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DOI
10.35199/EPDE.2022.92

Publication date
2022

Document Version
Final published version

Published in
Proceedings of the 24th International Conference on Engineering and Product Design Education (E&PDE 2022), London South Bank University in London, UK. 8th - 9th September 2022

INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
8–9 SEPTEMBER 2022, LONDON SOUTH BANK UNIVERSITY, LONDON, UK

DESIGN AND ENGINEERING AS AGENTS OF CHANGE: A CAPABILITIES FRAMEWORK

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ABSTRACT
Design is generally accepted to provide valuable contributions to addressing complex societal challenges. Even though design and engineering professionals show increasingly capable of making societal impact, it is not straightforward why some creative practices are more impactful in fostering systemic change, let alone what additional capabilities they pursue to be distinctive. The current study introduces a capabilities framework highlighting a set of advanced design capabilities expanding the conventional skillset of designers and engineers towards enabling the adoption of local innovation at a systemic scale. Afterwards, the developed capabilities framework is used as a pedagogical framework to design a learning environment to prepare the next generation of design and engineering students to respond to today's societal challenges. We close with a discussion on the professional and pedagogic role of design and engineering as agents of change.

Keywords: Design capabilities, disruption, reflection, societal challenges, hyper-local transformation

1 INTRODUCTION
The UN Sustainable Development Goals (SDGs) call for new approaches to design addressing complex societal challenges because existing solutions to climate change, mobility, or urban inequalities are often not powerful enough to trigger structural social change [1]. For instance, the Oslo manifesto [2] promotes universal adoption of the SDGs as a design brief for the 21st century, while others stress the need to completely reinvent our socio-technical systems if we are to meet the SDGs [3]. In fact, such a move towards more socially and ecologically sustainable futures represents a collective societal design challenge and asks us to rethink design thinking and the design profession [3]. The current work responds to the call for new design approaches and aims to contribute to the current debate on the next professional and pedagogical role of design in bringing forward societal change. Over the past years, there is a growing interest in the role of design in addressing societal challenges [4-6]; expert designers are leaving their studios to generate solutions for global challenges at a local level. In their pursuit to help address the societal challenges they oftentimes collaborate with a diverse mix of local innovators, such as citizens, local authorities, academia, as well as private and public organisations. Although these coalitions differ in nature, they do share an interest in proposing positive change [7]. Interestingly, a growing number of such local coalitions that use design methods and processes beyond the conventional design domain are capable of leveraging the resourceful and interconnected nature of cities to foster hyper-local transformations. However, we lack empirical understanding of what makes some of these creative practices more impactful than others. It is, therefore, timely to consider the professional and pedagogical role of design and engineering as agents of change who tackling societal challenges; not only their diverse backgrounds and perspectives but also the scale and complexity of societal challenges force them to constantly adapt and learn, acquiring new capabilities to advance their initiatives towards systemic change.

1.1 Context of study
The context of study is a European research programme that aims to foster the uptake and scaling of radical and transformative innovation across European cities. The programme deliberately focuses on the urban context, as complex societal challenges manifest within cities and become more evident when they are directly affecting the lives of citizens. Through three open calls, local coalitions are invited to propose design solutions to address the SDGs. In total, a hundred design-enabled innovation projects across Europe are financially supported in different stages of innovation maturity, respectively

feasibility studies (1st call), prototypes embedded in an urban context (2nd call), and finally, pilots scaling their innovation across cities (3rd call); see [8] for details. The application platform guided the strategic articulation of design methods used and whether and how the projects responded to complex societal and environmental issues connected to the SDGs. Consequently, the awarded projects can be seen as exemplary agents of change demonstrating the value of design in hyper-local transformations that address global challenges. Next to funding and guidance to design methods and tools, the programme provided a capacity-building programme that, on the one hand, can be seen as a collaborative space for learning and reflection, and on the other hand, a community of learners [9]. Therefore, the objective of the research was to understand which capabilities are key to fostering change, embedding innovation locally, and scaling disruptive urban transformations, and next, how to train such capabilities to further infrastructure a learning community of change agents to diffuse disruptive innovation practices even beyond the programme itself. The resulting capabilities framework highlighting a set of advanced design competencies enlarging the skillset of designers and engineers necessary for local embedment and adoption of innovation at a systemic scale has informed the content creation of the training activities and guided the further development of learning community into the overall capacity building programme.

The current work introduces the developed capabilities framework as a pedagogical framework to prepare the next generation of design and engineering students to respond to societal challenges. The next section describes the method for our study. Afterwards, we introduce the identified capabilities key to embedding innovation processes locally and motivate how the use of such a capabilities framework can help bachelor and master students to reflect upon their designerly skillset. We conclude by elaborating on the value of the capabilities framework to discuss the professional and pedagogical role of design and engineering contributing to today's societal challenges.

2 METHOD

In order to understand what kind of competencies are needed to leverage designers' capacity to design for systemic change at a societal level, we have investigated pioneering creative practitioners to understand the professional role and then studied the pedagogical role in an educational context. Part of the setup of the programme, a literature review was conducted analysing existing studies on design expertise, capacity and capabilities, innovation capabilities and other expertise meaningful for innovation in the urban space, resulting in a draft list of capabilities that was used to inform the setup of a series of semi-structured interviews with selected pilots in the above-mentioned European project. Ten representative members of pilot projects were interviewed to understand what kind of skills and expertise were used to stretch their impact during the setup and development of their design projects. Interviews were conducted via the online communication tool Zoom and were audio-recorded for data collection. Afterwards, transcripts were analysed and loosely coded for recurring themes, skills, and abilities that were mentioned by innovators during the interviews. In an expert session, these clusters were contrasted with finding from literature review and synthesized in a capabilities framework highlighting the advancing role of design and engineering as agents of transformation in the public realm. The resulting visual overview has been used as a pedagogical framework for building capacity in these new professional roles (see Section 3, Figure 1 and Table 1). The framework not only guided the setup of a series of training for design practitioners active in social and urban innovation within the introduced capacity building programme but also the successful development of a learning community.

The current study aims to further contribute to the debate on the professional and pedagogical role of designers and engineers as agents of change who aim at tackling societal issues. Hereto, the same framework has been utilised to set up a learning environment for design and engineering students with the aim to explore whether the newly identified capabilities fit their needs and bring opportunities for expanding current design and engineering education curricula. Two courses at the Faculty of Industrial Design Engineering were selected that fit within the scope of supporting design and engineering students in investigating the use of design for urban transformations and social innovation in urban environments. The first course, Design & the City, is a Master elective challenging design students to map, reflect, and elaborate propositions on the value that design plays within urban transformation processes, examine different roles of design and corresponding design capabilities, and explore what could be the next role of designers in supporting such enabling design processes at a systemic level in an urban context (n=158). The second course, People in Transit, is a Bachelor Minor attracting among others, students of Industrial Design Engineering, Mechanical Engineering, Aerospace Engineering, and aims to train

students to develop complex mobility systems changing the fruition of the urban environment, therefore involving the creation of systemically embedded innovation at the urban level (n=59). In order to facilitate a learning environment with students and enable reflection on the needed capabilities to act as agents of disruptive urban transformations, the framework was used as a placeholder to help students reflect on the complex and interrelated tasks. Accompanying the framework, canvases and templates were designed to guide students in collaborative reflections on their projects as well as on initiatives of urban innovation, helping them articulate their thoughts on their roles as agents of change, and help them by scaffolding which capabilities they found most relevant to learn as innovation professionals for their current and future projects. Next to the students' reflections part of their assignment, data for our study was collected by observing whether and how the students referred to the capabilities elaborated in the framework and taking notes of their reflections during collaborative activities in class.

3 CAPABILITIES FRAMEWORK

Figure 1 shows the resulting three-layered visual overview motivating a set of professional capabilities needed for igniting urban transformations and refers to ten training models co-developed with the participating pilots answering their learning needs.

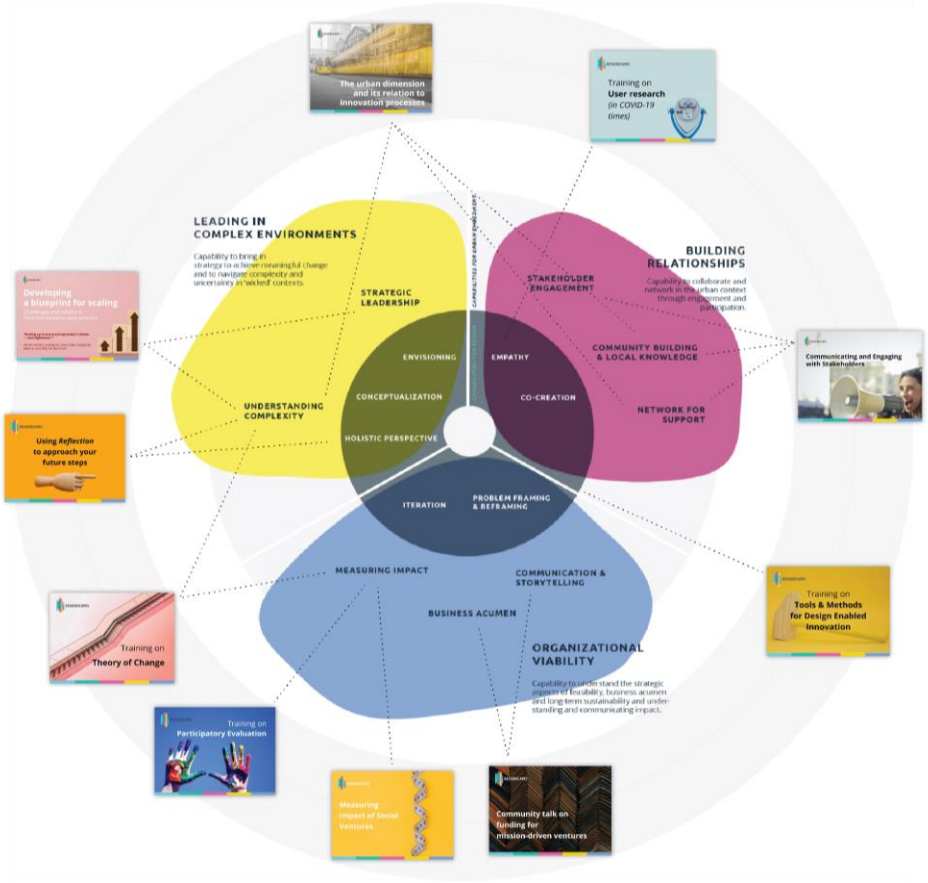

Figure 1. Framework of design capabilities for social innovation and urban transformations and corresponding training modules addressing key learning needs

3.1 Attitudes as pillars for change

The first, inner, layer of the capabilities framework shows what emerged as pillars for urban innovation, namely the main attitudes recognized as key for leading disruptive urban transformations. Key attitudes refer to important personal competencies that are necessary in order to sustain the right mindset when working on complex innovation processes aiming at bringing urban transformations.

3.2 Design capabilities for urban innovation

The second layer of the framework illustrates what has been recognized as specific design capabilities and skills that show precious in initiating and conducting innovation processes aimed at disruptive urban innovation. These include, among others, more conventional expert design skills such as problem reframing, the ability to conduct co-creation processes with stakeholders, conceptualizing abstract ideas.

3.3 Capabilities for embedding urban transformations

Finally, the third, outer, layer of the framework clusters that have emerged as additional competencies key to developing and embedding disruptive innovation processes within urban contexts. Such capabilities are clustered in three main areas of expertise and action that innovators should be capable of dealing with to succeed in their urban innovation processes, namely *working together*, intended as the ability and know-how for collaborating and networking (building relationships) in the urban context; *viability*, understanding of feasibility, business acumen and long-term sustainability; and *leading change*, the ability to create meaningful change by leading and creating the conditions that allow innovation (e.g., culture change, mindset). Table 1 shows the final list of competencies.

Table 1. List of competencies clustered in overarching capabilities and themes

1 - Personal Competencies		
Key attitudes	Passion and drive	
	Willingness to share and be open	
	Commitment and follow-through	
	Persistence	
2 - Design		
Design capabilities	Problem Framing & Reframing	Identify a problem or need, Explore different approaches and opportunities within the problem
	Conceptualization	Comfort with ambiguity and the abstract, Ability to visualize a concept or give ‘shape’ to it
	Envisioning	Conceptualizing an idea for the purpose of shared understanding and dialogue, Engaging stakeholders by using visualization to create a shared language
	Co-creation	Facilitation of creative skills in others
	Holistic Perspective	Understand the connection between details and the whole picture, Zooming in and out
	Empathy	Understand or share feelings of a user or stakeholder, Ability to conduct and apply user research for this purpose
	Iteration	Structuring loops or cycles of doing/testing and reflecting in order to come to the right solution
3 - Urban embedment		
Working Together	Stakeholder Engagement & Management	Stakeholder Mapping, Negotiation, Building consensus, Co-ownership models, Leadership skills, Building Trust & Transparency, Facilitation
	Community Building & Local Know-How	Building & mobilizing an on the ground network, Building trust & Transparency, Being accessible to the community, Being an Ally (e.g., Social Inclusion, Anti-Oppression Training, Understanding other), Embedding in the local urban context, Understanding the current context
	Network for Support and Connections	Peer support, Mentorship, Inspiration from others, Network or contacts in the field, Attending conferences, Connection to an established urban leader or institution in the field (legitimacy)

Leading Change	Strategic Leadership	Theory of Change, Strategy, Organizational Management, Stakeholder Management, Time and Project management
	Systems Thinking & Understanding Complexity	Systems mapping, Landscape mapping, Systems thinking
Viability	Business Acumen	Co-ownership models, Business model innovation, Sustainable value models (e.g., public or non-profit), Financing and investment (how to attract funding), Financial understanding, Validating an idea, Conducting a feasibility study
	Communication & Storytelling	Narratives & storytelling, Pitching
	Measuring Impact	Social Return on Investment, Demonstrating Value

3.4 Towards a pedagogical framework

The resulting framework was used to scaffold a guided reflection with students in two selected courses. The confirmed list of capabilities collected in our study, organized in layers explicitly exceeding the conventional design domain, facilitated students in acknowledging the expanded role of design practice when tackling urban transformations, allowing them to (indirectly) learn with and from design and engineering professionals' projects as concrete examples of disruptive urban transformations. Providing a lens to translate interconnected tasks into concrete competencies students could relate to, the framework facilitated students to compare their own projects with those of the selected design innovators who were seen as role models and enabled them to reflect on and articulate upon similarities and differences that would stretch their current design practice into agents of change.

4 DISCUSSION AND CONCLUSIONS

In the current section, we reflect on the proposed capabilities framework and discuss its value in stretching the current design and engineering curriculum and training future generations of urban innovators as agents of change in response to today's societal challenges. It can be concluded that the framework provides empirical evidence of key capabilities required by professional agents of change to successfully conduct social innovation and urban transformations. By elaborating upon three key areas of expertise fundamental for the embedment of disruptive innovation, the framework provides directions on how skills currently trained within design and engineering education could be expanded to build capacity of designer and engineers in establishing stronger "co-creative partnerships" [10] for innovation (working together), conceiving long-term sustainable innovation (viability), and facilitating the infrastructures and ecosystems [11] for social innovation (leading change). Furthermore, by employing the elaborated capabilities framework with university students we observed its value in use as a pedagogical framework supporting design and engineering students to increasingly become agents of change. Students showed to become more aware of the interconnectedness of tasks involved in urban transformations, and where and how different capabilities could be key for conducting such processes. Assessing the value and limitations of their current design and engineering expertise in accelerating urban change, also helped them to articulate how to expand their skillset as agents of change, particularly in the context of mission-driven innovation as well as facilitating local change, and urban transformation [12]. The following quote illustrates how bachelor students recognized the establishment of stronger relations with stakeholders at different levels as a key learning need for their team to conduct their mobility project in the city of Rotterdam.

"It would be nice to have the capabilities from Theme 3.1 (working together) more implemented in the team, since we then have more valuable connections to relevant parties", "I think it would be interesting to improve the ground network and maybe learn some techniques about interviewing or observing people in the urban context"

Interestingly, the framework also showed value as a scaffolding model to allow students to monitor their growth over time, towards becoming professional agents of transformation.

"It could be very nice to have one of those discussion sessions in the first week, to get a broad understanding of everything that is still needed, and one in the second or third week, to see how much progress has been made"

We particularly noticed how Master students transformed in their design practice after taking the course. Students embraced more complexity in their design projects and were able to identify multiple layers of design activity, for example, articulating strategic actions for ecosystems infrastructuring [11] next to conventional value creation activities:

"I really liked that I could (in the same project) zoom in to create immediate value, but also step back and look at the broader picture trying to create this network and infrastructure"

It can be concluded that the developed capabilities framework not only enabled students to become more aware of a new role that designers and engineers should take in order to accelerate urban transformations, but they also became more ambitious in their design projects (inclusion of multiple stakeholders, dealing with power literacy). In particular, the framework showed valuable in stimulating the engagement of students towards acquiring new competencies, activating students' receptiveness and eagerness to acquire and cultivate a larger skill set of capabilities, ultimately showing promise to guide them in developing their skills over time towards becoming increasingly capable agents of disruption and transformation in cities. Last but not least, several students even managed to articulate their pioneering role in job interviews and got hired as change agents within systemic service design agencies and/or leading tech consultancy firms.

ACKNOWLEDGEMENTS

The current work is part of DESIGNSCAPES (Building Capacity for Design enabled Innovation in Urban Environments) funded by the Horizon2020 call CO-CREATION-02-2016 - User-driven innovation: value creation through design-enabled innovation, under Grant Agreement No. 763784. Special thanks go to the students participating in the Master elective Design & the City and the Minor People in Transit as well as to Alicia Calderón González, Kirsten van Dam and Maya Goodwill for their support in interviewing the participating pilot projects. The support of and fruitful discussions with of Elmer van Grondelle and the partners of the DESIGNSCAPES consortium are gratefully acknowledged.

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