and relational dynamics that underpin sustainable WPM ecosystems. Digitalization emerges as a crucial enabler for advancing sustainable WPM, supporting circular strategies, real-time monitoring, operational optimization, and data-driven decision-making. The Smart Circular Economy paradigm emphasizes leveraging technologies to implement circular strategies and foster sustainability.

This doctoral research explores how to design smart circular WPM ecosystems through a systemic and strategic approach, culminating in the definition of Smart Circular Strategic Directions as actionable guidelines for practitioners and a conceptual framework for academics. The overarching aim is to support the sustainable and digital transition of the sector. Situated at the intersection of sustainability, mobility systems, and the smart circular economy, the research bridges design, management, transportation engineering, and maritime studies.

The study follows a qualitative methodology grounded in a research-though-design approach, where systemic design fosters a designerly way of knowing. It is structured around three sequential research questions (RQs), each addressing a specific gap and building iteratively on the previous stage. RQ1 explores how the WPM ecosystem is structured. By integrating a literature review and case study analysis, a systemic perspective on the sector was adopted. Through system mapping techniques, the ecosystem, its actors, their interactions, and the lifecycle phases were framed.

RQ2 examines how digital technologies can enable circular strategies. A Smart Circular WPM Ecosystem framework was developed by integrating circular economy principles with digital enablers, and applied to ten international case studies. Data were collected through desk research, semi-structured interviews, and field observations. Empirical practices found in the cases were reorganized along the service lifecycle and synthesized into a framework of 21 Smart Circular Strategies, supported by SWOT analysis and maturity mapping.

RQ3 investigates which design strategies and guidelines can support ecosystem transition. A scenario-based approach was employed to integrate practices into three Strategic Directions. System mapping, visualization, and foresight tools supported the analysis and the definition of the Strategic Directions, while expert validation sessions with both academics and practitioners ensured robustness, critical reflection, and sectoral relevance of the results.

The thesis offers several key contributions. First, it advances knowledge by conceptualizing WPM as an ecosystem, shifting from a product-oriented perspective to a systemic one that includes actors, infrastructures, digital assets, and lifecycle processes. Second, it develops a framework of smart circular strategies that synthesizes emerging practices in the sector, systematically mapped along the service lifecycle.

Third, it defines influencing factors (enablers, challenges, and barriers) for a smart circular transition of the WPM sector.

Fourth, as comprehensive outcome, it proposes three Strategic Directions that function as guidelines to support practitioners and policymakers in transitioning toward smart, circular, and sustainable WPM systems. Each Strategic Direction was described in terms of its purpose and objectives, embedded smart circular features, and expected sustainable benefits, as well as its value proposition, key resources and activities, primary roles and responsibilities, and the visual configuration of the supporting ecosystem.

The originality of the study lies in its systemic and strategic approach to WPM, which, for the first time, addresses actor relationships and ecosystem dynamics (systemic), while targeting long-term, comprehensive, and innovative actions (strategic). By integrating digital enablers with circular economy principles, it advances a multi-level framework that spans from individual strategies to a comprehensive, future-oriented roadmap, where all three Strategic Directions are integrated and mutually reinforcing.

From a practical perspective, the research provides policymakers, planners, and operators with clear tools to identify roles, foster collaboration, and manage transitions, while also anticipating barriers related to technology, regulation, and organizational change.

Theoretically, it contributes novel methods for ecosystem mapping and systemic design, introduces a lifecycle tailored to WPM services, and positions the findings within broader debates on digital and sustainable mobility systems.

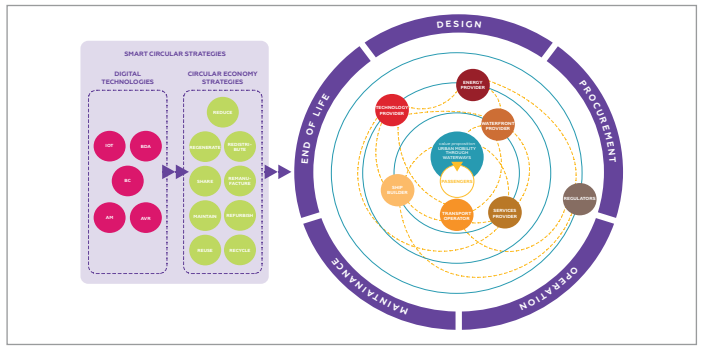

Fig. 1 - Research framework: Smart Circular WPM Ecosystem framework

INTEGRATING CIRCULAR DESIGN INNOVATION IN THE NEW PRODUCT DEVELOPMENT PROCESS: A CUSTOMISABLE FRAMEWORK AND DIGITAL TOOLSET FOR HOME APPLIANCE COMPANIES

Benedetta Rotondo - Supervisor: Venanzio Arquilla

Growing environmental pressures, resource depletion, climate change, and an increasingly stringent European regulatory framework are accelerating the transition of manufacturing industries towards more sustainable and circular models of production and consumption. Within this landscape, the household appliance sector represents a particularly critical domain for systemic intervention. It is characterised by intensive material extraction, high energy consumption during both production and use phases, complex global supply chains, and relatively short product life cycles. Recent European initiatives, including the Circular Economy Action Plan and the Ecodesign for Sustainable Products Regulation (ESPR), require companies to rethink not only product performance but also durability, repairability, recyclability, and material traceability. These regulatory shifts demand a strategic integration of circularity within innovation processes and corporate decision-making systems.

In this transition, design assumes a pivotal role. A large share of a product's environmental impact is determined in the early stages of the New Product Development (NPD) process, when decisions on materials, architecture, sourcing, user interaction, and end-of-life scenarios are made. Integrating circular design principles at these stages is therefore essential to avoid lock-in effects and costly redesigns. However, despite growing academic and professional attention, knowledge, methods, and tools remain fragmented and insufficiently embedded in established industrial processes. Companies often struggle to translate circular economy principles into operational practices aligned with organisational structures, time constraints, performance metrics, and risk management logics.

This doctoral research investigates how home appliance companies—specifically small domestic appliance brands within the De'Longhi Group—are integrating circular practices into their product development processes, and how a structured, customisable framework can support this transition from the early stages of innovation. The study is guided by two main questions: how companies are currently approaching circular product development, including barriers and opportunities; and how an adaptable framework can facilitate the effective integration of circular design principles within early-stage NPD while remaining compatible with industrial governance models. Adopting a multi-method qualitative approach, the research combines a systematic literature review, empirical investigation, and industrial validation. The literature review, conducted according to the PRISMA protocol, analyses how circular economy strategies are integrated into product development, with particular focus on early innovation phases. Although numerous circular design tools have been proposed, the findings reveal limited systematisation, contextual adaptability, and alignment with consolidated industrial innovation models, hindering practical adoption and cross-functional coordination.

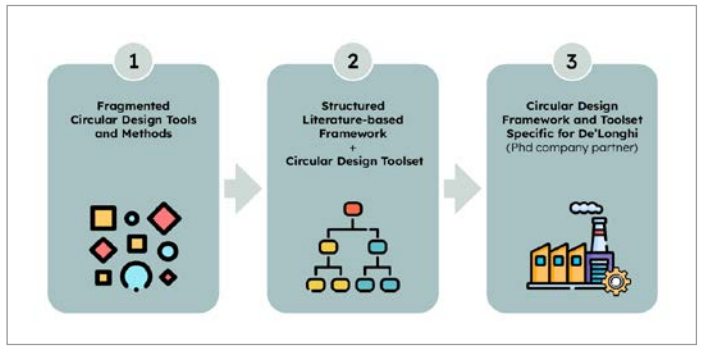

Fig. 1

The empirical phase involved 56 semi-structured interviews within the De'Longhi Group, engaging managers, designers, engineers, sustainability specialists, and other cross-functional actors across brands and organisational levels. The research was complemented by observation of NPD activities and co-design workshops aimed at exploring feasible circular scenarios.

The findings highlight multiple interrelated barriers—cultural, organisational, economic, technical, and regulatory—that limit the systemic integration of circular practices. These include competing priorities among cost, time-to-market, and sustainability, limited internal competencies, supply chain constraints, and uncertainty about evolving regulations. At the same time, opportunities emerge in strengthened cross-functional collaboration, increased managerial commitment, regulatory alignment as a driver of innovation, and the strategic repositioning of design as a mediator between sustainability objectives and business goals. Building on these insights, the thesis develops a customisable framework to guide companies in embedding circular design principles into early-stage NPD. The framework organises and maps 77 circular design tools identified through the literature review, classifying them according to objectives, NPD phases, team involvement, required effort, outputs, and regulatory relevance. The classification is aligned with established product development models, such as Stage-Gate and Double Diamond, ensuring compatibility with existing governance structures and decision-making milestones.

To enhance usability, the research introduces the Circular Design Toolset, a digital repository implemented on the Notion platform. The toolset translates the framework into a practical decision-support environment, enabling teams to filter and select tools based on project needs, strategic priorities, and regulatory constraints. Beyond its functional dimension, it acts as a shared knowledge infrastructure that supports organisational learning, improves transparency in decision-making, and fosters a common language around circularity across departments. The framework was validated with external manufacturing companies and further customised for the De'Longhi Group through structured engagement with senior managers. This iterative refinement process confirms its adaptability, practical relevance, and scalability beyond the initial case study.

Overall, the thesis advances both theory and practice in the field of sustainable and circular design. It shows how circular economy principles can be effectively embedded in early-stage product development through a coherent and adaptable framework that connects academic insights with industrial application. By aligning circular strategies with existing innovation structures, the research strengthens organisations' capacity to integrate sustainability into decision-making and highlights design as a key driver of systemic change.

SYSTEMIC SERVICE DESIGN FOR PATIENT EMPOWERMENT IN CHRONIC CARE: A RESOURCE INTEGRATION PERSPECTIVE

Sultan Serpil Erdonmez - Supervisor: Daniela Sangiorgi

1. INTRODUCTION

Chronic illness affects 74% of all deaths worldwide (WHO, 2024) and is projected to cost $47 trillion globally by 2030 (Hacker, 2024). Beyond its physical aspect, chronic illness disrupts patients' sense of identity, reshapes their social relationships, and demands a continuous process of adaptation and resilience (Charmaz, 1983; Bury, 1982). Patients must navigate a complex, fragmented healthcare ecosystem while reconstructing self-identity and integrating diverse resources (e.g. medical, social, and personal) to sustain their long-term well-being (Van Bulck et al., 2019; Levine, 2008).

To understand this complexity, this thesis focuses on two interrelated aspects. First, it examines the personal dimension, since chronic illness is an individual, lifelong journey that reshapes identity, daily routines, and relationships. Second, it addresses the healthcare system perspective, exploring how systemic structures enable or constrain patients' capacity to access and use resources. Together, these two perspectives frame the role of systemic service design in empowering patients throughout their chronic care journey, with a focus on resources, resource integration activities through meaning-making processes.

Resources and Resource Integration Activities

From a Service-Dominant Logic (SDL) perspective, resources are defined as either operant (capable of acting on other resources) or operand (requiring action to become valuable) (Archpru Akaka et al., 2012). Accordingly, resource integration activities represent the dynamic human actions through which patients and providers co-create health experiences (Joiner & Lusch, 2016). Patients are positioned as primary resource integrators, combining personal capabilities with those of family, peers, and healthcare professionals (Palumbo et al., 2017). Yet chronic illness introduces internal complexities; such as identity crisis, psychological distress, and social disruption that hinder a patient's ability to identify, access, and integrate necessary resources (Shippee et al., 2012; Bury, 1982). Patients could engage in three interrelated meaning-making processes to integrate resources, navigate their circumstances, and build resilience within a rigid and fragmented care system, because:

Sense-making involves interpreting the illness experience, by understanding what is happening, why, and what it means for one's life and identity (Kleinman, 1988; Park, 2013).

Benefit-finding refers to identifying positive outcomes, personal growth, or new strengths that emerge from the illness experience, helping patients reframe adversity (Tennen & Affleck, 2002).

Benefit-reminding involves recalling those insights during future difficulties by drawing on past resilience to maintain motivation and momentum throughout the chronic care journey (Tennen & Affleck, 2002).

The Concept of Empowerment

Patient empowerment could be defined as a bridge between the resource integration and the chronic healthcare ecosystem since it has been identified as a dynamic, iterative process unfolding across personal, relational, and collective dimensions (VeneKlasen & Miller, 2007; Rowlands, 1995; Gibson, 1991). Understanding the empowerment process requires examining the power dynamics within the system. Three types of power have been identified in the literature:

Personal Power, aligned with "power within," stems from self-confidence, self-awareness, and inner strength, enabling individuals to recognise their own resources, make informed decisions, and take control of their circumstances (Rowlands, 1995).

Relational Power, connected to "power to," shapes how individuals interact and negotiate influence , and once personal power is established, enables more effective communication and coordination with ecosystem actors (VeneKlasen & Miller, 2007).

Collective Power, rooted in "power with," emerges when individuals unite around shared goals, pooling resources and supporting one another to drive meaningful change (Rappaport, 1987; Rowlands, 1995), such as advocating for better healthcare policies or building peer support networks

This PhD proposes a novel interpretation of the empowerment process for individuals living with chronic conditions, examining how resources can be integrated through systemic service design; proposed as an integrated, emotionally grounded framework that zooms in on individual embodied lived experience and zooms out to address the relational and collective dimensions of the chronic healthcare ecosystem.

2. RESEARCH CONTEXT

The study focuses on autoimmune arthritis, chosen for its diagnostic complexity, psychological burden, and long-term management demands (Lin et al., 2020; Benkel et al., 2020). Field research was conducted in the United Kingdom, in partnership with the PDR Research Centre at Cardiff Metropolitan University.

3. DISCUSSION

"How can a systemic service design approach improve patient empowerment processes addressing patients' resource integration activities with a chronic healthcare ecosystem perspective?"

Systemic service design is understood as an integrated approach that emphasises long-term systemic connectedness (Jones, 2014; Koskela-Huotari et al., 2021). Within the chronic healthcare ecosystem, patient empowerment is not a fixed destination but an ongoing, dynamic process, one in which patients continuously activate, integrate, and exchange resources across personal, relational, and collective dimensions to manage their condition and sustain wellbeing.

The research reveals that empowerment begins with personal power and progressively connects to relational and then collective power through a circular, dynamic, and iterative process. Accordingly, the role of systemic service design has been identified across three interconnected dimensions:

Systemic Service Design for Personal Power - Individual: Embodied Emotional Lived Experience

Patients must first develop personal power by recognising inner resources such as motivation, body awareness, and self-efficacy before engaging meaningfully with others. This awareness is activated through sense-making, benefit-finding, and benefit-reminding: patients interpret their illness experience, identify personal growth within adversity, and draw on past resilience to face future challenges. Systemic service design seeks to understand patients' embodied emotional realities through the inclusion of personal narratives, giving voice to the lived complexity of chronic illness.

Relational Power - Relational Dynamics: Co-Constructed Care Relationships

Relational power grows when inner confidence is carried into care relationships, a feeling genuinely heard by a provider, negotiating treatment decisions, and building trust across formal and informal networks. Systemic service design explores the interactions between patients, caregivers, and professionals, supporting trust, empathy, and shared understanding as foundations for meaningful co-creation.

Systemic Service Design for Collective Power - Collective Structures: Collective Sense-Making and Reflection

Collective power emerges when relational experiences extend outward, patients connect with peers, share narratives, and collectively reshape care practices and institutional norms. Systemic service design engages with institutional norms and social systems, encouraging the collaborative redesign of care environments that promote agency, inclusivity, and long-term change. Systemic service design operates across all three dimensions by zooming in on embodied personal realities through narrative-based and reflective design approaches, and zooming out to address relational dynamics and collective structures through participatory and ecosystem-level interventions. This research does not impose solutions but creates conditions where the right resources can be recognised, activated, and integrated at the moments that matter most throughout the patient's evolving journey.

SERVICE DESIGN TO PROMOTE A SYSTEMIC AND DYNAMIC PERSPECTIVE OF WELL-BEING IN DEMENTIA CARE

Xiaolin Shen - Supervisor: Daniela Sangiorgi

In recent decades, design's role in supporting well-being has expanded beyond individual interventions to embrace systemic approaches. Service Design and Social Innovation now emphasize relational contexts, social networks, and environmental conditions as essential elements for fostering collective flourishing. Similarly, dementia care studies have evolved from focusing solely on individual outcomes to examining dyadic relationships, care networks, and community-level inclusivity. While both design and dementia care recognize systemic complexity, they often overlook how dynamic interactions among actors, and their connection to broader social, cultural, and institutional structures shape well-being. Current frameworks remain static, favoring subjective well-being metrics over the fluid, reciprocal relationships that sustain or undermine care ecosystems.

My research aims to explore how Service Design can adopt a systemic and dynamic perspective of well-being in dementia care, within the specific context of Dementia Friendly Community. It is positioned at the intersection of four key areas: dementia care, design, service, and well-being, and especially incorporates ideas from transformative service research. Figure 1 shows my research positioning map. To explore, three sub research questions were created: RQ1: What is the understanding of well-being from a systemic perspective in dementia care and its interrelations with existing care models and interventions? RQ2: How is the systemic perspective of well-being currently approached in dementia care, specifically in Dementia Friendly Communities? RQ3: How can Service Design introduce and foster a systemic perspective of well-being for dementia care?

This research employs a programmatic approach based on immersive, practice-based experimentation. After conducting a critical literature review and expert interviews (n=14), the researcher was embedded for approximately one year within a Dementia Friendly Community in Scotland. During this time, the researcher conducted auto-ethnographic research and three iterative design experiment clusters: (1) Emergent co-creation of meaningful activities to develop initiatives that amplify reciprocity and agency across care networks; (2) Participatory relational mapping and aligning, which traced interactions among people living with dementia, care partners, and community actors to identify assets and leverage points for re-imagining care; and (3) Embedded, small-scale experimentations to explore how situated design and minor procedural changes can create temporary spaces for negotiation and power rebalancing.

Building upon this embedded methodology, the research yielded three key findings that reframe how systemic well-being is understood, experienced, and facilitated within dementia care ecosystems.

First, this research developed a multi-layered understanding of systemic well-being in Dementia Care. Using the Transformative Service Research Entities and Outcomes framework to conduct an abductive analysis of 14 expert interviews, the research found that systemic well-being in dementia care is not just a static endpoint. Rather, it emerges from the continuous interplay of three layers: (1) The Foundational Core of individual experience, (2) The Relational Fabric of social connection, and (3) The Structural Architecture of culture and power.

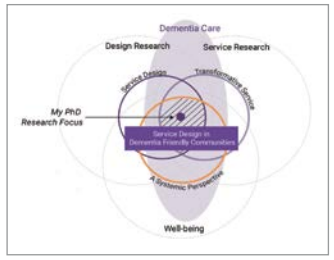

Fig. 1 - Research Positioning (sourche: the author)

Second, the research demonstrates the necessity of shifting Service Design from solution-creation to embedded facilitation. The three design experiment clusters revealed that to effectively transform dementia care systems, design should move from imposing external, finalized solutions. Instead, design operates as an embedded facilitator of change, working within a community over a prolonged period to build trust and relational capital. This agentic approach proves that service design can strengthen the collective capacity of the community, cultivating the conditions necessary for change and well-being to emerge organically from within the system itself.

This research also establishes a new operational paradigm for Transformative Service Design. Synthesizing the theoretical and practical insights, the research findings argue that Transformative Service Design should reposition well-being as both the precondition and the engine of the design process. Rather than simply aiming to design positive or happy user experiences, the findings suggest that proactively understanding, protecting, and cultivating the conditions for individual and collective flourishing is, in itself, the primary mechanism for driving systemic change.

Therefore, the contribution of this study is to illuminate the systemic and relational dynamics that shape well-being in dementia care, moving beyond individual subjective well-being to examine the collective and contextual factors that influence care experiences.

This research also challenges dominant deficit paradigms by demonstrating how well-being emerges through cross-systemic resonance. Practical implications advocate for dementia-inclusive co-design methodologies, asset-based community development, and polycentric governance models that institutionalize lived expertise. Table 1 shows a summary of my research gaps, questions, methodology and contributions.

RESEARCH GAPS	RESEARCH QUESTIONS	METHODOLOGY	RESEARCH CONTRIBUTIONS
RG1: Limited understanding of systemic well-being and of the dynamic interrelations between different levels of the care ecosystem (e.g., individual, family, community).	RQ1: What is the understanding of well-being from a systemic perspective in dementia care and its interrelations with existing care models and interventions?	Expert interviews (n=14) and Auto-ethnographic research in DFC Scotland	Understanding Systemic Well-being in Dement ia Care
RG2: There are limited studies investigating how systemic well-being is implemented, sustained, and experienced within real-world dementia care	RQ2: How is the systemic perspective of well-being currently approached in Dementia care, specifically in the Dementia Friendly Community (DFC)?	Auto-ethnographic research in DFC Scotland	Reconceptualizing Well-being's Role in Transformative Service Research: A Reciprocal and Cyclic Relationship
RG3: There has not been a study investigating how a service design approach can help transform existing systems to better implement systemic well-being in dementia care.	RQ3: How can service design introduce and foster a systemic perspective of well-being for Dementia Care?	Three design experiment clusters and reflection groups	An Embedded, Systemic & Agentic Service Design Approach in Dementia Design; Repositioning Well-being in Transformative Service Design

Tab. 1 - My research gaps, questions, methodology and contributions (source: the author)

USER ACCEPTANCE IMPLICATIONS FOR HUMAN-MACHINE INTERFACES IN SHARED AUTONOMOUS VEHICLES: STUDY OF HMI FOR AUTOMATED SHUTTLE BUSES THROUGH VR PROTOTYPING AND EVALUATION

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The advent of shared autonomous vehicles (SAVs) promises to revolutionize public transportation by moving beyond fixed schedules towards flexible, on-demand systems. However, the successful integration of this technology hinges less on technical prowess and more on a critical human factor: user acceptance. This doctoral research addresses this challenge by focusing on the Human-Machine Interface (HMI)—the essential communication bridge between users and SAVs. The primary objective is to explore how effective communication through HMI design can foster greater user acceptance of autonomous driving technology. The research begins by building a comprehensive theoretical framework, reviewing the state-of-the-art in HMI design for SAVs and distinguishing between interior HMIs for in-cabin interaction and exterior HMIs for communication with pedestrians. Through analysis of existing Automated Shuttle Bus concepts, the study establishes the current design landscape. Concurrently, it delves into literature on user acceptance, defining the concept, identifying key influencing factors, and summarizing prominent technology acceptance models.

This dual review establishes the critical link between user acceptance and HMI design. Building on this foundation, the study identifies core challenges. Examination of existing HMI design processes reveals a lack of systematic approaches tailored to SAVs' unique demands—the first research gap. A second gap is the absence of standardized procedures for measuring user acceptance specifically for SAV HMIs. The potential of Virtual Reality (VR) as a tool for experience prototyping is also explored. These findings are synthesized into following research questions addressing how HMI factors can increase user acceptance and what procedures are suitable for assessing it.

RQ1: How can different factors of HMI be used to increase user acceptance in SAVs?

SRQ 1.1: What factors influence user acceptance of SAV's HMI, and how can the definition of those factors be achieved?

SRQ 1.2: What might be the suitable design methods and processes for developing HMI in SAVs to improve user acceptance?

RQ2: What practical procedure is suitable for assessing the user acceptance of HMI in SAVs?

SRQ 2.1: How can the measurement of user acceptance of SAV's HMI be accomplished?

SRQ 2.2: What might be the suitable test methods and processes for HMI design solutions in SAVs to assess user acceptance?

To answer these questions, this research adopts a "Research through Design" methodology, which is well-suited to its iterative nature and integrates theory and practice. The thesis is structured around four core research phases

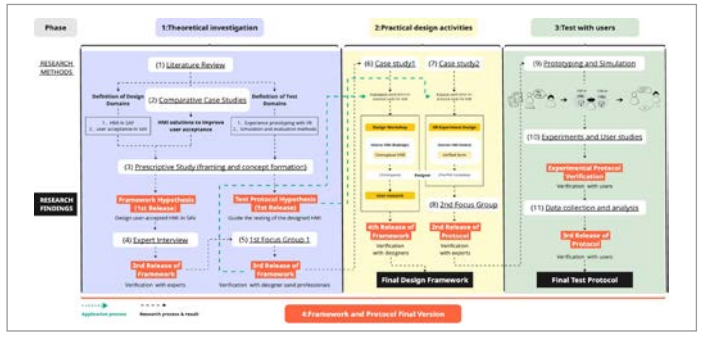

Fig. 1 - Overview of the research process, methods, and findings across four phases.

(Fig. 1) as below.

The first key output is a design framework (Fig. 2) guiding practitioners in creating HMIs for SAVs, focusing on factors influencing user acceptance during early design period. The framework was refined through expert interviews, a focus group with researchers, and design workshops, transforming the initial concept into a robust tool.

The second major contribution is a standardized test protocol (Fig. 3) empirically assessing acceptability of HMI solutions in SAVs. Developed through literature review, expert feedback, and validation via VR simulations testing exterior HMIs, it defines core acceptance dimensions including usefulness, efficiency, effectiveness, satisfaction, learnability and accessibility.

Together, these two outputs provide an integrated toolkit for designing and evaluating HMI solutions in SAVs. Their complementary nature addresses the full research problem—from how to design for acceptance to how to measure it. By reflecting on both outputs' strengths and limitations across contexts, this research offers actionable insights for practitioners and establishes a foundation for future investigations into emerging HMI technologies and cross-cultural adaptations in autonomous transportation.

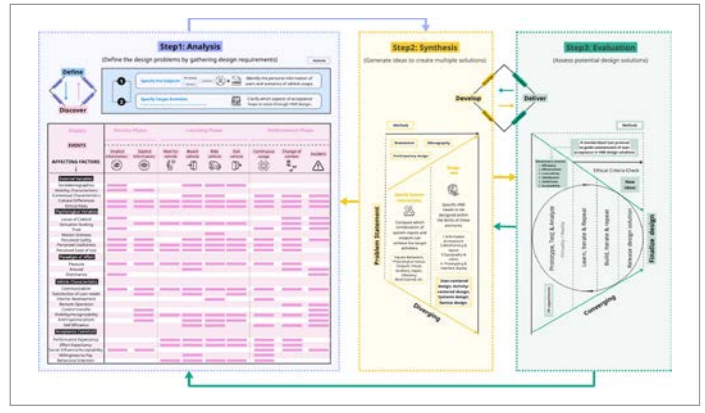

Fig. 2- Final version of the design framework: illustrating key steps, methods, and interactions across the design process.

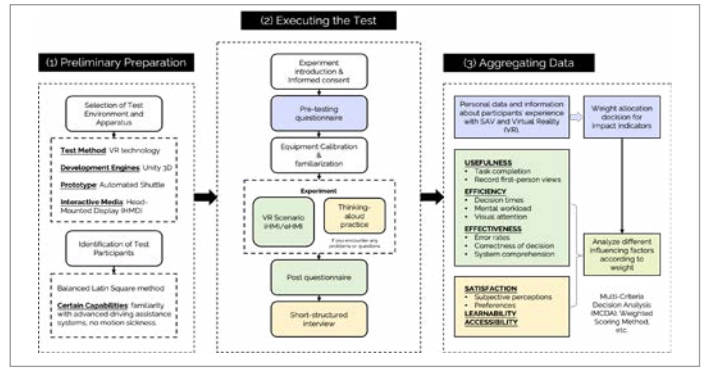

Fig. 3- Final version of the test protocol: illustrating key phases, steps, methods, and data indicators across the test process.