

Design for Multiplicity: Diving into the transdisciplinary nature of design processes

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The concept of "designing for multiplicity" has emerged as a transformative approach that challenges the conventional one-size-fits-all solutions and emphasizes the need for adaptable, flexible, and context-specific design strategies. This concept recognizes the heterogeneity of human experiences, environments, and cultures, advocating for a shift toward more inclusive and equitable design practices (Kocsis et al. 2023). The 2023 Design Factory Global Network Research conference has highlighted the significance of co-created collective pursuits in promoting change through shifts in transdisciplinary learning, research, and practice (Mobjörk 2010).

DFGN.R 2023, a two-day event hosted at the METU Design Factory in Ankara, Turkey, was the second research conference organized by the Design Factory Global Network (www.dfgn.org), a community of 37 innovation hubs in 25 countries on a mission to create change in the world of learning and research through passion-based culture and design-driven problem-solving. The conference offered an opportunity for like-minded educators, designers, and researchers to share insights and inspire others on education methods, practices, and ecosystems of co-creation and innovation around the idea of "Designing for Multiplicity".

The value of exploring novel approaches to address contemporary challenges emphasizes the critical concept of 'multiplicity' in breathing new life and meaning into design and related disciplines. The discourse around design and innovation has faced crucial issues such as inclusivity, diversity, sustainability, equity, and social justice, with the common thread being the overarching concept of 'multiplicity' demonstrated by interdisciplinary research and transdisciplinary practices.

The contributions in this issue represent a broad cross-section encompassing various fields such as phenomenology, social theory, psychology, philosophy, artificial intelligence, and art, resonating with the principles of 21st Century learning and the United Nations' Sustainable Development Goals, supporting the changing expectations of academics in producing alternative research outcomes in collaborative, practice-based research (Fam et al. 2020). These contributions offer valuable insights into how designers and innovators navigate the ever-expanding landscape of challenges and opportunities in multiple fields, elevating pedagogy and

enhancing the art and science of learning, thinking, and doing.

Through the lens of designing for multiplicity, the landscape of design is portrayed as a dynamic and adaptive process that responds to individuals' and communities' unique needs and aspirations. This approach dismantles conventional silos and forges connections between disciplines, cultures, and generations, offering new opportunities to create a more inclusive, equitable, and sustainable world for all (Mobjörk 2010).

The issue highlights the relationship between "design for multiplicity" and its relevance in engineering education, design thinking, transversal skills, and participatory design.

The multifaceted nature of design processes and the integration of diverse perspectives, strategies, and methodologies, provide a platform for researchers and innovators to explore, experiment, and innovate in diverse ways, fostering a culture of experimental innovation and transdisciplinary collaboration. The relationship between "design for multiplicity" and engineering education is multifaceted. It encompasses various aspects of curriculum development, transdisciplinary design processes, and the integration of real-world industrial problems into educational frameworks (Butt et al. 2018). While developing a transdisciplinary engineering design process curriculum, it is fundamental to consider empirical engineering design research in industry, educational psychology, and teaching approaches such as Bloom's Taxonomy and Kolb's Model of Experiential Learning, emphasizing the nature of skill development and the integration of transversal competencies into professional training (Sharunova et al. 2017).

Prototypes play a pivotal role in designing for multiplicity, as they facilitate the work of multidisciplinary innovation teams (Dosi, Mattarelli, and Vignoli 2020). By intentionally using prototypes in all phases of the design process, teams can resolve tensions and conflicts and learn how to progress in the innovation journey (Camburn et al. 2017).

Design Thinking is the backbone of designing for multiplicity due to the increasing complexity that comes from exponential technological developments. Expanding and translating the notion of the design



process to broader academic communities provides different methodologies and mindsets for successful innovation in transdisciplinary wicked problems (Dorst 2011; Vignoli, Dosi, and Balboni 2023) while supporting the development of empathy as a prominent and crucial skill.

Multiplicity requires the formation of additional transversal skills, empowering designers with a sense of personal effectiveness and global perception to meet real-world challenges. Those skills are central to developing and enacting the collaboration needed to work in interdisciplinary, international, and mixed-study-level teams.

The relationship between "design for multiplicity" and participatory design is rooted in both approaches' inclusive and collaborative nature. Participatory design aims to involve all stakeholders in each stage of the design process (Kang, Choo, and Watters, 2015). The cornerstone of participatory design is end-users' in the design process, reflecting the inclusive and diverse considerations inherent in "design for multiplicity."

This issue opens with the second note of our special section dedicated to methodological papers. The article from Massimo Florio and Paolo Castelnovo on quasi-experiments (Florio and Castelnovo, 2023) presents the use of quasi-experimental designs for social science. This methodology is beneficial when true experiments are not feasible due to practical constraints. Though not as rigorous as experiments, quasi-experiments can still establish causal relationships if confounding variables are properly controlled for using statistical techniques. The note provides an example of a study that used a quasi-experimental design to assess the impact of procurement contracts from the Italian Space Agency on supplier firms' patents. While quasi-experiments are better than purely observational studies, building a comparable control group remains challenging.

The article from Eriksson and colleagues (Eriksson et al., 2023), "Identifying and framing potential stakeholders in complex innovation ecosystems," presents scaffolding as a crucial method in engineering education, mainly when dealing with complex tasks involving diverse stakeholders. It involves providing students with support structures, such as soft or hard scaffolds, to enhance their task competence and guide their attention. Using scaffolding, students can navigate open-ended assignments and identify various stakeholders and their roles, including non-human stakeholders like technologies, fauna, and flora. This understanding of stakeholders and their connections supports a shift towards a more collaborative, inclusive, and human-centered innovation process in engineering education. Additionally, scaffolding helps students identify a broader range of stakeholders and consider diverse considerations, ultimately leading to informed choices. It is essential to design scaffolds carefully to avoid fixation that would limit student considerations. Furthermore, in the context of stakeholder partnerships,

understanding the different capacities through which stakeholders connect to a sought-after end goal is crucial for constructing a more holistic mapping of the stakeholder ecosystem.

The article by Kirjavainen and colleagues (Kirjavainen et al., 2023), "Prototyping in practice – Paths and partners for testing novel industrial product and service ideas," examines prototyping practices in an industrial technology company with 31 engineering design professionals. The researchers conducted thematic interviews focusing on critical incidents to identify patterns in the participants' prototyping activities. The analysis resulted in 62 prototyping paths. The results show that most prototyping paths started with the practitioners' activities, which were more likely to lead to longer prototyping paths than those that started in collaboration. Overall, the prototyping paths were short, indicating a lack of iteration. Practitioners described testing final prototypes rather than engaging in early low-fidelity prototyping. The study suggests that organizations could support more iterative prototyping from the beginning of the development process by providing resources and collaboration opportunities.

Cocchi and colleagues (Cocchi et al., 2023), in their article "Tech to Organization. Assessing and designing technology adoption with design thinking," explore how design thinking can be adapted to support technology adoption projects. Through a case study of seven technology adoption projects, the authors identify five new tools and propose an adapted design thinking process called "Tech to Organization". The authors argue that technology adoption projects require a different approach from traditional design thinking processes. They propose a three-stage "Tech to Organization" process: 1) Technology-Organization fit - an exploratory phase to understand the potential applications of the technology within the organization; 2) Context research - exploring the application context and testing the technology; 3) Solution concept design - developing the solution concept and business model. The "Tech to Organization" process, with its initial focus on the technology and organizational context, is proposed as a tailored approach for technology adoption projects, distinguishing it from conventional design thinking processes. The study provides managers and designers with a structured approach and toolkit to manage technology adoption projects.

The study from Jussila and collaborators (Jussila et al., 2023), "Developing students' transversal skills: A case study of an international product development project," investigates how an international product development project course supports the development of students' transversal skills. Transversal skills include physical and manual, thinking, social and communication, self-management, and core skills. The researchers interviewed students before and after the course to understand their expectations and perceptions of skill development. Before the course, students

expected to develop their physical and manual skills through prototyping. They are also expected to improve their social and communication skills by working in international and interdisciplinary teams. However, after the course, students perceived that their social, communication, and self-management skills had developed the most. This was due to the challenges of communicating in a foreign language, with different cultural backgrounds and disciplinary languages within the student teams. The study highlights the importance of forming interdisciplinary, international, and mixed academic-level teams to provide opportunities for students to develop various transversal skills within a single course. However, students may require support to develop skills like interdisciplinary teamwork and knowledge of other cultures, which are missing from existing transversal skills frameworks. In conclusion, organizing learning through mobility and diverse student teams can effectively develop transversal skills, but appropriate guidance and teaching practices are also needed.

Van der Marel (Van der Marel, 2023), in his study “How participatory design influences issue framing: a hospital case study,” examines how participatory design initiatives like design workshops and training impact how employees frame ideas for creating an open and innovative culture in a hospital setting. Before the design initiative, employees' ideas mainly focused on needing more resources like staff, time, and physical resources. After the initiative, their ideas shifted to improving working methods, such as internal collaboration, patient experiences, and practices. This suggests that the design training helped employees better understand organizational complexity, empathy for other stakeholders, and self-efficacy, allowing them to frame more controllable and effective ideas. The study highlights how participatory design can empower employees to identify and address challenges in organizational transformation. However, the study was limited by its small sample size and single location. More research is needed to understand the long-term impact on employee framing and receptivity to change.

The research by Rosenbaum et al. (Rosenbaum et al., 2023), “The use of generative AI tools in Design Thinking academic makeathon,” studies the use of generative AI tools by students during an intensive four-day makeathon focused on Design Thinking. The makeathon brings together hundreds of engineering and design students to solve real-world challenges. The study found that around 80% of students used generative AI tools during the event, perceiving them as assisting rather than solution-dictating tools. However, there were differences between engineering and design students in their approach and trust in the tools. Engineering students were more skeptical and validated AI results, while design students mostly accepted results without validation. Students mainly used textual AI tools like ChatGPT during the research and empathy stages. In

contrast, they used more visual AI and textual tools in the ideation and prototyping stages. Students combining both types of AI tools reported higher satisfaction. However, many students used ChatGPT as a conventional search engine rather than fully exploring its capabilities. The study suggests that generative AI tools can potentially improve the design thinking process, but their integration could be further optimized to improve the innovation process radically. In conclusion, the study provides insights into how generative AI tools were used during the makeathon but notes that the full potential of human-AI collaboration in Design Thinking can be unlocked with proper guidance.

In conclusion, the concept of 'multiplicity' has emerged as a transformative force in design and innovation, challenging traditional approaches and advocating for more inclusive, adaptable, and context-specific design strategies. The Design Factory Global Network Research conference has been a platform for exploring the significance of co-created collective pursuits in promoting change and addressing contemporary challenges through transdisciplinary learning, research, and practice.

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