RSD10

PROCEEDINGS

Playing with Tensions

Embracing new complexity, collaboration and contexts in systemic design

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Editorial

The RSD10 symposium was held at the faculty of Industrial Design Engineering, Delft University of Technology, 2nd-6th November 2021. After a successful (yet unforeseen) online version of the RSD 9 symposium, RSD10 was designed as a hybrid conference.

How can we facilitate the physical encounters that inspire our work, yet ensure a global easy access for joining the conference, while dealing well with the ongoing uncertainties of the global COVID pandemic at the same time? In hindsight, the theme of RSD10 could not have been a better fit with the conditions in which it had to be organized: *"Playing with Tensions: Embracing new complexity, collaboration and contexts in systemic design".*

Playing with Tensions

Complex systems do not lend themselves for simplification. Systemic designers have no choice but to embrace complexity, and in doing so, embrace opposing concepts and the resulting paradoxes. It is at the interplay of these ideas that they find the most fruitful regions of exploration. The main conference theme explored design and systems thinking practices as mediators to deal fruitfully with tensions. Our human tendency is to relieve the tensions, and in design, to resolve the so-called "pain points." But tensions reveal paradoxes, the sites of connection, breaks in scale, emergence of complexity. Can we embrace the tension and paradoxes as valuable social feedback in our path to just and sustainable futures?

The symposium took off with two days of well-attended workshops on campus and online. One could sense tensions through embodied experiences in one of the workshops, while reframing systemic paradoxes as fruitful design starting points in another. In the tradition of RSD, a Gigamap Exhibition was organized. The exhibition showcased mind-blowing visuals that reveal the tension between our own desire for order and structure and our desire to capture real-life dynamics and contradicting perspectives. Many of us enjoyed the high quality and diversity in the keynotes throughout the symposium. As chair of the SDA, Dr. Silvia Barbero opened in her keynote with a reflection on the start and impressive evolution of the Relating Systems thinking and Design symposia. Prof.Dr. Derk Loorbach showed us how transition research conceptualizes shifts in societal systems and gave us a glimpse into their efforts to foster desired ones. Prof. Dr. Elisa Giaccardi took us along a journey of technologically mediated agency. She advocated for a radical shift in design to deal with this complex web of relationships between things and humans. Indy Johar talked about the need to reimagine our relationship with the world as one based on fundamental interdependence. And finally, Prof.Dr. Klaus Krippendorf systematically unpacked the systemic consequences of design decisions. Together these keynote speakers provided important insights into the role of design in embracing systemic complexity, from the micro-scale of our material contexts to the macro-scale of globally connected societies. And of course, RSD10 would not be an RSD symposium if it did not offer a place to connect around practical case examples and discuss how knowledge could improve practice and how practice could inform and guide research.

Proceedings

RSD10 has been the first symposium in which contributors were asked to submit a full paper: either a short one that presented work-in-progress, or a long one presenting finished work. With the help of an excellent list of reviewers, this set-up allowed us to shape a symposium that offered stage for high-quality research, providing a platform for critical and fruitful conversations. Short papers were combined around a research approach or methodology, aiming for peer-learning on how to increase the rigour and relevance of our studies. Long papers were combined around commonalities in the phenomena under study, offering state-of-the-art research. The moderation of engaged and knowledgeable chairs and audience lifted the quality of our discussions.

In total, these proceedings cover 33 short papers and 19 long papers from all over the world. From India to the United States, and Australia to Italy. In the table of contents, each paper is represented under its RSD 10 symposium track as well as a list of authors ordered alphabetically. The RSD10 proceedings capture the great variety of high-quality papers yet is limited to only textual contributions. We invite any reader to visit the rsdsymposium.org website to browse through slide-decks, video recordings, drawing notes and the exhibition to get the full experience of RSD10 and witness how great minds and insights have been beautifully captured!

Word of thanks

Let us close off with a word of thanks to our dean and colleagues for supporting us in hosting this conference, the SDA for their trust and guidance, Dr. Peter Jones and Dr. Silvia Barbero for being part of the RSD10 scientific committee, but especially everyone who contributed to the content of the symposium: workshop moderators, presenters, and anyone who participated in the RSD 10 conversation. It is only in this complex web of (friction-full) relationships that we can further our knowledge on systemic design: thanks for being part of it!

Dr. JC Diehl, Dr. Nynke Tromp, and Dr. Mieke van der Bijl-Brouwer
Editors RSD10

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Track 1: **Work in progress**

Chair: Nynke Tromp

Exposing the Emotional Dynamics of Making Tensions Tangible in Systemic Design

Elin Engström, Matilda Legeby, Pia Mcaleenan, Hanna Andersson, Karin Petrusson, Manuela Aguirre & Josina Vink

Increasingly in systemic design there is an emphasis on the value of visualizing, materializing and enacting tensions. However, there has to date not been much focus on what happens when these tensions are exposed within systemic design processes. The emotional aspects of responding to tensions play a particularly central role in guiding people's resulting actions, but are seldom discussed in the systemic design discourse. Fear is positioned as a key emotion driving tensions and a conceptual framework (the four Fs) is proposed to unpack the consequences to fear. Ignoring emotions such as fear in change processes may perpetuate a false narrative about emotional dynamics and increases the risk of harmful, unintended consequences. This paper shares stories and reflections from Förnyelselabbet's work that uses designerly approaches to facilitate meaningful change within complex societal challenges in Sweden, particularly in relation to newly arrived minors. These stories situated in the context of exploratory lab and co-design work reveal the emotional dynamics unfold when tensions are exposed and help raise an emotional literacy in systemic design practice.

Keywords: materializing systems; enacting tensions; feeling fear; co-designing for social change

Introduction

Within the evolving systemic design discourse, there has been growing acknowledgement of the role of tensions in this practice. In design, conflicting requirements are recognized as fruitful triggers to creating alternative frames for understanding a problem situation (Dorst, 2011). One key strategy that is often advocated for within systemic design is to make this tensions tangible through visualizations, materializations or enactments. For example, GIGA maps offer a way of investigating the tensions amid complexity by exploring the relations between seemingly separate things (Sevaldson, 2011). In addition, there are approaches to materializing relations by representing them through different types of string that support a more open dialogue on the tensions between stakeholders in a system (Aguirre Ulloa & Paulsen, 2017). Constellations have been another way in which tensions between stakeholders have been explored with different people positioning themselves relative to others within a room to explore the energy and tensions within a stakeholder network (van der Lugt, 2017).

While there is recognition that managing tensions well within the systemic design process can result in deeper trust, it has also been highlighted that mismanaging tensions can result in the polarization and disenfranchisement of stakeholders (Gaskin, 2020). Questions have been raised about how far tensions should be pushed and how to create safe spaces for working with them (Ryan, Baumgardt and Pangaro, 2016). A lot is still unknown about what happens when designers work with, make tangible and further expose tensions in systemic design. In particular, there is a need to further delve into the emotional dynamics of making tensions tangible as these emotions play such a significant role in people's responses within the evolving systems adaptation. As such, this paper zooms into the emotional dynamics of exposing tensions in the context of systemic design practice through a narrative exploration by designers in Förnyelselabbet, a group that has been employing systemic design to address complex challenges in Sweden. The stories told through the perspectives of the designers, often with input and reflections from others involved, offer hopeful and sometimes uncomfortable accounts of what happens when tensions are made explicit and the different emotions that emerged from various stakeholders involved. These situated anecdotes help to show the importance of building an emotionally conscious practice when confronting tension in systemic design.

About Förnyelselabbet

Initiated by the Swedish Ministry of Social Affairs and the Swedish Association of Local Municipalities and Regions, Förnyelselabbet has been run by the Swedish Industrial Design Foundation since 2016. In an effort to explore new methods and mindsets for design in the field of organizational complexity, the lab has served as an explorative arena. There has been a particular emphasis where inhabitants risk falling in between the cracks of the system and where a more holistic and collaborative approach is needed across siloed organizations. The team is made up primarily of designers but collaborates with other disciplines as well such as analysts, change managers and legal experts.

When the lab was first set up, the societal challenge most pressing at the time was the wellbeing of newly arrived minors. This has been a focus of the work in Förnyelselabbet and the context in which most of the methods have been developed. We believe the work with systems change needs to be contextual, which is why the labs have been set up in close collaboration with local municipalities and the stakeholders needing to collaborate locally. They have worked in several local communities all over Sweden and engaged hundreds of children, youth and related stakeholders. The team now has an ambition to apply the same methods and mindsets to other societal challenges in need of a systems and collaborative transformation. A central acknowledgement in the Förnyelselabbet team is an awareness that these design processes need time for reflection both amongst participants, but also within the design team itself.

Tensions have been inherent in the multi-stakeholder, complex and political systems in which the design team is working. The team uses a variety of designerly approaches to work with complex challenges and expose tensions within the systems their labs are situated within. In particular, Förnyelselabbet has made visual maps, developed a visual survey for children, make enactments of tensions out of clay and materialized relations between people with different types of yarn (based on the work of Aguirre Ulloa & Paulsen, 2017). Below are four stories told through the perspective of the designers involved: The Wall Between Us, Forces at Play, Winter Sandals and A Sign of Relief. The stories unfold the emotional dynamics that Förnyelselabbet encounters when exposing tensions in their systemic design work.

The Wall Between Us

During 2019, we set up one of our first labs where we worked with the general reception of newly arrived children and youth. “What is their experience and how can it improve?” —the integration coordinator in the municipality asked a group of teachers and civil servants that were gathered from different parts of the administration. The work of the lab is organized in activities where each group shares their own experience and reflect upon stories from the children’s experience when interacting with the municipality and other agencies. These activities serve to broaden the understanding from different perspectives and develop a more systemic view on the underlying patterns of issues.

In this process, we mainly met children at their school or at the local leisure centre. The municipality has a policy document that suggests that the school is the space to meet and interact with people from different backgrounds. However, the stories from children and youth at different schools in the town suggests that what is experienced is much different. The newly arrived students (from age ten) spend their first couple of years learning Swedish and other subjects at introductory courses. These systems differ between municipalities, but many schools organise the newly arrived children in separate introduction classes at first. The classes, regardless of age, were all situated outside or at the periphery of the school. This meant that the students rarely interacted with the other students as they did not share the schoolyard or have breaks at the same time. To surface the experiences of newly arrived students, we asked them to map where they felt safe and unsafe. "They probably think I’m a monster” —said one eleven-year-old girl as she described how it feels eating in the canteen. "I feel unsafe walking in that part of the school, where the national programs are" —a teenager at a high school in the same town said.

The students were also invited to describe the social dynamics inside the school through clay, role play, and storyboards. They were asked to share their gestalt with the rest of the group and their stories were documented through video. One group of students from the high school, with students from both the national and the introduction programs, shared their experience by shaping an imaginary wall raised between them, dividing those in the national programs from those in the language introduction program (shown in Figure 1). The realness of this imaginary wall was described in how they felt they could not walk in the corridor of the other. They felt as the wall was placed by the school, in particular by their principals and administrative staff as one student was told not to go to the corridor of the introduction program. The imaginary wall, they said, reproduces and upholds segregation and feelings of uncertainty inside the school. "As there is this wall between us, we feel like question marks to each other in our shared space." When we asked them how they would change these segregated dynamics, they felt powerless at first, but then they reflected on their space of action, on the micro actions that could change the dynamics. As the group checked out from the session, most of the students felt motivated to act differently.

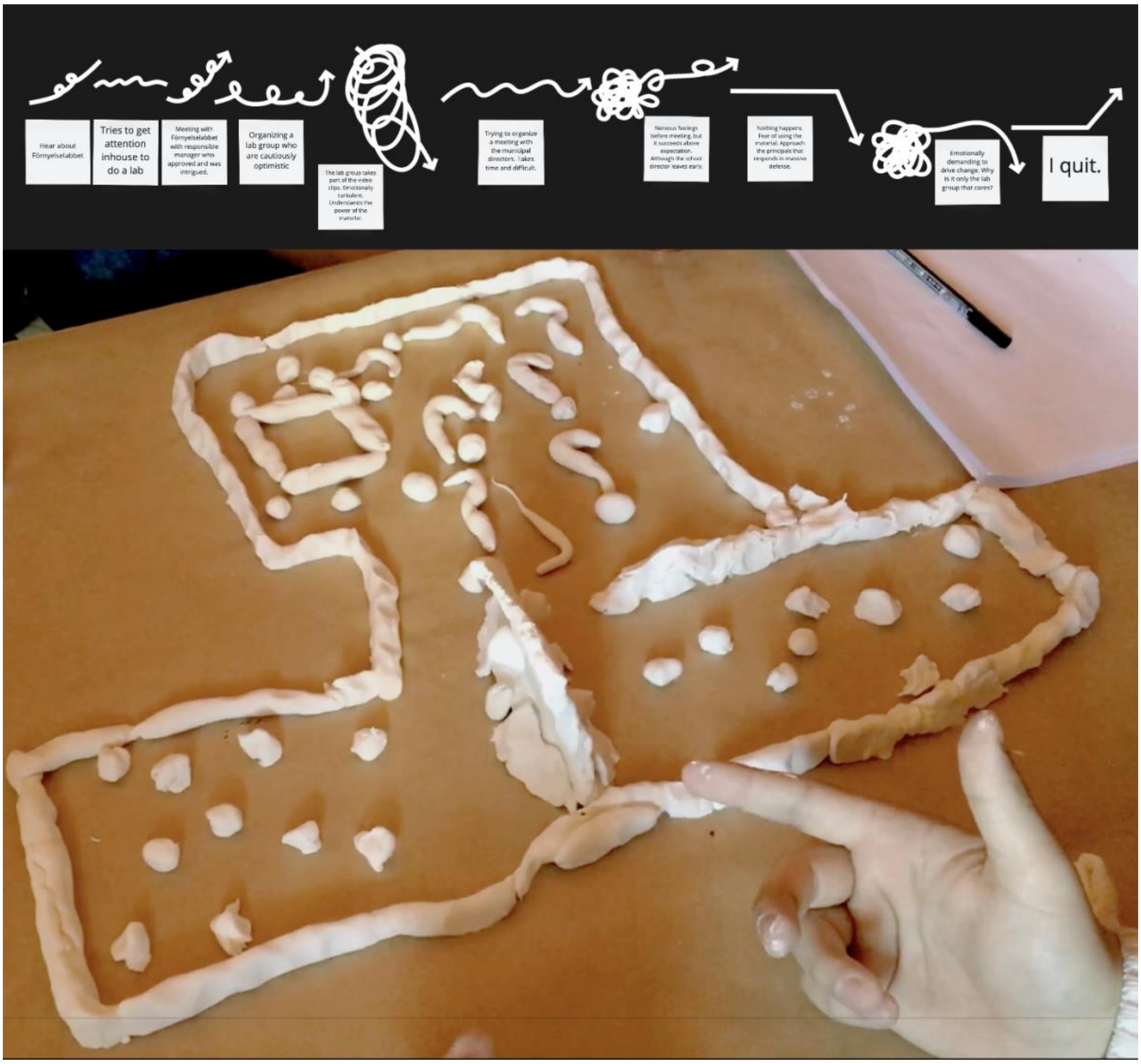

Figure 1: The clay wall created by the students annotated above with the emotional journey of the civil servant leading this process.

The stories from the students were shared with the rest of the lab group and the leading civil servants of the municipality at two different occasions. "I've always thought the school was a reflection of society, but what if the society is a reflection of school?" —a leading manager asked, while listening to the students' video clip. The lab group responded emotionally and said that their suspicions were confirmed. However, they said, slightly resigned, that change will never come out of this, even if we have these stories to share. They suggested that it was too loaded as these stories are also a description of the overall mental model that the lab unfolded; these newly arrived children are treated as a burden rather than people with resources. The lab group felt as this group of children was not being prioritised in the highest levels of the system.

Throughout the lab process, the lab group described a nervous administration, where people who engage with a critical view and from the perspective of the citizen are less supported. The person who gathered the lab group felt at first that the only way to use this material was to go to the media. She felt uncertain of the consequences she would face if she would suggest change based on these stories. She felt at risk of losing her position or becoming discarded from projects. Despite her fear, she took the materials to discuss with the responsible school principles. They reacted defensively and wanted the name of the students who said this, rather than being curious about how such experiences might have emerged. As our lab process ended, the municipality was offered to continue in a second phase focused on actions within the school. They turned down the offer and the integration coordinator has now left the administration as she felt it is not possible to drive change anymore there.

Forces at Play

The finale of a year-long project was coming up. We had explored the situation of arriving in Sweden as a refugee child, unaccompanied by parents. The participants in the lab ranged from the border police to the Red Cross—all actors who meet the child in the process of entering into Sweden. We were, for different reasons, not able to include the youth who had participated in the process in the final event, but we felt that it was crucial to include children and their experiences in some way. This event included both the people that had participated during the year, but also people new to both the findings and the method. The main purpose of this event was to present findings and get feedback from the organization's funder. This was an important event with a lot at stake for everybody involved.

In order to bring the voices and bodies of youth in the room, we suggested that a youth theatre group, with their own experience of arriving as refugees to Sweden, come and perform a play. The play had already been performed a few times at theatres and we had seen it. The play pin-pointed the situation of being a lonely child, and the feeling of being in a slow, odd process where you feel randomly tossed around by a grown-up world with a language that is, perhaps intentionally, hard to understand. We, as designers, were aware of the power of the arts and making things tangible and experiential. We saw the benefit of using "another language" as a way to tap into the experiences of one's own. We saw that this process was also a way to allow others to be invited to the feelings of an experience. However, in this case, we did not fully account the immense power of the arts and that this power can be scary when you are not in control.

The script for the play was sent to us by the theatre group, and we communicated this to the project manager who was hosting the event. We had, together with the theatre group, chosen two scenes that we felt were most fitting to the event. The email was sent, and the response was: "Scene 1 is ok, but do you have another alternative for the other scene? This is not really relevant for this particular process." Another scene was selected, and so the back and forth continued. This process was tormenting. It was extra frustrating due to the fact that the project manager, who was initially positive in their response, later became more hesitant around the same question. We understood, since she also was a project leader, she was trying to balance the needs she felt with the organisation's approach. The tension between a stand-alone project and the main organisation became more visible.

The final request was to exclude one specific word "because it is so politically sensitive". At this point we had a tense relation with the theatre group who had gone from expressing excitement of doing their play at this event to telling us how many hours it took from their free time to do these changes. We claimed their right to their artistic freedom, as we had tried to do during the process, and suggested to find a middle ground. We knew that the youths' own stories would not be possible to have opinions on in the same way, so we suggested that the youth in the theatre group instead would do a reading of a story they had written themselves of their own experiences. This was accepted with a sigh of relief from the organisation, and with a sigh of frustration from the theatre group.

During this process, and in the aftermath, I have questioned my assumption of why art is not more strategically involved in change processes of communities. I have assumed that art or artistic expressions are not used due to a lack of craft skills that are wrongly assumed that you need to have to participate in artistic processes. However, I am now inclined to believe that the artistic expression is not used partly because of its power. Art's interpretation is not specific, but rather dependent on the person's previous experiences, and is often multi-layered. I have found it fascinating and beneficial as a facilitator to use artistic expression, sketches, and clay in order to get in touch with the feelings, such as those of youth. Through this process, these feelings become possible to bring into another room by making them materials as we try to create an understanding of a system in a facilitated change process.

To turn experiences into a complete piece of art that awakes feelings, maybe feelings of guilt and discomfort, is hard. One of the worst fears for many, including me, is to create feelings of discomfort in contact with your superior. But as I see it, sitting in feelings of discomfort is one way to start a process for change. This supported that feelings of discomfort might have to play out in safe rooms with a safe group with supported reflection, often meaning that managers and superiors cannot be present. I think we as designers were a bit naive, and the organisation was not. We did not fully understand the forces in play and the immense mind moving power of the arts.

Figure 2: Illustration of the process of adapting a play from a powerful provocation to a "safe" format (Illustration by: anonymized for review).

Winter Sandals

We were invited to a preschool as a part of an exploration into the school system for children with experience of migration, either experienced by themselves directly or by their parents. We had scheduled an interview with three preschool teachers. We started our semi-structured interview by putting a blank paper on the table, drawing a line across with "entering the Swedish school" at the start and "included in the school" at the end. We asked them to describe what happens and what information is given when a child starts here at the pre-school. They talked about the difference for children with parents who are born in Sweden and who have lived experience of what a "mellanmål" (snack) is, compared to the blank faces expressed by parents with no previous experience of the Swedish system and or knowledge preschool terminology.

As they were talking, we were drawing the childrens' and parents' way into the school system and into a Swedish culture. Then one of the preschool teachers says: "at one time, a mother brought her three-year-old with sandals on her feet in the middle of the winter", the mother explained. "If she can't have the sandals she screams, and if she screams, then the neighbours think I am hitting her, and then the social workers might come and take her away." This is a common and very present fear for many of the newly arrived parents. The winter sandals were embodied in clay, shown in Figure 3, to reflect on and spark further dialogue around this underlying tension.

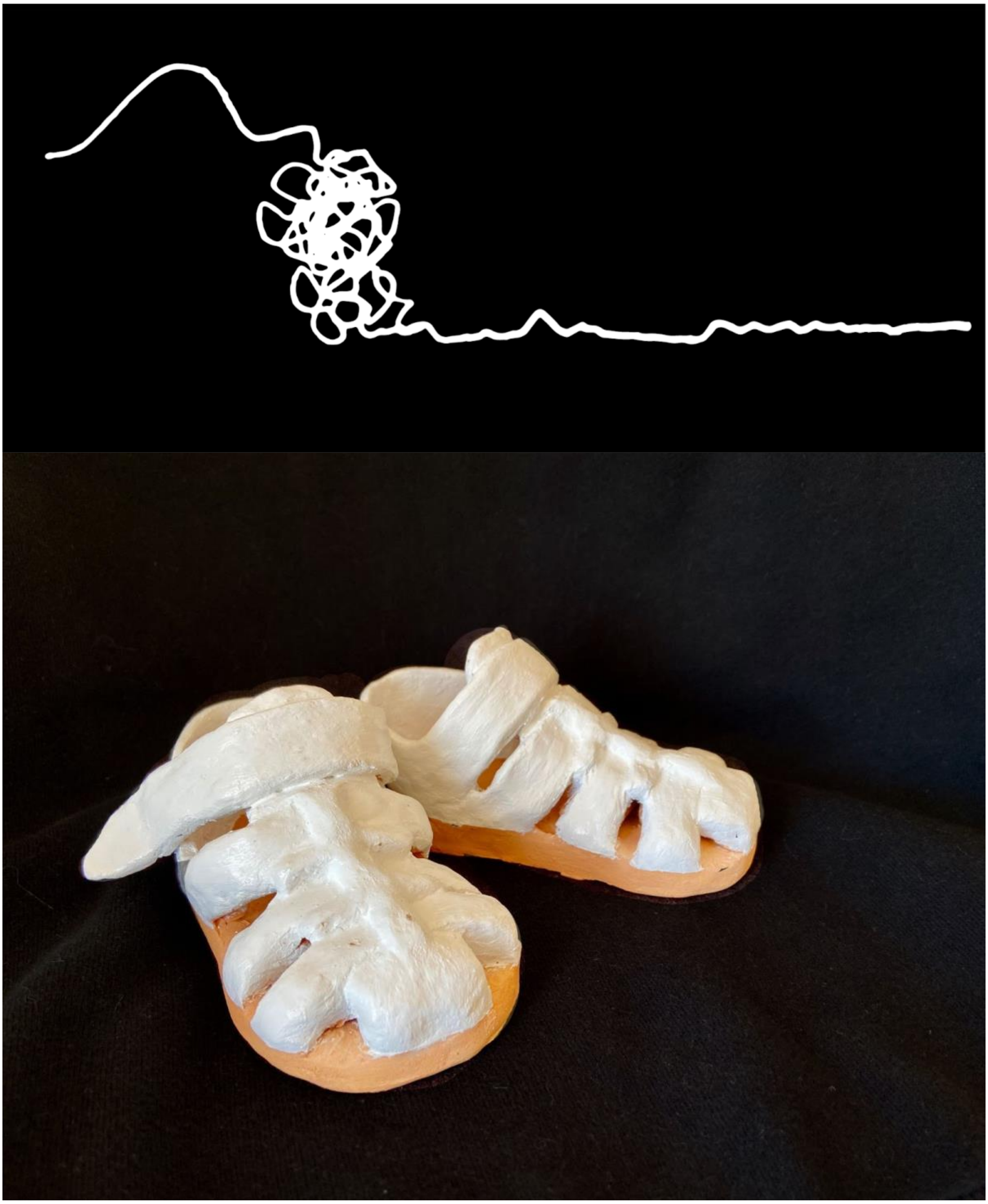

Figure 3: An embodiment of the winter sandals in clay that spark dialogue around an underlying tension, together with the emotional journey map by the designer who created it above (sandals by: anonymized for review).

It is a terrifying outcome to fear that your child might be taken if other's fear that you do not obey the government. According to the pre-school teachers, this fear is affecting the parent's behaviour and clouding their judgement. The preschool teachers are handling situations like these by explaining, time and time again, how the system is set-up.

However, what was more heart-breaking was the next discussion, which actually made the fear expressed by the newly arrived parents more tangible and real.

“Sometimes we understand that a child is being physically reprimanded in some way by their parents. We have a duty to report child abuse to the authorities. But when the families recently have arrived, we explain to the parents that physical reprimands are not allowed in Sweden. They often know and understand that it is wrong, but they are unsure of how to raise a child without being physical. How do I teach my child what is right or wrong if I can’t reprimand them properly?”

The preschool teachers continued to talk about how they weigh the responsibility towards the child. They experience a tension between being physically hurt and being emotionally traumatized because of separation from their parents. They also must adhere to the dualities of teachers’ responsibility in relation to Swedish authorities and laws. How much bending is beneficial and when is the actual law broken? This type of question, they said, is the main reason for their loss of sleep.

Setting up a safe space where this discussion can take place is what we as designers aspire to do. Analysing the experiences and putting these experiences in the context of the system of laws, authorities, policies, practitioners and cultures surrounding these issues. Considering the feelings and fears involved in making decisions and affecting relationships in this system of actors.

A Sign of Relief

The final story we will share is about when we engaged different participants who assisted newly arrived children on a daily basis from both from the public sector and civil society in an exercise to identify how many levels of managers or governing bodies they have in their respective organizations. Due to covid-19, the activity was held through a digital workshop with breakout rooms. One breakout room had participants from the municipality and other breakout rooms had different civil society organizations. One organization identified as many as 5-8 different layers of hierarchy. “I have no idea what the top management of my organization does, and they probably have no idea what kind of issues I deal with at work. There is no contact between our layers.” —said a social worker participating in the lab.

What happens to people in such hierarchical organizations? What do these layers of hierarchy do to creativity and collaboration? How much tension is being created and how much is being released in such a structure? These were the questions that surfaced during the lab workshop. The participants in our lab groups are often positioned at the lower managerial levels, close to the citizens, but sometimes we have higher-level managers included in the groups as well. Through our lab process, there was growing acknowledgement that our lab participants need to navigate entrenched hierarchical organizational structures which result in many tense relationships, high threshold for meeting and structures around power sharing and mandate. Could hierarchical layers be a reason for participants feeling a lack of mandate in collaborative processes? To some extent, these organizational layers seemed to add fear of doing something wrong.

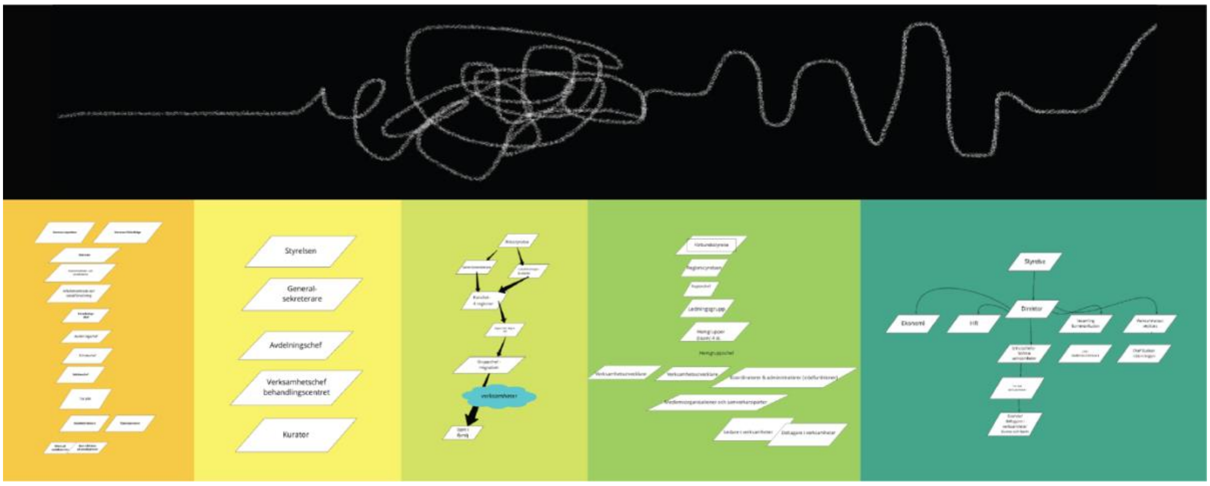

Figure 4: Visualizing the managerial or governing layers of public sector organizations and civil organizations who assist newly arrived minors together with the emotional journey (above) of the designer facilitating the visualization process.

When the exercise was over, it was just one part of the overall agenda, we all got together, and each group presented their chart. There was a near sigh of relief audible, a feeling of the tension being lessened as we started to see the pattern. Showing each other the insides of the lab participants' organizations helped to form a shared understanding of underlying patterns across organizations. There were many layers in all the participating organization, both in the public sector organization but similarly in the civil society organizations (shown in Figure 4). Does this pattern and these layers interfere with our ambitions to collaborate cross-sectorally? Can these hierarchical layers be attributed as a key issue of why collaboration fails? Does the layering of organizations tell us something important about our mental models, both in terms of structures of organization and cross-sectoral collaboration?

What we found in our lab exercise was essential for our understanding of how to bring about change in systems. We gave the lab participants a chance to discuss their own embedded structures, cultures and their space for action. We gave them the chance to feel for collaborating partners part of their underlying structures, norms and mental models. We found this to be a critical step for reflection and believe it to help shape the understanding of how to best intentionally shift the system. The process helps each participant see their own room for manoeuvring more clearly and for the joint system to ask itself how to best create space for action.

In this way, we believe the lab participants will also feel more resilient and curious to let in collaborating others into their transformation processes. We hope they become more comfortable making these things visible so that they can address them head on. Helping them visualize, craft representations, see patterns and explore new ways of dealing with these layers helps participants feel their tensions together and grow their understanding on how to best influence their organization. The intention was to make it possible for the lab participants to see themselves in their own organizational systems and in their joint endeavour to shift it collectively. In this workshop, the design patterns of hierarchy were visualized and made tangible. In doing so they are also made actionable for future collaborative endeavours. Showcasing participants individual and joint frustrations of being trapped in a system and in-between layers of hierarchy, not always with enough room for manoeuvre, was one way of feeling the tensions, and thus releasing them allowing for creativity to take its place. It can also allow for participants to shape alternative spaces for collaborative action.

Exposing Emotional Dynamics through four Fs: Fight, flight, freeze, and feel

Each story told provide insight into the emotional dynamics that emerge when making tensions tangible in systemic design practice. We want to specially highlight the different responses towards tensions, driven in particularly by the emotion of *fear*. Patterns in people's responses to fear is connected with the key behaviours that occur in the context of a perceived threat described as "fight or flight" (coined by Cannon 1927). These possible responses were later expanded to also include "freeze", where for example one could "pay dead" (Gallup, 1977). However, we also see one other hopeful additional response that shows up in these stories, the response is simply to "feel".

In the first story (This Wall Between Us) and the second (Forces at Play), we see examples of *fight* as a response to fear, with the principals seeking to blame the students and the staff censoring the play based on lived experience. The first story also shows an example of *flight*, where in the end one of the civil servants seeks to remove themselves from the situation by quitting her job. The third (Winter Sandals) and forth (A Sigh of Relief) stories show *freeze* as another response to the intense emotion of fear, where the day care workers feel as though they are stuck carrying out the law and the staff have little room to act amid the many layers of their organization. However, the first (This Wall Between Us) and the last (A Sigh of Relief) stories also show a fourth response to fear which is to *feel*, where the youth by embodying the tensions start to feel the dynamics of the divide and it motivates them to act and the staff within the organizations start to genuinely take in what their hierarchies mean for them and their collaborative work.

We see the four Fs – *fight, flight, freeze, and feel* – as a potential starting place for understanding responses to fear that arises in systemic design practice. Perhaps knowledge of the four Fs can aid service design practitioners in better planning for how to support stakeholders to work with tensions in a constructive way. Further investigation into the four Fs and the conditions that contribute to each response would help to further advance working with the nuances of emotions in complex systems change processes.

These stories prompt many questions and suggest that there is a lot more knowledge needed on how best to navigate the emotional dynamics of exposing and working with tensions in systemic design. What contributes to tangible enactments of tensions sparking motivation for action verses defensiveness? How can systemic designers support safety in exploring the tensions and constructive dialogue related to tensions? How might systemic designers confront resistance, flight or freeze and instead support feeling tensions to address them head on? Much work needs to be done within systemic design, not just in the technical aspects of how to make tensions tangible or leverage them in problem reframing, but also with the emotional dynamics that transpire as these tensions are further illuminated through the four Fs.

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When a tree is also a multispecies collective, a photosynthesis process and a carbon cycle

A systemic typology of natural nonhuman stakeholders when designing for sustainability

Emīlija Veselova and İdil Gaziulusoy

Design research and practice is increasingly aware of the sustainability crisis. Various initiatives have started to argue for a need to acknowledge and accommodate the needs of natural entities and systems in relation to sustainability. Such more-than-human considerations have also entered collaborative and participatory design. However, there yet seems to be a lack of broad and systemic perspectives on which natural entities to consider when designing for sustainability. Therefore, we developed a systemic typology of natural nonhuman stakeholders based on empirical study in a garden and analysis rooted in the distinctions, systems, relationships, perspectives – DSRP – theoretical structure for systems thinking. Our typology suggests seven distinct types: individual organisms, single species collectives, multispecies collectives, life processes, living systems, biogeochemical cycles and processes of the atmosphere. However, our findings indicate that one living entity represents several stakeholder types simultaneously. This illuminates a tension between the simplistic and systemic view of stakeholders in collaborative design and calls for a shift towards systemic mental models and new theories, approaches, methods and tools. In this article, we present our methodology and the typology developed; then we discuss the potential implications of the typology on collaborative and participatory design and avenues for further research.

Keywords: more-than-human design, multispecies design, co-design, systems thinking, design for sustainability

Introduction

The sustainability crisis is very urgent and pressing. Design is increasingly recognizing the need for rapid further development in its theory and practice to address this crisis (Gaziulusoy & Erdoğan Öztekin, 2019). One of the areas for such development is the strive for including and accounting for the needs of more than just humans: more-than-human design. Initiatives in this category accentuate the need to rethink the currently dominant human-centric and human-exclusive design principles. Some researchers use the term more-than-human design to refer to artificial nonhuman entities and systems (e.g. see Forlano, 2016). Meanwhile others focus on the need to acknowledge and accommodate the needs of natural entities and systems (e.g. see Akama et al., 2020; Mancini, 2011; Westerlaken, 2020a). We belong to the second group. We align with perspectives from sustainability science, such as the *strong sustainability model* proposed by Neumayer (2003) and the *multispecies sustainability concept* proposed by Rupprecht et al. (2020), see Figure 1. These perspectives acknowledge the irreversible hierarchies between systems that are subjects of sustainability science: humans and human-made systems (such as economic systems and technological systems) depend on ecological systems for resources, sustenance and survival. These perspectives also underline that systems created by human society with their technological, social, political and cultural dimensions, are nested within nature and should not be viewed in separation from it. Additionally, we align with the views that human and natural systems are extensively interconnected and human systems can only be sustainable if natural systems are well functioning (Gaziulusoy, 2015). The visualizations of the strong sustainability model and the multispecies sustainability concept, however, seem to focus on visualising the dependence of humans on nature rather than the interconnectedness of all elements. They do not directly present the dynamic, interconnected nature of the human-made and natural entities and systems. Therefore, we additionally visualize our perspectives in an interconnected manner, see Figure 1. This interconnected perspective on sustainability accentuates that humans and our societal, economic and technological entities are closely and inseparably connected to the natural, environmental entities. However, it does not equally well represent the dependence of human-made systems on natural systems. Overall, these three views on sustainability suggest that designing for sustainability requires a joint consideration of humans, human-made entities and environmental entities in a systemic manner while acknowledging the dependence of human and human-made entities on the natural entities.

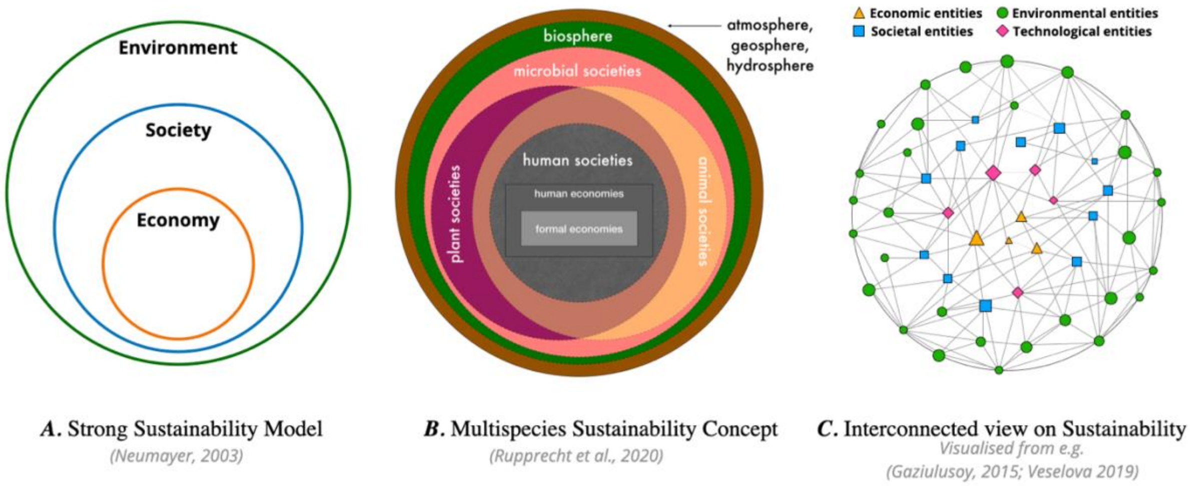

Figure 1. Three views on sustainability that highlight the importance of natural nonhuman entities when designing for sustainability

Collaborative and participatory design (C&PD) is an area of design in which designers involve varied stakeholders, for example potential users, local citizens or business representatives, as direct and active participants of design processes (Sanders & Stappers, 2008; Simonsen & Robertson, 2012). Here, we use the term stakeholder to refer to someone who is involved in creating or affected by the design process or solution (Veselova & Gaziulusoy, 2019). In C&PD, designers can involve stakeholders to jointly explore and learn about the problem; to collectively envision, design and test the solution to a problem; or both (Steen, 2013). Thus, the stakeholders have a large impact on what, how and why something is being designed. Unfortunately, the current mainstream C&PD theory and practice predominantly recognizes humans or societal, economic and technological entities as stakeholders (Veselova & Gaziulusoy, 2019). This is concerning because the acknowledged and involved stakeholders have a strong impact on the definition of the problem and exploration and creation of potential solutions. Thus, if the involved or recognized stakeholders are only human or systems and structures created by human society, it is likely that the definition of the problem and the solution is going to disregard most if not all considerations of the needs of natural entities and systems (Veselova & Gaziulusoy, 2019).

Recently, however, more-than-human considerations in C&PD has been rapidly growing. Researchers are proposing that natural entities should be viewed as important stakeholders in design projects (e.g. see Akama et al., 2020; Westerlaken, 2020a). Unfortunately, a systemic perspective on who or what should be considered as relevant stakeholders for C&PD when designing for sustainability seems to be lacking. Our earlier research indicates that designers typically consider or include mammals, such as dogs or orangutans, to co-create ways that these natural entities interact with humans and technology (Veselova & Gaziulusoy, 2019). Only a few projects, according to our findings, had considered and designed for the systemic interconnections and interrelations in the natural world (e.g. Avila, 2017) and for sustainability. Overall, there seems to be a lack of a broad, systemic perspective on which natural entities can be considered as stakeholders in C&PD processes that strive to design for sustainability. Our research aims to fill this gap by developing a systemic typology of potentially relevant natural stakeholders for C&PD for sustainability.

This paper presents and discusses this systemic typology and its potential implications for more-than-human C&PD when aiming to design for sustainability. The following section describes the research context and methodology. Then, in the *Results & Discussion* section we present the developed typology of natural nonhuman stakeholders and critically discuss the typology and its implications for C&PD and design overall. Finally, we conclude with main take-aways and avenues for further research.

Methodology

The research methodology was based on the principles of multispecies ethnography. Multispecies ethnography is an approach to ethnography which studies natural entities and, especially, their links to humans and the social world (Kirksey & Helmreich, 2010). It views that humans come into being through their interaction with nonhumans in assemblages (Ogden et al., 2013). "We use the term 'assemblage' to suggest not a mere collection of entities and things, but a complex and dynamic process whereupon the collective's properties exceed their constitutive elements" (Ogden et al., 2013, p. 7). Multispecies ethnography focuses on events and actions in which human and nonhuman worlds interact (Kirksey & Helmreich, 2010) and analyzes how these interactions shape each other and the setting (Ogden et al., 2013). It uses methods from ethnography (Ogden et al., 2013), such as participant and nonparticipant observations, interviews and visual research methods, such as photography, videography and audio recordings.

The data collection was conducted by the first author of the article in her family's garden in a small town in Latvia. She selected this location for four reasons. First, a garden is a context that includes humans, natural entities and observable processes and interactions among and between them. Second, the garden encompasses over 25 years of her contextualized experience and knowledge of the natural world previously excluded from her professional practice. She has extensively worked and lived in the garden most of her life. Third, it was a familiar environment that allowed her to avoid a language barrier and to focus on the natural entities and interactions instead of spending time on familiarizing herself with an unknown location, species and language. This enabled her to also incorporate her extensive theoretical knowledge from biology studies in basic and upper secondary school[1]. Finally, it allowed her to have unlimited access to the site while following the safety precautions related to the COVID-19 pandemic.

The first author of the article was immersed in the research context for five consecutive weeks in the summer of 2020. Data collection methods included participant observations; interviews with humans in the setting; recording of ad hoc conversations that took place while humans worked in the garden; recording of photos and short videos of the garden, its elements and nonhuman inhabitants; accounting of the plants in the garden; and recording long audio and video clips of the garden during the time when no human had been in the area. The processes in the garden and the natural entities encountered were carefully documented by taking photographs and videos to capture and preserve rich data about them. Figures 2 and 3 provide two examples of the data captured in photographs.

The collected data was analyzed using the theoretical structures of systems thinking developed by Derek and Laura Cabrera and their colleagues (see Cabrera et al., 2008, 2015, 2021; Cabrera & Colosi, 2008). This theoretical structure is based on four universal and interdependent patterns of systems thinking - distinctions, systems, relationships and perspectives - abbreviated as DSRP. ***Distinctions*** is a pattern of systems thinking in which an analyst observes a boundary between an element and 'the other' thus defining or distinguishing what the element is and what it is not (Cabrera et al., 2015; Cabrera & Cabrera, 2018). Distinction is done, for example, through naming, labelling or defining (Cabrera et al., 2015). Distinction also indicates that the defined element is part of a larger whole that encompasses the element and 'the other' (Cabrera et al., 2008). ***Systems*** is a pattern in which the analyst sees this larger whole as a system of 'two or more related parts' (Cabrera et al., 2008, p. 305). The analyst can and should mentally organize different elements in varied systems to make meaning, and the arrangement of the system changes the meaning that the analyst will draw from it (Cabrera & Cabrera, 2018). ***Relationships*** is a pattern of systems thinking in which the analyst strives to recognize the relationships between the elements in the system (Cabrera & Cabrera, 2018). "Relationships come in all types: causal, correlation, direct/indirect, etc.," (Cabrera & Cabrera, 2018). Relationships are dynamic, and there are seemingly multiple ways through which two elements can be related (Cabrera et al., 2008). ***Perspectives*** is the pattern in which the analyst recognizes that any distinctions, interpretation, relationship-making and meaning-making is done from a certain perspective or point of view (Cabrera et al., 2008; Cabrera & Cabrera, 2018). Changing a perspective through which a

[1] Emīlija Veselova has competed in and achieved high results at the state level biology olympiads of Latvia in 2006 and 2008. Results available here, http://priede.bf.lu.lv/olimpiade/gadi/, under sections Rezultāti.

Figure 2. A close-up photograph of a sweet cherry tree which showcases ripe and rotten cherries as well as dark spots on the leaves from a viral or bacterial disease.

Figure 3. A photograph of the same sweet cherry tree (see Figure 2) which showcases lichens on the tree trunk, the soil in which the tree grows, a human and animal which consume the cherries and a green plastic net used to protect the ripe cherries from birds which live in the adjacent forest and eat them.

system is viewed and interpreted can "instantly transform whole systems, rearrange distinctions, and cause relationships to appear or disappear" (Cabrera et al., 2008, p. 305). The perspective can be informed by many aspects, such as disciplinary training, social norms or personal experience (Cabrera & Colosi, 2008), and can be attributed both to humans and more-than-human elements, including natural nonhuman entities and systems. However, we find it important to highlight that a human, at their core, can only have a human perspective on systems: "one concept (subject) cannot literally 'see' another's point of view, but instead interprets and attributes a particular perspective of the other (object)" (Cabrera et al., 2008, p. 305). The four DSRP patterns of this theoretical structure for systems thinking are inseparable from each other and operate concurrently in the analyst's mind (Cabrera et al., 2008, 2021; Cabrera & Cabrera, 2018; Cabrera & Colosi, 2008). "Even though four patterns are simple, the result of their interactions can be wildly complex" (Cabrera & Colosi, 2008, p. 312). These four patterns served as guiding principles for data analysis.

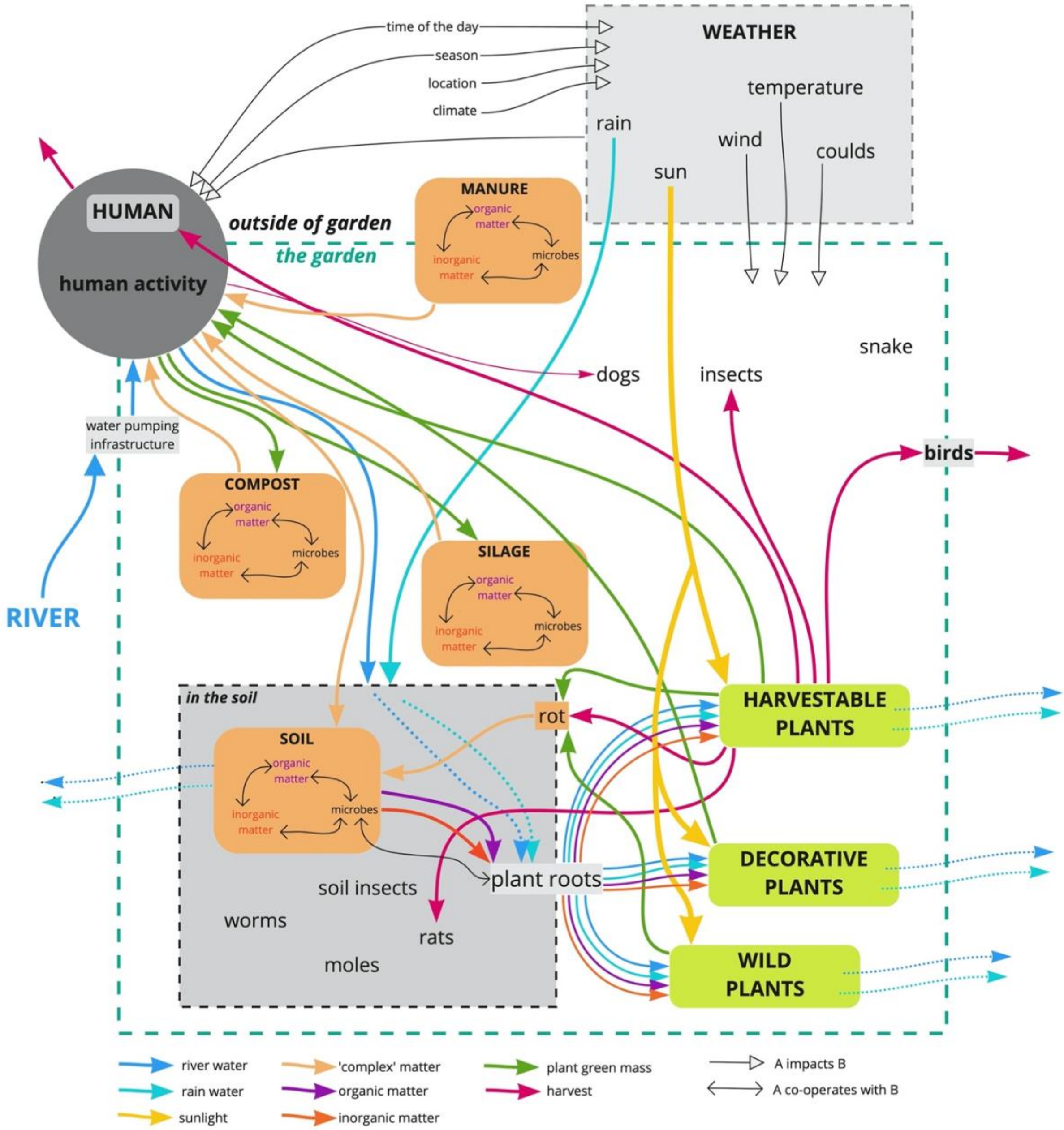

Figure 4. A systems model of the garden developed during data analysis.

We analyzed the data iteratively and collaboratively. Jointly we developed and discussed the analysis strategy. Then, the first author of the article qualitatively coded (Saldaña, 2015) her fieldnotes to start identifying the elements in the garden and interaction or interrelations between these elements. Then, she coded the data in videos and pictures. Throughout the coding, she supplemented empirical data with scientific and other expert knowledge, for example, on farming or gardening via scientific and professional publications, the online edition of Encyclopedia Britannica and species collections. The online edition of Encyclopedia Britannica was selected as a resource because its entries are regularly updated by prominent scholars from the fields that relate to the entry (*Britannica Knowledge Experts*, n.d.). During the coding, the first author utilized the *distinctions* pattern of systems (Cabrera et al., 2015; Cabrera & Cabrera, 2018): she distinguished various elements in the garden by acknowledging how she had called/named them in her field notes or by naming what she saw in the videos and pictures. At the same time, she utilized the *relationships* pattern of systems thinking (Cabrera et al., 2008, Cabrera & Cabrera, 2018) when identifying what relationships between the elements she had described or were visible in visual data. Based on identified elements and relationships, she used the *systems* pattern of system thinking and mentally arranged them into a systems and iteratively visualized this system in a systems model.

She developed four iterations of this systems model; Figure 4 present the fourth and final developed systems model. Throughout this process she retained the perspective of a human and a C&PD researcher and practitioner which aligned with the aim of developing a typology of natural nonhuman stakeholders for C&PD. Thus, the first author of the article continuously utilized the *perspective* structure of systems thinking (Cabrera et al., 2008; Cabrera & Cabrera, 2018). Furthermore, we jointly discussed the elements, relationships, systems models to interpret them through the perspective of the second author. The data, systems models and discussions between the authors about theory and practice of C&PD, design for sustainability and systems thinking informed several iterations of the stakeholder typology and reflections on its implications, future research avenues and limitations. The systemic typology and the reflections are presented in the next section.

Results & Discussion

Table 1. A systemic typology of natural nonhuman stakeholders when designing for sustainability.

Type	Examples
Individual Organism An organism typically seen as an independent living entity	Plants Animals, incl. mammals, birds, reptiles, insects, amphibians, crustaceans, mollusks
Single species collective A collective of organisms from a single species that live together and might have a special organization of their life	Social insect colonies Bryophytes, incl. mosses and hornworts Algae Fungi
Multispecies collective A collective of living organisms, such as microorganisms, insects, worms, and gases, organic and inorganic matter that jointly partake in life processes	Bacterial collectives Lichens Soil Compost Animal manure
Life Processe A flows of elements between living and nonliving parts of the biosphere	Photosynthesis Decomposition of organic matter Respiration Nitrogen Fixation
Living system A location-tied system of living organisms, collectives and the organic and inorganic matter and gasses that jointly partake in life processes ("Ecosystem," 2020)	Garden Lawn Greenhouse Forest River
Biogeochemical Cycle A cyclical flow of an elements between the living and nonliving parts of the biosphere ("Biogeochemical Cycle," 2020)	Carbon cycle Nitrogen cycle Phosphorus cycle Water cycle
Processe of the atmosphere A short-, mid-, or long-term processe in the atmosphere that determines presence of elements and energetic resources for life processes (Waggoner, 2020)	Weather Season Climate

The typology strives to represent the key distinct variations of natural nonhuman stakeholders observed during the case study rather than precise, definite, mutually exclusive or universal categories. However, it can also be seen as a mental model for making sense of the complexity when working with natural nonhuman stakeholders. While the typology seems to indicate clear-cut boundaries between the types, the reality is, of course, more complex. For example, an apple tree is an individual organism, yet it also likely hosts lichens, fungi and insects. It needs pollinators to bear fruit, and it needs microbes to draw nutrients from the soil (Montgomery & Biklé, 2015). It breathes and goes through the process of photosynthesis; thus, it takes part in the cycles of water, oxygen, carbon and other elements. This same tree could and should be seen as an individual organism, a multispecies collective, a living system and a representation of life processes and biogeochemical cycles, all at the same time. In essence, the same living entity is several stakeholder types simultaneously. Figure 5 schematically presents these complex relationships between observable entities and the systemic types of stakeholders. When identifying natural nonhuman stakeholders for C&PD projects it is vital to concurrently view the same entity as different stakeholders. The entity should be viewed through a systemic mental model. Cabrera et al. (2021) suggest a similar notion with an example of the same object being used both as a desk and as a barricade. "*A being a desk* OR *A being a barricade* refers to our mental model of A (our epistemological or cognitive reality)" (Cabrera et al., 2021, p. 14). This challenges the currently dominant perspective on stakeholders in C&PD which views one natural nonhuman entity as one type of stakeholder.

In this research, we deliberately chose to exclude humans from our categorization. Meanwhile, humans could be seen as one of the individual organisms that is included in or related to other natural nonhuman stakeholder types. For example, humans breathe; thus, they are part of the oxygen and carbon cycles. Moreover, human creations and their activity also are linked to the natural nonhuman stakeholders. For example, a mobile app is powered by electrical energy and, therefore, via the energy system is linked to the carbon cycle. This highlights that even projects that seem to have no visible natural nonhuman stakeholders, when viewed through a systemic perspective, have them. Further research is needed to more clearly outline how humans and their activity are interlinked with the natural nonhuman stakeholders, particularly when using a socio-technical systems lens within which they generally are disregarded. This also correlated to our previous research that every design project is linked to ecological systems and sustainability (Veselova, 2019).

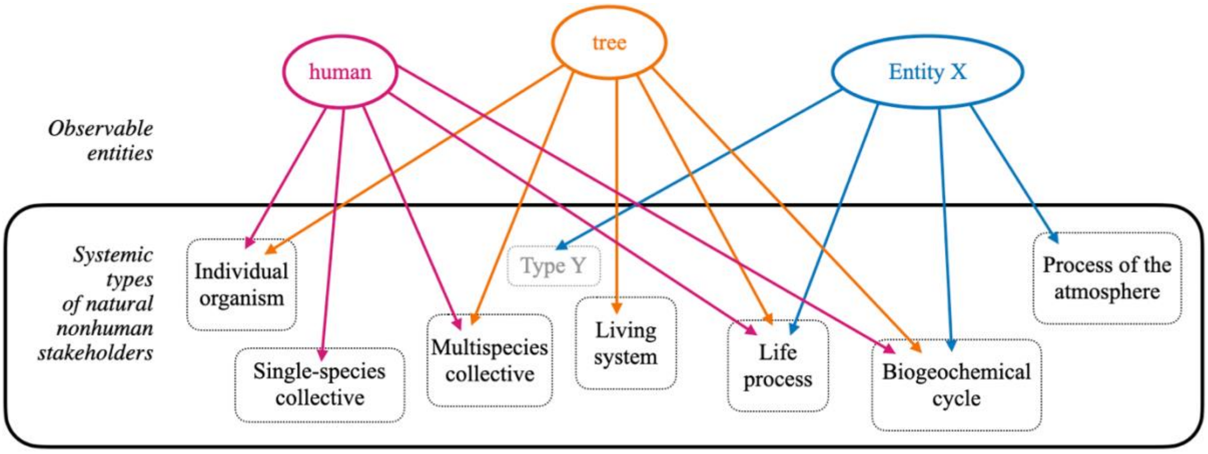

Figure 5. Schematic representation of the relationship between observable entities and the systemic types of natural nonhuman stakeholders.

Thus, designers should view each living entity, including humans, as a collection of several systemic stakeholder types rather than one individual stakeholder. This requires a paradigmatic shift from a fragmented, reductionist view of stakeholders in design processes to one which acknowledges and works with systemic complexity. Such shift seems to challenge the currently dominant perspective that a stakeholder is a separate, independent entity. Our systemic typology suggests one mental model through which a designer could approach viewing natural nonhuman entities. It also accentuates and provides solutions to the often-ignored tension between isolated C&PD projects and systemic world they operate it. This mental model should be further integrated into C&PD theory, approaches, methods and tools to stimulate and support expansion of the mental models of researchers, theorists and practitioners working in the field. For example, when making stakeholder maps for C&PD projects, the designers could first identify the visible entities and beings in the project and then, with the help of the typology, trace back other relevant systemic stakeholders. Currently, such thinking does not seem to be prominent in more-than-human C&PD projects. Typically, such projects view a natural nonhuman stakeholder only as an individual organism (e.g. see Jönsson & Lenskjold, 2014; Robinson & Torjussen, 2020; Webber et al., 2020; Westerlaken, 2020b). However, there have been some projects that take a more complex and systemic outlook. For example, Avila (2017) has identified a plant as a part of feeding and pollination processes of bees. Thus, further research is needed to problematize currently dominant framing of stakeholder in C&PD through a systemic perspective.

The variety of natural nonhuman stakeholder types also raises questions about the current definition of participation in C&PD. It seems that C&PD typically views participation as a direct input of a human being often through the means of verbal or visual communication (Simonsen & Robertson, 2012). However, neither a tree, process of photosynthesis nor carbon cycle can engage in such forms of participations. Overall, none of the types of natural nonhuman stakeholders can directly participate in the co-design process. Nevertheless, all or some of them are still stakeholders of the process that have to be considered and accounted for. Additionally, most often participation seems to be viewed in relation to the design project timeframe; meanwhile, natural entities live according to their timeframes. Therefore, there seems to be a need to re-question what participation is and how to conceptualize it for natural nonhuman entities. This re-conceptualization of participation would have a direct impact on how natural nonhuman stakeholders are considered, included and represented in the projects. The current C&PD tools, methods and approaches have been developed for direct human participation. Therefore, it is crucial to evaluate their relevance when representing complex natural nonhuman stakeholders and to develop novel tools for the purpose.

Additionally, we view our typology as a starting point for an exploration of systemic perspectives on natural nonhuman stakeholders in C&PD and design for sustainability. Our typology should be developed further to represent and accommodate various design contexts. Currently, our typology is based on one case study of a particular outdoor setting. Meanwhile, C&PD is applied in many fields, settings, contexts, both indoors and outdoors. All of these contexts include at least some types of the natural nonhuman stakeholders. However, not all contexts will include the same elements and processes that led to the creation of our typology. Thus, it is necessary to apply this typology in varied arrangements to identify whether it represents the natural nonhuman entities in that setting and how the typology might need to be adapted or expanded. This would also allow the design community to identify which types of natural stakeholders are relevant in particular types of co-design projects and in which ways. Such research would contribute to shaping this typology to be robust and flexible for different locations, contexts, projects, aims and stakeholder configurations.

Furthermore, the research to further develop the typology needs to include direct input of varied scientific and applied disciplines. Currently, our typology encompasses scientific knowledge that we have gathered from secondary scientific sources. Such an approach allowed us to rapidly access verified, up-to-date scientific knowledge from various domains and disciplines. However, it limited the depth and breadth of knowledge that we could access and likely excluded critical disciplinary and interdisciplinary discussions. Moreover, our typology encompasses local, practice-based knowledge of humans in the garden about various processes, cycles and history of the location. Therefore, it seems that the further development of this and creation of similar typologies would highly benefit from transdisciplinary knowledge building. Here, we use the term transdisciplinary to indicate knowledge building that integrates knowledge from varied scientific disciplines and non-academic actors (Hirsch Hadorn et al., 2008). Our work indicates that input from the natural sciences, such as biology, ecology and various branches of Earth science, life sciences would be especially relevant in further development of the framework. Input from sustainability science would be necessary, to include the emerging natural nonhuman frameworks of sustainability, such as the recent multispecies sustainability framework (Rupprecht et al., 2020). Additionally, practitioners in the design community and practitioners working closely with natural entities can support the development of the framework by providing insights on contextual needs, processes and specifications.

Finally, our research also indicates that, when working in the natural nonhuman arena, there is a need for C&PD designers to have an understanding of (1) the natural world, (2) systems thinking and (3) transdisciplinary work. First, when starting to consider natural entities in design, it is necessary to have knowledge about organisms, life processes and the principles under which nature operates. Such knowledge allows the designer to rapidly grasp the basic natural organisms and systems and then creatively engage with them. For example, the research work of the first author was extensively supported by and would be much harder without her previous extensive training in biology and decades of practical experience in gardening. This insight resonates with many researchers working with more-than-human design and on intersections of design and nature (for examples see Fletcher et al., 2019), biomimicry (Benyus, 1998) and regenerative design (Lyle, 1996). Second, more-than-human C&PD designers should have an understanding of and skills working with systems thinking. Nature operates in systems, and sustainability is a systemic property. Therefore, there is a deep need to educate designers that are able to work with these issues with appropriate, systemic mental models and tools. This notion also resonates with designers working in areas of design for sustainability (Ceschin & Gaziulusoy, 2020), urban design (e.g. Yang & Yamagata, 2020) and systemic design (Jones & Kijima, 2018). The DSRP theoretical structure for systems thinking served as a simple entry point to such thinking; however, particular approaches, methodologies, such as systems dynamics, soft systems methodology, critical systems heuristics, systems science (see Cabrera et al., 2021 for overview) could provide further depth and breadth to the exploration and theoretical and practical development. Lastly, designers need to be able to work in a transdisciplinary manner. Research into the natural world is ongoing, and design projects will likely always also include varied human stakeholders. Thus, it is important for designers to be competent in effectively engaging with academic and nonacademic experts and partners and integrating these varied perspectives into design processes and solutions.

Conclusion

In this research, we aimed to develop a systemic typology of natural nonhuman stakeholders that would outline which natural entities should be viewed as stakeholders in collaborative and participatory design projects that strive to contribute to systemic sustainability. Based on empirical research in a garden and analysis of the data using the DSRP theoretical structure for systems thinking, we propose that there are seven key types of natural nonhuman stakeholders: individual organisms, single species collectives, multispecies collectives, life processes, living systems, biogeochemical cycles and processes of the atmosphere. While the seven outlined types are distinctly different, our research indicates that a single natural entity represents several stakeholder types simultaneously. For example, an apple tree is an individual organism, a multispecies collective, a part of life processes and biogeochemical cycles. Additionally, a human could also be seen as an individual organism that is part of several natural nonhuman stakeholder types. Therefore, C&PD should start viewing each living entity, including a human, as a collection of several systemic stakeholders. This suggests a necessity for a potential need to shift towards a systemic, multidimensional mental model about who and what is considered a stakeholder. The systemic perspectives also indicate a potential need for reconceptualization of what participation in C&PD means. Almost none of the natural nonhuman stakeholder types can participate in co-design through direct and deliberate communication, which is currently often seen as the main and only form of participation in C&PD. Thus, a systemic mental model and theory for C&PD and, consequently, tools, methods and approaches for participation in such C&PD are needed. These shifts will also require designers to develop knowledge of the natural world and its processes as well as systems thinking and working with varied scientific disciplines. The typology presented in this paper should be seen as a first step in the long journey towards developing a robust, scientifically sound systemic typology of natural nonhuman stakeholders applicable in most design projects.

Our research indicates that the following future research directions could support development of such typology:

- Further developing the typology to (1) include multidisciplinary and systemic scientific knowledge of the natural world and (2) accommodate various design contexts, locations, projects, aims and stakeholder configurations;
- Building understanding on the ways in which humans and their activities are interlinked with the natural nonhuman stakeholder concept;
- Identifying how C&PD currently perceives and defines a stakeholder and participation and relating that to the systemic natural nonhuman perspectives;
- Identifying whether and how C&PD could adopt the thinking models and tools from systems thinking approaches and systemic design;
- Re-conceptualizing participation in C&PD to be inclusive of natural nonhuman participation and development of tools, methods, approaches that support it.

These developments are likely to contribute to development of C&PD practice that develops projects and solutions that support systemic transitions towards sustainability.

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Track 2: **State-of-the-art**

Chair: Nynke Tromp

Dilemmas and conflicts in systemic design:

Towards a theoretical framework for individual-system dialectic

Deger Ozkaramanli

The productive potential of conflicts, dilemmas, and tensions have attracted scholarly attention, which is also implied by the conference theme: Playing with Tensions. This paper proposes that interconnections in a complex system can be examined using dialectic thinking (i.e. thesis-antithesis-synthesis), which can be facilitated through the micro-meso-macro system architecture. Borrowing insights from a project on bike-security systems, individual dilemmas at the micro-level, interstakeholder conflicts at the meso-level, and conceptual conflicts at the macro-level are examined. Although conflicts are traceable at each level, their structure changes from experiential conflicts (i.e. dilemmas) to interpersonal and conceptual conflicts, respectively. In systemic design, dilemmas help maintain the richness and nuance of individuals' lived experiences when shifting the focus from individuals to systems. In addition, interstakeholder conflicts help address conflicting values and perspectives among stakeholders through revealing their interconnections; and conceptual conflicts help expose the moral and political dimensions of design decisions. Finally, dialectic thinking helps 'probe' the system to reveal the reciprocal and emergent relationships among the interconnected elements of a system. Future research is needed to further deepen the theoretical grounding of this framework and to reveal its implications for systemic design practices.

Keywords: conflict, dilemma-driven design, systemic design, dialectics, micro-meso-macro

Introduction

The concept of conflict and related concepts, such as dilemmas or tensions, have gained considerable traction in design research and practice. For instance, dilemma-driven design utilizes intra-personal (i.e. within-person) conflicts as promising starting points for conceptual design (e.g. contextual research, idea generation) (Ozkaramanli, Desmet, & Özcan, 2020). Moreover, value sensitive design (Friedman & Hendry, 2019) focuses on tensions among stakeholder values (e.g. safety, autonomy) to highlight ethical questions in technology development. In addition, vision in product design (ViP) (Hekkert & van Dijk, 2011) emphasizes that conflicts, which surface when analysing contextual data, signal valuable starting points for formulating a vision that drives design innovation. Building on ViP, Tromp and Hekkert (2014) conceptualizes conflicts between individual and societal goals as social dilemmas and employ these dilemmas as a lens to study the social implications of designing for behaviour change. The productive potential of conflicts is also evident in systemic design, since systems are characterized by complexity, ambiguity and value conflicts (e.g. Dorst, 2019; van der Bijl-Brouwer & Malcolm, 2020). This is also implied by this year's conference theme: *Playing with Tensions*.

Borrowing from Meadows (2008), a system can be defined as an interconnected set of elements (human and non-human) that is coherently organized to achieve a purpose. In this paper, I argue that these interconnections can be examined using dialectic thinking, and this examination can be facilitated through a focus on conflicts across micro-meso-macro levels of a system. Dialectics is a theory of thought development, which is characterized by the dialectic triad: thesis, anti-thesis, and synthesis (e.g. Basseches, 2005; Samson, 2019). In dialectics, the perceived conflict between a thesis and an antithesis sparks a synthesis. A dialectic approach to systemic design can help pinpoint the reciprocal and emergent relationships that exist between the interconnected elements in a system.

To facilitate dialectic thinking, I suggest examining conflicts using the micro–meso–macro system architecture (e.g. Li, 2012). At the micro-level, dilemma-driven design can guide design decisions (Ozkaramanli, Desmet, & Özcan, 2020). However, systemic design shifts the focus of analysis from individuals (micro-level) to organizations (meso-level) and society (macro-level). This creates a more complex design space, in which managing 'messes' replaces solving problems (Ackoff, 1994). For instance, at the meso-level, various stakeholders can have conflicting perspectives or requirements from the system (e.g. Castano et al., 2017). Moreover, one can possibly trace the sources of intra- or interstakeholder conflicts to macro-level structures (e.g. laws, legal regulations, policies). Consequently, dilemma analysis needs to be expanded to examine conflicts across the micro-meso-macro levels.

As a result, the main goal of this paper is to set the stage for an individual-system dialectic through examining conflicts using the micro–meso–macro system architecture. This theoretical framework aims to help maintain the richness and nuance of individuals' lived experiences when shifting the focus from individuals to complex systems; and to create a shared relational vocabulary for mapping reciprocal relationships in a complex system.

Dilemmas, conflicts and systemic design

This section elaborates on the theoretical framework underlying the individual-system dialectic by borrowing insights from a design project completed as part of a ten-week, bachelor-level research internship at the University of Twente (supervised by the author). This project focused on using dilemma-driven design (DDD) (Ozkaramanli, Desmet, & Ozcan, 2020) to design a bicycle security system for large cities in the United Kingdom (Hepburn, 2020). DDD is supported by a set of methods and tools that generate empathy for people's deeply-held goals and values in contextual research and stimulate associative thinking in idea generation (Ozkaramanli, Desmet, & Ozcan, 2016). DDD has so far mainly focused on identifying and addressing end-user dilemmas that prevail in daily life (micro-level conflicts). The bicycle-security project was a step towards using DDD methods to identify and address interstakeholder conflicts (meso-level conflicts).

Micro-level conflicts

One of the challenges of owning a sophisticated bicycle is to prevent it from getting stolen. Imagine having purchased such a bicycle after saving up for it for months. You decide to store it in your apartment overnight to keep it secure. But after a long evening out with friends, you feel too tired to carry it indoors. You hesitate: Lifting a bicycle is quite a chore when you are exhausted. But, isn't it better to be safe than sorry? This moment of hesitation characterizes an everyday dilemma, and it can potentially be resolved through design. In DDD, the design team identifies end-user dilemmas relevant for a specific project through analysing contextual research data with a focus on dilemmas. In the bicycle-security project, the dilemma analysis yielded five dilemmas (Figure 1a), which were further analysed using the framework of dilemmas (Figure 1b).

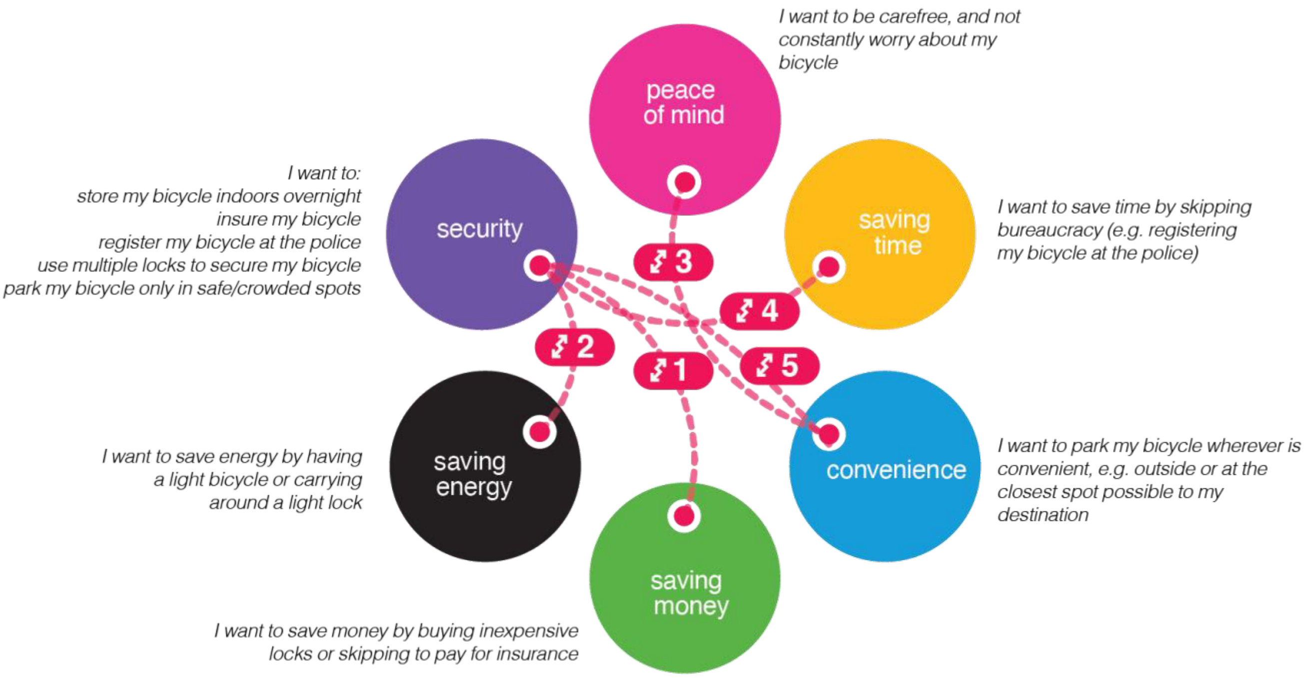

Figure 1a. The conflicting relationships among cyclists' goals at the micro-level

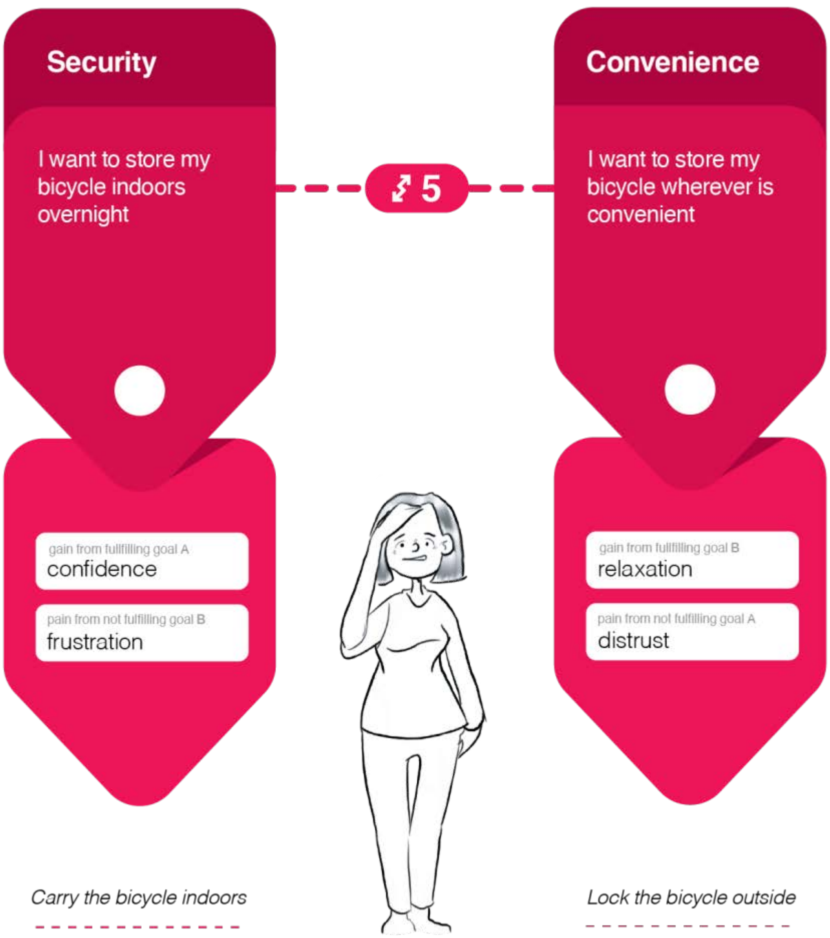

Figure 1b. Framework of dilemmas for designers illustrating the security-convenience dilemma (#5 on Figure 1a)

The framework of dilemmas acts as an analytical tool to unpack the experiential components of a dilemma, which are conflicting goals, mixed emotions, and mutually exclusive choices (Ozkaramanli, Desmet, & Ozcan, 2016). The process of filling out this framework facilitates a shared, in-depth understanding of dilemmas and stimulates empathy with the end-user. Simultaneously, juxtaposing the two choices as an 'either-or' scenario strengthens the perceived conflict among these choices and fuels creativity in idea generation. This productive function of conflicts is a tenet of dialectical thinking (Basseches, 2005), which evaluates a thesis (choice A), an antithesis (choice B) to form a synthesis (design solution). Figure 2 shows a bicycle-frame handle which can potentially resolve this dilemma by helping to lift one's bicycle comfortably (i.e. design solution as synthesis).

Figure 2. Bicycle frame handle by Walnut Studio[1]

In summary, DDD conceives human psyche as a web of relations and emphasizes conflicting relationships among goals as promising entry points for design. On the one hand, this micro-level analysis can be framed as systemic design: it considers human psychology as a complex system of interrelated goals in a particular context and synthesizes design opportunities through playing with the tension between two mutually exclusive choices. On the other hand, micro-level interventions may risk addressing the symptoms of a challenge (e.g. the difficulty of carrying a bicycle) rather than its root causes (e.g. the high rate of petty crime in a city). This understanding calls for expanding the dilemma analysis to interstakeholder conflicts at the meso-level.

Meso-level conflicts

To identify interstakeholder conflicts, Hepburn (2020) interviewed a police officer, a bicycle shop owner, an employee of an insurance company, and a former bicycle thief. An overview of interstakeholder conflicts is shown in Figure 3, where each number corresponds to a conflict.

[1] https://www.kickstarter.com/projects/walnutstudiolo/bicycle-frame-handle

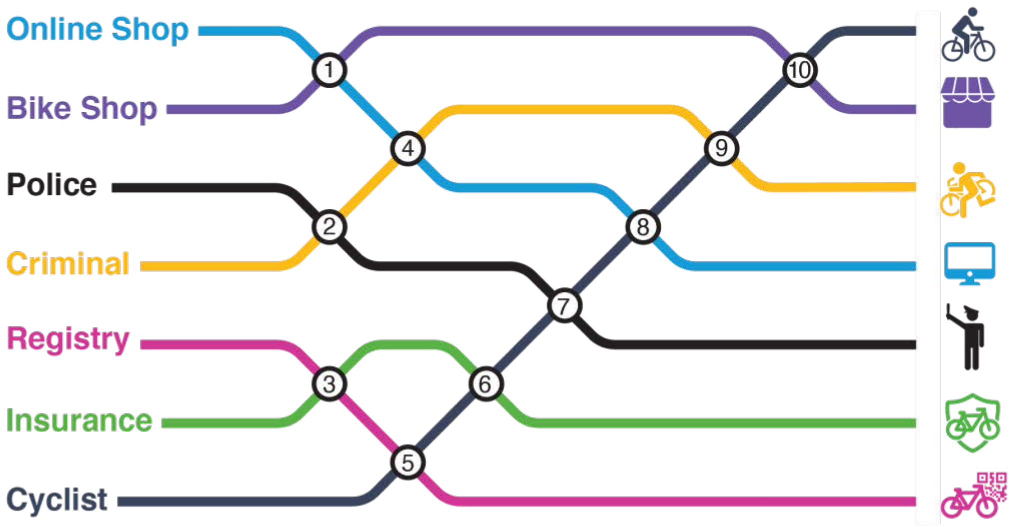

Figure 3. The overview of ten different interstakeholder conflicts

Arguably, any conflict presents a design opportunity that can improve the bike-security system. However, the dialectical thinking approach suggests that the reciprocal relationships between interconnected elements should be examined through multiple thesis-antithesis-synthesis cycles before (if at all) settling on a design intervention. For instance, the police needs solid evidence to catch a bicycle thief, which takes time (thesis-1). Yet, the cyclist expects the police to retrieve a stolen bicycle before it is sold (antithesis-1). This conflict between the police and the cyclist (intersection #7 in Figure 3) inspired Buckle-Up. Buckle-Up (synthesis-1, see Figure 4) is a product-service system that combines a smartphone application and a GPS-enabled bicycle-lock. The lock enables tracking the location of the bicycle, and the app facilitates communicating with the police department.

Figure 4. Buckle-Up, a product-service system

Buckle-Up is based on sharing the responsibility between the cyclist and the police. Although this may be a satisfactory end-result from a user-centred design perspective, dialectic thinking suggests that the project could continue to better understand the emergent properties of the system. For this, the initial synthesis (Buckle-Up) can be transformed to a new thesis. For instance, knowing the location of a stolen bicycle does not necessarily mean that the police will act on it. This leaves the cyclist with the dilemma of wanting to retrieve a stolen bicycle without informing the police (thesis-2), yet fearing the potentially harmful consequences of this action (antithesis-2). This dilemma could be addressed through a new synthesis, such as using social media to slow down selling a stolen bicycle (synthesis-2). In summary, continuing to probe the system in this way will not only lead to new ideas, but it will also reveal reciprocal and emergent relationships among the stakeholders.

Macro-level conflicts

Any system is part of a larger social, cultural, political structure (e.g. an organization, a nation). Therefore, it seems important to set system boundaries in a way that this larger structures can be examined and challenged. This requires a critical perspective for which the ethics of technology and critical theory can form the basis for exposing and challenging the ways in which oppressive social and political structures have come to be normalized (e.g. Ogbonnaya-Ogburu et al., 2021).

For instance, in a 2014 Dutch documentary by Sunny Bergman[2], a social, field experiment was carried out in which three men of the same age and wearing identical clothes try to cut the lock of a bicycle in a public space. The only difference between the men is their ethnicity. Passers-by, who are later interviewed, assume that the white man had forgotten his key, whereas they question the other men (with different ethnicities) whether the bicycle belonged to them. What can be learned from this field experiment is the following: While designing products to resolve conflicts is tempting, it is a relatively naïve stance when not accompanied by moral engagement with the topic (Ozkaramanli & Nagenborg, 2020). Although it is not possible (nor desirable) to reduce insights from the ethics of technology and critical theory to a set of critical questions, I will offer some illustrative questions for the sake of clarity. For instance, any dilemma at the micro-level can be critically examined by asking: why is this dilemma experienced? Who benefits from provoking/resolving this dilemma, and who gets harmed? A conflict often has a premise (e.g. a person of colour is more likely to be a criminal, x is an unsafe neighbourhood). And it is arguably through unlearning and relearning these premises that systemic design can drive social innovation.

Early conclusions and future research

In this paper, I argued that interconnections in a complex system can be examined using dialectic thinking, and this examination can be facilitated through a focus on conflicts across micro-meso-macro levels of a system. Borrowing insights from a design project on a bike-security system, end-user dilemmas at the micro-level, interstakeholder conflicts at the meso-level, and conceptual conflicts at the macro-level were examined. Moreover, this paper contributes to capturing the emergent properties of a complex system by positioning the dialectic triad (thesis-antithesis-synthesis) as a thinking tool to probe the system. This can be compared to the co-evolution model of the problem and its solution (e.g. Dorst & Cross, 2001; Dorst, 2019b), with the difference being that conflicts (vs. problems) form the unit of analysis and dialectic thinking serves as mechanism to probe the system through these conflicts (cf. Dorst, 2019a).

Although the concept of conflict forms the main unit of analysis at each level, the structure of these conflicts changes from *experiential conflicts* (i.e. dilemmas) at the micro-level, to *interpersonal conflicts* at the meso-level, and *conceptual conflicts* distilled from critical analysis of the system at the macro-level. Out of these three different 'flavours' of conflicts, dilemmas are perhaps the most accessible and easily relatable due to their experiential qualities. In systemic design, this may help to maintain the richness and nuance of individuals' lived experiences when shifting the focus from individuals to complex systems. At the same time, focusing strictly on dilemmas may risk overlooking conflicts among stakeholders, as well as the ethical and political dimensions of design decisions. Therefore, handling conceptual conflicts at the macro-level calls for bridging ethical reflection and systemic design. Guidance ethics (Verbeek & Tijink, 2020) is a promising approach for making this bridge, as it facilitates asking critical-ethical questions throughout the design process, enabling stakeholders to collaboratively expose and challenge values, biases, and assumptions underlying their design moves (cf. Schön, 1984).

The proposed individual-system dialectic framework is promising yet not complete. Insights from organizational and moral psychology can help deepen the understanding of meso-level conflicts. Moreover, critical theory (e.g. Ogbonnaya-Ogburu et al., 2021) and guidance ethics (Verbeek & Tijink, 2020) can help get a grip on macro-level, conceptual conflicts. Here, critical systems theory can also form a suitable interdisciplinary bridge (e.g. Eelderink, Vervoort, & Laerhoven, 2020). To further unpack the reciprocal relationships between dilemmas,

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[2] https://www.vpro.nl/programmas/2doc/kijk/2doc-overzicht/2016/zwart-als-roet.html

interstakeholder conflicts, and conceptual conflicts, the dialectic method will be implemented in a large-scale social innovation project in the future.

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Storytelling for systems design

Embedding and communicating complex and intangible data through narratives

Elise Talgorn, Monique Hendriks

Our research explores how storytelling can support complex systems thinking. In systems thinking, a major challenge is to communicate the large amount of data of complex systems and to give meaning to this data through expressing intangible aspects such as interpretation, intuition, purpose, mental bias, and uncertainty. This is key for systems thinkers to fully apprehend systems, but also for other stakeholders involved in the co-design process to easily access this complexity. There is a need for practical tools that embed in the systems design process the systems' complexity associated with relevant intangible aspects. Narratives do have the potential to gather, embed, make understandable and memorable the complex and intangible data of systems. We propose several uses of *systemic storytelling*, an approach based on building parallel story arcs constructed on and/or connected by systems' elements. Systemic storytelling combines logical analysis to an intuitive and empathetic comprehension of systems. This approach has benefits at several stages of the systems design process: to engage stakeholders and enable the sharing and capturing of their different perspectives, to effectively communicate systems insights, and to ideate on future systems. In this short paper we describe the method principles and show three preliminary application examples.

Keywords: storytelling, complexity, intangibility, perspective, communication

1 Introduction

Transforming our world positively and sustainably requires embracing the complexity of current global challenges. We need methods to approach systems from a complexity perspective, which implies studying and designing for open, unpredictable systems. This represents a major mindset shift that must be embraced not only by designers but also by other stakeholders involved in the system transformation. Furthermore, tools that are accessible and applicable in a practice context for e.g. social, organizational or innovation transformation are lacking (Hazy & Uhl-Bien, 2014; Lorino, Tricard, & Clot, 2011; Nijs, 2014).

To be successful, systems design must be a participatory process that regularly involves stakeholders in the co-design. Such co-design requires tools that support deep and holistic comprehension of systemic challenges and the ways to influence these systems. These tools must be graspable for all stakeholders with different expertise, education, and culture. Representing the complexity of the system in a way that it is communicable and understandable by all stakeholders is challenging. Visual representations of system data (called system maps, or gigamaps) are a good way to thoroughly capture system variables and connections between them but are too rich to be communicated to anyone not involved in building the map.

Another challenge is that data collection can never be complete as we deal with open systems where knowledge is heterogeneous, dispersed, incomplete, often tacit (Nijs, 2014) and "fuzzy" (Dimitrov, 2003). In selecting the data to represent the system, one cannot be exhaustive, and must rely on the insights, interpretation and intuition of the stakeholders' carrying the perspectives in the system.

With our research we want to address the need to embed in the systems design process complexity as well as intangibility, subtlety, and intuition in a way that is structural but also accessible.

2 Why stories for systems design

Understanding the complexity of a system is a matter of interpretation, and needs methods that combine a logico-scientific with an intuitive, or narrative, mode of thought (Lorino et al., 2011). The narrative mode, or other interpretive uses of language like poetic language, stimulate interpretation and communication of complexity by embedding contextuality, reflexivity, contradictions inherent to the system, purposes and motives (Stroh, 2015; Tsoukas & Hatch, 2013).

In complexity thinking the transformative outcome must be considered in terms of evolutions instead of solutions (Dimitrov, 2003). This means shifting from a linear problem/solution mindset to an evolutionary mindset (Hazy & Uhl-Bien, 2014), i.e. generating new dynamics, behaviors, ideas and processes that can evolve over time, possibly beyond the designers' control. It is difficult for people to accept the inherent unpredictability of open, non-linear systems. Storytelling has the power to unlock imagination for the storyteller and their audience and to get them out of the logical flow to spark new ideas or perspectives (Quesenbery & Brooks, 2010). Narratives can onboard stakeholders by supporting a shift from an analytical and linear mindset to an awareness of dynamic processes, relationships, unpredictability, novelty and emergence in complex systems (Tsoukas & Hatch, 2013). This allows seeing the whole system picture while relating it to its deeper structures and dynamics, which in turns may support individual awareness and willingness to act (Saltmarshe, 2018; Stroh, 2015).

Finally, storytelling transcends cultural divides of multidisciplinary teams (Gruen, Rauch, Redpath, & Ruettinger, 2002) and provides a common understanding and vocabulary (Quesenbery & Brooks, 2010). Participatory storytelling has been shown to enable inclusive and creative multi-disciplinary collaboration and the expression of different perspectives between various stakeholders that is necessary for systems co-design (Iwaniec et al., 2020; Talgorn, Hendriks, Geurts, & Bakker, 2021).

3 The systemic storytelling approach

In our research, we use *systemic stories:* parallel storylines that intersect to represent an interpretation of a system. The intersections can occur because different people interact with each other or with a same object, different events happen at the same location, a same event is perceived differently, or different people share similar behaviors, emotions, thoughts, goals or threats.

Systemic storytelling deviates from typical storytelling because:

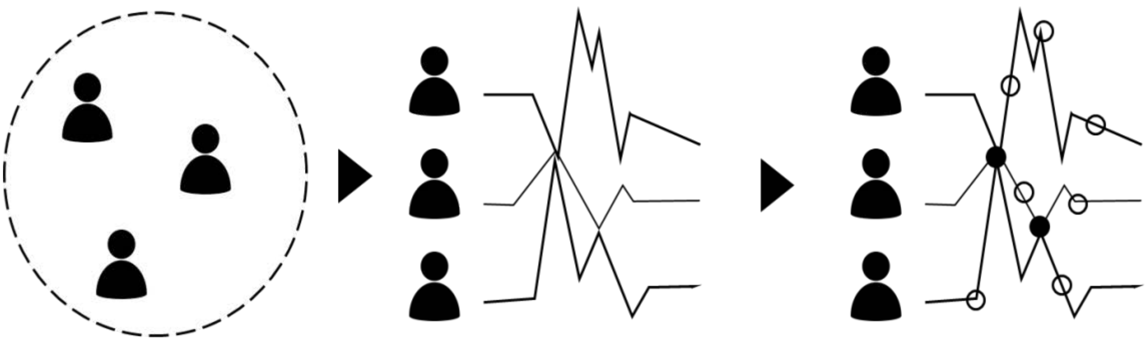
- **Parallel stories show different perspectives.** They focus not on one but several heroes and bring a broader perspective than traditional user-centrism. Different narrative techniques and media can be used, e.g. using first- or third-person perspectives in static or interactive stories. For example the interactive storytelling experiment depicting Shakespeare's *Merchant of Venice* – notorious for offering multiple interpretations from different perspectives – creates a story world that can be explored several times (Charles, Porteous, & Cavazza, 2010).

- **Systemic stories are non-linear.** Systemic stories can be read cyclically or in parallel, without per se a beginning nor an end. For example, in the *Ghost Boat* investigation the reader navigates interwoven personal stories to find out what happened to a boat carrying 243 refugees that went missing in the Mediterranean (Reidy et al., 2015).

- **Systemic stories enable zooming in and out between different levels of comprehension.** They connect the individual experiences to the interpersonal and sociopolitical views and to the factors responsible for the problems and proposed solutions (Saltmarshe, 2018; Stroh, 2015; Winskell & Enger, 2014). They combine analytical reasoning typical in classical systems thinking with the imagination and empathy triggered by storytelling.

We foresee four uses of systemic storytelling:

1) **Engage stakeholders and show their different points of view.** Awareness of the multiple perspectives in the system is the first step to a co-design process. Storytelling of the stakeholders' experiences and opinions, for instance using auto-ethnography methods, makes them explicit and reveals tacit information important in shaping the system. In Figure 1, we show how the stakeholders narratives – visualized as story arcs (Freytag & MacEwan, 1960) – must be expressed to extract *individual variables*, i.e. data that are relative to a certain stakeholder's behavior, thought, emotion, past, environment, and how these narratives are connected by *collective variables,* i.e. shared or conflicting elements.



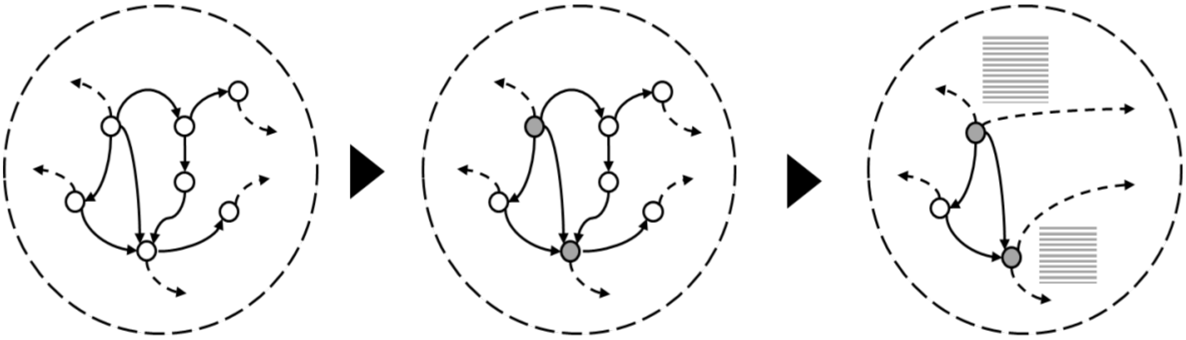
Mapping of stakeholders in a system.

Individual storytelling of stakeholder's narratives. The black line represents the story arc, i.e. the line of action and emotion in a character's story.

Identification of individual variables (black line circles) along the stakeholder's story and collective variables (full black circles) that are common to several stakeholders' stories.

Figure 1. Storytelling to express different perspectives in a system and gather related data

2) **Comprehend and communicate system complexity and intangibility.** Complex system maps are tedious to analyze and communicate. One can use stories to facilitate details memorization (Marsh, Meade, & Roediger Iii, 2003) and to integrate subtle and intangible aspects of people's experiences such as purpose, priorities, mental bias, social interdependencies, and emotions. Stories can highlight the most relevant or critical parts of the system, reflecting the interpretation and intuition of the system analyst to create meaning as well as communicating uncertainties. Secondary data can be embedded less prevalently in the story e.g. through descriptions, anecdotes, subplots, hence staying in the background without being excluded. Figure 2 shows how a system map can be simplified using narratives.



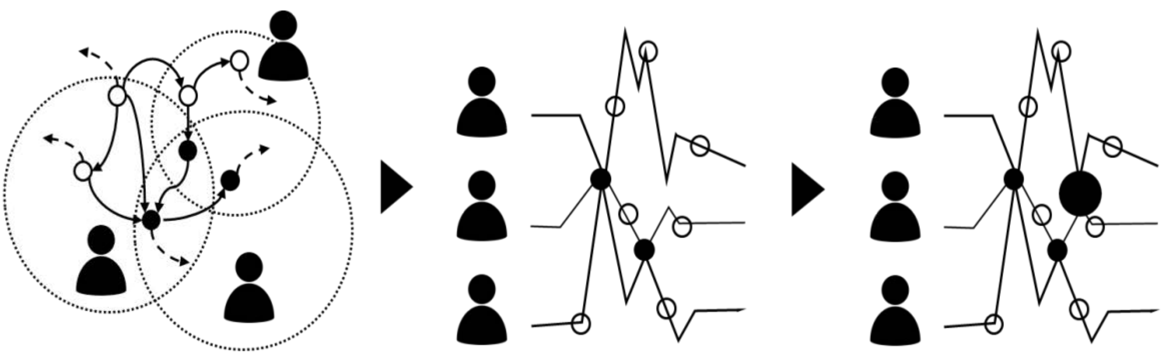
Mapping of a large number (n>>30) of variables in a system.

Identification of leverage points (grey filled circles). Leverage points are main variables/topics that need to be tackled as they are major players in the problem or solution.

Simplified map with a limited number of variables (n<20) and stories (dashed rectangles) expressing the removed variables, their relationships and the intangible aspects.

Figure 2. Storytelling combined with system mapping to communicate complex and intangible systems insights

3) **Ideate on future systems.** Systems transformation is generally a stepwise process, where solution ideation is often approached from an incremental perspective. Disruptive transformation can also be achieved by imagining radically new systems and back casting realistic transformation steps. However, it is very difficult to envision radically transformed systems because it implies a major change and reshuffle of the system elements, hence assimilating large data sets and new mental models. Storytelling supports apprehending a large amount of details as explained above and story or scenario building is a known design tool for creative future ideation (Bourgeois-Bougrine, Latorre, & Mourey, 2018; Lichaw, 2016; Parrish, 2014). Future story creation based on current systems data can be used for disruptive system ideation (Iwaniec et al., 2020). In Figure 3 we propose such an ideation process that uses envisioning of parallel future stakeholders' narratives from which future systems data, as well as unthought-of connections that are seeds for new solutions, are extracted.



Mapping of variables in a system and the sphere of influence/experience of stakeholders (dashed circles) with individual (black line circles) and collective (black full circles) variables.

Parallel story building of future stakeholders' narratives using systems variables and relationships and connected by collective variables.

Identification of new or unthought-of variables and relationships such as unexpected future interactions, conflicts, and new solutions (big black full circle).

Figure 3. Parallel story building to ideate on future systems

4) **Change behaviors to transform systems.** Storytelling has the power to change bias and trigger action through awareness creation and narrative transportation. This can be used for behavior and cultural change of users and consumers in the solution implementation phase (Chamberlin & Boks, 2018; Daae, Chamberlin, & Boks, 2018; Gebbers, De Wit, & Appel, 2017; Van den Hende, 2010; Winskell & Enger, 2014) to enable system transformation. It can also be used to engage critical stakeholders during the system co-design, by changing bias or creating a sense of community around a narrative or vision (Sergeeva & Trifilova, 2018; Winskell & Enger, 2014).

4 Exploratory systemic storytelling experiments

In this section, we share examples of the first three uses of storytelling in systems design, executed at a large company as part of the innovation process. The systems design process that we typically follow is represented in Figure 4. It is inspired by the Systemic Design Toolkit from the design agency Namahn (Namahn). In the first phase of exploring which data to include in the system study, we use storytelling to engage stakeholders in sharing their perspective (*Example 1*). After building the system map, storytelling is used to communicate the system's complex insights and the interpretation of the systems analyst to stakeholders (*Example 2*). The system map is then used to identify leverage points and opportunities for ideation. The ideation for intervention points and future systems is supported by the creation of parallel and intersecting storylines (*Example 3*). Finally, when implementing solutions, storytelling can again be used for stakeholder engagement and user/consumer behavior change.

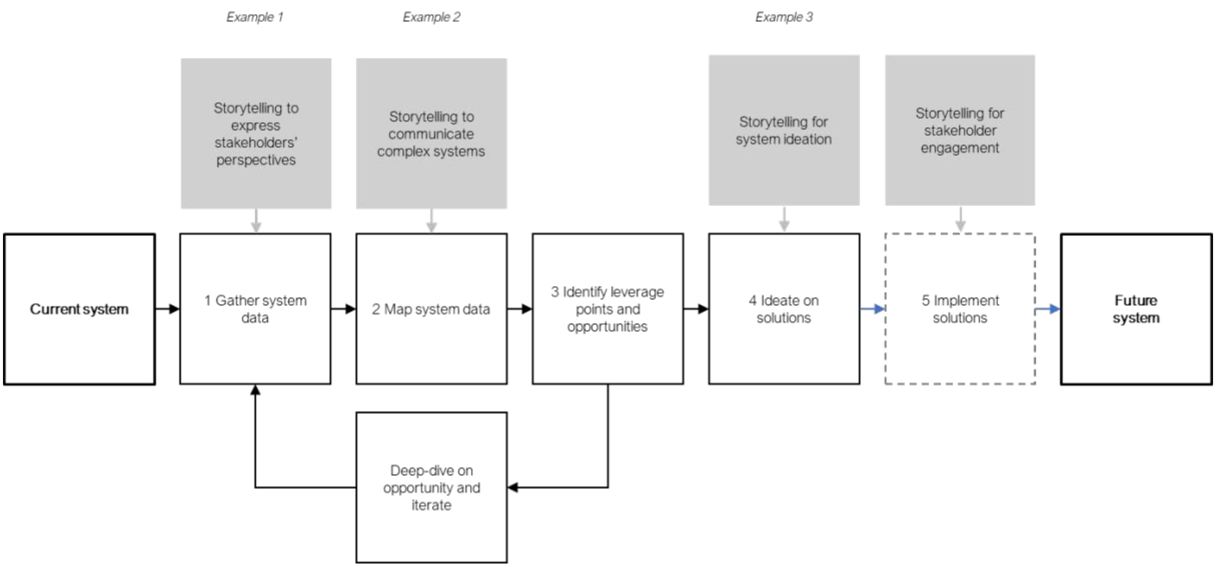


Figure 4. Simplified representation of our systems design process with storytelling intervention points

Example 1 | Individual perspective writing to express the dynamics of collaboration in a multidisciplinary group.

For a systemic study aimed at understanding and improving the dynamics of internal collaboration in an organization, we gathered people's perspectives within small multidisciplinary teams representative of the bigger group. We organized a role play, putting the participants in a fictional situation, which was the kick-start of a multidisciplinary project. We asked them to align on the project's main deliverable and define roles. Afterwards, each participant wrote about their individual experience of the collaboration and the perception of their role by others. In a third step, the participants read their personal stories to each other and discussed the differences and commonalities. They listed the barriers and enablers for collaboration, as well as the emerging mental models for each role.

This exercise resulted in preliminary identification of critical attention points and opportunity areas. The participants felt the exercise generated insights into the collaboration dynamics at a deep level (bringing up topics such as trust and fear of conflict). As a secondary benefit, the expression of individual emotions and perceptions contributed to team building and a better understanding of the roles and responsibilities.

Example 2 | A system representation combining mapping and stories to effectively communicate to decision makers.

To identify enablers for an organizational transformation towards a defined strategic target, we analyzed systemically the organization structure and dynamics resulting in an extensive system map with n>200 variables. Alignment with key stakeholders and decision makers required effectively sharing the insights of the map with them.

Verbally explaining the variables, their connections, the identified gaps and opportunities while navigating the map visually took 45 minutes. While the stakeholders praised the methodology for the insights it uncovered, the general feedback was that it was "a lot of information to consume all at once" and that "the output is complicated and difficult to understand".

We simplified the map following the process shown in Figure 3, creating story blocks that expressed the deleted variables, connections, gaps, opportunities and intangible aspects such as stakeholders' biases, struggles and sense of urgency. Graphical elements were used to visually guide the reading, such as circularly arranging the story blocks and associating them with the respective parts of the simplified map using color coding. The systemic story map could be shared in 30 minutes. The stakeholders underscored that the map was "an awesome communication piece" and appreciated the tangibility of non-obvious connections and wide-ranging perspectives.

Creation of the complete, granular system map was necessary in the analysis phase to organize the collected data and to obtain the profound understanding of the system mechanics needed to identify hidden gaps and opportunities, but it was impossible to communicate the map full complexity to stakeholders and trying to do so can even damage their engagement. The simplified map using stories, with an important role of visual storytelling, did enable to successfully share the complex insights.

Example 3 | Parallel story building to ideate on new solutions to a systemic problem.

In this project the goal was to find new solutions to improve awareness for a health problem with lifestyle causes and consequences, associated with multiple co-morbidities. We approached the issue holistically, using system mapping to form a model of the interactions leading to and resulting from this condition, including clinical, experiential, social, emotional aspects and the set up and perception of the health care system.

In an ideation workshop, a team of designers and scientists created sets of parallel future storylines based on the system map of the current situation. We used exercises to guide exploration of the system map and to coach on creative story writing. Each participant built a fictional character experiencing tensions and problems found in the map. The participants shared their characters in groups of four and brainstormed on a plotline where the individual storylines intersected, i.e. where their characters interacted with each other, experienced the same events, and/or interacted with the same object. The participants individually wrote stories from their character's perspective but involving all four characters. After the workshop, the stories were analyzed to filter out new ideas or unexpected conflicts.

The process resulted in identification of 8 interesting new opportunities to explore of which 4 were systemic in nature, meaning that they crossed the borders of a purely technical intervention or point solution: they solved problems related to many users with conflicting needs or to large heterogeneous data ecosystems.

5 Future research and outlook

The three experiments described here show promising results for the use of storytelling at different stages of the systems design process, ranging from the gathering of insights to construct the map to communicating the complexity of the constructed map and ideating on future states of the system. Through engaging logic reasoning as well as narrative thought, systemic storytelling allows for thorough understanding of complex systems with limited time investment and without requiring expertise on systems design. It enables expression and involvement of different perspectives, which is crucial to reveal hidden systems mechanics and new opportunities, as well as engaging a diverse set of stakeholders in the envisioned systemic change.

Future experiments should empirically investigate these effects, as well as the influence of different narrative techniques, genres and media, to conclude on the impact of systemic storytelling on the systems design process and outcome. Also, the application of the approach in different contexts and at different scales should be categorized and linked to the existing literature in transformative and complexity practices.

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Track 3:

Education As Research Platform

Chair: Praveen Nahar

Education as a transforming practice

Designing together for complex, sustainable living

Caroline Hummels and Pierre Lévy

Our current education systems do not adequately support students to learn how to deal with complex challenges and to create together alternative practices aimed at sustainable futures. We have developed a design approach and repository for transforming practices (TP) in order to engage with the world in co-response-able ways. During the past 20 years, we have explored and transformed educational practices to enable situated, self-directed and lifelong learning. In this paper we explain our journey of transforming our education systems and how the 5 principles of TP have been guiding this process, i.e., complexity, situatedness, aesthetics, co-response-ability and co-development. We illustrate with examples from our own educational practices how TP can help transforming current education systems into corresponding lifelong learning practices that support designers and participants in designing for alternative complex, sustainable futures.

Keywords: designing for transforming practices; self-directed lifelong learning, complexity; situatedness, co-response-ability

Introduction

The first author recently saw a movie *The Man Who Knew Infinity* (2015) about the genius Indian mathematician Srinivasa Ramanujan (1887-1920). Despite it being a beautiful movie, it is painful to see that such a genius was thwarted by the existing education systems and the dominant views of doing proper education and research during almost his entire life. It was thanks to specific persons like professor Hardy, who enabled him to come to work/study?? England, that Ramanujan finally got recognition for his exceptional work in the field of mathematics, although he is still quite unknown in the Western world given his brilliant talent.

We are now over a century later. Have we managed to change rigid education systems that crush students who do not fit in? Do our current education systems support individual students to learn, grow and get the best out of themselves? Ken Robinson states that this is clearly not the case. Our education systems are still modelled on principles of industrialism, as if school were factory lines with ringing bells, separate facilities and subjects, and batches of students divided by age (Robinson and Aronica, 2016). Not only is it likely, that geniuses like Ramanujan will be crushed in our current education systems, but many students will not fit in, as rapper and spoken word artist Prince Ea (2016) also indicates in his clip *I sued the school system*.

Apart from the tension that individuals experience when their values clash with those of the education system, one might also wonder whether the current system suits our (future) necessities. Are our education systems adequate to prepare students for unknown futures, up to at least 40 years from now, when they will still be working? Do current education systems support us learning to deal with complex challenges and create roads to sustainable futures? Here too, we feel tension and see major value and paradigmatic conflicts. Most education systems seem to fit better with the classical-scientific view based on reductionism, determinism, objectivity and predictability developed by, for example, Newton, than with "new" scientific views based on relativity, self-organization, complexity, and non-reversibility developed by, for example, Einstein, Bohr and Prigogine (Doll, 1986). This seems strange, especially since many researchers and institutes stress the necessity of building upon the latter scientific view, i.e., embracing principles like complexity and self-organisation, to deal with our major societal challenges. This relates to both developing resilient complex systems to handle shocks and disruptions like global warming or Covid-19 (e.g., Barabasi et al., 2013; Vermeer, 2014; Mühlenbein & Rutsch, 2020), as well developing complex education systems that learn students and institutes to become competent with complex thinking and doing (Doll, 1986; Fleener, 2005; Rayner et al., 2010; Jacobson et al., 2019).

We postulate that a transformation of concrete educational practices is needed to anticipate future paradigms -by which we mean shared beliefs, values, models and exemplars (Kuhn, 1970) - that fit new scientific directions and are able to address complex societal challenges. Over the past 20 years, we have been exploring and developing together with colleagues and students such alternative practices for education, that focus on, e.g., self-organisation and complexity. We have been focusing on higher and professional education but regard our work and principles valuable and applicable for all levels and forms of learning. We have captured our approach and principles under the heading Transforming Practice (TP), based on 5 principles: complexity, situatedness, aesthetics, co-response-ability and co-development, which we will elucidate in the second part of this paper.

Our work, which is part of the Systemic Change group at ID, TU/e, is highly related to the theme of this conference 'Playing with tensions - embracing new complexity, collaboration and contexts in systemic design'. We are exploring new ways to transform practices fitting alternative paradigms using similar principles as targeted by this conference. Additionally, tension forms a main part of TP, through the concept of dialogic – i.e., seeking duality in unity, where things are both complementary and antagonistic, which Morin (2008) coins as one of the three dimensions to deal with complexity. Moreover, our search for alternative paradigms evokes tension with existing paradigms that are based on different shared beliefs, as explained more in detail in our other publications (Hummels, 2021). For example, our continuous development of competency-centred learning eco-systems facilitating situated, self-directed and life-long learning is at odds with traditional learning approaches. We experienced that our radically different philosophical and pedagogical take is difficult to sustain in a landscape of schools with predominantly classical educational approaches, focusing more on end terms than on the process of learning, developing, and growing of learners in relation to the peers and surrounding.

In this paper, we'll first explain our journey of transforming in the educational landscape and the conditions that made it work. In the second part of the paper, we'll explain the five resulting principles of our Transforming Practices "approach" (Hummels, 2021), illustrated with examples from our recent educational activities. This way we aim to support the discussion on learning with systemic designers and educational transformation.

Transforming our ways of learning – 2001-2011

Since the first author's student days, she has been fascinated by education. This feeling was fuelled by experiencing two radically different education systems, despite both being focused on product design: 1) the department 3D Design at the Arnhem School of Arts (where she studied between 1985-1987) focused on making, experimenting, discussing and finding one's own strengths, and 2) the Faculty of Industrial Design Engineering at the Delft University of Technology (where she studied between 1987-1993) focused on gaining extensive knowledge and skills through various courses and subsequently applying this in design projects. Both forms of education have their advantages and disadvantages, and the combination of the two turned out to be particularly valuable and influential for her future career. Especially because she was able to apply and refine the self-directed learning approach that she had mastered at the School of the Arts, at the TU Delft and beyond. It made her a strong advocate of self-directed and lifelong learning.

Next to her various experiments with self-directed and lifelong learning, when the first author was assistant professor at the Faculty of Industrial Design Engineering at the TU Delft (Hummels et al., 2003), her first major active contribution to this form of education took place between 2008-2011, when the first author became Director of Education at the department of Industrial Design (ID) at the Eindhoven University of Technology (TU/e). The department had a unique competency-centred learning approach as of its start in 2000. Her aspiration was to develop it further by creating a full-fledged, hologrammatic education system, where the values, principles and character of the whole system was present in every detail and vice versa. At the end of her term in 2011, ID had competency-centred, self-directed and life-long learning in the blood of its organisation. It encouraged and supported staff to take a learning-centred instead of a teacher-centred approach, and facilitated students learning to learn (what, how and why). This was concretised by having students writing their personal development plan (PDP) every semester and creating their own unique tailor-made curriculum based on their PDP. Students selected their courses and projects based on their individual learning needs and in accordance with the ID competency framework. During and at the end of each learning activity, students reflected on their activities and received written feedback on processes and results from relevant staff members. There were no exams and no grades, apart from the final bachelor or master exam (also without grades). Throughout their study, students developed and maintained a portfolio to show and substantiate their growth as a designer. In combination with an exhibition and an interview with the assessor and coach, they received at the end of each semester one of four possible verdicts: excellent, promoted, conditionally promoted or hold (Hummels and Vinke, 2009; Hummels, 2017).

The entire learning-centred approach and system was socially situated. Design projects were organised in theme-based living labs, i.e., open, flexible learning communities with a variety of disciplines and backgrounds (students, staff and external professionals / institutes) working together on a specific theme like health care, playful interactions or wearable senses. The building facilitated physical engagement and collaboration, e.g., in the ID café, and various platforms and social networks enhanced digital connections and exchange. The curriculum offered four completely free ‘identity weeks’ per year to encourage open learning activities for the whole community. Moreover, we organised four internal exhibitions per year and one big public exhibition during Dutch Design Week to enhance experiential learning for the entire community and beyond (Hummels, 2017).

Fig. 1. The department of Industrial Design at the TU/e organized four internal exhibitions per year (left), enabled students to select projects at the project market (middle), and used showcases as a means for tracking the growth of students, by letting them show and reflect on their progress (right)

The official accreditations of the education of the department and various other forms of evaluation showed that this alternative way of learning was very successful. Many teachers and stakeholders indicated that they saw the students develop rapidly way beyond their expectations (many Bachelor students were mistaken for Master students, and we had many discussions about Cum Laude, at points preferring to grant this predicate for almost half of the master’s students). We saw them succeed brilliantly in their professional career, being able to learn new skills and adapt to new situations in no time. But also, the teachers indicated they learned and grew themselves. We were able to transform together our practice of teaching and learning design and simultaneously the individuals working and learning in this system were transformed (at times from a convinced opponent to dedicated advocate).

However, despite its success, there were also various tensions. Firstly, this system turned out not to be suitable for all students, since not everyone is comfortable and capable at that age to deal with large amounts of freedom and responsibility. We emphasised the required attitude during information days and at the start of the study, and we supported students who found it more challenging through intense individual mentorship. Secondly, our approach reinforced the tension with other departments which had a traditional educational approach. When ID became part of the Bachelor College of the TU/e in September 2011, with its own stance on education, it changed the education system of ID quite a bit (e.g., introducing exams, grades and obligatory courses), although our aspiration for self-directed lifelong learning remained. It taught us the complexity of society and that an education system at a department is always part of a bigger eco-system, which influences its practices. It taught us the importance of acknowledging and working with the interwovenness, complexity and situatedness of different eco-systems, which can help addressing tensions and maturing and stabilising alternative education paradigms. Especially dialogic is important to stress both unity (we are part of the TU/e education system) and duality (striving for a new education paradigm), asking for collaboration and communication with colleagues and partner institutes situated in other paradigms.

Transforming educational practices in the field of design

Despite the change of our education system at ID and the ending of my term as director of education in September 2011, we did continue our research into transforming practices; not only in relation to education, but more generally in addressing complex societal challenges. As briefly indicated in the introduction, we are exploring new paradigms and design for transforming practices (Hummels and Lévy, 2013, Hummels et al., 2019) that are embracing complexity, situatedness, aesthetics, co-response-ability and co-development (Hummels, 2021). We focus on the scale of practices, by which we mean temporary, relatively steady ways of living and working with others (Wittgenstein, 1993) in which human activities are intertwined with material arrangements - in particular people, artefacts, organisms and nature -, and which are informed by roughly defined aspirations, certain "rules" and specific ethics and values (Schatzki, 2010). We focus on practices since that offers designers a way to address both (preferred) values and the bigger scope of living and society, as well as the concreteness of the creation and appropriation of particular designed artifacts. We aim at transforming existing and developing new alternative practices by designing itineratively with stakeholders and beneficiaries new material arrangements and related activities to discuss, reflect on and transform the underlying aspirations, "rules", ethics and values of a practice. And we are doing this in practices related to, e.g., energy transition, healthcare, new forms of financing, organisational change, the Netherlands in 2050, and of course education. We focus both on education for students at higher education, e.g., through our BOOST! project (the TU/e Education Innovation programme), as well as at professionals, e.g., European policy makers (ITHACA Policy Learning project). Moreover, we have projects like the Comenius Senior Fellowship of the first author, that focus on the learning eco-systems as a whole and the connections between various education systems. Comenius and BOOST! especially explored how to prepare design students for unknown futures and support them and us to learn to deal with complex challenges and design propositions that aim at enhancing sustainable living.

In the remaining part of this paper, we will show through examples of our work, how we concretised these alternative educational practices to support designing for transformation and addressing societal challenges. We will explain the five underlying principles of TP and simultaneously illustrate education projects and results elucidating these principles. After explaining and illustrating each principle, we will indicate the tensions we have experienced. Let us start with the first principle: complexity.

Complexity

Principles

To engage in self-organising, open complex systems, we use Morin's three main dimensions (Morin, 2008):

- **dialogic**: seeks duality in unity, where things are both complementary and antagonistic. This means that TP does not strive for compromises and uniformity, but focuses on plurality and differences between learners, roles, methods etc.

- **organizational recursion**: a phenomenon is both producer and product, both cause and effect, in a continuous self-organising and self-producing cycle. This means that universities constitute students and students constitute universities, as well as that education systems are a product of society and simultaneously a means to constitute and steer society. TP also stresses that teachers support students to learn and by doing so, they also learn themselves through these activities.

- **hologrammatic principle:** the information of the whole is in every part, and every part is in the whole. This means that TP is going beyond reductionism (focusing on parts) as well as holism (focusing on the whole). For education this implies that even the smallest detail of an activity or instrument embodies the gist of the overall educational system, and vice versa. The student is the educational system, and the education system is also the student.

Example from education

Let us elucidate complexity with the project *Probing Emerging Futures*. In this joint project between Philips Experience Design, Frank Kolkman Studio, Design Academy Eindhoven and Eindhoven University of Technology (2018 – 2019), we explored through design various potential future paradigms in the realm of healthcare: a post-biological society glorifying intelligence, a super-human society with the ideal of immortality, a steady-state no-growth society for all, or an eco-centric society where people live in harmony with nature. By designing and discussing prototypes for these different futures, we were able to research values and socio-cultural processes in society.

Fig. 2.: Probing Emerging Futures project exhibited at the Dutch Design Week in 2018 (left; photos by Juuke Schoorl) and in 2019 (right; photo by Philips Experience Design)

During this education project, a dialogic was pursued between different institutes, between researchers from different disciplines, between different students (within and between different institutes) and different paradigms. Moreover, the resulting prototypes for the 4 potential futures were presented at the Dutch Design Week (DDW) in 2018 and in 2019, thus stimulating dialogic debates with the broader audience. And a dialogic debate amongst professionals (from academia, industry and governance) was facilitated during the DRIVE festival at the DDW'18. Education in this project was approached from the perspective of a large learning community, with a variety of people, roles and disciplines, making use of a diverse set of activities, as well as multiple media, methods and tools to collaborate, co-create, communicate and to share insights.

Tension

Organising education at the cross-section of multiple institutes in collaboration with society is at points challenging. It causes tension, since curricula generally do not match, time schedules differ, motivations and aspired outcome can differ, software platform often don't allow joint access, and organising joint working spaces require effort and flexibility of the participants.

Situatedness

Principles

At the beginning of the 20th century, new philosophical practices overturned the Cartesian Western worldview and refuted the subject-object and mind-body dichotomies. Phenomenology departed from "*être au monde*" or "*being in the world*" (Merleau-Ponty, 1962), meaning that we perceive the world from our own point of view, our 1st person perspective (Trotto et al., 2011). We are situated beings, with our brain, body and environment fully intertwined, and dynamically enacting world without mental representation of our goals (Gallagher, 2017). We cope skilfully in the world from day to day, in an embodied and unreflective way, solicited by the situation at hand (Dreyfus, 1996).

For TP this means that we start from having attention for embodied intersubjective practices (Gallagher, 2017) and participatory sensemaking (De Jaegher and Di Paolo, 2007), stressing the importance of situated working and learning together with a variety of people, as the Probing Emerging Futures project also showed. It also means we are incorporating a 1st person perspective (Trotto et al., 2011) since people cannot avoid their own point of view, thereby refuting objectivism, while stimulating dialogic interaction to maintain a plurality of perspectives. We embrace self-directed, lifelong learning in a community setting. Finally, we are working from the concept of affordances, which are skill-dependent, relevant possibilities for action situated in the context of a form of life, i.e., a specific practice (Smith et al., 2021). That is to say, we are developing specific materials arrangements and activities to support situated learning.

Example from education

In our situated learning environment, we facilitate individual and community learning in relevant, meaningful environments for the participating students, researchers and external stakeholders, as well as for a broader public of citizens and interested parties. We do this for example, by jointly constructing all design projects with the participants, incorporating their individual aspirations and boundaries. Moreover, the context of learning is continuously tailored to the activities and ambitions. For example, we rented and furnished the Designhuis as a learning hub situated in the city centre of Eindhoven for several years. With its many spaces and our props, the

Designhuis afforded intensified collaboration between students, citizens and external partners through gatherings, workshops and exhibitions. Additionally, we organise various learning activities that stimulate exchange of different perspectives. For example, our Friday assemblies are open arenas for exploring and discussing topics brought forward and organised by one or more students or staff members. The last year, Covid forced us to drastically review our situated learning environment to accommodate the different individual needs, including wellbeing and counterbalancing social isolation. Hence, we explored various new media, tools and activities, e.g., Miro boards, hybrid spaces and bots that provokes coincidental online encounters.

Fig. 3. Designhuis acted as a 'blank canvas' to create different spaces fitting various activities for a broad audience in the city centre (left and middle). Friday assemblies are open arenas for voluntary learning (right)

Tension

Organising situated learning can create tension with administrative, financial and support systems of schools and universities. Learning in the city, in unusual places, or in joint pop-up spaces does not fit in with most organisations (organisation and financial models assume usage of existing educational spaces and equipment), nor does learning outside office hours (e.g., hard to get access to buildings) or learning with external stakeholders (e.g., no access to learning platforms). Nowadays hybrid teaching, shows again the necessity of flexible, appropriate situated infrastructures, which do often not align with the standard education settings.

Aesthetics

Principles

Coming from a situated perspective, we consider aesthetics not to be an inherent property of the design itself, but sense of beauty that arises when appropriating the design. It can be gratifying for our senses, for our intellectual capacities, for a sense of social belonging and many other things. Aesthetics can refer to small concrete details, to large complex systems, to abstract concepts, etcetera. We believe that creating beautiful education in all its facets and manifestations is an important part of transforming educational practices, including e.g. its organisation.

To elicit aesthetics, we use the concept '*landscapes of affordances'* posed by recent movements in ecological and enactive philosophy, i.e., an ecological niche in the bigger scope of socio-cultural practices, in which possibilities for action are offered to people through our designs, which stand out as relevant for people in that specific situation (Bruineberg and Rietveld, 2014). Within TP, we strive for an aesthetics of material arrangements that can stimulate appropriation in several ways: to enable people to make sense of complex situations (Gaver et al., 2003), to spark people's imagination, and to subtly opening them up to the yet unimaginable (Overbeeke, 2007), thus nurturing the development of alternative practices and paradigms.

Example from education

We continuously develop and experiment with a blended learning environment, where the procedures, platforms, projects, learning materials, methods, tools spaces, exhibitions etc. are developed to support designing for transforming practices. Our learning environment aims at evoking a sense of beauty, while enabling all learners (students, researchers and external stakeholders) to make sense of and play with complex matters. For example, we designed and offer physical banners and personal websites for leaving traces as well as organising activities to stimulate joint reflection. We developed a large variety of embodied tools that can easily be transported to facilitate also situated workshop with external partners. Moreover, we researched together with the students the concept of an exhibition from a transforming practices perspective, resulting in hosted events with personal guides, offering a variety of routes and giving different entries to explore the designs, the theoretical concepts, the approaches and topics.

Fig. 4. Traces of the design process are positioned in the space as well as online (left 1-2). Collective mappings are made physically and online to reflect on the overall complexity of a topic (left 3-4). A variety of suitcases with embodied tools were developed to support situated workshops, e.g., for external stakeholders (right 5-6).

Tension

Giving attention to aesthetics causes tension, e.g., when being at odds with the amount of work and deadlines, although our self-directed exhibitions showed that all parties involved considered them very rewarding. But most tension is experienced due to the lack of organisational aesthetics, for example, administrative procedures and software, learning management systems like Canvas, and learning equipment, are designed primarily for functionality and efficiency, and not for interacting with each other in beautiful ways. We are strong advocates of investigating how an entire education system with all its procedures can be experienced as beautiful.

Co-response-ability

Principles

As indicated above, situatedness implies an inextricable relation between beings and their environment. (Jonas (1985) calls on people to take responsibility for our environment, to take care of other beings and not to endanger human existence on/and earth. Jonas indicates that we should especially look at the potential problems caused by our technological progress, which might have far-reaching or even irreversible consequences when we may not even foresee. Haraway (2016) also urges us to be aware of this tight interweaving between multispecies and their environment, by encouraging sympoiesis - making together- and stressing our ability to respond to each other, which Haraway captured in the term response-ability. As responsive beings, also responsibility for each other and the environment falls to us (Ingold, 2016). We use the term co-response-ability to emphasize that people have both personally and as a community an ethical responsibility. TP embrace Jonas's, Haraway's and Ingold's stance to take responsibility and pursue a sustainable world.

We argue that design can create material arrangements and activities supporting co-response-ability and constituting alternative practices fitting paradigms that respect our environment. Moreover, co-response-ability demands a particular attitude and repertoire of actions. Sennett (2008, 2012) describes various of those elements, including commitment, trusting others and oneself, working with uncertainties and resistance, learning through failure, experimenting, being curious and empathic. Part of our TP is making the various participants familiar and comfortable with this attitude and way of working, which can be quite uncomfortable at first for most of them.

Example from education

We explore with external stakeholders possible, probable, plausible and possible futures (Hancock, T. and Bezold, C., 1994) in relation to areas such as energy (with Enpuls, ZET and Province of North Brabant), healthcare (with Philips Experience Design), cities (with Eindhoven and Umeå), the Netherlands (with WUR and Rijkswaterstaat). By imagining futures, be it 1, 10, 30 or even 100 years ahead, and connecting them to the here and now through storytelling and prototyping, students, citizens, researchers and external stakeholders reflect on current practices in relation to preferred values and paradigms. We develop dedicated methods and workshops to support TP-oriented speculation. Moreover, we support students and lifelong learners to develop new attitudes and skills, like trusting others, working with ambiguity and reflecting on their own responsibility towards the world.

Fig. 5. We develop speculative stories and toolkits (left; photo Tom Djajadiningrat, DesignDrone) and prototypes such as these seaweed shoes (middle; design and photo Jing-cai Liu) to facilitate imagining the Netherlands in 2050, in collaboration with Rijkswaterstaat (Smith et al., 2021). We train new skills, e.g. drawing mutual portraits using each other's hands acts as an icebreaker to trust others (right).

Tension

We experience the most tension between all participants in taking co-response-ability, towards differences in ambitions and goals, the timeframe for change and impact, freedom for thinking out of the box, support for learning, and finally budget and time for experimenting. Transforming practices, systemic change and realising alternative paradigms is a matter of the long haul. It requires partnerships and communities that trust each other and find unity in duality to make a difference together our societal challenges. It requires nurturing of joint efforts and people willing to take to lead in facilitating joint initiatives and learning.

co-development

Principles

The last TP principle relates to the slow process of transforming concrete practices and bringing new emerging paradigms to fruition, including alternative educational practices to fruition. We discern four types of activities: learning, co-creating, appropriating and researching.

Moving toward alternative paradigms is per definition an unknown and challenging quest for everyone, which requires lifelong learning in dynamic situated learning settings. TP invites people to engage in an experience without judgment, and respond to surprises through reflection, thus learning from their actions (Dewey, 1916, Schön, 1983) with the possibility to transform their practices. We stimulate corresponding between a variety of learners (Ingold, 2016).

TP co-creates new material arrangements with a variety of stakeholders (Sanders & Stappers, 2008), navigating complexity and exploring and building alternative futures. Through visualizing and prototyping, TP makes ideas, dreams and potential futures from 1 to 100 years ahead, imaginable, experienceable and discussable in relation to current practices and past learnings experiences. In this way, we are collectively open ourselves to transforming practices.

Since the new designs are unknown to future users, we focus also on the appropriation of these designs, i.e., the way people make sense of them in relation to their understanding of the world, while using them in their daily practices (Kudina, 2019; which can be different than the intensions and ambitions of the designers. This requires experienceable prototypes to enable people to appropriate the designs which might help them to transform.

Finally, TP is using the act of researching through design in a multi-stakeholder setting, with attention to richness, nuances and situatedness, to generate knowledge (Zimmerman et al., 2007), to support the emergence of alternative practices and paradigms. We support transdisciplinary knowledge development on transformation in its broadest sense, including philosophy, anthropology, design, technology, economy, governance, business, education, and many more disciplines.

Example from education

The above-mentioned examples for the other 4 principles are all examples of co-development, some focusing slightly more on learning through reflection (see aesthetics), some more on co-creating (see aesthetics and co-response-ability), some more on appropriation (see situatedness and co-response-ability) and some more on researching through design (see complexity and co-response-ability). In general, all four activities are intertwined and incorporated in our processes towards transforming practices.

Tension

The previous mentioned tensions for the other four principles, generally also surface during co-development. We do spot an additional tension that relates to the discipline of design itself. Developing TP as a transdisciplinary approach with a strong emphasis on design, can cause tension between the different disciplines; the ways of working, language, practices, values etc. do not always align. Moreover, being a discipline that is heavily interwoven with other disciplines, it is at times difficult to pinpoint and communicate the value of design and the proposed attitude and skills.

Wrap up

In this paper we aimed at sharing our quest of transforming educational practices based on alternative paradigms. We elucidated our educational journey and illustrated five underlying principles - complexity, situatedness, aesthetics, co-response-ability and co-development – that drive our endeavours to transform our educational practices. As can be expected in the setting of complexity and situatedness, our work to address societal challenges and move towards alternative paradigm is never finished. Nevertheless, we hope that our experiences and insights support the endeavours of broader community of system thinking and design, in realising alternative complex, sustainable futures.

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Relate systems archetypes and collaboration

A case study in the context of DIY bio-based materials in design education

Louise Dumon and Francesca Ostuzzi

Introducing sustainability and circular economy (CE) in higher education is becoming a key instrument for tackling climate change. When we look at design curricula, several skills are required for designing for circularity among which the systems-oriented focus and the intrapersonal skill of collaboration. In this paper, we report on a case study where 15 teams of design students re-designed a university system to enable the use and development of DIY bio-based circular materials. Specifically, what we observed is the correlation between the systems archetypes used by the students both diagnostically and prognostically (Braun, 2002) and the number of collaborations the students created with other teams and external stakeholders. Results show that by adopting a systemic view, students could take in consideration possible positive and negative effects of (not) collaboration with other actors in their system. It is not yet explored the depth of this correlation, which could become a focus of future studies.

Keywords: Systems Archetypes; Systems Loops; Design Education; Collaboration; DIY bio-based materials.

Introduction

Introducing sustainability and circular economy (CE) in higher education is becoming a key instrument for tackling climate change (Bocken et al. 2016; de los Rios and Charnley 2017; Wiek, Withycombe, and Redman 2011). In the field of industrial design engineering several approaches to *design for circularity* have been proposed, one of which is the focus on valorising biological streams. In this broad context, the development of new materials, often DIY, circular and bio-based constitutes an interesting focus to be explored further. So far, there has been little discussion about how to replace traditional materials with these more sustainable alternatives. Few studies are emerging to find solutions to turn waste into new products (Camere and Karana 2018; Rognoli et al. 2015; M. Sauerwein and Doubrovski 2018; Marita Sauerwein, Karana, and Rognoli 2017). To help speed up this process design students should gain the right knowledge and skills (de los Rios and Charnley 2017; Sumter et al. 2020). If we look at the design stage, we discover that to be able to design for sustainable innovations, the outcome should be systems-based rather than solution-based (Charnley, Lemon, and Evans 2011; de los Rios and Charnley 2017; McMahon and Hadfield 2007; Wiek, Withycombe, and Redman 2011). Finally, to implement this whole system design, designers should collaborate to optimize the system rather than optimizing one implementation of a material (Blizzard and Klotz 2012).

State of the art

Currently, one of the most widespread models to represent the circular economy is the so-called “butterfly diagram” proposed by the Ellen MacArthur Foundation (Ellen MacArthur Foundation 2019). This model reports on two main streams: a technical and a biological one. In the industrial design engineering field strategies to “close loops” on the technical cycles are becoming more and more common (Despeisse et al. 2017; Nascimento et al. 2019). A lot of examples to design services systems for reparation, reuse, maintenance, etc. can be found (Bocken et al. 2016; Hopkinson, de Angelis, and Zils 2020). Vice versa, the biological cycles are yet hard to address. There are multiple ways to address the implementation by design of the biological cycle. In this paper we focus on one possibility; the development and implementation of so-called bio-based circular materials, as for example: mycelium-based materials, bio-based leathers, etc. Although these materials are gaining interest from many actors of the value chain, only few industrial examples exist. As prove of this gained interest, many DIY and open-source versions of these materials have been developed and can be found in online database such as Materiom and BioFabForum.

System approach to design and the value of collaboration

McMahon and Hadfield note in 'The butterfly effect" that a holistic approach is needed to create sustainable design solutions and that designers should take the lead in restructuring these systems (McMahon and Hadfield 2007). Wiek's definition of the systems-thinking competence is "System-thinking competence is the ability to collectively analyse complex systems across different domains (society, environment, economy, etc.) and across different scales (local to global), thereby considering cascading effects, inertia, feedback loops and other systemic features related to sustainability issues and sustainability problem-solving frameworks" (Wiek, Withycombe, and Redman 2011). To gain insight in the patterns and behaviours happening in a system Braun (2002) suggests using archetypes as a diagnostic tool. These archetypes might be used to gain insights in the system integrating and using bio-based circular materials by the user.

In her analysis of circular economy competences for design, Sumter (2020) identifies seven core competencies. Among these seven competences there are three of them that refer to collaboration with stakeholders; circular user engagement, circular economy collaboration and circular economy communication. This view is supported by McMahon and Handfield who listed communication and co-operation as pathways to systems thinking for sustainable design solutions (McMahon and Hadfield 2007). Wiek even goes further and argues that the interpersonal skills are the crosscutting key competence in enabling sustainability (Wiek, Withycombe, and Redman 2011). The research to date has tended to focus on stating the importance of the competency of collaboration rather than on techniques and suggestions how to implement collaboration for sustainability in design education. Furthermore, industries interest in collaborating to reach sustainability is growing too (Fadeeva 2005; Kiron David et al. 2015; Lozano 2007) it might be worth to prepare students for these collaboration skills. (Cairns, Hielscher, and Light 2020; Wiek, Withycombe, and Redman 2011)

This paper explores how system thinking relates to the student's attitude towards collaborations (seen as interpersonal competence) and how it can be implemented in the design curriculum of industrial design students.

Methodology

This study is based on the case of design students working on DIY bio-based circular materials. For 12 weeks, 45 bachelor industrial design students, divided in 15 teams, have been trained in systems design, including the use of systems archetypes and feedback loops. Students got assigned different yet related design challenges of which some were more material based, starting from an existing recipe of a DIY bio-based material while other challenges where more overarching the other teams. For example, focusing on the end-of-life strategies. The course was a mix of practice and theory, where students got information about the systems-thinking; systems archetypes; and feedback loops reading and writing (Braun 2002). The students were challenged to bridge the practice of working with DIY bio-based materials and the given theory. Furthermore, they were asked to upload two types of deliverables:

1. Weekly highlights including the key findings and/or experiences that took place in that specific week (33 per team in total).

2. Starting from the one proposed by (Braun 2002) students were invited to share the "applied" systems archetypes relevant to their system.

In this study the relation between using systems archetypes and the level of *collaboration* is studied with more detailed research questions.

1. What is the number of within-class collaborations (with other teams)?

2. What is the number of outside-class collaborations (with different actors)?

3. Is there a link between the amount of within-class and outside-class collaborations and the archetypes analysed by the students throughout the course?

In this study, collaborating means working together with other teams inside the class (within-class collaboration) or stakeholders outside the class (outside-class collaboration) to achieve the goal of their design challenge.

Data analysis

To verify the extend of collaborations we counted the times each team mentioned in the "weekly highlights" one of the other teams. With Graph Commons we visualised a more detailed information on the amount and nature (one- or two-way) of the occurring collaboration. To analyse the relation between the used archetypes (Braun 2002) and the number of collaborations, we analysed in depth the way students used and appropriated archetypes to their design context. In this paper only two teams have been here reported.

Results

Within-class collaboration

The table below shows the number of times a team mentions another team in the weekly highlights.

Table 1. Team, category and number of mentioning or being mentioned in daily highlights.

Team Num.	Subject of the team	Category challenge	Num. highlights mentioning teams (of 33)	Num. teams being mentioned (of 14)	Num. teams that mention this team (of 14)	Num.two-sided connections
1	Mycelium based materials	Material-driven	10	10	6	5
2	Kombucha leather	Material-driven	0	0	3	0
3	Natural fibres with releaf	Material-driven	3	2	3	1
4	Bio colors in prototypes	Material-driven	3	3	3	1
5	Devel'up 2.0	Material-driven	0	0	2	0
6	3D printing eggshell	Material-driven	1	1	3	0
7	3D print coffee	Material-driven	/	/	/	/
8	Wilderness in design	Overarching	5	4	3	2
9	Silicon mold substitution	Material-driven	3	2	2	1
10	Knotplex application	Material-driven	5	4	3	1
11	Press for biomaterials	Overarching	0	0	5	0
12	Wooden chips	Material-driven	4	3	2	1
13	Bridging academia and industry	Overarching	8	6	4	4
14	End-of-life	Overarching	2	2	4	2
15	Connections in prototypes	Overarching	16	14	4	4

To visualise the connections in the list above, the data is imported and visualized using Kumu to show the interrelation between these teams.

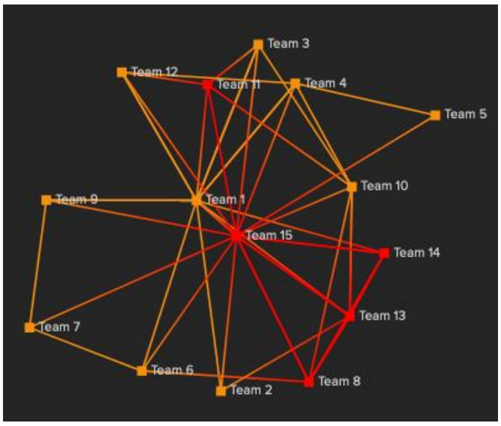

Figure 1. Visualization of the interclass collaborations. Each link represents if a team has mentioned another team or has being mentioned in the “weekly highlights”. The red dots represent teams with an over-arching design challenge, the orange lines represent teams with a material-based design challenge.

Interestingly, we can observe connections between all 15 teams. In table 1, we can see that not all the teams mention other teams in their daily highlights. These teams are nevertheless get mentioned by other teams (generating a one-sided connection).

One-sided or two-sided collaborations

To see more in detail how these teams are connected we used the weighted data (number of times a daily highlight mentions a team) and the information about who mentioned who. This way the one-way and two-way connections could be analysed. To visualize the one- or two-sided connections and the more detailed information, the data is imported in Graph Commons. The number of two-sided connections in table 1 is a result of counting the two-sided connections generated by Graph Commons.

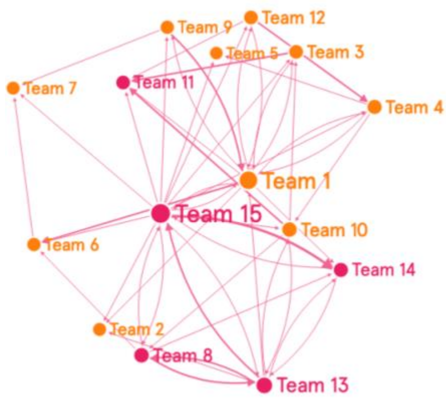

Figure 2. Visualization (Graph commons) of the interclass collaboration of all the teams. The thickness of the arrow represents the number of times the team mentions the other team (in this study this number lays between 1 and 3 times). The arrow represents who mentions who.

The following paragraph shows a close-up of one team with a material-driven design challenge (Team 1) and of one team with an over-arching design challenge (Team 13).

Examples Teams 1 and 13

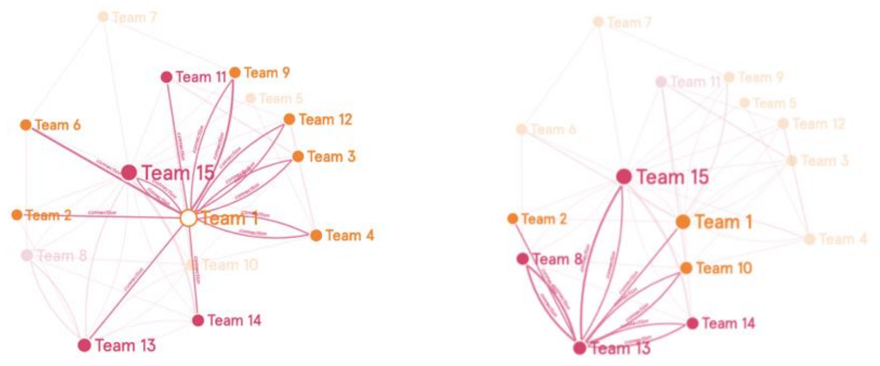

Figure 3. Visualization (made with Graph Commons) of the interclass collaboration of (from left to right) Team 1 and 13. The arrow displays who mentions who. The thickness of the arrow represents the number of times the team mentions the other team. Both one-sided and two-sided connections are visible.

Team 1 managed to connect with 10 other teams from which 5 out of 10 mentioned Team 1 in return in their weekly highlights (two-sided collaboration). Striking to see is that from the five two-sided connections of Team 15, a team working on a material-driven design challenge, 4 teams had a material-driven design challenge too.

Although Team 13 has an overarching design challenge they do not reach the highest number of interconnections. But if looking in detail they mention the same teams several times and these teams they mention, mostly mention them back (two-sided collaboration and prolonged in time). From the four two-sided collaborations, three of them have just like team 13 an overarching design challenge.

Outside-class collaboration

The outside-class collaborations were analysed in an analogous way as analysing the inter-class collaboration by counting the weekly highlights, now counting the number of weekly highlights mentioning a stakeholder and how many categories of stakeholders were touched upon in these weekly highlights (table 2). These stakeholders were categorized in six Stakeholder groups listed in Table 2.

Table 2. Categories of stakeholders

Number	Category name	Description of the stakeholders
1	Atelier	The atelier is the name of the workshop at Ghent University Kortrijk it involves the staff using, maintaining and managing the workshop.
2	Students inside the course	Students subscribed to the course
3	Students outside the course	Students outside the course (other years, or other curricula – since the atelier where many experiments tool place is shared)
4	Lecturer outside the course	Lecturers using the workshop for classes
5	Material sourcing company/organisation	Companies or organisations with bio-waste streams that could be collected and used by the students
6	Others, outside university	Everyone not fitting inside the other categories listed above

Table 3. Team, category and number of mentioning or being mentioned in daily highlights.

Team Number	Subject of the team	Category challenge	Number of stakeholder categories mentioned (out of 6)	Total weekly highlights mentioning a stakeholder (out of 33)
1	Mycelium based materials	Material-driven	3	4
2	Kombucha leather	Material-driven	2	10
3	Natural fibres with releaf	Material-driven	2	3
4	Bio colors in prototypes	Material-driven	2	6
5	Devel'up 2.0	Material-driven	1	5
6	3D printing eggshell	Material-driven	3	7
8	Wilderness in design	Overarching	1	2
9	Silicon mold substitution	Material-driven	1	4
10	Knotplex application	Material-driven	1	2
11	Press for biomaterials	Overarching	0	0
12	Wooden chips	Material-driven	2	3
13	Bridging academia and industry	Overarching	4	9
14	End-of-life	Overarching	3	6
15	Connections in prototypes	Overarching	5	12

Two teams (Team 7 and 11) did not mention any stakeholders at all in their weekly highlights. Nine out of fifteen teams mentioned students outside the team in their weekly highlights. The atelier is only mentioned by two teams as a stakeholder (Team 14 and team 13). Material sourcing is only mentioned by three teams (Team 3, 6 and 15). Other stakeholders outside the university are mentioned by 4 teams. (6,13, 14 and 12). Three teams (team 1,2 and 15) approached other lecturers to implement bio-based circular materials in their course.

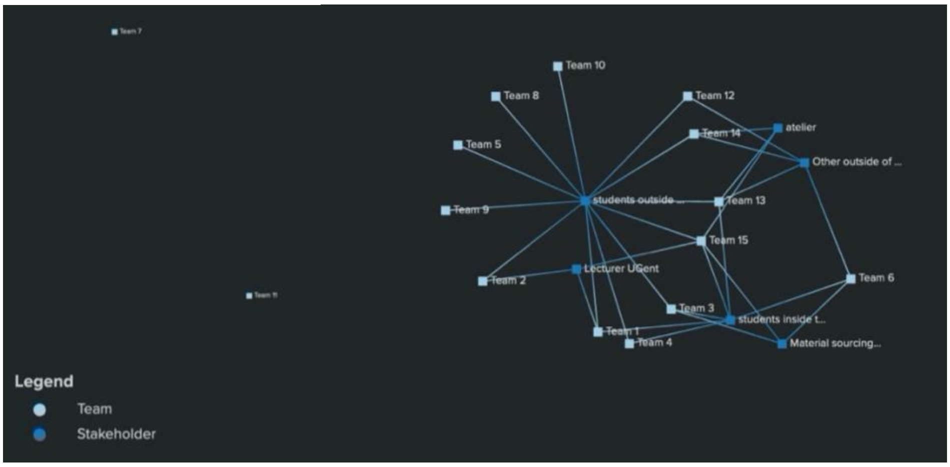

Figure 4. Visualization of teams and categories of stakeholders (made with kumu) mentioned in the weekly highlights.

Analysis of the relation between the inter-class and outer-class collaboration and the archetypes

Team 1

Team 1 scored high on the inter-class collaborations, they managed to create 5 two-sided inter-class collaborations, which is the highest reached in this study. Team 1 only mentioned stakeholders in 4 of the weekly highlights. Compared to Team 15, who mentioned 12 times a stakeholder, Team 1 scores rather low on the outside-class collaboration. When looking at the archetypes of Team 1, they modelled 6 archetypes, Using the limits to growth, success to the successful and 3 balancing feedback loops. Team 1 filled in all the archetypes implementing no stakeholders and no other teams, they used the feedback loops only to describe the technical parameters (growth, process, available space) of the mycelium.

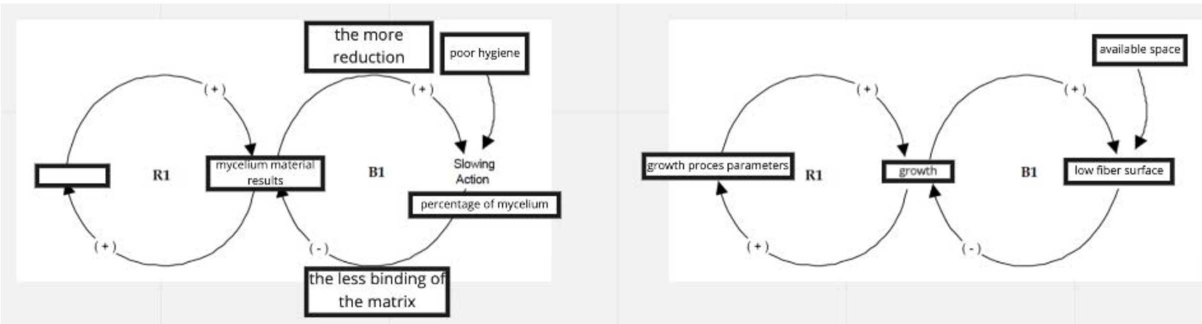

Figure 5. Team 1: Basil Bataille, Maité Priëels and Casper Van Herzele; two descriptions of an archetype 'Limits of growth'.

Team 13

Team 13 mentioned or got mentioned by 6 teams in the weekly highlights, 4 of these connections with these teams were two-sided collaborations. They had less but stronger connections compared to team 15. Team 13 made 8 archetypes, three of them contained stakeholders, the other five mentioned the other teams. In figure 7 the students describe how the interaction between the teams can be higher by using the Instagram page. During the feedback session the students mentioned that it was hard to reach some teams. The teams did not see the value yet of the collaboration proposed by Team 13. The strategy of Team 13 was work together with the teams they were able to reach, hoping that once there where results to be shown, the other teams would follow. This might be linked to the fact that in the weekly highlights they mentioned less teams but the amount of mentioning them was high.

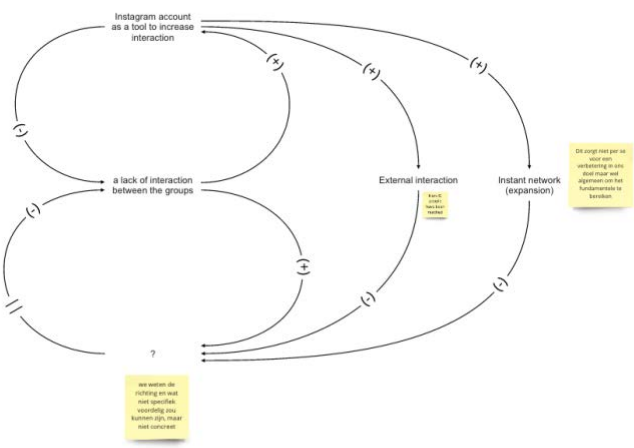

Figure 7. Team 13; Lotte Beernaert, Alesio Descamps, Interpretation of the archetype 'shifting the burden'.

Discussion

In this paper we explore the value of teaching systems to trigger the interpersonal skill of collaboration. Yet, this might not be enough to enable corporative collaboration – since the barriers highlighted today for such collaboration is clearly also institutional. This paper focuses on design education, although there are insights that could be talking to industry, it is important to note that in the design challenge the students needed to design a system that would be self-sustaining but not necessarily create monetary value. The 2 analysed cases show a link between using a certain archetype and collaboration with other teams and stakeholders. Further research should be conducted to see if the archetypes trigger the collaboration, or the collaboration trigger the archetypes.

Looking at the results, the students are collaborating with other stakeholders within-class and outside-class, yet the amount is not at its highest. Teams with a material-based design challenge tend to focus on technical aspects, they struggle understanding the importance of engage others, when engaging with other teams it seems that they more often collaborate with other teams working on a material-based design challenge. On the other hand, teams with an over-arching design challenge have more often a collaboration with other teams with an over-arching design challenge, for these teams it is harder to reach out to teams with a material-based design challenge. Finally, this study does not look at the quality of the collaboration, although the quality could be of high importance.

Further research should be conducted to see what influences the view on the archetypes and if it is possible to give students the tools to change their view from seeing their peers as competitors to collaborators or as we like to call it; strive for co-opetition.

Acknowledgements

This work is part of the research project prototyping circulair, making it possible to integrate bio-based circular materials in the prototyping process of industrial design students and is financed by Vlaanderen Circulair. Specifically, we gratefully acknowledge the help of Yolan Gielen (thanks for introducing us to the term "co-opetition") and Liesbeth Van Ackeleyen. We would like to thank Jan Leyssens from Switchrs and Jasper Bloemen from Glimps.bio for being a partner in the project of prototyping circulair and for coaching the students during the course. Finally, we would like to thank the Industrial Design Engineering students of UGent Campus Kortrijk for working with passion on the Prototyping Circulair design assignment.

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Between Heaven and Earth

Design Tensions in the Book of Changes

Evan Barba, J.R. Osborn

For some time, we have been using the ancient Chinese *Book of Changes*, or *I Ching*, as a resource for systemic design in both professional and classroom settings. We have found the results of these experiments to be surprising and encouraging, and suggestive of a more complete and formalized methodology. Here, we tie the theoretical underpinnings of this methodology to a few important concepts and texts in the systemic design canon, emphasizing design as intentional change and the dynamic equilibrium, constant transition, and interconnectedness of systems. We then articulate our notion that the sixty-four passages of the *I Ching* correlate to commonly observed stages of iterative design, and the creative process more generally. Finally, we encourage others to explore the *I Ching*'s usefulness as a collection of design prompts by providing the backbone of our method — design-centered interpretations of the eight essential trigrams of the *I Ching* and sixty-four designerly names for the hexagrams — as a means of scaffolding interested designers in their own application of the text.

Keywords: intentional change, methodology, I Ching, systemic design, design pedagogy

Introduction: Change

There are many definitions of design in usage, and each emphasizes different aspects and values of the design process. One that has some purchase within the systemic design community is found in Nelson and Stolterman's ***The Design Way***, where they describe design as *the creation of intentional change* (Nelson & Stolterman, 2012). This is a useful definition because it applies to many fields and subspecialties, from product design to service design, as well as accounting for less formal design activities like crafting and making. It also applies to engineering disciplines and to the sciences more broadly, as in the design of experiments or medical treatments, for example. While this definition does exclude 'accidental' acts of creation that might more properly belong in the domain of expressive art, it bears noting that such a definition may be so overly broad that it might not communicate subtleties or allow for easy differentiation of designed products or design activities. For present purposes though, the definition ties together two important concepts that we can use to begin a productive discussion: **creation** and **change**.

Change and creativity go hand in hand. During the creative process what was there before, either in terms of physical materials or a given non-physical configuration (social or socio-technical for example), is altered in some non-trivial and intentional way. With change so clearly articulated as the object and purpose of design, it stands to reason that other sources that describe the nature and processes of change and transition may yield useful design insights. If the creation of intentional change is what we seek as designers, anything that better helps us understand that process is helpful. For this reason, we have chosen to investigate the oldest and most widely used text on the nature and process of change, the ***Book of Changes***, or ***I Ching*** (sometimes ***Yijing***) as it is known in its original Chinese.

About the I Ching

The ***I Ching*** is a classic Chinese text that dates back well over 3000 years in its written form, although it assuredly was passed down through oral traditions long before that. It is one of the most studied texts in the world and one of the oldest documents in continuous use; by some accounts, second only to the Bible (Shaughnessy, 1997). Western translations of the text are much more recent, and began appearing in the 1800's. The most commonly referenced, by Wilhelm, was first translated into German in 1923 and re-translated to English by Baynes in 1950 (Wilhelm and Baynes, 1950), but many more have appeared since then. As western understanding of Chinese traditions has grown, so has our understanding (and misunderstanding) of the relevance and content of the ***I Ching***. These translations reflect not only those deeper understandings, but also the influences and expectations of their audiences at the times of translation. For example, Legge's 1899 (Legge, 1963) translation is formally worded and expresses the mystery surrounding Chinese culture in 19th century Europe. More recently, Wing's 1979 (Wing, 1979) translation has the flavor of New Age mysticism found in mainstream American culture during the 1970s, while Pearson's 2011 translation (Pearson, 2011) contains distinctly feminist perspectives. As with any classic, contemporary readers can find new meanings in the text relevant to their time and culture. A natural extension of this idea is that these meanings can also be relevant to different domains, and our attempt to adapt the text into a distinctly design-oriented interpretation is very much in keeping with this tradition.

In what follows, we have adopted this mentality in our interpretation and application of the ***I Ching*** to design practice. By reconciling the different interpretations and meanings attributed to the passages of the ***I Ching*** we have triangulated our own design-centered interpretation — effectively 'rendering the ideas' and guidance of the ***I Ching*** in the language and manner of design. We have found insight into the creative process; useful tools for theory, teaching, and practice; and even some insights into the text itself that appear to have eluded previous translators because of their unfamiliarity with design practice and systems thinking.

The System of the Yi

At the most basic level, divination with the ***I Ching*** is a means of generating timely and time-tested advice in difficult situations. That advice is based on the idea that the process of change, although continuous and ongoing, can be segmented into identifiable and understandable stages, essentially different 'states' of the system. As Wing (1979) says, *'Think of it as clicking the shutter of a camera in order to capture a picture of the moment and examine in detail its meaning'* (p. 9). Knowing what stage any particular project is in, and taking appropriate action moves the project forward. The ***I Ching*** offers insight into these stages and provides a method for accessing those insights in a timely manner. Whether the **I *Ching*** really offers a window into the universe's purposes and the designer's role in affecting those changes is largely irrelevant. What matters at a practical level are really only two things: 1) the 64 hexagrams of the **I Ching** correlate to stages of the creative process that have been observed and named; and 2) the designer can operationalize this advice to advance a project.

As instructors, we are often called upon to give students advice on varied projects, sometimes with little time to dive deeply into observed problems and offer appropriate solutions. At times, our assessments and suggestions are spot-on and the student can take our advice at face value and use it effectively. Other times this is less exact. We all have limited experience to draw on, with no access to students' inner processes, intentions, or motivations, and can only help scaffold their insight by providing our opinions. In our experience though, any advice is helpful, and even inappropriate, incomplete, or misunderstood advice can get a student unstuck. In this sense it matters little whether the ***I Ching*** is mystically capable of revealing the correct course of action for a project, what matters is that it can be used productively. In our experience, this is indeed the case. If nothing else, the ***I Ching*** offers a novel method to introduce a new variable that 'shakes up' a stagnant project.

Some will no doubt find it blasphemous for educators to suggest that their advice, trained over thousands of hours of experience, is no better than a randomly selected passage from a cryptic 3000 year old text; but this misses the point. It's more accurate to say that what students — and, frankly, even seasoned professionals — need at many times during the creative process is something to push them forward. Having a clear sense of where one is in the creative cycle and what actions to prioritize can make a world of difference when one is conflicted and confused about where to put their next effort. What the ***I Ching*** provides in these cases is simply a prompt for rumination, interpretation, and action that can change the mindset of the designer, give them a new perspective on the project, and help them decide for themselves what the best next step might be.

Applying the Lessons of the I Ching

The hexagrams are six-line wholes, that are assembled from two parts called 'trigrams' (three lines each), one upper and one lower. Within a trigram, each of the three lines can be either solid or broken, making the original distinction — upon which the trigrams and the entire system of the Yi are built — a binary one. Traditionally, each of the trigrams is assigned a certain character based on its relation to natural forces and elements: Heaven, Earth, Wind/Wood, Water, Fire, Lake, Mountain and Thunder. In keeping with Heaven and Earth cosmology described above, the nature of each hexagram is defined by the tension between its upper and lower trigrams. As Wing (1979) states:

> The coming together of the two trigrams within the hexagrams represents the coming together of heaven (upper) and earth (lower), while their interaction and dynamism represent the cosmic forces as they affect human affairs. (p. 15)

Mapping this general statement into the realm of design by replacing the phrase, 'cosmic forces as they affect human affairs,' with 'tensions to be resolved in the design', reveals the nature and usefulness of our method. We reinterpreted the traditional characteristics of the eight trigrams into a collection of ideas more accessible to designers, and we provide those below alongside more design-focused interpretations of all 64 hexagrams (Table 1 and Table 2). Although space prevents us from providing a complete reinterpretations of the hexagrams, it is perhaps more useful for the interested designer to derive their own interpretations by contemplating the tensions between the upper and lower trigrams in relation to the design term we provide for the hexagram. We encourage interested readers to examine the text of the ***I Ching*** themselves (particularly the guidelines for divination) and to use our reinterpretations as a guide to advancing their own projects and understanding of systemic design.

In our use of the ***I Ching*** we have relied heavily on the "coin method" of divination, in which three coins are tossed six times to construct a hexagram that the reader can then look up in the text to contemplate in regard to their own situation. The more traditional yarrow stick method yields similar results but is more cumbersome. However, if one's purpose is to simply generate a random number from 1-64, any reliable method can work. Simply using a search engine or other program is effective and efficient. Rolling an 8-sided die can also get a random number between 1 and 64 (9d8 -8) or simulate the same probability of outcomes as the coin toss method (more complicated) . We encourage the interested reader to examine these methods in more detail. Instructions can be found in the introductions to most of the translations we reference and on the many web pages dedicated to the ***I Ching***. We also encourage more playful approaches. A particular favourite is to ask a student what number is currently the most significant in their project, then using it to seed a random number generator or in modulo arithmetic (mod64) to obtain a result. Simply using the text intentionally, by identifying and referencing the passage relevant to the stage you believe you are in, is another possibility. Again, the point here is less about using the ***I Ching*** 'correctly' than it is about using it 'productively.'

Conclusion

We have explained the logic behind our adoption of the ***I Ching*** as an aid to systemic design through its philosophical connection to both design and systems, and we have outlined our argument for how the hexagrams of the ***I Ching*** can be mapped upon 64 common stages of a creative cycle. The commentary surrounding each hexagram characterizes that single step in the creative process and suggests mindsets and actions that can move the cycle forward. These will be readily recognized by the experienced designer, and can be intuitively felt by the novice. Not every cycle contains every step, and some projects may force us to revisit a few steps repeatedly. For sure, experience alone can often help us determine where we are and where to go next, but even the most experienced designer can be humbled by new challenges, divergent possibilities, and surprise results. It never hurts to have a guide when navigating through complex and foreign terrain. Even familiar territory can prove treacherous when our assumptions and confidence fail us. In these cases, and especially at inflection points when decisions with lasting consequences are made, we need the wisdom of time-tested advice. This is what the ***I Ching*** provides. It can function as a guidebook to the creative process that contains, not only the collected wisdom and experience of those who have seen the patterns before, but also as a means of accessing that knowledge and resolving creative tensions in both theory and method.

Table 1. The Eight Trigrams, their Chinese names, and traditional translations alongside our design-focused names and reinterpretations.

☰ Ch'ien Heaven	**Concept** Typical interpretations of Heaven, or pure yin, ascribe attributes such as creativity, strength, action, drive, etc. The doubling of this trigram into the hexagram we call'"Inspiration' begins the creative cycle, and so the line trigram encompasses that idea in a slightly more subdued way. When this trigram appears, we interpret it simply as a reference to the concept in it's most idealized and solution-neutral form. That enthusiasm you have when the lightbulb goes off in your head and you feel motivated to pursue a new idea is the heart of ch'ien.
☷ K'un Earth	**Material** Beneath heaven is the earth represented by this trigram of three broken lines symbolizing pure yang. The doubled K'un is the second hexagram of the I Ching, and for us represents the inert tools and materials waiting to be formed by concept and action. As the counterpart to yin, it typically connotes characteristics of receptivity and inaction. We have found that it also represents the needs of end users or clients, those who encounter our creations in the wild or for whom they are designed.
☳ Chên Thunder	**Work** The connotations of this trigram commonly identify movement and wakefulness, as if a clap of thunder has woken you from a more sedate frame of mind. We find it useful to think of this trigram as representing work in all its forms. Sometimes you need a clap of thunder to rouse you from your complacency to get to work, and sometimes you just need to put your nose to the grindstone. Either way, this trigram is a reminder that your effort and attention are needed.
☴ Sun Wood/Wind	**Structure/Process** The idea connoted by this trigram is often penetration or gentle, slow, and imperceptible progress. The growth of a tree or the blowing of the wind are both invisible on short time scales but we can see the results of these incremental processes in the changing shape of the tree and the patterns on the landscape. Thus, for our purposes we think of this trigram as representing patterns and the unobservable forces that create them.
☲ Li Fire	**Features/Details** Clinging is a traditional concept here, the way a flame clings to a log. Brightness, brilliance, and dependence appear frequently as concepts as well. We interpret this as 'features' or 'details', as we know how one can cling to these in our creations as well as how they are very dependent on context and attach themselves to designs. They are also commonly the eye-catching or defining aspects of a design that set it apart from others, they can be bright, shiny, and brilliant in every sense of the word, but also dependent on the rest of the design and cannot hold on their own.
☵ K'an	**Formlessness** Typically the most negatively interpreted trigram, K'an often connotes danger through a ceaseless descent. We recognize this danger in terms of creative designs as 'formlessness' and this has many implications. Form is critical to any final design and lacking it will lead to disaster. However, water also

Water

takes the shape of its container and therefore attention to context and constraints when interpreting this trigram matters quite a bit. Going deeper and sinking are also important connotations. Not all are negative however, the formlessness of flowing water is a positive connotation that might well be a hallmark of well-designed interaction.

☱

Tui

Lake

Joy/Delight

Most occurrences of this trigram have it representing joy or joyousness. The concept behind this is that lakes are where people go to swim, bathe, relax and rejuvenate. The delight of users is an important part of design, as is the emergence of such delight through play. And so, for us, we use notions of playful discovery and surprise as the guiding forces in our interpretation of this trigram.

☶

Ken

Mountain

Convention

Connotations here are of stopping, stillness, permanence, and continuity. These are all important aspects of a creative process and in play whenever this trigram appears. We tend to interpret this as ‘convention’ or ‘tradition’. The mountain is the long-standing body of work that a new iteration builds upon. Sometimes progress necessitates breaking with this tradition and sometimes it is a return to it — through study, reproduction, or reference — that reveals the way forward.

Table 2. The 64 hexagrams of the I Ching and our design terms for each.

▯ 1 Inspiration	▯ 17 Finding a Rhythm	▯ 33 Reflect	▯ 49 Metamorphosis
▯ 2 Adoption	▯ 18 Branching Out	▯ 34 Strength	▯ 50 Incubate
▯ 3 Getting Started	▯ 19 Flourishing	▯ 35 Proceed	▯ 51 Get to Work
▯ 4 Exuberance	▯ 20 Listening	▯ 36 Recover	▯ 52 Pause
▯ 5 Waiting	▯ 21 Sink Your Teeth In	▯ 37 Teamwork	▯ 53 Slow and Steady
▯ 6 Tension	▯ 22 Adornment	▯ 38 Divergence	▯ 54 Duty-Bound
▯ 7 Leading	▯ 23 Shedding	▯ 39 Hardship	▯ 55 Apex
▯ 8 Organize	▯ 24 Revisit	▯ 40 Relief	▯ 56 Explore
▯ 9 Stocking Up	▯ 25 Sincerity	▯ 41 Dial it Down	▯ 57 Second Wind
▯ 10 Step Lightly	▯ 26 Continuity	▯ 42 Turn it Up	▯ 58 Coupled
▯ 11 Progress	▯ 27 Restraint	▯ 43 Resolve	▯ 59 Dispersing
▯ 12 Impasse	▯ 28 Critical Mass	▯ 44 Influence	▯ 60 Constraints
▯ 13 Fellowship	▯ 29 Bogged Down	▯ 45 Convergence	▯ 61 Inherent Value
▯ 14 Abundance	▯ 30 Clarity	▯ 46 Scaling Up	▯ 62 Slight Advantage
▯ 15 Moderation	▯ 31 Second Opinion	▯ 47 Exhaustion	▯ 63 Loose Ends
▯ 16 Mobilize	▯ 32 Keep it Up	▯ 48 Replenishment	▯ 64 Never-Ending

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Track 4:

Design Of Food Or Water Systems: A Case Study

Chair: Emilija Veselova

Mountain water management through systemic design: the Monviso Institute real-world laboratory

Francesca Carraro, Silvia Barbero, Tobias Luthe

This research deals with the sustainable management of water resources in rural areas, through the study and design of integrated water systems in a mountain environment. The work promotes a new model of sustainable use and treatment of water in a real context, created to be experimented by the public, by the research center and born from the need for the development of a new environmental activism, based on conscience and awareness. Thinking across scales of space and governance, a scalable and replicable system is outlined, based on cooperation between local actors, addressing current tensions while thinking of long-term effects. The trans-disciplinary approach joins systemic projects from different fields, brought together to model a single cooperating system. We outline the regenerative water management model at the campus of the MonViso Institute, a real-world laboratory advancing sustainability and regenerative design in the Italian Alps, as an illustrative case for the design of regenerative water systems.

The delineation of the project came to life thanks to a careful initial research phase, which clarified the identity of the chosen site and the local culture. These were the foundations for the design project of water systems on campus, applying the development of natural technologies, creation of connections and circularity as of reusing water and nutrient flows. The interaction between the components highlights the desired dependence between one and the other, which generates the value of the whole system.

Keywords: Water systems, Cross-scalar design, Systemic integration, Real-world laboratory, Water experience

Introduction

The progressive water scarcity at world level raises problems related to the appropriate resource and its close correlation with the mountain areas, the main suppliers of water also for the rest of urban areas, paying particular attention to the need for responsible and conscious management. It is necessary to consider the good governance of water in the mountains not only as a fundamental pillar for environmental protection and sustainability in the use of natural resources, but also as a decisive element for social, economic and productive wellbeing and for regeneration (Viviroli et al. 2011). By developing a sustainable water management system in the mountains, the MonViso Institute is considered a real-world illustration able to demonstrate the effectiveness of the proposed system, which includes systems for retention, storage, purification and circular reuse in a systemic whole. Each element has been studied in detail about its functionality and in the interaction with the entire integrated system, generating a network of connections and practices aimed at a correct use of the water resource and preservation of the related ecosystem services.

The design is developed starting from the main architectural structure present on the campus: the "Doppio", a duplex passive net-positive wooden house, the first re-built structure out of six abandoned stone ruins. We define water systems for internal use, purification systems, studying the availability and storage of water through the use of systems linked to natural principles and local materials, creating a close link with the territory and the environment in which it is located. The project is developed through the implementation of the management system of the MonViso Institute site and rises to the description of a possible scenario given by its application, within the valley in which the campus is located, to highlight its benefits and spread awareness.

In this paper we analyze technical, social and economic aspects through the study and visual representation of the various phases of research and design. The real interaction with the campus, the various actors and the institutions involved in the design represent an important element for the advancement of the research, giving way to the birth of collaboration and interaction with significantly impacting realities for the project, such as for the community and the local territory.

Hydrological systems are often conceived as a small component of a vast global complex. A holistic perspective is able to take into consideration the existing internal relationships and the interfaces of the various subsets, including the social, economic and institutional ones, perceiving water as an integral part of the (social) ecosystem itself. It includes quantitative and qualitative aspects, ground and surface water, which can be preserved by an improvement in sustainable water use patterns, by conservation and by minimizing waste. A fundamental role is also identified in the proper management of the soil and landscape planning, which are partly responsible for the increased pollution and eutrophication of water resources.

Project setup

This systemic design project dealt with an interconnected process, in which the retention, filtering and purification elements are integrated in a circle of use with the intention of using the water in a transitory way, re-introducing it purified at the end of the cycle into the environment. The system displays a new way of experiencing water within a mountain campus, avoiding the exclusive use of drinking water and taking care of the correct disposal of the water used, before returning it to nature. This is made possible by the participatory approach of the project, which includes workshops of creation and comparison. Furthermore, the layout of the technologies and the creation of "viewing areas" were studied, where visitors can consult their operation and guidelines. The campus under consideration currently has a single building built, treated by the research as a pilot project for the next buildings of both the MonViso Institute, the community of Ostana, and the surrounding valley.

The building scale water system

Focusing on the challenges related to the water resource inside the houses, it is appropriate to highlight the percentages of water consumption and usage types in the home, which, due to the hygienic-sanitary regulatory constraints, must use drinking water to be carried out. From an ISTAT (Istat 2020) research on domestic consumption emerges the differing usage in two almost equivalent halves: those that must necessarily come into contact with the inhabitants and those in which this does not happen, for which the use of non-potable water is sufficient. A rainwater tank collection system was designed for the use of the toilet and washing machine drain. The grey water of the system is conveyed into a tank specially designed and reused for the discharge of services, or purified through phyto-purification and used for irrigation.

By implementing the proposed model, a reduction in drinking water consumption is estimated from 160 liters per day to an indicative average of about 40 liters, thanks to the addition of 44 liters of grey water and 35 liters of rainwater.

This is made possible thanks to the use of:

- Jet reduction systems

- Rainwater accumulation systems

- Grey water reuse systems

- Purification systems

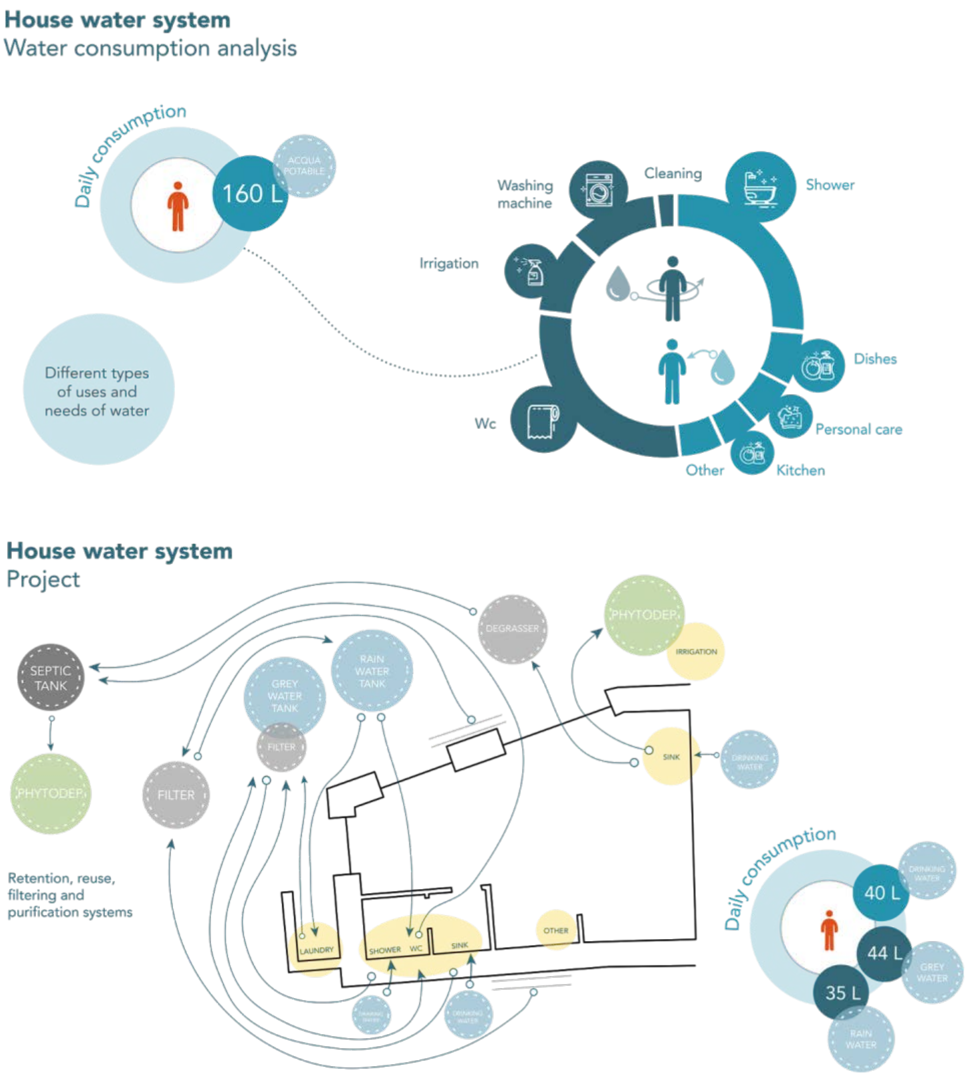

Figure 1. Graphical scheme of the designed water system (Carraro, 2021)

Purification system

The 40 liters of water estimated for the daily use per person within the campus are treated internally.

In particular, the black water (i. e. coming from the toilets) is conveyed through pipes up to two remotely positioned septic tanks. Here the first wastewater purification process takes place, composing the waste and dividing it into solid and liquid materials. The liquid one, after exceeding the capacity level of the pits, is generally poured into nature or into a river body. This practice is rather harmful for the territory, since septic tank water is contaminated with high concentrations of nitrates, phosphates and other harmful components, which, when pouring into the soil, lead to its progressive eutrophication. In this regard, a natural plant-based purification system has been designed to be positioned after the septic tanks, to purify the water that comes out of it.

The chosen purification system is a phytodepuration plant. This technology requires that the wastewater is purified using a waterproofed basin, in which several layers of gravel and vegetables purify the water flowing into the gravel bed, coming into contact with the roots of the plants in the system. This wetland system extracts the pollutants present in the water without the use of additional energy and electromechanical parts, a simple, reliable and regenerative system.

To achieve water circularity demands that purified water returns to nature. In our design we emphasize the ability of the selected plants to improve the conditions of the soil and avoid the overflow of sewage harmful to the environment. The choice to reuse the treated water falls within the guidelines of the project and coincides with the creation of a circular system, where the waste of one process is essential to be able to implement another. In this case, the purified and revitalized wastewater from the innovative stone sculptures “flowform” (https://flowform.org) is rich in nutrients, providing an excellent water resource for fields and gardens. A flowform sculpture is a sculpture capable of exploiting the self-cleaning properties inherent in water, its rhythm and chemical-physical qualities. Water passing through these sculptures forms infinite curves, which allow the water to purify itself (Spencer 1995).

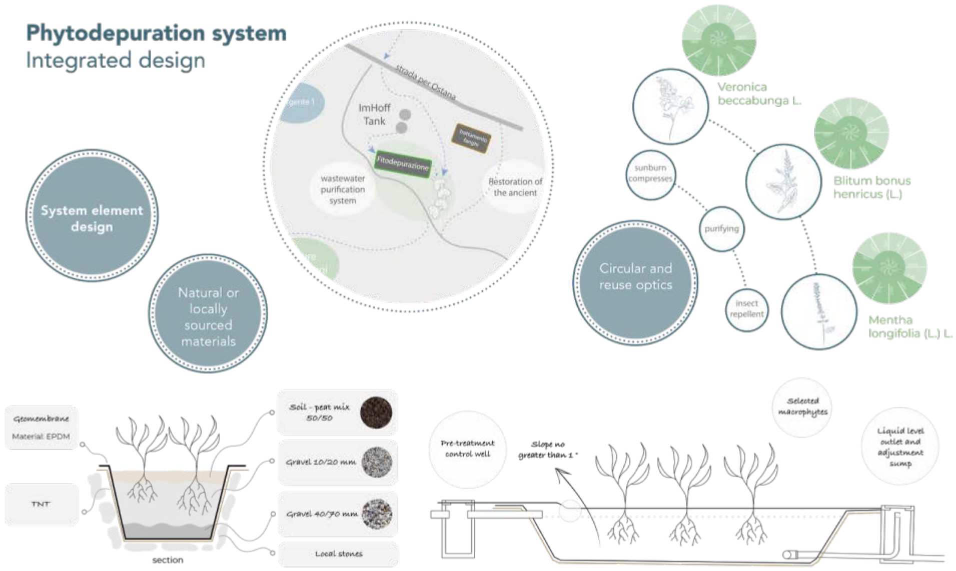

Figure 2. Graphical scheme of the designed phytodepuration system at Monviso Institute campus (Carraro, 2021)

Natural swimming pond and water reservoir

Among the systems developed and designed in this project, the design of a natural swimming pond and water reservoir stands out. This element represents an important factor for local biodiversity and for the availability of water in case of fire in the area. The humidity of the valley suffers in particular from progressive climate change, manifesting in the decrease of wetlands as natural environments necessary for the protection of local biodiversity.

The planned pond covers an area of approximately 100 square meters. The design started from the need to create three distinct areas of the natural pool:

- bathing area

- area for phytodepuration

- walkable external area

For water purification, the integrated phytodepuration system was chosen to create watercircularity without the use of a pumping system. In the construction of a bathing pond, biocompatible engineering techniques are used, avoiding overbuilding interventions. By adopting a sustainable approach based on the principles of the circular economy, natural materials such as local stone and wood were preferred for the construction of the constituent elements, fully embracing the philosophy of the MonViso Institute and recovering them on site, using natural stones and untreated wood, ensuring an organic effect with the surrounding environment and a methodology that is careful to reduce waste.

The location of the pond adheres to the extreme temperature range from hot summers to winters with temperatures down to minus twenty degrees Celsius which the selected plants have to deal with. Native plants have been selected that are used to an alpine environment, resistant with deep and well developed root systems, a high growth rate, non-toxic or pests and aesthetically attractive (i.e. visual blossoming). A key feature was to take into account the possible use of flowers and leaves of the plant species for the creation of products such as natural spreads or washing detergents directly on campus. Embracing the philosophy of the MonViso Institute as of systemic design, the use of herbs and overall plant systems for the organization of workshops to spread principles of circularity are considered important to guests and outsiders.

The main water supply for the pond is a spring on the land of the MonViso Institute. The spring is connected to the pond through a diversion system for the course of the water flow, which branches off to a diversion pit. The water flowing out of the pond is joining the wetlands below, fundamental for the protection of the local biodiversity as a key point during each step of this systemic water design project.

The entire water management, also in the design of the system linked to the management of the pond, is based on the principle of the correct and responsible use of the water and the springs, which were included in the project without any purpose related to the exclusive consumption of the resource. The water passes through the pond, is being used as biotope and for humans to swim, being purified by the phytodepuration system and the flowform sculpture, and is then poured back into nature.

Once outlined all the elements studied for the generation of the system, a gigamap has been created and designed to define all the connections between parts and technologies.

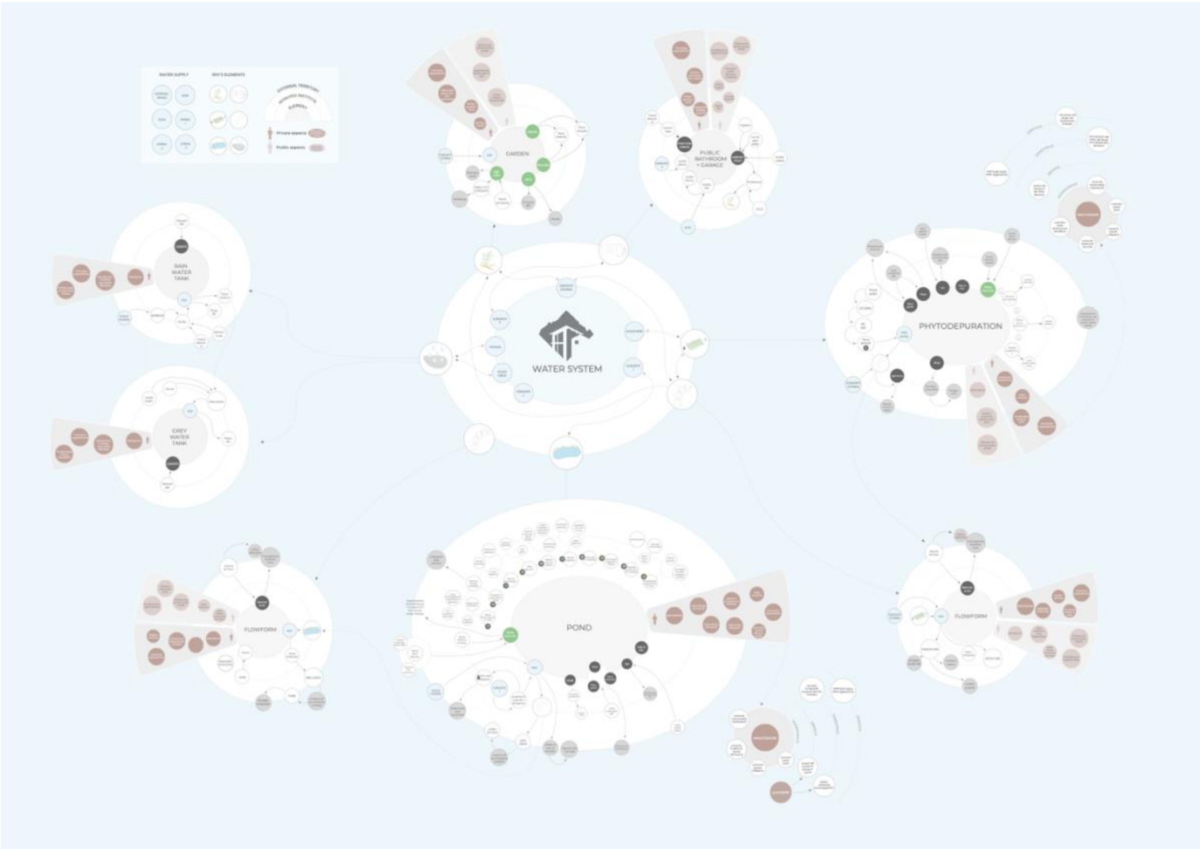

Figure 3. Gigamap of the system designed for the MonViso Institute campus (Carraro, 2021)

Conclusions

The replicability and upscaling of this systemic water design application and illustration are related with the awareness of water as a holistic resource and circularity element. Water must be perceived as an integral part of the ecosystem, as a natural resource and social-economic good, no longer as a detached and separate element. The system itself generates value, connecting people, materials, knowledge and technologies in a single complex network, regulating the functioning of the individual elements. The whole system created is worth more than the individual disconnected components. Systemic design as illustrated in this project is needed and beneficial to develop, implement and maintain such systems functions and systemic values.

The integrated management of water resources should be applied on a level of worldwide acceptance, thus leading us to start from small local realities following the famous motto quoted by René Dubòs: "Think global, act local". Starting from the MonViso Institute as a real-world lab, the goal is to spread awareness for the urgency of a virtuous change towards a responsible and systemic relationship between man and natural resources, a pillar of sustainable and permanent social and economic development. Water as element and resource is a connecting enabler of such better understanding and relational driver.

This research treats the case study of the MonViso Institute as a replicable model, inserting the contextualized study in the reference valley. This arises from the need to demonstrate to the local community what the benefits of this paradigm shift can actually be, always bearing in mind that each system is in any case closely related to the context, thus delineating it as a reference case study and not as an invariable model.

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A systemic project for a local fruit farm and the valorisation of by-products

A case study of a micro-enterprise in Piedmont, Italy

Ferrero Enrica, Ferrero Giulia, Ghignone Elisa, Motta Martina, Ruffa Marco

Covid-19 recalled the importance of local products and the limitations of globalized agriculture, food and health, questioning current production methods. In the fruit sector, traditional and organic crops are being rediscovered, but these must be confronted with the aesthetic standards of the current market, which generates significant amounts of second-rate fruit. These are fruits which cannot be sold because their appearance does not meet aesthetic standards and therefore companies have to make other uses of them. Climate change also affects the amount of second-rate and non-edible food, increasing food waste throughout the supply chain. Systemic design can therefore fit in not only to plan a reuse of these foods, but also to create new value on the territory. Understanding the specificities of the area and the actors involved is essential to define new opportunities and adapt the systemic design.

As a case study, the farm Magnarosa was explored as part of the Open System course of the "Aurelio Peccei" Master's Degree in Systemic Design at the Politecnico di Torino. The farm is located in a small rural area in Piedmont, Italy, with a very strong identity. It is a young, family-run micro enterprise specialised in organic production, mainly of fruit.

Keywords: Systemic Design, Holistic Diagnosis, Agricultural Sector, Ecosystem services, micro enterprises

Introduction

The agricultural sector is strongly related to the logic of the big market, which prefers long supply chains and products with very strict aesthetic standards, particularly in the fruit sector. Therefore, farmers have to deal with large quantities of second-rate products and production waste. Covid-19 showed us the weaknesses and paradoxes of this system, exacerbated by climate change. Systemic design can respond to these critical issues by enhancing the value of local products and territory and helping in the transition to more sustainable supply chains.

This paper presents the research for the realization of a systemic project with the Magnarosa farm (Piedmont, Italy). It is proposed as a case study in a very restricted local context, strongly linked to the territory and local production. The project originated from the Open System course of the Master's degree in Systemic Design "Aurelio Peccei" of the Politecnico di Torino, in collaboration with a young local company characterized by organic production, care for the territory and for social issues. Its proactive attitude and openness to innovation have represented a fertile context to create a dialogue between designers and company, an essential requirement to fully understand the project’s context of development.

Systemic Design Methodology

The methodology follows the Systemic Design Approach, an iterative process in which the steps influence each other. The Holistic Diagnosis allows to create a big picture of the territory and the company, used to define the Challenges to respond to and the unexpressed and emerged Opportunities. The collected Solutions are evaluated through a Multi-criteria analysis to select the optimal ones for the specific context. The Systemic project designs relationships, flows, partners involved, and timing of the various actions creating value. The approach concludes with an evaluation of project Outcomes and future implementation steps. (Barbero, 2017)

Holistic analysis of the territory

Magnarosa is a small business. In order to carry out the holistic analysis, the territory of reference was specifically selected within a radius of 8-10 km. The boundaries considered include three municipalities in the province of Cuneo (Barge, Bagnolo Piemonte and Envie) and one in the province of Turin (Cavour), located in the area surrounding the company and included in the Infernotto Valley.

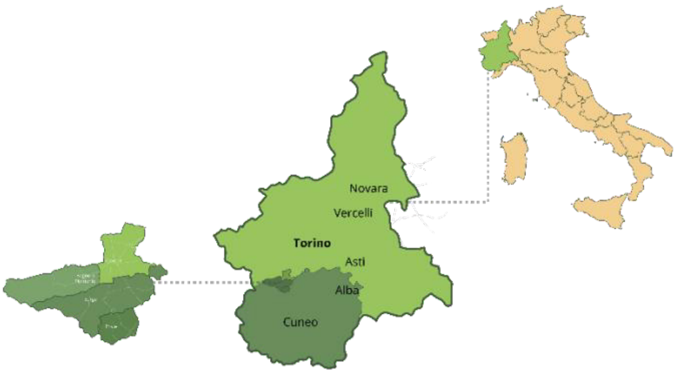

Figure 1. Location of area analyzed in comparison to Piedmont and Italy

The area has a mainly hilly morphology, and it is located at the foot of Mount Bracco, where there is also a small natural park, Rocca di Cavour.

The total population of the area is 21,000. Barge, where Magnarosa is located, is the most densely populated municipality. (tuttitalia.it, n.d.)

Furthermore, the area is home to the second largest Chinese community in Europe, as a consequence of a strong migration at the end of the last century from a Chinese region specialised in stone-working, Zijiang (Chambra D'òc, n.d.). It was precisely the presence of a territory similar to the motherland, rich in quarries of Quartzite or Bargiolina stone, that linked the Infernotto Valley to the homeland of the nascent community.

The other main sector of the area is agriculture, with orchards in particular. The area is rich of historical and cultural events, such as fairs presenting typical local products, and various tourist routes and itineraries to discover local goods, as wines and apples.

Agriculture is the main sector of the area, together with animal husbandry. The percentage of micro enterprises with less than 10 employees, which are 94% of the total number of enterprises in the territory (Censimento Industria Servizi Istat, 2011), confirms the local dimension of the area considered.

This area has a lower-than-average age: this is due to the fact that many businesses are family owned and therefore run also by young people. Moreover, the area has many schools concerning gastronomy and agriculture.

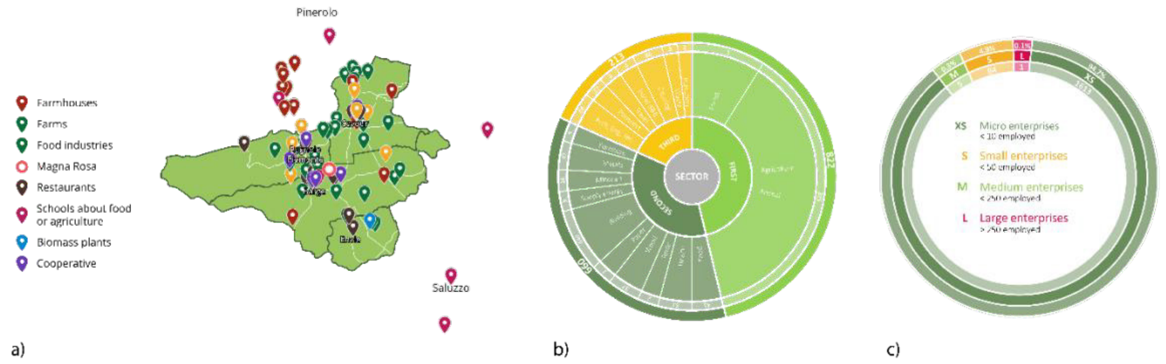

Figure 2. a) Territory mapping of realities related to the company's sector, b) Companies divided by productive sectors, c) Size of enterprises

The main local products are cereals, fruit, nuts and mushrooms harvested in the mountain areas. The area's morphology is particularly suitable for this type of cultivation. Magnarosa produces mainly apples, hazelnuts and blueberries, with small numbers of pears, chestnuts and grapes.

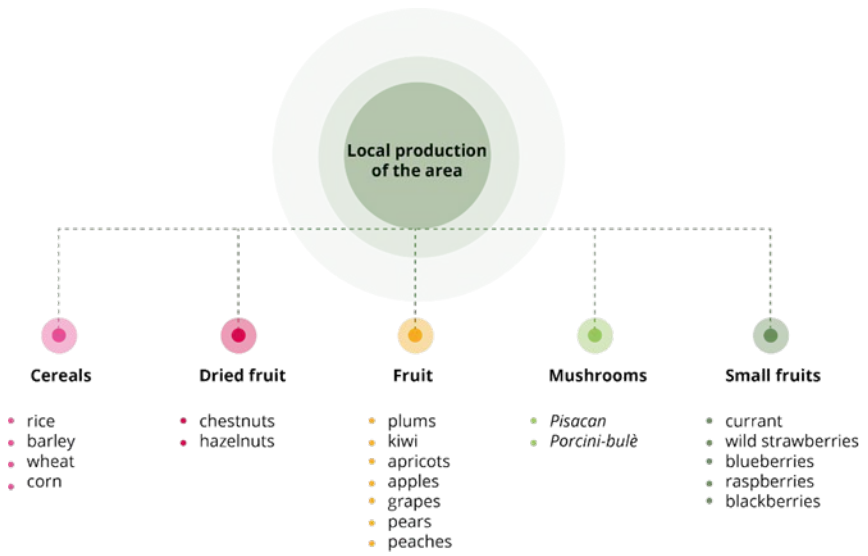

Figure 3. Differentiation of local productions in the area

Holistic analysis of Magnarosa

Magnarosa farm is located within the triad of municipalities of Bagnolo Piemonte, Barge and Cavour, in the province of Cuneo. The small, family-run business, despite its few years of activity, boasts an important responsibility in terms of sustainable production and an ethical attitude towards the environment. The crops produced are grown organically, with the aim of intervening in terms of treatments and mechanical work as little as possible, to keep the natural ecosystem active. This leads to fruit productions of pears, apples, blueberries, hazelnuts and chestnuts, in the total absence of chemical herbicides or pesticides. The most important and ancient cultivars of the company are apples, such as the "Bella di Barge" variety.

On the one hand, the company's attitude is based on the traditional knowledge imparted by Aunt Rosa's family, from which the name Magnarosa derives; on the other hand, it adopts a glocal vision, strongly enterprising, attentive to the needs of the territory and always willing to update itself.

In addition to the zero-km production of crops, the Magnarosa farm is also a holiday farm for a stay surrounded by nature. This reality is one of the first to have brought the BIO concept to Barge and the surrounding area, with the hope of providing a new vision: exporting a local project to the global dimension, thus making it scalable and replicable.

The company's projects are continually evolving and the most visionary ones include the launch of a start-up capable of coordinating waste from apple production to the cosmetics sector, and a start-up of the first protective forest in the Piedmont region.

Thanks to the enterprising vision of the young people working behind Magnarosa, the farm has built prolific relationships with other local and non-local entities over the years, to expand its sales network, online as well, and to join various projects. These include Reynaldi Cosmetics, with which the company is linked to start the production cycle of BIO cosmetics, and "Il Frutto Permesso", which processes raw materials from Magnarosa, such as apple juice.

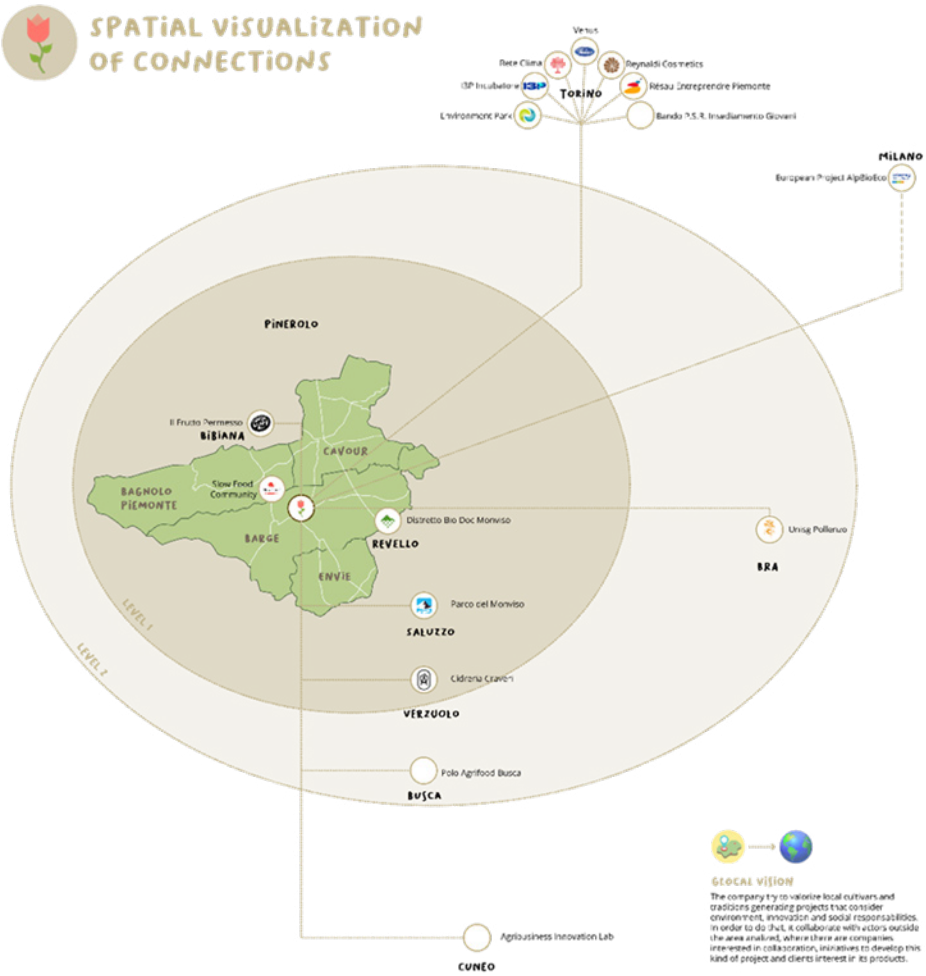

Figure 4. Spatial visualization of local connections related to Magnarosa

Challenges and opportunities

For the definition of the challenges-opportunities' system related to the territory and the company, the general impact of the agricultural sector was taken into consideration, in order to fully understand the problems, both in terms of intensive agriculture and of exploitation of human capital. (Sinatti, 2019)

A first important step of the project was the contextualisation, and the subsequent justification, of some perceptions and qualitative feedback reported by the Magnarosa company, related to the territory. For example, if the impression was that there was little interest in collaboration between small local realities, this was due to the difficulties encountered by companies in establishing relations in the absence of calls for tenders or external funding. Moreover, the Magnarosa company perceived a limited open-mindedness from small entities in the area. This was due to a low participation of the latter in training as agricultural operators (12%), because of a low awareness of the value of training on issues, also related to the environmental impact of the agricultural sector (IRES Piemonte, 2017).

Furthermore, when analysing the barriers encountered in the project, one of the most significant was the coordination of the three phases of research, brainstorming and design thinking, crossed by the group members, which took place entirely remotely. In addition to this, establishing a proper dialogue with the company itself has been challenging. In order to create a sense of mutual trust, and to work in synergy, defining a project suitable for the company's size was the priority.

In this respect, Magnarosa's entrepreneurial reality proved to be immediately available and open to discussion, despite the initial difficulty in understanding systemic project logic, especially in certain phases.

An important limiting factor of the company is its young age: although it is a highly enterprising reality with a strong incentive for innovation, it does have some limits in terms of economic availability, partly caused by the advent of the pandemic, which forced the temporary closure of the farmhouse.

The aim is therefore to propose economically viable and sustainable solutions, even in the long term, possibly taking advantage of external opportunities such as calls for tender organized in the area, or funding.

The innate open-mindedness of the small entrepreneurial reality offers various possibilities for action, some of which have already been undertaken, such as the launch of the start-up Vortex, others are in progress, and others are still to be developed in the near future.

The critical points of the territory - economic, cultural, social and environmental - were compared, and weighted according to different values, and then cross-referenced with those specific to the company. Among the main critical points highlighted - coming from the analysis of the production flows, of the transformation processes of products and by-products, and from the network of relations present in the territory- the following should be considered:

- the important quantity of second-grade apples, partly coming from non-edible percentages of the harvest (5%, equal to about 37.5 quintals per year), partly from a selection that cannot be sold due to poor aesthetic qualities (up to 70%, equal to 105 quintals per year). The big market of fruit and vegetable imposes strict quality standards, which exclude large quantities of fruit and vegetables from the sales system, due to colour, shape, size, weight considered unsuitable.

- the strong dependence of the farm's production on climatic effects, or the possible presence of pests, also considering the absence of appropriate anti-hail nets, due to their high costs. This leads to significant crop instability, resulting in a considerable impact on sales and incomes.

- the limited active relations in the territory between micro-enterprises belonging to the same production sector.

With regard to the opportunities for the development of the systemic project, it is important that these take into account the feasibility and the resources that the territory, together with the company, is able to offer.

Speaking in terms of reusing apple waste, the pomace can be used in various transformation processes for possible productions, such as snacks and biscuits, baby food, flavored craft beers, yoghurt, jams, sorbets, fruit pulp or soaps. While the dry part, consisting of cuticles, can be used for paper and the development of textile fibers.

To cope with the pressure of possible pests or adverse climatic events, the company can seize the opportunity to participate in calls for tenders in the Piedmont region, which would allow up to 80% financing of protective insect nets, or study the insertion of friendly insects and bats that feed on these pests.

Finally, in order to encourage greater relations and communication between the small local authorities, it is possible to develop activities that promote local tourism: tasting sessions of typical products, mountain itineraries and excursions, or even educational courses for children, involving agricultural and hotel schools.

Multi-criteria analysis

The future steps of the project will include the final choice of the most suitable solution for the context and the farm, in order to realise a project that fulfils the five points of the systemic approach. (Barbero, 2017)

A further criterion to be taken into account will be the economic feasibility of the intervention, assessed in parallel with Magnarosa's propensity create additional links with local actors. The aim is to develop a project that places man at the centre, capable of maintaining and regulating himself, in order to enhance the relationships with the territory.

Conclusions and future steps

In order to carry out the systemic project, it was necessary to get inside the specific context of reference, understanding the peculiarities of the company and its relations with the territory. Thanks to the easy dialogue developed with Magnarosa, a further understanding of the local know-how took place, enriched at the same time by the team's research of skills in the field.

The project, the confrontation with the company, and the active research using a desk and field approach, allowed the designers to reach a new level of awareness, fully understanding the steps and sensitivity required to develop a value creation project. As a first experience in the field, and according to this type of approach, the collaboration has brought to light different competences, contributing to the development of the final project outputs.

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Sustainability and its paradoxes: the case study of a big coffee roasting company in the Turin Metropolitan Area on the lens of Systemic Design.

Chiara Campolmi, Mariaserena Di Giovanni, Domenico Devanna, Daniel Jaramillo Rueda, Tommaso Muzi, Alisia Pellegrini

Coffee is one of the most important agricultural commodities in the world. Due to its economic importance and its growing worldwide demand, it is well-known that the coffee value chain is responsible for several wicked problems, mainly associated with sustainability. Systemic Design (SD) seems to provide an answer to deal with these issues, by defining a structured and holistic process and promoting an innovative approach towards a sustainable and resilient future. This paper aims to frame the role of the systemic designer as a figure capable of proposing sustainable strategies with an innovative and transdisciplinary approach. The discussion is narrowed to the specific case study of a big coffee roasting company present on the territory of the Turin Metropolitan Area, which has been analyzed on the lens of the SD approach. The set of tools and methods provided by SD has led to the identification of paradoxes related to the sustainability vision promoted by the company itself. Owing to the fact that the company also operates on the international scene, very often it tends to confine its interventions towards sustainability to localized actions, instead of considering the whole system made of inter-connections. The role of the systemic designer becomes crucial in dealing with these tensions and proposing solutions in order to strike a balance in the sustainability dilemma.

Keywords: Systemic Design, Holistic Approach, Design for sustainability, Wicked Problems, Coffee value chain.

A look at coffee supply chain and its issues

Coffee supply chain plays a central role in the global economy, being coffee one of the most commercialized products in the world, second only to petroleum (Giraldi-Díaz, Medina-Salas, Castillo-González & León-Lira, 2018). Despite the coffee industry being one of the most flourishing on the world stage, it is also responsible for several dire consequences to the well-being of our Planet, such as soil erosion and deforestation, air and water pollution, food loss and food waste, to mention a few. However, the long-term sustainability of this production chain depends not only on actions aimed at reducing these environmental impacts. In fact, the coffee value chain has to contend with social issues such as food insecurity and poverty in coffee communities, unfavourable working conditions due to the long working hours, health related problems in workers and many more (Samper & Quiñones-Ruiz, 2017). To these environmental and social issues must be added also the consequences caused by interests of businesses and international agreements, which contribute to making the need to develop strategies for a sustainable and resilient future more urgent.

The design discipline has addressed this critical value chain in many ways over the years, developing products and services capable of making a shift in the sustainability vision proposed by international coffee companies, which tend to confine their interventions towards sustainability to localized actions, instead of considering the whole system made of inter-connections. Systemic Design (SD) provides a method to face complexity in a more holistic way, helping companies to include into their business model a circular vision that creates new value and delivers long-term prosperity and profit. The aim of this paper is to deal with the criticalities and paradoxes in terms of sustainability associated with the coffee value chain through SD. The discussion is narrowed to the specific case study of a big coffee roasting company present on the territory of the Turin Metropolitan Area (which for practical and disclosure reasons we will call Cofix), that also operates on an international scale with the aim of dealing with these tensions and proposing solutions in order to strike a balance in the sustainability dilemma in the coffee value chain.

Establishing a methodology

Following the SD principles, we started our work with a Holistic Diagnosis (HD) of the Metropolitan City of Turin and Cofix, gathering data regarding social, economical and cultural aspects. As a first result of our research we put out a giga map, a systemic visual representation of all main data collected, creating clusters of information and links between those. Within this analysis we examined each aspect of Cofix, and gave a strong focus to their supply chain. Thanks to this particular view we were able to take a deep look into the different outputs of the company and found out that these outputs were in some cases treated as a by-product and in other cases as an ordinary waste.

By crossing the data taken from the HD, we were able to identify various insights that pointed out challenges and assets for the company and the territory. Those insights with a challenging nature were rated and then filtered by understanding their relevance to the territory and the company. We understood the relevance of each challenge through a SWOT analysis, taking into consideration the strengths, weaknesses, opportunities and threats that the territory and company presented with respect to each specific challenge. The most relevant challenges were then taken further by turning the SWOT into TOWS, understanding which possible strategies could be followed in order to address these challenges through Cofix actions. We identified 6 main strategies, and then selected 3 with the widest range of impact that generated a domino effect in various challenges. These 3 were then shifted into stated opportunities by doing desk research on good practices all around the world and inside the territory. Lastly we created different scenarios for the implementation of these found practices combined with the assets of the territory and made an evaluation through a multicriteria analysis turning qualitative characteristics into quantitative data, being able to rate its feasibility in the territory, its importance and impact to the local actors and the company, time scales of action, sustainability concerns and advantages, among others. All this helped as a filter for setting up the first draft of our system, a set of actions and interconnection of actors that by collaborating would be able to generate a value to the company's wastes and to the territory.

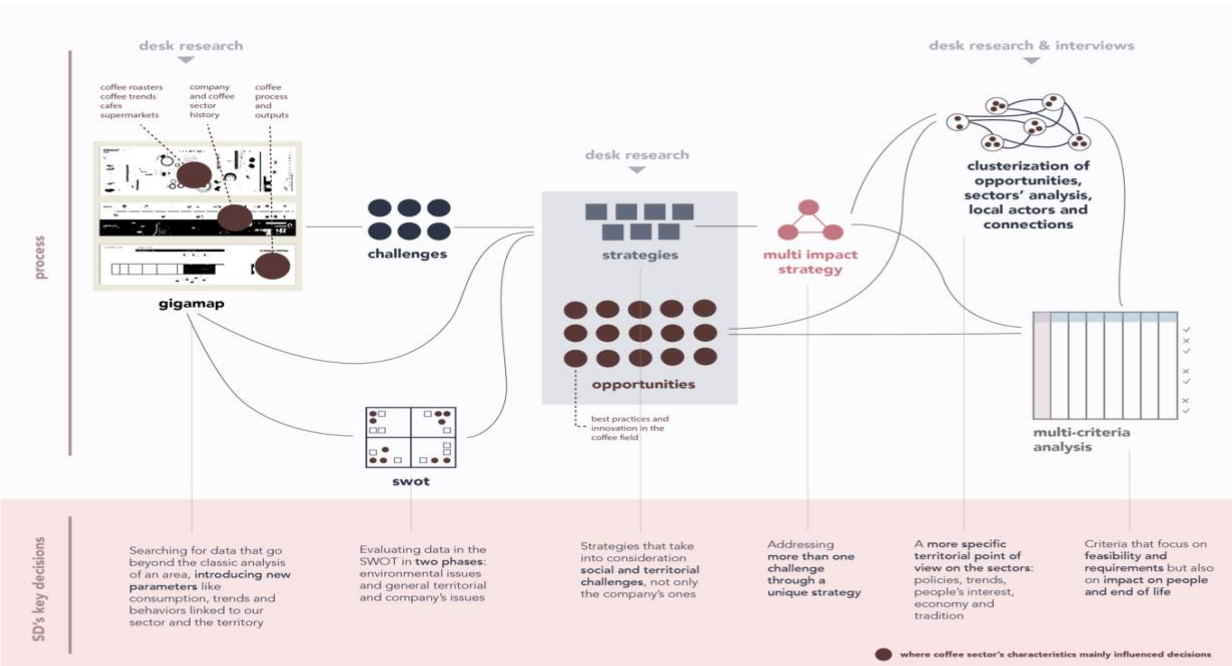

Figure 1. Schematization of the methodology followed for the case study. Source: Authors

Addressing the tensions

As exposed previously, the tension between sustainable visions may vary according to the lens from which it is seen, and the case study of Cofix is not an exception. We were initially introduced by the company to some possible paths that were being explored towards innovation in their sustainability programs. It's here where the first tension appears, although it might be seamless, the fact of giving a possible path might be easily taken as a route into a dead end. We addressed this first tension by putting aside their suggestions and making an analysis that gave an entire panorama of the company's and the territorial conditions. It is important to clarify that it is not a fact that the company was doing things wrong or didn't know what to propose, however it is crucial for an SD analysis to have a clear view of all the present assets in order to prioritize the different criticalities present within the context.

For this instance the company proposal pushed their innovation route into a purely technological solution: Take one specific output and use its chemical components as an input in 3 different industries. However thanks to our first phase of analysis we noticed that some sectors were left behind nevertheless these were showing a big presence inside the territory and a will and need for change, potentially impacting in a big scale the population and realities of the context. We noticed that by addressing different paths from those proposed we were able to still offer a similar impact to the one the company initially was looking for and additionally give an added value to other critical issues inside the contextual reality.

It now appears one of the biggest tensions between the visions of sustainability of the company and of the SD. The economical feasibility; nevertheless the SD shows a clear strategic path for the addressment of these criticalities, the system is mainly based in assumptions, assumptions that can't be easily sustented by economical means, not because there is no possible economical return but because every actor inside a system wants to receive a value from it. It is a strategic plan not only for Cofix but for the entire network of actors, and Cofix must be willing to mediate in order to have a return, be part of an autopoietic flux. In this case it was really important for us the creation of a system where every actor sees a beneficial symbiotic relation, for this purpose we returned once more to the criticalities inside the territory and the potential opportunities and found different issues that could be resolved by the treatment of this specific waste, creating what we could call a chain of favors, which in each step were adding value to the actors of the network and to strong realities of the territory.

We realized the system could add value to the coffee waste by creating a network of local actors that operate in various sectors, whoever two of these sectors came out as the most suitable by what they had to offer for the system and their impact in the territory, those were the automotive and the agrifood sector. The system envisions a chain of actions which benefits each actor in a unique way. This collaboration allows the transformation of Cofix waste into: coffee based bio-polymers used for automotive production and non-chemical fertilizers destined to local crops of barley, one of the most important crops in the territory and also input for new products of Cofix.

This collaboration not only brings a monetarial retribution for Cofix, it also helps them to position themselves as a "sustainable" and "innovative" company, as they are experimenting new solutions in the field of circular economy. Moreover, the system's actions work as a trigger for new habits, both in the company and the territory. So the valorization of the waste system is capable of creating new commercial values in other production chains that generate new networks that benefit people in the territory.

The outcomes of the analysis

Now more than ever, contemporary society is experiencing an increased complexity of challenges caused by social, economic and environmental transformations. Designers are dealing with this complexity and are learning to reframe questions in order to think more expansively and face tensions through a holistic view. Within such scenarios are necessary new approaches like SD, which is capable of providing designers with specific tools and structured methods for intervening in contemporary issues and designing new strategies for a sustainable future. Among the issues that are affecting our society, sustainability is gaining a growing interest from governments, communities, industries and many more. However, as discussed below, very often the vision of sustainability proposed by companies does not take into account the social, environmental and economic dimensions and the global systemic point of view. The case study that has been analysed in this paper shows how a holistic and systemic approach applied to a company operating in such a complex sector such as the coffee industry can actually bring benefits in terms of Corporate Social Responsibility (CSR), impact on people, and positive effects on the environment. The systemic designer, as a multifaceted figure, can act as a mediator between knowledge and needs, capable of displaying hidden relationships, connecting local assets, actors, people and proposing strategies that aim to find a balance between economic-oriented visions and sustainable-oriented perspectives. The systemic designer has a key role in facilitating the relationship between various actors and disciplines, building a common language to solve problems and criticalities at different scales. The creation of a shared and accessible system of communication could be fundamental to narrow the gap between different sustainability visions in a SD project, therefore future research could be oriented towards this common language, helping to address the tensions analysed throughout this paper.

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Acting on a company to relaunch a territory: the application of the Systemic Design Methodology.

A case study in the province of Biella, Italy.

Alice Marchesi, Denisa Moldovan, Mariapaola Puglielli, Martina Troppino, William Tonelli, Xinwei Wu

A company that relates in all aspects to its territory, responds directly and indirectly to every change of it. When the well-being of the territory is lacking due to external or internal forces, the company is also subjected to the difficulties that this entails. In a period strongly characterized by unforeseen environmental events, companies must be able to develop resilient behaviour, to face any scenario.
With this awareness, the Systemic Design methodology is able to highlight the relationships between the territory and a company, give an overview of this network and through a transdisciplinary method, design practical solutions.
The methodology has been applied, in the specific case, to study the industrial activity of a dairy farm in Biella province, an area seriously affected by economic crises, which needs to establish a new balance and enhance itself. The approach aims to expand the network of relationships that bind the two systems for mutual reinforcement. Finally, the process merged into three fields of action that affect environmental, economic, and social issues: the use of tangible and intangible resources, the value of by-products and the awareness of the community that lives in these places.

Keywords: Systemic Design; dairy company; territorial enhancement; process efficiency; communication.

Introduction

This research aims to demonstrate how the Systemic Design (SD) methodology can be a successful tool to **highlight the relationships between a company and its territory, to enhance mutual development**. It is allowed thanks to the modality of SD to deal with scenarios with a high degree of complexity: the transdisciplinary approach needs to create a horizontal dialogue among parts, to design systemic and multiple interconnected solutions. From the Holistic Theory, SD maintains the assertion in which the whole is more than the sum of its single parts. In particular, the way of thinking enterprises as a part of a whole helps to find innovative and sustainable solutions with the participation of the territorial actors. This concept overcomes the idea that a single entity is enough for itself, showing how the development of one brings shared wealth.

A company that is born and remains for years in the same territory, lives the transformations that it undergoes. In times of growth, both benefit from cultural, social, and economic wealth; as well as a territory in crisis affects the companies that inhabit it. “This involves recognizing the nature of firms not only as legally bounded entities and owners of proprietary assets (both tangible and intangible) but also as institutions with permeable and highly blurred boundaries—in other words, conceptualizing them as “networks within networks” or “systems within systems.” (Dicken & Malmberg, 2001).

Enacting the Systemic Design methodology for a specific case study

A specific case study concerns Caseificio Rosso, a historical company that produces cheese. The company is rooted in the province of Biella, where Rosa Pidello Rosso in 1894 started the business; still, now it is a family-run enterprise (biella.cna.it, 2020).

To act with a systemic approach to the company, it was essential to carry out a Holistic Diagnosis, first of the territory and then of the company. To analyze the territorial system, demographic, geographic, economic, historical, and cultural data has been gathered from reliable sources into a shared datasheet. While the study of the enterprise has been articulated through the comprehension of the corporate structure, and its history; then the production line, the assets, the markets, and the competitors. This means a large amount of data collection, which framed the state of art of the two networks. Once processed, data led to some considerations. The Challenges of the two fields of action highlight problems and possible common paths, which can turn out into Opportunities. First, through desk research, potential case studies arising from such issues have been identified. To understand which Opportunities to carry out in our studies and transform them into strategies of action, Multi-criteria analysis has been the selection tool, thanks to which each item has been evaluated according to common parameters: Feasibility, Impact on the territory, Economic impact, Systemic Design Principles (Autopoiesis, Human-centred Design, Outputs into Inputs, Relationships, Act locally). The specific solution of a problem must always be measured with the will of the company and the needs and limits of the territory. The role of mediators of designers is here more than in other moments, fundamental to open the dialogue between all the actors (Barbero, 2017; Barbero, 2021).

General overview of the territory

The province of Biella, with a population of 174.170, is distributed in 74 municipalities (tuttitalia.it, 2021). This territory is characterized by a particular morphology: it is in fact subdivided into three parts almost equal between mountains, hills, and flatlands; with 40% of soil covered by forests and only 0,7% by superficial water. (data from geoportale.piemonte.it, 2019 processed by the authors with a Geographic Information System program). The area is therefore characterized by an urban distribution that follows the location of the valleys and their respective waterways. During the industrial expansion, until today the province is strongly characterized by the harmonious coexistence between man and nature.

The predominantly mountainous topography has not favored agriculture but has preferred animal breeding. Since the XV century, small landowners played a key role, in which having animals allowed the inhabitants of valleys, in a vision of self-sufficiency, on one hand, to raise their own livestock, and on the other, to be able to work wool and fabrics on their own properties (lanedibiella.com, n.d). Still, now, the primary sector is composed of **37% of the enterprises dedicated to farming**. The second sector is instead subdivided into equal parts between building and manufacturing. In the manufacturing sector, the textile district corresponds to 17% of the whole. Its turnover amounts to € 8.905.004 per year (business.bigprofiles.it, 2019a), and the export to € 1456.58 million (Camera di Commercio di Biella, 2019). The **textile sector** has always been the great power of Biella territory and the main source of income. For this reason, the province has never had to advertise itself and has never tried to develop other sectors and new job opportunities. Moreover, the latest researches show that this **economic monopoly has led to a long-term impoverishment of other sectors** (Regione Piemonte & POLI Design, 2015).

The **agri-food sector** is smaller, with 3% of the total with € 2,565,566 revenue per year (business.bigprofiles.it, 2019b), boasts beer industries, including Menabrea S.p.a. and dairy industries, and water ones, like Lauretana S.p.a.

The territory is the common starting point of these districts. The **peculiar morphology** of the Alps is the ideal condition to raise an economy based on animal industry. Moreover, **water resources** are restrained, but with excellent qualities (with low-fixed residue) that reflect both in the softness of fabrics and tasty milk. In recent years, however, there have been phenomena of water scarcity, and reduction of quality in the main waterways of the area. These circumstances are due to the historical presence in the territory of textile industries that used to throw wastewater directly into rivers. Since 1979, Cordar Consortium has managed the purification treatments of industrial wastewater.

However, the two sectors had very different developments: textile became the most typical sector of the region, while the agri-food sector remained mainly marginal and tied to its traditions. Today, the textile sector is less strong than in the past and Biella has lost the epithet of *Manchester of Italy* (Regione Piemonte & POLI Design, 2015). Moreover, historical, and various economic researches show a pattern comparing the two districts trends: over the years, the number of textile industries has fallen dramatically, but the food industry has always maintained a certain balance. This is especially evident with the arrival of the crisis in 2008, which most affected the textile industries. This situation led to several connected problems: factory abandonment, lack of labor opportunities, depopulation and decrease of young people inhabitants, and land abandonment. The crisis occurred in parallel with the crumbling of the formal relations between the economic and cultural realities that inhabited it. So, now, the first need of the territory is to renew and promote itself.

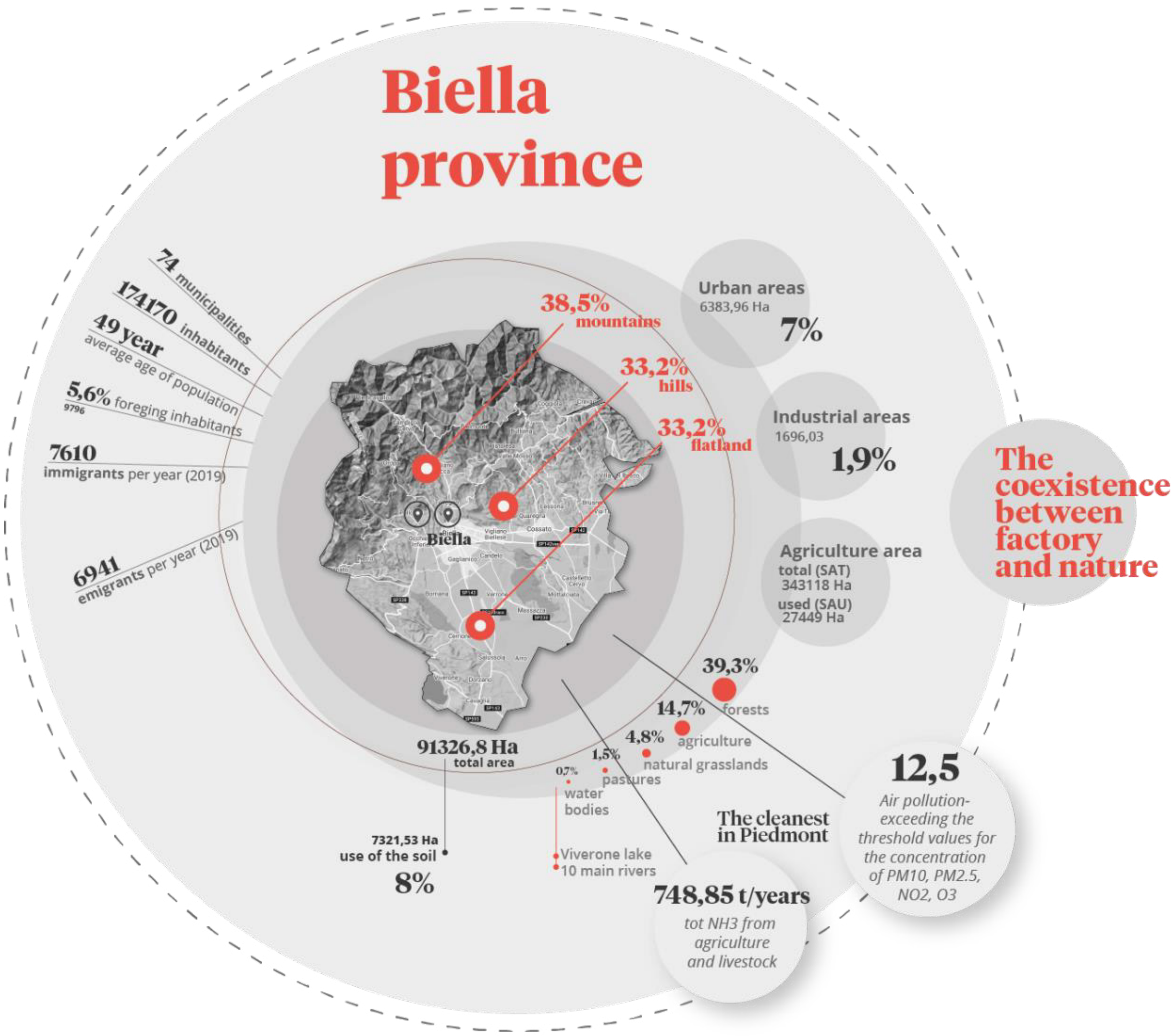

Figure 1. Relevant data of the Province of Biella (Source: Authors).

Specific overview of the dairy company

Caseificio Pier Luigi Rosso was born in the middle of the Biella Alps, where Oropa Valley meets Cervo Valley. The fourth generation of the Rosso family is the manager of the dairy, a small reality of 14 employees. The Company has two different plants: the administrative office and the production site are located in Biella (BI), where the milk is processed to become cheese. Just 7 kilometers away, in Pollone (BI), the employees carry out the ripening phase and manage the delivery trucks; next to the plant, there is also a tiny shop for direct sales. The possibility to follow the production, from the acquisition of the raw materials to the conclusion of the aging, allows Caseificio Rosso to **ensure the highest quality** and consistency of the finished product in **full respect of the tradition**. During the century, the company **acted locally**, tightening a close network of local suppliers.

They sell their products locally and export through Italian-large distributors, always maintaining the high quality of the products (Enrico Rosso's Interview, 2021).

The **cheese production process** starts from the milk collecting and ends with the sale of the products. Milk is collected six days a week from local producers and, in autumn, by additional two Piedmontese producers located outside the province. During the process, the milk releases 80% of it in **whey**, a liquid by-product rich in nutrients, that the company sells to a pig farm in the same area. Since the whey contains a high quantity of lactose and proteins, if thrown away, it constitutes an abundant waste of food resources, and worst, if not treated well, it damages the soil.

Another **relevant input is constituted by the water**, not only for the processing but also for the frequent cleaning phases. The quantity of water per month is almost 300.000 liters. The water, once used, must be purified because it does not only contain organic components but also chemical cleaning agents. For that, comes into action Cordar Consortium: the society that manages the industrial exhaust system, a network of pipes created for the disposal of wastewater from industries. This infrastructure has a significant role in the reuse of wastewater, which, if released in the environment before treatments, can affect nutrient cycling and the development of diseases. Despite the contribution of the Consortium, the water does not return to its initial degree of purity (Consorzio Cordar, 2014a; Consorzio Cordar, 2014b).

Finally, it is important to mention the amount of energy necessary for the entire cheese-making process. In particular, the most energy-consuming phases of the process are the pasteurization of 90% of milk, and the ripening phase, which involves four different cold rooms for an average period of around 60 days for cheese. Solar panels installed in the two plants produce part of the energy needed, while the rest is from fossil fuel sources. Non-renewable energy input transforms into air pollutants output that influences the air quality and climate regulation, and indirectly on human health.

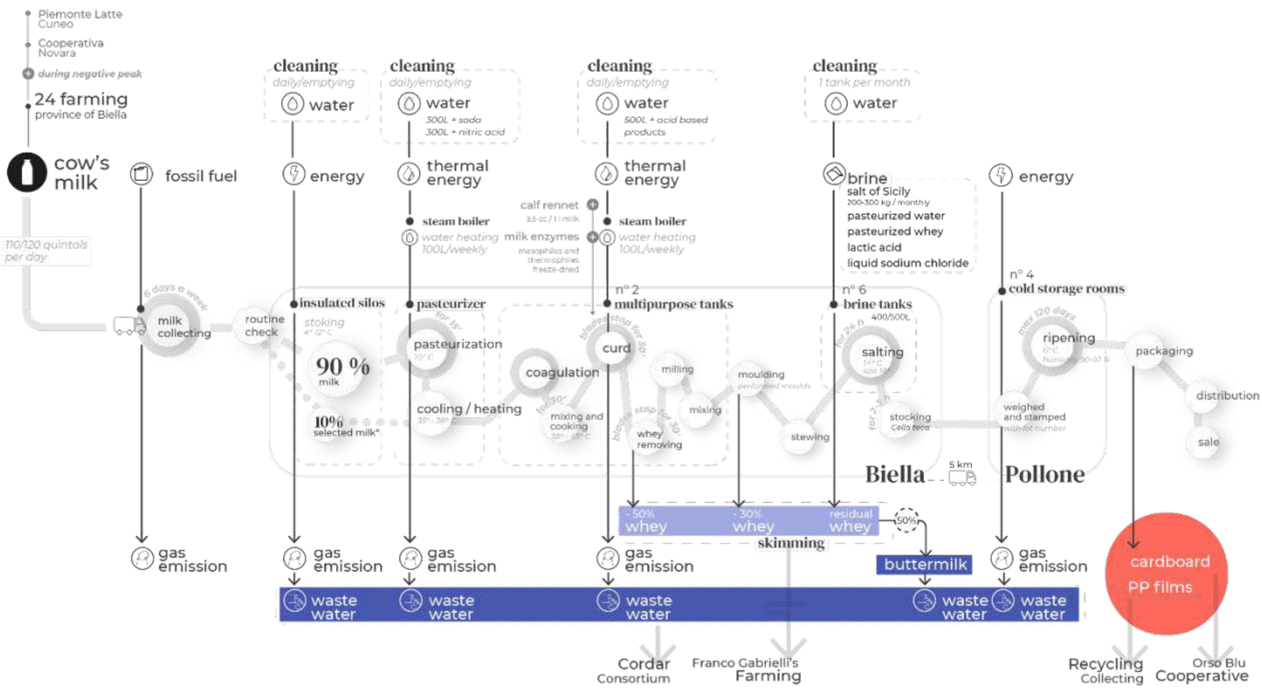

Figure 2. Productive process of the company (Source: Authors).

Cross-cutting research to define strategies

From The Holistic Diagnosis of both the territory and the company, several factors emerged as critical and some others as potential opportunities and strength. The key was to draw links among all the points to read the set of nodes as the same network.

The action plan aims to **enhance the use of the resources** (1), to **bring value to by-products** (2) and to **communicate the strong know-how behind the final product and its territory** (3).

1- More specifically, the first area of interest concerns **water**. The high consumption of the resource in the productive process collides with the scarcity of water in the area (Provincia di Biella, 2019). The applied strategy touches 3 different points: reducing the volume of water through physical tools like low-volume/high-pressure nozzles; raising awareness among employees, in order to acquire a pro-environmental behaviour, also as citizens (Wells et al., 2016) with the visualization of the quantity of water they use daily. Finally, water scarcity of the territory is communicated outside the dairy thanks to infographics, displays, social media and events.

2- The **organic waste is an output of the process that, for now, represents** the 80% of total waste sent to the municipal service disposal. It can be **re-introduced in the system** as a fertilizer component through shared treatment among multiple users nearby, in a form of collective composting management. This shared action is, moreover, permits to **create relations** with other actors and the territorial spaces.

3- The textile crisis has taken away the international recognition of the industrial value of the province of Biella. **Districts still alive can tell the territory and its history** again. For this, a direct communication on the products of the dairy can have a marketing function for the company and mouthpiece of the province. This can be realized in the form of tangible actions (through material and graphics of packaging). Cotton scraps from the textile sector are used as the primary packaging for a part of the dairy's production. The material would add value on several levels through the use of material that becomes a resource from waste, through the differentiation of Caseificio Rosso's products on the market, and through the enhancement of the informal relationships existing between local entrepreneurs, in addition to being a material that guarantees optimal conservation of the cheese.

Conclusions

The project started with the idea of acting with a systemic approach on the selected company. The methodology used allowed us, through qualitative and quantitative data, to obtain a holistic view of the company and the territory in which it operates, from which emerged common challenges: we discovered the strength of the link between Caseificio Rosso and the province of Biella in which it operates and how the needs of one meet the needs of the other.

It follows that the **methodology of Systemic Design applied to a business reality enhances the company-territory feedback loop**.

The effectiveness of this approach is to relaunch the company based on, first of all, going to make the production process more efficient and re-evaluate its resources, whether these are raw materials or by-products that the company produces. Through a material (output>input) and immaterial flow, different realities can link together; as punctual gestures (such as plant modification) could initiate deeper cultural transformations (starting from employees) that can reach, in a long term, macro-scale actions. Concurrently, the company could take advantage of the context and become stronger starting from the strengths or weaknesses of the territory. Local peculiarities lead to the design of unique solutions, such as to trigger positive effects on the business reality. These favorable impacts resonate in the territory, closing (and starting) the exchange of inputs and outputs of the whole system.

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Track 5:

Design Methodological Research To Develop Tools For Dealing With Systemic Conflicts

Chair: Prof.dr. Paul Hekkert

Mapping Transition Readiness

A model for identifying how and where design can intervene in system transitions

Hannah Goss, Nynke Tromp, and Hendrik N.J. Schifferstein

Designers are increasingly tackling complex societal challenges and fostering system transitions. Transitions are long-term, multi-level, multi-phasal system changes involving numerous actors, requiring innovations that develop new relationships within the system. Therefore, the process of designing for transitions requires new ways of bridging system analysis and system synthesis. This paper explores the concepts of 'transition readiness' and 'value conflicts' as valuable indicators to bridge this gap and support designers in fostering system transitions. Synthesizing insights from literature and previous experience, we propose a first step towards an integrative model for mapping a system transition in a way that inspires design. Our model, called the Transition Readiness Profiles, anticipates the dynamics of a system transition and helps identify how and where design can intervene to accelerate the transition. It analyzes the transition at the individual-, organization-, and system level to understand the system dynamics and reveal what organizations can bring forward to foster the transition relative to others. The Profiles capture the relational dimension of a transition by mapping readiness, value conflict, and stakeholder relationships and dependencies.

Keywords: designing for transitions, value conflict, system mapping, transition readiness

Introduction

Complex societal challenges are increasingly the focus of research scholars and practitioners in multiple disciplines—including design. The urgency and relevance of these complex challenges have inspired new areas of design that are positioned between the domains of systems thinking and design, such as systemic design (Ryan, 2014), designX (Norman & Stappers, 2015), and transition design (Irwin, 2015). These new areas have opened discussions about how designers can cope with complex system transitions. However, less emphasis has been on how to actually design for or foster system transitions.

Transitions are complex and non-linear processes of systemic change that occur over a long time, usually over 25-50 years. As further described by Rotmans and colleagues (2001), *"a transition [is] a set of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems. A transition can be seen as a spiral that reinforces itself; there is multiple causality and co-evolution caused by independent developments" (p.16)*. Although a complete structural transition takes a long time to materialize, partial processes that begin to destabilize the current system can occur suddenly and with significant impacts, such as with radical innovation or behaviour change (e.g., the Coronavirus). Achieving a transition can only be realized through cooperation between innovators with shared strategies and a collective long-term goal that establishes change at all levels of society (Loorbach, 2007, p. 11). The issue of how to promote and govern a transition has received increasing attention in social science (Loorbach, 2007; Markard, Raven, & Truffer, 2012) and design research (De Koning, 2019; Gaziulusoy & Ryan, 2017, 2018)

This paper explores how systems thinking and design practice can foster system transitions. The type of innovation that takes place in a transition is called 'system innovation'. These innovations aim to change the relationship between individuals, organizations, and companies involved in the transition (Rotmans, 2005, p. 11). In this research, we are interested in exploring the concepts 'transition readiness' and 'value conflicts' as anchor points for designing system innovations. We explore these concepts through Transition Readiness Profiles aimed at helping designers understand how or where to intervene in a system to accelerate a transition. With the concept of 'transition readiness' we explore the willingness and state of preparedness of a variety of stakeholders to move in the direction conceptualized in the transition vision, and/or to particularly position themselves in the light of the transition. Transition readiness is relational. We can evaluate an individual organizations' readiness relative to the transition vision, as well as organizations' readiness relative to one another to understand what each can bring forward to foster the transition. With 'value conflict', we consider a more comprehensive and holistic view of what drives and steers the behaviour of the system from an organization perspective. We consider what innovations can be of value to the system stakeholders while also contributing to their values as individuals, a collective organization, and system actors. Value conflicts are also relational. For example, they can be between an organization and the transition direction, between the short-term and long-term goals, or between consumers and organizations. Fortunately, designers are skilled at overcoming conflicts through integrative thinking, which is powerful in light of transitions. However, anticipating a changing system and identifying potential value conflicts that serve as design input has been of less focus in transition and design research and practice.

Through the development of Transition Readiness Profiles of multiple organisations, we explore the following questions:

- How might system and conflict mapping tools and methods provide conceptual grounding for design practice in system transitions?
- How might Transition Readiness Profiles help us to bridge our understanding of a transition and how and where design has the most potential to intervene?
- How can design relate to the shift from system analysis to system synthesis of a system transition?

Transition Readiness Profiles (TPRs) offer insights in (potential) system dynamics to help designers understand how and where to intervene in a transition. By mapping an organization's readiness for transition, we reveal value conflicts. These value conflicts later serve as input for design innovation. Presently, the Profile consists of analysing an organisation and its relation to the vision[1], at three levels: the individual, the organization, and the system (figure 1).

Figure 1. The levels of the Transition Readiness Profile for one organization. This Profile is repeated for multiple organizations.

The Transition Readiness Profile

Reviewing other disciplines as input

The use of TRPs adopts a qualitative approach and primarily analyses the system and synthesizes the information to stimulate idea generation. To develop the TRPs, we began by reviewing various methods from systemic design, conflict and stakeholder theory, and innovative business models (Table 1) to identify how they might inform a design process aimed at mapping a transition. System- and stakeholder-mapping techniques offer strategies to gain an overview of complex system dynamics and stakeholder relationships. Systems thinking scholars and practitioners have proposed numerous ways to map systems, such as through Giga-mapping (Sevaldson, 2011) and Causal-loop diagrams (Hirsch, Levine, & Miller, 2007). Similarly, business scholars propose conflict mapping (Mason & Rychard, 2005) and the power-influence matrix (Eden & Ackerman, 1998) as promising options. When reviewing these tools and methods we reflected upon their potential to provide insight into the readiness of the transition and identify value conflicts.

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[1] **Prior to using the Transition Readiness Profiles it is important to first establish a shared transition vision. Without a clear path for the transition it is difficult to determine how aligned organizations are to the transition path, or where design has the most potential to intervene.**

Table 1. Methods, tools, and frameworks reviewed during the development of the Transition Readiness Profiles.

Field	Tool/Method	Citation	Impression relative to Transition Readiness Profiles
Systemic Design	Giga-Mapping	(Sevaldson, 2011)	- A communication tool which maps many variables to reflect the system and to understand the system components. Very complex, so difficult to use as a way to receive feedback
	Causal-Loop Diagram	(Hirsch et al., 2007)	- Influence of relationships is clearly visualized - Illustrate system-as-is relationship mapping temporal changes may be challenging - Provides an understanding of the system, but lacks 'designability'
Conflict and Stakeholder Analysis	Power-Influence Matrix	(Eden & Ackerman, 1998)	- Classifies stakeholders by power and interest and identifies how actors might be engaged with one another - Anticipates what changes in relationships occur when actors change their power/interest but limited to two variables
	Conflict Map	(Mason & Rychard, 2005)	- Clarifies relationships and power dynamics between actors in the current system - Provides over of conflicts by visualizing types with symbols
	Needs-fear Mapping	(Irwin & Kossoff, 2017; Mason & Rychard, 2005)	- Analyses conflict of single actors and hypothetical responses from other actors in the system-as-is - Compares various actors' attributes and understand to different perceptions
Transition Studies	Multi-level Perspective	(Geels & Schot, 2007; Kemp, 1998)	- Provides analytical lens to understand transitions but remains at an abstract level
	Transition Management Framework	(Loorbach, 2007)	- Provides a structure to what frontrunners are doing in transitions, but remains at an abstract level - Provides a process of facilitating and accelerating towards sustainability transitions
	Multi-Phase Model	(Rotmans et al., 2001)	- Illustrates phases of change in a transition in an abstract way
Organization Innovation	Organizational Identity	(Gilmore & Pine, 2007)	- Determines a business's identity: Essence of enterprise, Nature of offerings, Effects of heritage, Sense of purpose, and Body of values
	Sustainable Business model	(Bocken, Short, Rana, & Evans, 2013)	- Considers changes to the individual organization from its perspective.
	Value Framework; Value Flow Model	(den Ouden, 2012)	- Considers value on multiple levels and perspectives in a way that reflects design skills (focus on value) - Maps system/business model-as-is and uses values as a way to reveal innovation opportunities - Flow model maps numerous elements money, knowledge etc., to assess the system-as-is to reveal possible design opportunities

Description of the Transition Readiness Profiles

The objective of the Transition Readiness Profiles is to explore where there are possibilities to intervene when designing in transitions by anticipating the system dynamics and identifying value conflicts that hinder various organization from entering or moving with the transition. Additionally, it supports understanding what one organization can bring forward to foster the transition relative to others. The key benefit of the TRPs is that it helps designers anticipate future system dynamics and foresee how design may accelerate the transition. Suppose there is a vision for a transition direction, and a designer wants to accelerate the transition by transforming, bypassing or resolving system conflict(s) (Tromp & Hekkert, 2018). The Profiles identify these conflicts by understanding various organizations readiness to transition as conceptualized in the vision. The Profiles reveal which conflicts exist within an organization, and what characteristics of an organization can be strengthened relative to others. Together the Profiles captures the relational element within and between organizations in the system.

Design aspects of the Transition Readiness Profiles include:

- A multi-level analysis to reflect system transitions. It includes the individual- organization-, and system level, as well as implicitly the societal landscape.
- The consideration for the macroscopic and microscopic perspective through identifying value conflicts.
- A probing tool to stimulate designers. The Profiles can be iteratively reflected upon as more information is gathered. There can be multiple variations of the Profiles depending on which characteristics of the system are brought forward.

The three levels of the Profiles

Individual-level

This level focuses on understanding what practices hinder the transition and what value conflicts are present around the individual (e.g., short-term versus long-term health goals). Identifying practices explains the system as-is, but explored in light of the vision, future practices can be anticipated. For example, if a transition aims to halve food waste by 2030, the designer explores wasteful practices and associated value conflicts. Analysing the transition on the individual level reveals mental models, opportunities for new meaning, and contextualizes an organization's behaviour (e.g., a canned food company increases single-sized portion production because there is an increase in single homeowners).

Questions to consider for this level:
Behaviour and practices

- What consumer practices accelerate and hinder the transition?
- What value conflicts are present around the individual (e.g., between short-term and long-term goals)?
- What is the prominent worldview that accelerates and hinders the transition (e.g., values, beliefs, norms)?
- What states, principles, trends, or developments are accelerating or hindering the transition? What patterns or dynamics in the current system are hindering its change?

Organization-level

The goal of this level is to identify potential barriers for organizations to enter the transition. Drawing from business literature (Eden & Ackerman, 1998; Gilmore & Pine, 2007), we propose that an organization analysis focus on three themes: how the organization runs their business, its driving forces, and its capability to adapt. This level reveals the core of how an organization currently operates, which likely remains stable in the future (e.g., how they innovate now and in the transition). Interpreting an organization in light of the transition vision illuminates how aligned the organization is with the transition direction and possible conflicts/barriers that hinder their transition.

Questions to consider for this level:

Running of the organization

- How is the organization structured? Who are the decision makers?
- What is the organization’s operating model? How do they keep the organization running?
- What are the organization’s main activities? What do they offer others?

Driving forces

- What is the organization’s identity?
- What are their values?
- Why are they operating, what is their purpose and vision?
- What is their history?

Capability to adapt

- What is the organization’s innovation capability? How do they innovate?
- What are potential barriers of the organization to move with the transition?
- Does your organization have any relationships with other actors that obstruct or facilitate organizational change?
- Are there barriers that stand out for the organization that need to be overcome for them to transition?

System-level

This level focuses on understanding the dependencies, relationships, and unique qualities of an organization in the transition system. It supports a designer to anticipate what characteristics of organizations, which we refer to as capital(s) of power, can be brought out to accelerate the transition. We focus on mapping capitals of power rather than more common system mapping items like the flow of goods or money to shift the Profiles away from being an assessment tool of the system, towards a way to reveal what can be brought forward in the system by design. Once the system is understood from an organization perspective, designers can creatively leverage an organization’s capitals, barriers, and relationships through an innovation.

Currently, we have identified seven capitals of powers that can inspire design innovations:

- *Human Capital:* Organization competencies, creativity, skills, knowledge, and habits of staff.
- *Structural Capital*: Data and information, intellectual property, patents/copyrights, and trade secrets.
- *Relational Capital:* Social networks, alliances, partnerships, formal and informal relationships.
- *Financial Capital:* Debt and equity.
- *Reputational Capital:* Organization perception (e.g., trust, transparency, customer service etc.,).
- *Resource Capital:* Material, land, buildings, and rights of use.
- *Cultural Capital:* National pride and cultural significance.

Questions to consider for this level:

Capitals of power
- What could be the organization's unique quality (e.g., capital) to accelerate the transition?
- What value creating and value adding activities is performed by the organization?

Dependencies and relationships
- What other actors (internal or external to the system) need to be considered for this organization to transition? What are the dependencies/relationships between these and how do they relate to the organization's transition (e.g., consumers)?
- What are the relations between the potential capitals of power?

Barriers and Conflicts
- Which barrier and/or conflict in the system can be leveraged by the organization to accelerate the transition?
- How may design relate to the barriers and conflicts from the organization's perspective?

Discussion

We envision that a selection of stakeholders relevant to the transition each have a Transition Readiness Profile, making visible how ready they are for the transition as well as how they relate to the transition. Taking the Profiles together reveals how the designer can best intervene to accelerate the transition. For example, the designer could focus on an innovation by using an organizations capital that is key to transition the system. Alternatively, they could decide to overcome a barrier that is hindering multiple organizations from transitioning. The Profiles may also be used as a conversation tool allowing clearer feedback from actors with regards to their position in the transition.

Ultimately, we conceive the TRPs as an intermediary step in the transition design process. The Profiles allow the designer to zoom in to each individual organization pertinent to the transition and understand how that organization functions in its system, or zoom out to see how the numerous organizations relate and function in the transition system. Zooming in and out at different levels of the transition whilst focusing on the concepts of 'transition readiness' and 'value conflicts' serves as input and inspiration to bridge system analysis and designing innovations. We continue to reflect upon whether the three levels of individual, organization, and system, and the corresponding questions inspire design and serve as suitable elements to anticipate the changes of a system in light of a transition.

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Leveraging creative tension between Sustainable Development Targets for developing micro-macro level collaboration

Anshul Agrawal, Maya Narayan

The Sustainable Development Goals (SDGs) provide a shared blueprint for peace and prosperity of people as well as the planet. Although national governments have been mandated with monitoring progress, it is impossible to achieve the SDG targets by 2030, without the active contribution of other stakeholders like private companies, civil society organisations, etc. However, there is lack of clarity on roles the different stakeholders are expected to play, inadequate accountability mechanisms and the urgent need to create spaces for collective action towards the 2030 Agenda. This situation gives rise to two distinct forms of tensions, among others. Firstly, the inherent power differences between the government, civil society and industry, poses a challenge to collaboration, where they don't see eye to eye on what constitutes "sustainable development. Secondly, progress on SDG implementation is being monitored top-down, while most implementation is taking place bottom-up. In order to deal with these tensions, there is a need to explore the interrelations among different SDGs and their underlying targets. This study explores the merit of using systems thinking to amplify the positive interactions (enablers) between various SDG targets, and mitigate the negative ones (inhibitors) for unlocking their transformative potential.

Keywords; SDGs, Enablers, Inhibitors, Interactions, Tension

Introduction

In 2015, 193 United Nations (UN) member states jointly established the Sustainable Development Goals (SDGs), and committed to achieving them worldwide by 2030. The SDGs provide a shared blueprint for peace and prosperity of people as well as the planet. They comprise 17 global goals and 169 underlying targets that "are integrated and indivisible and balance the three dimensions of sustainable development - economic, social and environmental." (UN General Assembly Resolution, 2017).

Figure 1. Source: A Novel ICT Framework for Sustainable Development Goals

Tensions in implementation of the 2030 Agenda

While governments have the primary responsibility for implementing the 2030 Agenda, various other stakeholders are expected to play either of two roles in contributing towards achieving it: "Holding governments accountable for their actions or lack thereof, and making their own contributions to implement the SDGs." (UN DESA, 2021). In this regard, although a few member states have managed to institutionalise the global goals by incorporating them into their national plans, progress is either negligible or very slow in a majority of them.

Today, more than ever before, the interdependencies between global social, economic, and environmental systems have been exposed, due to complex issues such as climate change, socio-economic inequities, a global pandemic, etc., which makes us believe that we are living in a world comprising interconnected human and ecological systems that are continually self-organising. As these interconnected global issues continue to affect security and well-being of people and the planet, traversing the boundaries laid down by nation states, the overarching tension faced by countries across the board with regards to implementation of the 2030 Agenda is about how to forego the current siloed approach and advance collaboration, both within as well as externally with each other.

Presently, the implementation of SDGs is overseen by a Global Monitoring Framework, with key touch points at the national, regional as well as global scales. This framework largely follows a top-down hierarchical structure, where national governments have been mandated with monitoring progress against the 2030 Agenda. However, literature on the subject increasingly shows that most action with regards to implementation takes place at the state and local levels. Due to lack of appropriate collaborative structures the dynamic behaviour that unfolds on ground as a result of interlinkages between the different SDGs, is not concretely captured by national governments.

This is mainly because of three key challenges (Bowen et al., 2017) that have been identified as critical to implementing the SDGs:

1. Creating inclusive spaces for stakeholder interaction to nurture collective action;

2. Focusing on equity, justice and fairness while deliberating over difficult trade-offs; and

3. Ensuring accountability mechanisms exist for various actors

As we have stepped into the "Decade of Action", there is an urgent need to address the systemic nature and scope of the 2030 Agenda, keeping in mind the urgency for remediating the challenges mentioned above. For this purpose, it is imperative that policy makers and other stakeholders analyse critically the nature of interactions across the three SDG domains: Economic, Environmental and Social; and explore how the goals and their underlying targets are interconnected, both within and across the domains. "Understanding possible trade-offs as well as synergistic relations between the different SDGs is crucial for achieving long-lasting sustainable development outcomes."

Firstly, we need to understand the dynamics that emerge from the interactions between different SDGs, especially between the targets, at local levels. This is critical for identifying enablers and inhibitors that can influence decisions with regards to difficult trade-offs. SDG targets are connected to multiple goals in different ways, such that the viability of one target may either get amplified or constrained, depending on another being realised. Thus careful deliberation is needed in a multitude of ways:

- between different development paths;

- involving different sectors at different spatial levels; and

- factoring in environmental integrity and societal needs

The International Council for Science (ICSU), in its recently launched report titled, "A GUIDE TO SDG INTERACTIONS: FROM SCIENCE TO IMPLEMENTATION", has specifically studied the interactions among SDG targets, and defined a range of positive (enabling) as well as negative (inhibiting) interactions among different SDGs. (International Science Council, 2019) Using a 7-point scale, scientists evaluated causal and functional relations emerging from target-level interactions between various SDGs and attributed a score to such interactions, as depicted below:

- ☐ positive interactions were assigned scores of +1 (‘enabling’), +2 (‘reinforcing’) or +3 (‘indivisible’);
- ☐ negative interactions characterising trade-offs were assigned scores of -1 (‘constraining’), -2 (‘counteracting’), or -3 (‘cancelling’);
- ☐ neutral interactions between SDGs were assigned 0.

Considering the example of SDG 7: Affordable and clean energy, which is underpinned by three targets:

1. 7.1 - ensuring universal access to energy services,
2. 7.2 - increasing the share of renewables in the energy mix, and
3. 7.3 - improving energy efficiency

Figure 2. below depict interactions between SDG 7 targets and targets of SDGs 1, 2, 3, 6, 8 and 13.

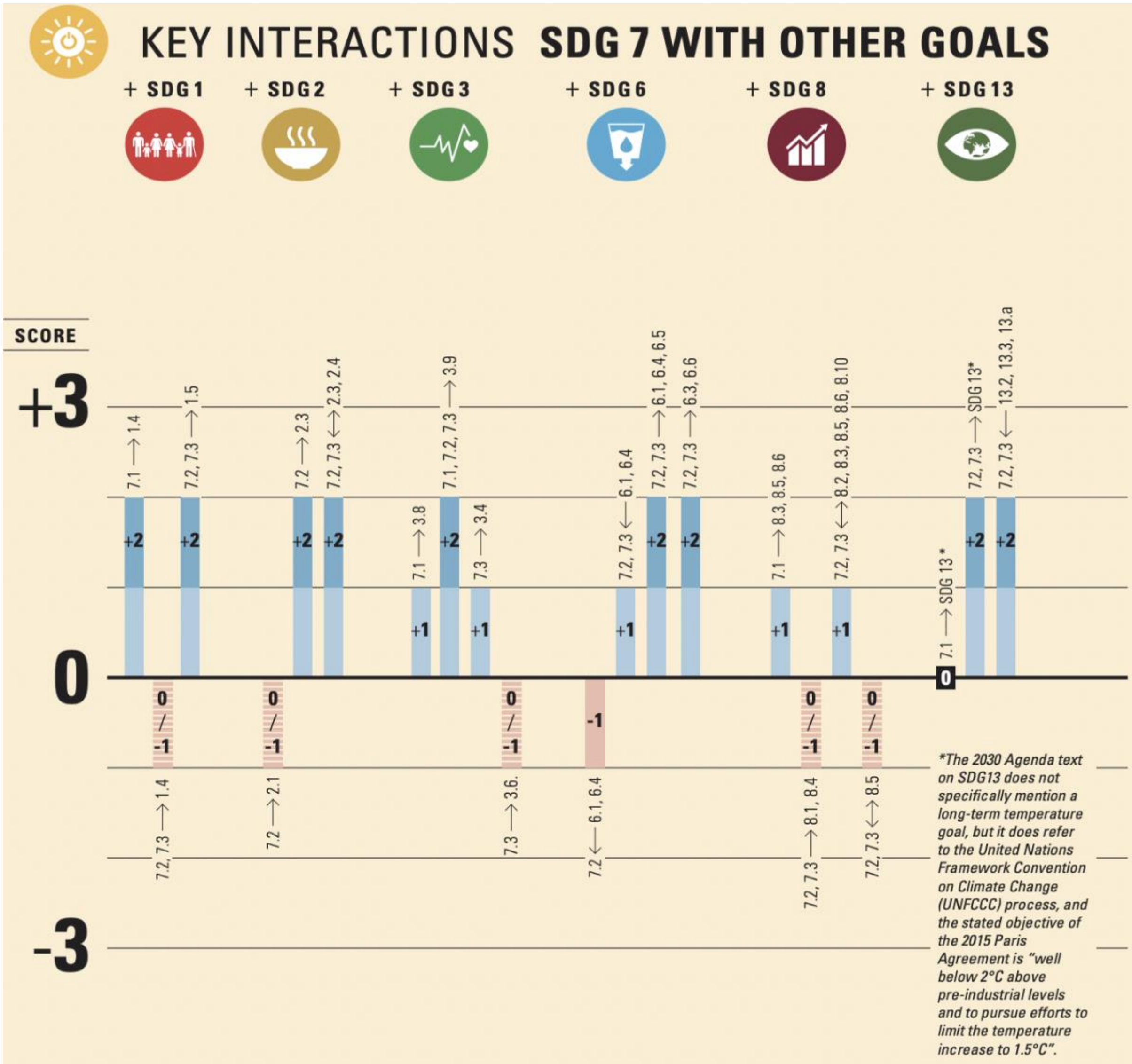

Figure 2. Source: SDG Interactions Report, International Council for Science (ICSU)

Table 1. Illustrates how the interactions between targets of SDGs 1 and 7 have been scored.

Table 1. Source: SDG Interactions Report, International Council for Science (ICSU)

Targets	Key interactions	Scores
7.1 & 1.4	Energy is a basic service, therefore universal energy access reinforces the achievement of 1.4	+2
7.2, 7.3 & 1.4	Decarbonizing the energy system 0/-1 through renewables and efficiency is consistent with the provision of basic energy services as long as policies help to shield the poor from any fuel price increases that may result. Lacking such policies, 7.2 and 7.3 could constrain the options for achieving 1.4	0 / -1
7.2, 7.3 & 1.5	Renewables and energy efficiency are a necessary precondition for limiting global climate change; in turn, exposure of the poor to climate-related extreme events will be reduced	+2
7.1 & 1.4	Energy is a basic service, therefore universal energy access reinforces the achievement of 1.4	+2

Systems thinking for streamlining implementation of the 2030 Agenda

Using some of the findings from this report on SDG interactions, we have derived certain key insights for intervention design for effective implementation of the 2030 Agenda.

- Understanding the behaviour of interactions between SDG targets is both contextual as well as critical to identify enablers and inhibitors
- Different dimensions can be used to contextualise the assessment of specific enablers and inhibitors, providing deeper insights into attributes that the SDG-level and target-level interactions depend on. These include:
    - Directionality
    - Governance
    - Technology and
    - Time- frame
- Using various systems thinking tools, we should be able to identify leverage points for transforming the identified enablers and inhibitors, as depicted below:

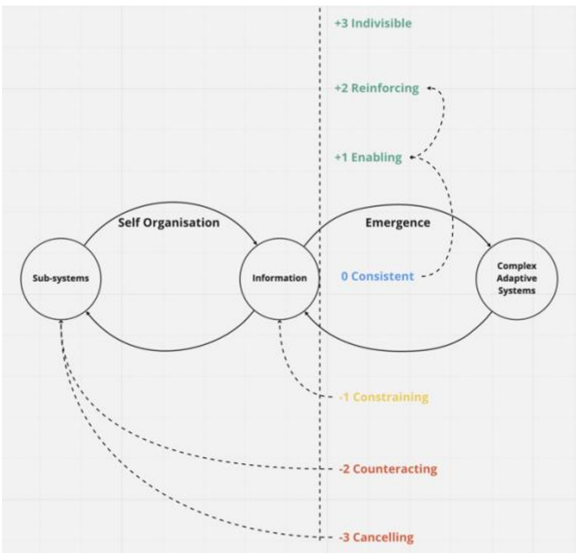

Figure 3. Leveraging creative tension between SDG targets

We are aware that commissioning such a study for all 17 SDGs is a very extensive project, and would require a lot of time and resources. Hence, we aim to conduct a pilot of sorts, by limiting the scope of this study. To help us decide on the particular SDGs we conducted some secondary research, and learnt that four major sectors i.e. food and agriculture, cities, energy and materials, and health and well-being), collectively amount to almost 60 percent of the real economy and hence opportunities in these sectors will be critical in delivering on the 2030 Agenda. (Business and Sustainable Development Commission, 2017) Given these findings we are interested in using a nexus approach, by highlighting interconnections between the following 3 SDGs and their underlying targets:

- ☐ SDG 3: Good health and well-being
- ☐ SDG 7: Affordable and clean energy
- ☐ SDG 8: Decent work and economic growth

As stated previously, we will be using systems thinking tools to evaluate feedback caused by various enablers and inhibitors that can be influenced in order to leverage emergence, bottom-up.

The objective of this study, is to seek answers to the following questions:

1. How can we empirically establish interconnections between different SDGs and targets?
2. How can we design an objective lens to address concerns of co-benefits and trade-offs among different stakeholders?
3. How can we support policy makers and other stakeholders in making more coherent and effective decisions for achieving the 2030 Agenda?

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Bottom-up-down approach

Creating system maps by understanding people's stories

Bruno Martins Rizardi, Daniela Gomes Metello

Working through a wicked problem is a great challenge for public managers all over the world. At Gnova, Brazil 's federal government innovation lab, we decided to develop an approach that brings together design, system thinking and behavioral sciences to approach complex issues such as vicious cycles of extreme poverty in rural areas of Brazil.

The project is still ongoing, but there are few good indications that lead us to think that individual stories can be transformed into systems maps. Our main goal is to evaluate the behavior leverages of these systems to formulate and propose effective public policies that change the lives of the people in those stories. In this article, we explore what is called this the bottom-up-down approach, a way to understand how individual behaviors compose or even emerge in systemic behavior.

Keywords: behavior; storytelling; system map; public policy.

Introduction

Understanding human behavior has been challenging for centuries. With the development of experimental psychology and its implications in behavior economics, observing and intervening in this area has become more and more a practice among policymakers, designers, engineers, publicists and even politicians (OECD, 2017). Its most known applications to the public sector are nudges, little pushes that induce or encourage desired behavior towards a pre-stated goal. The experiments and policies designed with nudges, specially from the Behavioral Insights Team (Halpern & Service, 2019), are well documented and have become an aspiration to many governments around the world.

Although effective, nudges are meant to change very specific behavior related to very specific problems. When working with more complex scenarios, like rural poverty, nudges can fall short on both the scale and the diversity of change needed in people's ways of doing and thinking (Sunstein, 2017). In these settings, behavior science may have better answers for group behavior, complex problems and systemic change.

As a part of the Gnova's team - Brazil's federal government innovation lab, our challenge is to explore and develop an approach that brings together behavior science and systems thinking in public policy design. Our case for experimenting this novel approach is a rural productive inclusion policy from Brazil's Ministry of Citizenship, that aims to encourage and support extreme poor rural producers to achieve a surplus of produce to generate income. As this could be considered a wicked problem (Rittel; Webber, 1973), we decided to work with a systemic approach, seeking to understand how causes and consequences intertwine in this complicated vicious cycle that keeps families in food insecurity for many generations.

Certainly, there are many objective factors that reinforce rural poverty, such as low access to productive land and tools, credit and productive structure. However, the Ministry of Citizenship diagnosis, as most public policies, does not account for behavioral factors of the people that are suffering from chronic poverty. In that sense, we decided to bring the behavioral science perspective as a tool to map variables in this complex system.

The main goal of this project is to prototype and test a solution that considers behavioral factors and system thinking in the redesign of public policy that aims to reduce the extreme rural poverty in Brazil.

About Gnova

Gnova is a government innovation lab founded in 2016 at the Brazil Federal Government 's National School of Public Administration (ENAP). The lab is focused on creating public value and fostering public innovation by training public administration departments through innovative projects that apply the design approach to transform public policies. To work in such projects, the lab recruits mixed teams of lab innovators and "problem owners", people that oversee the public policy and seek to innovate on it. Therefore, the lab serves a double purpose: innovating in public projects and creating capacity in public servants.

After working in more than 30 projects with design thinking tools, the lab team decided to test new approaches, since frequently the lab's projects work over wicked problems - complex, systemic, multicausal and cyclic issues - and the double diamond approach has shown to be insufficient to deal with such problems. In 2021, to expand the methods and tools of the lab, the team brought two new approaches: systemic design and *behavior*al sciences, applying both on this year's projects, the Inclusive Rural project among them.

Problem context

The Ministry of Citizenship's Social and Productive Inclusion Secretary (SEISP) points out that there are about 3.7 million families living in extreme poverty and social vulnerability in rural areas in Brazil. In general, this population has a low level of education and difficulties to access jobs and generate income.

The social vulnerability and poverty settings are multidimensional and twist together different causes and consequences in a perverse vicious cycle that has been reinforcing itself along decades. According to SEISP analysis, this cycle can be described as: the structural inequality and the excluding modernization of Brazilian agricultural industry resulted in millions of rural families that (i) doesn't access basic rights (sanitation, health, education, habitation and documentation), (ii) have a poor access to productive land, tools, credit and productive structures and (iii) have few opportunities to access jobs and generate income. As a consequence, these families have insufficient food consumption and could be described as living under food and nutritional insecurity, which impacts their health and education, deepening the social vulnerability and diminishing their jobs opportunities, then reinforcing the poverty cycle.

In the last 20 years, some policies have been developed to improve rural families' conditions with relative success. However, there are still 3.7 million families living under poverty lines in rural areas. This number has grown in the last 5 years, posing a challenge to the government to reverse this trend.

Therefore, it is fundamental to deeply understand the different dimensions that caused this vicious cycle to emerge, making the systemic design approach the best fit to map and change the system.

From a telescope to a microscope - identifying behavior as variables

Brazil's government is both centralized and distributed: national strategic policies and most of its financing are set by federal government ministries and agencies, whereas minor policies, most implementation and public services are provided by local governments. This uneven distribution of prerogatives has made Brazil's federal executive public servants very distant from citizen's realities and challenges, but heavily equipped to deal with macroscopic views, abstract thinking and critical inquiry abilities. Understanding, at a bigger level, how systems work, their main features and problems is an important step walking into systemic thinking (Jones, 2020), but realizing these systems' implications in the experience of citizens (Buchanan, 2019) is key to designing better interventions that promote systemic change.

When designing the method for Inclusive Rural project, it was important to bring together design's potential of shaping human interaction with artefacts (Flusser, 2017), behavioral sciences' understanding of how individuals and groups behave, and systems thinking tools to map and find leverage points that can promote systemic change (Meadows & Wright, 2015). The overlapping of disciplines and practices was translated in a method that alternates between macroscopic and microscopic views, and changes between systemic and behavior lenses.

Our main goal observing these systems through both systemic and behavioral lenses is to understand if different behaviors of individuals that could result in systemic behaviors, through events such as auto-organization and emergence. Identifying the links and leverages between individual, group and system behavior is necessary to civil servants to propose an intervention (public policy) in the system.

Beginning the project Inclusive Rural

The first step to understand this complex system was to analyse the stories, variables and causes of the problem, defined as "a significant portion of rural families cannot produce enough for both consumption and commercialization". This process was approached through system thinking and design tools, such as double-Q-diagrams[1] (Kim, 2016), storytelling and mind mapping. The result was a very intricate and also very dense set of initial variables, relating to structural and conjunctural perspectives. The team also enumerated some behavioral variables, although these variables were highly biased since these public servants had very little experience on the field with poor rural communities and families.

Empathizing on the field: design approaches to understanding human experiences

Since the main challenge for the team was to identify behavioral variables, specially at an individual level, the next step was to find the relationship between individual behavior, group behavior and system behavior. This approach leads us to consider different kinds of behavior variables such as: motivations, self-control, lack of attention and social norms.

These behaviors can be observed through different approaches. In this project, design research[2] (Downton, 2005) approaches were deployed as the main method to understand rural communities and families' experiences. It is important to note that the team also is experimenting with more scientific-based surveys to analyze these behaviors, although COVID-19 severely impairs the application on field with such target audience.

We developed an ethnographic research plan focused on mapping behaviors and stories of both target groups and street-level bureaucrats in the field. The research was focused on mapping out how these communities interacted with rural productive inclusion policies through public agents. The main tool used was in-depth interviews, applied as semi-structured surveys with two subgroups: typical cases (groups that struggled to achieve a goal) and positive deviant cases[3] (Pascale et al., 2010). By comparing these 2 groups, we expected to find some patterns of behaviors and objective conditions that will help us to clarify some variables of this system.

Bottom-up-down: individual stories that make up a system; system intervention that changes stories

The next step is to deploy the ethnographic research plan and build a behavioral systemic map of the poor rural communities. This step is based on two assumptions: first, that it is possible to assemble a system by mapping out subsystems and second, that understanding individuals' stories enables experts to find patterns and map out these subsystems. Of course, this final map isn't limited to individual and group behaviors, as structural and conjunctural factors may also play a part on how these systems behave as a whole. However, by taking a behavioral approach towards systemic design, it is possible to create solutions that leverage already successful behaviors or mitigate prejudicial ones. By bringing together a microscopic and macroscopic approach, we may

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[1] A double-Q-diagram is a framework for mapping quantitative and qualitative variables in a system.

[2] Design research states that design can be used as a way of researching and inquiring.

[3] Positive Deviance occurs when certain individuals or groups find better solutions to problems than their peers, while having access to the same resources and facing similar challenges.

change the system's behavior and, consequently, families' lives. That is what we have called the bottom-up-down approach.

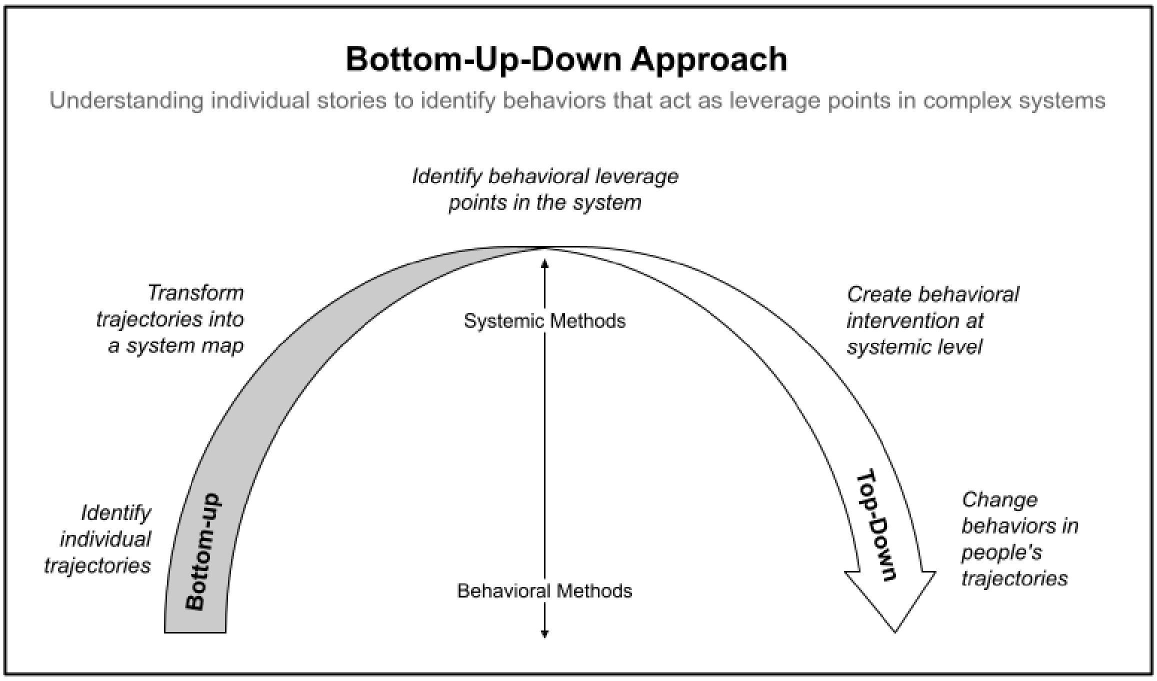

Figure 1 The bottom-up-down approach as a way to intervene at systemic level by understanding people's stories.

The behavioral and systemic assessments are important to map individual trajectories and to observe general group behaviors. This switch between individual or subsystemic perspective to a group or systemic perspective is important to understand which behaviors can leverage systemic change. Although is not clear at this point of the project, this link between individual behavior, group behavior and system behavior (and the other way around) is a promising way to design and implement effective policies that are both bottom-up-down (changing people's behaviors to create positive impact) and evolutive (by changing certain aspects of human behavior, the systems might adapt towards a more desirable state).

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Track 6:

Theoretical Explorations Of Synergies Between Disciplines

Chair: Prof.dr. Caroline Hummels

Towards Speculative Services for an inclusive society:

Understanding the relationships between Systemic-, Service- and Speculative Design

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Social exclusion needs to be studied from a comprehensive and exploratory perspective as a complex and systemic social problem, and there is an urgent need to promote social transformation towards an inclusive society. Over the past decade, Speculative Design has shown great potential as a critical approach to exploring the future and dealing with social issues. Also, there has been growing discussion about the approaches and applications of Service Design and Systemic Design to social issues and complex system problems. Complexity is a keyword in common for coping with social transformation and these three approaches. Further, to reach an inclusive society, designers have to face complex systems and wicked problems at different scales, from government, organizations, communities to final users, even including a non-human perspective. Therefore, the purpose of this paper is to build a more comprehensive understanding of Speculative Design, Service Design, and Systemic Design themselves and the relationships between them by drawing together discussions from existing literature. This paper aims to support the startup of new research exploring whether integrating these three design approaches can support the systemic inclusive social transformation.

Keywords: Systemic social transformation; Systemic Design; Service Design; Speculative Design

Introduction

In Europe and Central Asia, many groups face social exclusion that prevents them from fully participating in political, economic, and social life. Social exclusion is in many aspects, such as poverty, lack of basic capacities, limited employment, educational opportunities, and inadequate access to social and community networks or activities (Andjelkovic et al., 2011).

Moreover, in many cases, development policies tend to focus on developing national and regional governments or the private sector without sufficient attention to the development of communities. Social exclusion not only has negative effects on those who are excluded, but it may also lead to costs to the economy and society (World Bank, n.d.). Therefore, it is necessary and urgent to promote a more inclusive society.

Achieving social inclusion requires systematic coordination of national and local policies. Governments should address the three dimensions of social exclusion - exclusion of economic life, exclusion of social services, and exclusion of civic life and networks - in an integrated manner (Andjelkovic et al., 2011). Multiple interventions that reflect the complexity of the problem need to be implemented in a coordinated way. Above all, a strong public voice and participation are needed in making the right policy choices since different conditions in different regions require thoughtful, comprehensive, and systemic solutions tailored to the specific context.

Transformation to social inclusion involves at least two steps. One is to remove barriers in a broad sense: barriers to participation and access to resources and opportunities. The second is to promote a change in attitudes and mindsets. In favor of generally accepted values, changing mindsets have direct policy implications (Andjelkovic et al., 2011; United Nations Department of Economic and Social Affairs (UNDESA), 2009). This will gradually change social exclusion drivers and start to become drivers of inclusion and increase social tolerance.

The transformation of society is also the transformation of a large participatory system. The various parts of the system are interconnected and have intersystem impacts. Social transformation is a complex process to design for complex social situations, social systems, policymaking, and community design, and it needs to be worked on by multiple stakeholders (Jones, 2014). In the field of design, Speculative Design, Service Design, and Systemic Design are considered with the potentiality to address and improve complex social problems (Auger, 2013; Jones, 2014; Mitrovic, 2015; Yang & Sung, 2016). Therefore, this paper aims to review these three main design approaches and their relationships to see if they can be integrated and support the systemic inclusive social transformation.

Literature Review

Theoretical foundation

To achieve an inclusive society, designers must face complex systems and wicked problems at different levels, from the individual, community, organization to society level (Waddock et al., 2015). Therefore, facilitating the transformation of a system, or designing a new system, requires a participatory, systemic, comprehensive, and creative approach that addresses a multitude of interconnected and complex issues.

Speculative Design (SPD) strives to foster social dreaming and discuss what the future should be (Mitrovic, 2015). SPD relies on imagination and aims to open a new perspective for the Wicked Problem, using design to create future innovation as a social dreaming approach. The SPD approach brings narrative and fictional qualities into the design and 'expresses the unthinkable' through the language of design. By encouraging public debate about the social issues, this approach with an implicit "call to action" stimulates practical imagination and action by people to imagine and perform the change (Dunne & Raby, 2013; Hanna, 2019).

SPD emphasizes ethical and societal features of design practice with broader social implications. As mentioned in the former section, promoting a change in attitudes and mindsets contributes to become drivers of inclusion and increase social tolerance. Therefore, when exploring the issue of social transformation, SPD has a strong potential for contributing to this change from the level of inclusive perception and consciousness of individuals, communities, and even society.

Service Design (SD) is a design-based multidisciplinary approach that brings a human-centered, holistic perspective and methods with service systems thinking to design complex service systems (Yu, 2020). By integrating tangible and intangible touchpoints, SD provides systemic design activities and useful tools to facilitate interdisciplinary co-creation, communication, and participation between designers, users, and other stakeholders and actors at different levels and ranges to effectively achieve value co-creation in dealing with social issues (Yang & Sung, 2016). It also greatly increases the ways in which people can explore, express, and evaluate their current experiences and future lifestyles (Sanders & Stappers, 2014).

In recent years, the importance of service systems and service ecosystems in SD is attracting more attention (Sangiorgi et al., 2018; Vink et al., 2017). Service ecosystem design is an ongoing and collective process. In this process, the actors can achieve the desired futures by making, breaking and maintaining institutional arrangements, thus shaping value-in-context. This process also features reflexivity that can help actors overcome the constraints of the existing institutional arrangements (Vink et al., 2017).

Design thinking is viewed as a human-centered or bottom-up approach. In contrast, systems thinking is considered as a top-down approach that provides a panoramic view of the ecosystem (Tjendra, 2018). **Systemic Design (SYD)** integrates systems thinking and human-centered design to help designers to shift their focus from single elements to the whole picture while considering actors within the system. SYD approach is then appropriate to face complex social transformation processes (Jones, 2018).

The complexity of society requires specialized design and system facilitators, as well as the necessary stakeholders (Jones, 2018). When designing for complex systems, the understanding of the systems by the designer or co-designers would influence the systems of inquiry through design interventions. This design process requires a switch between an overall understanding of the system and the needs of stakeholders and users. Therefore, when working in increasingly complex fields, such as the systemic social transformation discussed in this study, adopting a systemic, visual, participatory and critical thinking process is necessary.

- **Systems Oriented Design (SOD)** is considered to help designers better understand, analyze and deal with very complex problems. In an era of environmental crisis, Actor-network theory holds that non-human stakeholders are important factors, which are as important as humans, in creating social situations (Latour, 2005). SOD entails such complexity, considering non-human stakeholders in addition to the human-centered approach, to generating holistic and synergistic solutions/interventions for complex challenges in a systemic perspective (Sevaldson, 2009). The theory of **Social Systems Design** states that when designing for social systems and communities, all those who influence and are influenced by the design outcomes should be part of the design community (Banathy, 1996). Therefore, when dealing with systemic problems with multi-level actors, SOD can promote the boundary-crossing between different levels and different fields visually and practically and support the sense-sharing of different perspectives.

- **Critical Systems Heuristic (CSH)** (Ulrich, 1983) is considered a theoretical framework that can deal with the issues of participation and power structures. CSH is a framework for reflective practice that focuses on the systemic examination and discussion of contextual assumptions and multiple perspectives about the relevant issues. CSH aims to support reflective practice through critical systems thinking (CST) to design and improve systems. CSH is also considered to provide a new civic capability for citizens to participate in social issues (Ulrich, 2005), to contribute at the level of civic and social participation when dealing with this topic.

- **Soft systems methodology (SSM)** (Checkland, 2000) is an action-oriented approach for tackling perceived problematical (social) situations. When coping with "soft problems", such as the context in this study, reducing social exclusion, and fostering social inclusion, actors within the system can learn their situations through social learning to take action to improve it.

- The complex systems are constantly changing and evolving. Therefore, when dealing with complex systemic problems, designers should not focus on one "solution". Only continuous design and redesign in the system, known as **"Dancing with systems"** (Meadows, n.d.), provides interventions that are likely to impact the system.

Relationships between Speculative Design (SPD), Systemic Design (SYD) and Service Design (SD)

In this section, we will briefly discuss the relationship between the three main approaches. The overlaps are that they are participatory and suitable for dealing with social issues.

Participatory: Value co-creation and participation have become prominent features of these three approaches. SD and SYD both involve multiple actors in the design process. SD stresses the importance of actors co-creating value, and some methods and tools have been adapted to the SD process with many benefits (Akoglu, 2014; Steen et al., 2011). In recent years, participation and value co-creation have also gained prominence in systemic design approaches, especially when dealing with issues related to services and complex systems (Jones, 2018). In SPD, interdisciplinary co-creation is a distinct feature, embedded in various actors co-speculating critically but rationally about the technological future (Dunne & Raby, 2013).

Dealing with social issues: From designing products and services to designing complex service systems, organizations, policies, and strategies, designers increasingly need to deeply understand the complexities and wicked problems of the social systems and develop new design practices for these systems (Bijl-Brouwer & Malcolm, 2020). Over the past decade, there has been an increasing number of studies on systems thinking and design practices applied to complex social problems, such as Transition Design (Irwin et al., 2015) and Design 4.0 (Jones, 2014). SD has also been increasingly applied to cope with social problems and challenges over the past two decades (Yang & Sung, 2016). The speculative approach moves away from the constraints of the commercial practice and allows designers to rethink future products, services, systems, and the world through speculation and initiate debate among the audience, helping to discuss social issues and foster social dreaming (Auger, 2013).

In addition, there are some other overlaps and differences between the three approaches:

Focus: SD is a human-centered approach, and it attaches importance to the advantages of user and stakeholder participation. SPD focuses on technology and future development, which does not emphasize consumer needs but focuses on rethinking the technological future or societal problems that reflect the current situation (Mitrovic, 2015). SYD emphasizes interrelationships (context and connections), focusing on the complexity of the systems and how multiple actors interact and influence each other. Systems Oriented Design also helps to think in a multi-centric way that concerns different perspectives (Sevaldson, 2009).

Systemic: Systemic here refers to systemic thinking and practice embed in the design process. In SD, there are growing acknowledgments and discussions of its systemic nature since different stakeholders, actors, and their relationships are considered when designing the service (eco-)systems (Vink & Rodrigues, 2016). However, few discussions about systemic in SPD and SPD practice are more focusing on technology or emerging phenomena. Although SPD has the potentiality and ability to deal with the complex social issues related to systems, the systems thinking in this process is still underexplored.

Critical: SPD is developed from Critical Design (Dunne & Raby, 2013), the critical thinking is transmitted by speculation so that the audience can think and reflect on it. Critical thinking can also be found in SYD, such as CSH (Ulrich, 2005). However, in SD, which is practical, critical is a concept less mentioned and discussed in the literature.

Application of methods and tools: SD is an approach with a very clear framework, and its process emphasizes practical methods and tools (Sangiorgi, 2009). On the other side, there is no fixed framework, methods, techniques, and tools for SPD, but a variety of methods and techniques are being adjusted and adapted according to different contexts, technologies, perspectives, and audiences (Auger, 2013). SYD is more valued for its systematic thinking, that is, the ability to deal with complexity, than for methods and tools. However, it is worth noting that in SOD, many designerly methods are applied in the design process (Sevaldson, 2013).

Communication: In practice, SYD is sometimes challenging to be understood by actors due to its complexity. The cost and threshold for understanding and participating are high, but once the complexity is understood, it is an advantage to deal with wicked problems and have a sustainable and long-term perspective. For example, methods in SOD, such as Gigamapping (Sevaldson, 2011), can visualize the complexity of the system and reduce the communication threshold. Besides, one of the overlaps between SD and SPD is that both have the advantage of communicating through storytelling, scenarios, prototypes, or fiction in a visual or experiential manner, giving actors the advantage of communicating and understanding the value of the design in question.

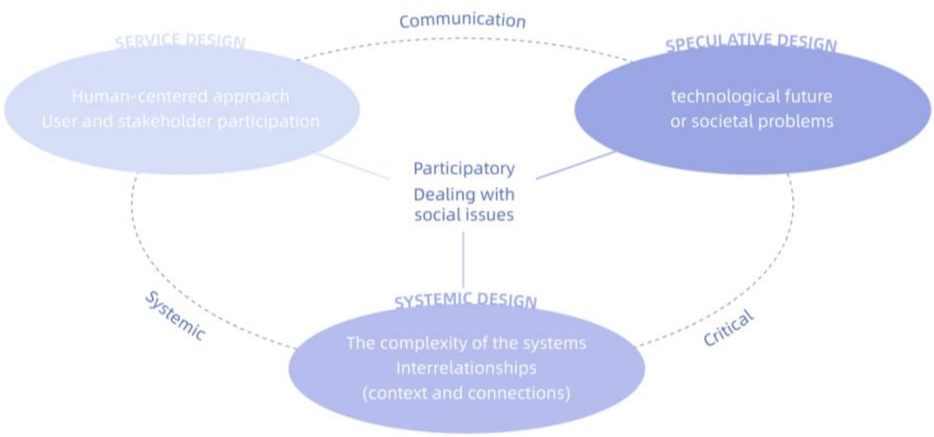

Figure 1. Relationships between SPD, SYD and SD. Illustrated by author.

Towards Speculative Services for an inclusive society

Although there has been more and more integration and practice between Systemic Design and Service Design in recent years, the discussion between these two design approaches and Speculative Design remains underexplored. The context of this study will fall on the complex social issue of an inclusive society. As we mentioned in the previous sections, the characteristics of each of the approaches can add value to this context and further the design process in their own way. Therefore, this study will explore the theoretical framework and practical methods of "Speculative Services", integrating these three main approaches for an inclusive society.

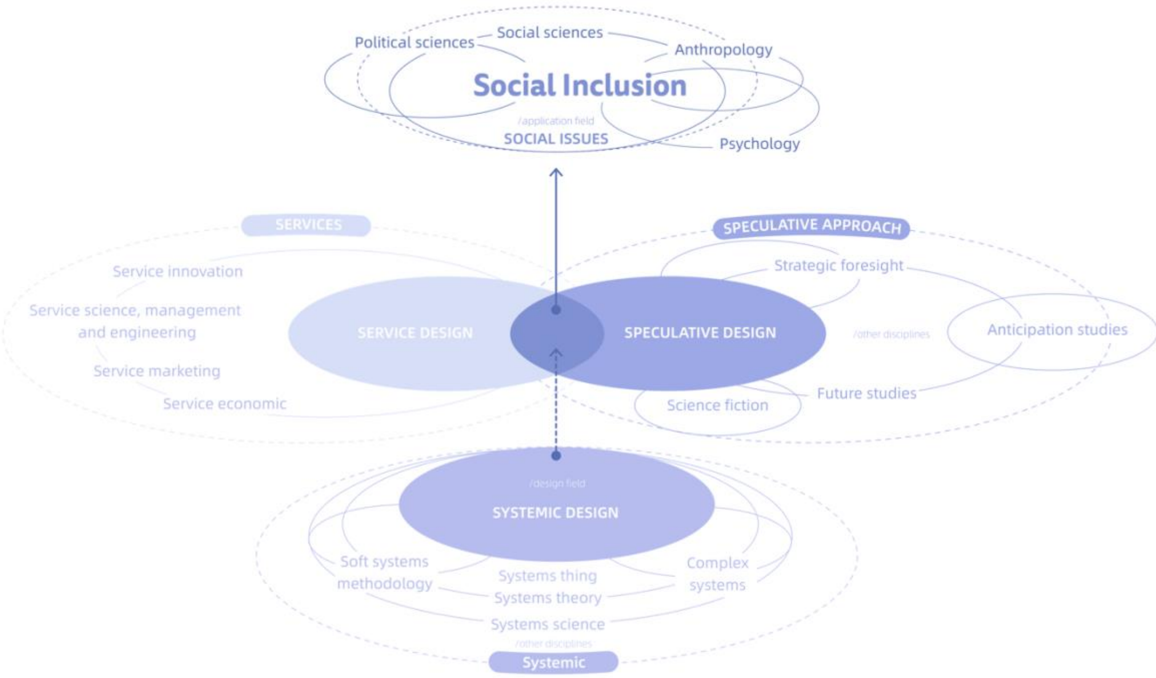

Figure 2. Mapping of Speculative Services. Illustrated by author.

Here are some of our reflections on further exploring the integration of these three approaches for an inclusive social transformation:

We decided to include all three approaches to foster an inclusive society because we have identified the benefits of each approach in dealing with this topic. These three approaches are complementary but also have some conflicts with each other.

In terms of complementarity, SPD's exploratory and critical characteristics can help SD and SYD in the design process to problematize phenomena to raise new questions for future exploration. The systemic and critical thinking of SYD can inject mindsets and competencies in dealing with complexity to SD and SPD. The advantage of SD lies in its value co-creation with multiple actors and its practicality and visualization, making the design process of SPD and SYD more inclusive and bring in user-friendly methods and tools.

In addition, we think it is necessary to redefine the design process, methods, and tools of "Speculative Services". Within the literature on SD and SPD, there has been a strong emphasis on practice (Hanna, 2019; Karpen et al., 2017). In SD, there are practical methods and tools like service blueprint and service roadmap (Almqvist, 2018; Bitner et al., 2007). However, most subjects intend SPD as an exploratory approach, more than a formal methodology, to bring together multiple disciplines, competencies, methods, and cultures, and have flexibility during the practice (Iaconesi, 2019). In addition, in SYD, several systemic approaches for understanding, analysis, participation, and innovation, can bring critical and dynamic systemic thinking and methods to the design process while keeping the design features. Therefore, it can be considered that SYD has great potential to be integrated into the SD and SPD process to bring systemic advantages.

These three approaches have their own advantages. However, it should be noted that in design practice, a seemingly related but conflicting design process can be confusing if there is not a proper positioning and framework to guide designers or co-designers. The methods and tools of these three approaches are also very scattered, and in practice, choosing and deciding the appropriate tools may also become a frustration. Therefore, this study believes that it is necessary to redefine a theoretical framework. Compared with the single approach, the integrated approach is expected to refer to and combine the design process, methods, and tools of the three approaches to providing a clear framework and guidance for the design process.

Based on the understanding of these three approaches, the future study will explore the theoretical framework and practical methods of "Speculative Services", in particular when applied to societal transformation. Banathy

(1996) argues that designing social systems is not to create design communities to learn from users or design from users' perspective, but to make them part of the community itself as user-designers. This ethical stance on social systems design allows us to view co-design from a systemic perspective. In the context of an inclusive society, the Speculative Services approach aims to enable policymakers and civics to understand, explore, discuss and reflect on the topic of social exclusion, to empower them as 'designers' in this social system design, thereby promoting relevant policies, interventions, services, etc., to promote the inclusive development of society.

This study is expected to be conducted under the issue of social exclusion and social inclusion. But apart from social inclusion, what other aspects of social and systems issues might benefit from the Speculative Services approach? Like social exclusion, many social problems are also complex, systemic, and multi-level. Therefore, if the Speculative Services approach can contribute to the issue of social exclusion, it may also be applied to other social problems or other complex and systems-related problems that need to be explored for future possibilities.

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Option evaluation in multi-disciplinary Strategic Design: Using scenarios for system prototyping

Mehdi Mozuni, Maren Ohlhoff, Gerhard Glatzel

Evaluating and deciding on technical options is an increasingly complex challenge in disruptive product development and transformative system engineering. The practice requires thinking ahead a path through a regulatory, economic, social and technological unstable environment. Yet, such strategic decisions are often interconnected, dependent on further internal and external variables and need to be communicated and met simultaneously by several disciplines. This holds especially through, when teams from heterogeneous disciplines have to come to consensus on several future events that contain a high level of contingencies. In the foresight research, scenarios are used as alternative prototypes of the future(s) and are the subject of cross-disciplinary discourses and decisions. Based on the analogy between scenarios and prototypes as artefacts of an iterative design practice, we suggest that scenarios can be well applied by designers for knowledge-communication and technical option evaluation among heterogeneous disciplines and stakeholders. With the example of two ongoing transdisciplinary projects (E4A[1], SE^{2}A [2]) a generic 10-step procedure is proposed which can be adopted to similar strategic design inquires.

Keywords: Strategic Design, Decision Making, Option Evaluation, Prototyping, Scenario Technique, Transdisciplinarity

Introduction – Human-System-Interaction in a future system

Which technical option is more sustainable? Equipping the agricultural machine with battery on board, or connecting it with cable to a power station? Which option will gain more acceptance by agricultural socio-economic systems? This and many similar questions are complex and cannot be treated by one single discipline.

Technical decision-making is an increasingly complex challenge in disruptive product development and transformative system engineering. The practice requires thinking ahead a path through a regulatory, economic, social and technological unstable environment. Yet, such strategic decisions are often interconnected, dependent on further internal and external variables and need to be communicated and met simultaneously by several disciplines. This holds especially through, when teams from heterogeneous disciplines have to come to consensus on several future events that contain a high level of contingencies: Will political measures be facilitative or restrictive? How might sociotechnical trends evolve? Could they make our venture obsolete?

A critical requirement for processing such project ventures is a near-realistic prediction on the Human System Interaction (HSI) in the targeted usage time, i.e. anticipating whether the to-be-designed disruptive system is going to meet wishes, needs and consumption patterns of users of future.

The issue has been observed in systems transformations requiring a very long strategic preparation (e.g. electrification of agriculture). The same concern is also valid for designing products with a long life cycle (e.g. civil aircraft design) or in entrepreneurship when pioneering a service for the first time (e.g. Netflix). In all these cases,

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[1] Energy-4-Agri: Funded by the Federal Ministry for Economic Affairs and Energy; Project sponsor Jülich, research center Project website: https://www.tu-braunschweig.de/energy-4-agri

[2] Sustainable and Energy-Efficient Aviation: Funded by the German Research Foundation DFG through the Cluster of Excellence SE²A - EXC 2163, project website https://www.tu-braunschweig.de/en/se2a

the socio-technical contingencies inherent in the system exceeds the available certain information, and therefore multi-disciplinary teams are likely to fail in designing a sound solution that is sustainably optimized and meets user needs.

Various approaches have been introduced by the body of systemic design for tackling system complexity (see e.g. Aaltonen, 2010; Jones, 2014), in a few modelling and prototyping play a central role and are the mean of communication through stakeholders (see e.g.Blomkvist, 2014). On the base of the definition for scientific models (Stachowiak 1983), we raise the question, whether we can replace the practice of building prototypes with building scenarios for communicating HSI in future systems.

Scientific Models vs Prototypes vs Scenarios

While scenarios demonstrate many epistemological similarities in form and their functionality to prototypes, less design processes have emphasized on the modelling advantages of scenario technique in facilitating transdisciplinary product development.

Indeed the application of prototypes and other scientific models must be traced back to pragmatism in design practice: they facilitate communication among stakeholders (Kac 1969 in Weinberg 1975:43). Based on design objectives and communicative requirements, prototypes are generated to encode, decode and translate knowledge among stakeholders (Lauff et al. 2020). Near this communicative role that is common among all scientific models, prototypes in design research play also a generative role in enabling the designer to reflect on own design and explore the solution space (Lim, Stolterman, and Tenenberg 2008). On this rational ground, certain prototyping methods (tangible/virtual, low/high fidelity, 2D/3D etc.) has been appealing to particular design disciplines and are even vastly recognized as standard procedure in the design process (e.g wireframing in UX Design).

With design practice emerging in the last years from a traditional creative/innovative role to a rather moderator/mediator role, we believe that scenarios and scenario-technique will increasingly draw more attention as a complementary or even stand-alone modelling and prototyping method in many design sub-disciplines.

Yet, one might raise the question, to what disciplines and how might scenario technique come handy? In his seminal work on model theory, (Stachowiak 1983, 119) allocates three pragmatic functions to scientific models: graphic, technical and semantic functions, noting that a modelling technique might contain more than one pragmatic function. Bearing in mind that scenarios carry essentially all the three characteristics with the main focus being on semantic/ narrative functions (Börjeson et al. 2006; De Smedt, Borch, and Fuller 2013), we suggest that scenario technique will be rather in disciplines advantageous, that are of a disruptive future-oriented nature. Such characteristics are often seen in strategic and service design inquires. In particular, for design commissions, in which, convergence and common perception regarding the problem/solution space is a requirement for decision-making.

User centricity without users

Prototyping is an important phase of an iterative Design process. Iterative low and high fidelity prototypes and usability testing sessions with potential users promise a sound understanding of customer actual needs, wishes and probable incentives for using the targeted product or service. Yet, how to perform the user research in a strategic design approach, when the user is not accessible and/or has no prediction on his long term needs?

From a methodological point of view, we will encounter in such research cases two obstacles:

1- Providing the user with a valid prototype and its future environment for examining the usability is due to technical limitations barely possible.

2- "The user of future" does not exist yet, common marketing-driven surveys and similar measures on current customers cannot validate the desirability of our solution, as "the users of today" do not entirely represent the mindset and other socio-cultural characteristics of their next generation.

In the foresight research, where researchers often deal with various stakeholders with a large set of uncertainties, scenario technique is used to fill the knowledge-gap with the help of so called "consistency analysis" and "plausibility checks" (Ritchey 1998, 2011). Scenarios discuss the probabilities and not the facts (Huss 1988); they have no claim on delivering true knowledge about the future (Kosow and Gaßner 2008). They rather facilitate innovation via trans-disciplinary discussion and mutual creative impulses. Yet, how to integrate (a preferably iterative) user research in a process of generating scenarios? Moreover, which user research methods are best compatible with the scenario process?

Mozuni and Jonas (2018) proposed the approach "Morphological Delphi", in which tools from foresight research are integrated in design-Thinking method, so that scenarios are generated systematically with the help of experts' consensus knowledge. Building on this ground, we have designate for our agriculture project a step-by-step approach, in which, not only experts opinion, but user data from various sources (e.g. mass surveying, interviewing, etc.) could be iteratively communicated through scenarios and serve technical decision makings.

Asking experts instead of users

A methodological concern on solutions for the middle and far future is the incapability of the user to depict their future needs. We encountered the same problem in the E4A project regarding the capability of agriculturalists in reflection on the future. Although a qualitative user research (e.g. focus groups) would be in this matter more effective than a quantitative research (e.g. surveying), yet general market research or raising data by surveying current user, might mislead us: many supposed wishes and/or future needs might become obsolete in the long term. The reason is that for the user, unknown data and ambiguous information about the future exceeds the known intelligible knowledge.

Reasonably, in such a case, when common user experience research (UXR) methods are unable to deliver data about "the user of future", experts opinions are a proper alternative for collecting data (Everett 1993; Sackman 1975). Experts can relate political, economic, technical and social factors and deliver innovative scenarios. Scenarios can then be taken as prototypes and being used in the form of common UX researches.

Scenarios as prototypes for UX researches

As Mogensen (1994) states, prototypes are representations of otherwise internal or unavailable ideas of what the future should or could look like. Seemingly are prototypes seen by Blomkvist (2014) as surrogate for the future situation of service. This definition conveys the same understanding in the body of foresight research about scenarios (see e.g. Börjeson et al., 2006; Fink & Schlake, n.d.; Malhotra et al., 2014).

Therefore, in addition to the functionality of facilitating discourses among experts, scenarios can be effectively used as service prototypes to be used in user experience research approach (UXR), for instance as *service walkthrough* (Figure 1).

Prototyping services are different from prototyping physical products, as they need to consider the whole human system interaction rather than focusing on micro functions. Nevertheless, many designers accustomed and still use traditional UXR approaches, that are tailored for micro (digital) solutions (Blomkvist and Bode 2012). With the help of *the designated Scenario Technique,* UX researches will be able to generate scenarios, visualize them as *Service Walkthroughs* and finally evaluate them with their conventional UXR methods.

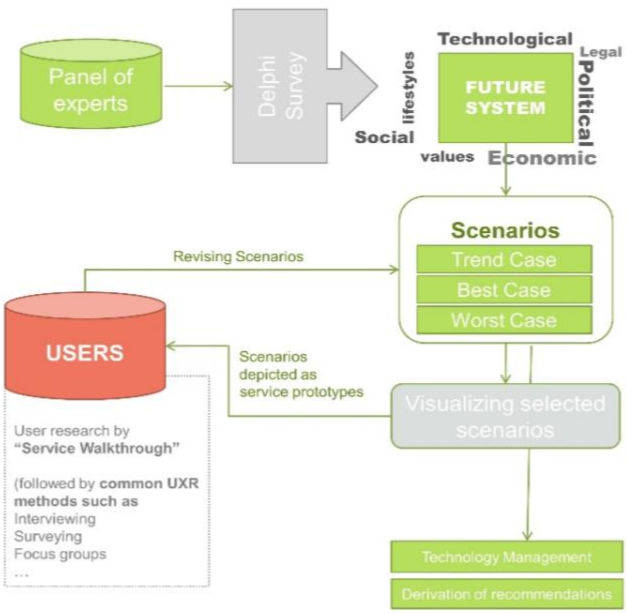

Figure 1: Integrating scenario prototyping and UX research in a strategic design inquiry

Transferring knowledge

Even though transdisciplinary research always aims to combine disciplinary knowledge (inclusive) and tackle problems in a holistic way (integrative) (Carceller-Maicas 2015, 307), we must however recognize that we will never achieve absolute knowledge (Clayton and Ratcliffe 1996, 212; Skrimizea, Haniotou, and Parra 2019, 129). Therefore, elaboration and description of possible futures are nothing than deductive models. Models (i.e. also other methods and techniques) are deductive by definition. Loss of information must be accepted in order to achieve simplicity, clarity and understanding of the research subject (Clayton & Radcliffe: 1996, 190) "We cannot deal with reality in all its complexity"(Cilliers 2008, 50 ff). In this regard, scenarios have the advantage that, in principle, they are simple in nature and convey less details (Kosow and Gaßner 2008; Kosow and León 2015, 219) since they must represent many alternative futures (Braun, A., Glauner, and Zweck 2005). In addition, scenarios have an iterative and thus an adaptive character: Through the constant involvement of experts and stakeholders, the research field must be constantly evaluated and negotiated. In addition, depending on the research field, different methods for stakeholder involvement can be used under the umbrella of scenario technique.

The potential of multidisciplinary or transdisciplinary scenarios lies in conveying information and shared knowledge and facilitating social discourse (Greeuw Marjolein et al. 2000). Thus, scenarios can also be seen as a better alternative to the classic research report to disseminate information (Glatzel and Wiehle 2019). By integrating various actors, knowledge and perspectives, the scenarios also bring a balance of interests between possible stakeholders. It also fosters acceptance and understanding about the generated solution or concept.

Scenarios in the E4A project focus on two narratives: firstly, several possible system states are outlined (target knowledge), secondly, alternatives are discussed, what must happen from today's point of view (or should not happen) in order to achieve a certain system state (transformation knowledge). Both narratives build on improving the systemic knowledge. The complexity of the problem is dealt with participation, creativity and prototyping, in particular by combining several scenario processes. “Scenarios make possible futures tangible” here also means making complexity tangible. Stories have the potential to create understanding for a complex field of research, but it is important to constantly question the truth behind the stories (Sandercock 2010).

Practical implementation in two research projects

With the help of our ongoing projects E4A and SE^{2}A, we outline our designation for using scenarios as prototypes for multi-disciplinary decision-making

The project is characterized with following features:

- Addressing a future system.
- Need for derivation of future digital and analogue products.
- Transdisciplinary Technology management is an issue.
- HSI management with user-centrism.
- Recommendations must be generated for policy making.

For a better understanding of the reasons behind single steps, we follow an inverted goal-oriented requirement chronology (Van Lamsweerde 2001):

Goal a: Recommendations must be generated for policy making

Goal b: HSI must be optimized

Requirement: User must have been evaluating the solutions in advance

Goal: Evaluating solutions by user

Requirement: UX research by Service Walkthroughs

Goal: Providing and running Service Walkthroughs

Requirement: Scenarios must be visualized (for example via VR prototyping)

Goal: Generating scenarios

Requirement a: Morphological analysis must be ran(Álvarez and Ritchey 2015)

Requirement b: trans-disciplinary Delphi workshops must be held

Goal a: Running Morphological analysis

Goal b: relating quantitative and qualitative knowledge from different PEST disciplines

Requirement: Crass-impact analysis & consistency analysis (Mozuni & Jonas, 2018b)

Goal: Crass-impact analysis (see also Ohlhoff et.al 2021)

Requirement a: Building a matrix consisting of factors in columns and their possible projections in rows: Listing macro-worlds (up to 4) as projections of one column named *Macro Worlds*, and several PEST micro factors (up to 9) each with up to 4 projections in further columns

Goal: Building macro-worlds

Requirement: Building 3 or 4 macro scenarios (worlds) with the help of Quattro-stagioni scenario technique(Godet 2006, 82)

Goal : Building 3 Worlds with Quattro-stagioni technique

Requirement: Sensitivity Analysis (Vester 2002)

Goal: running Sensitivity Analysis

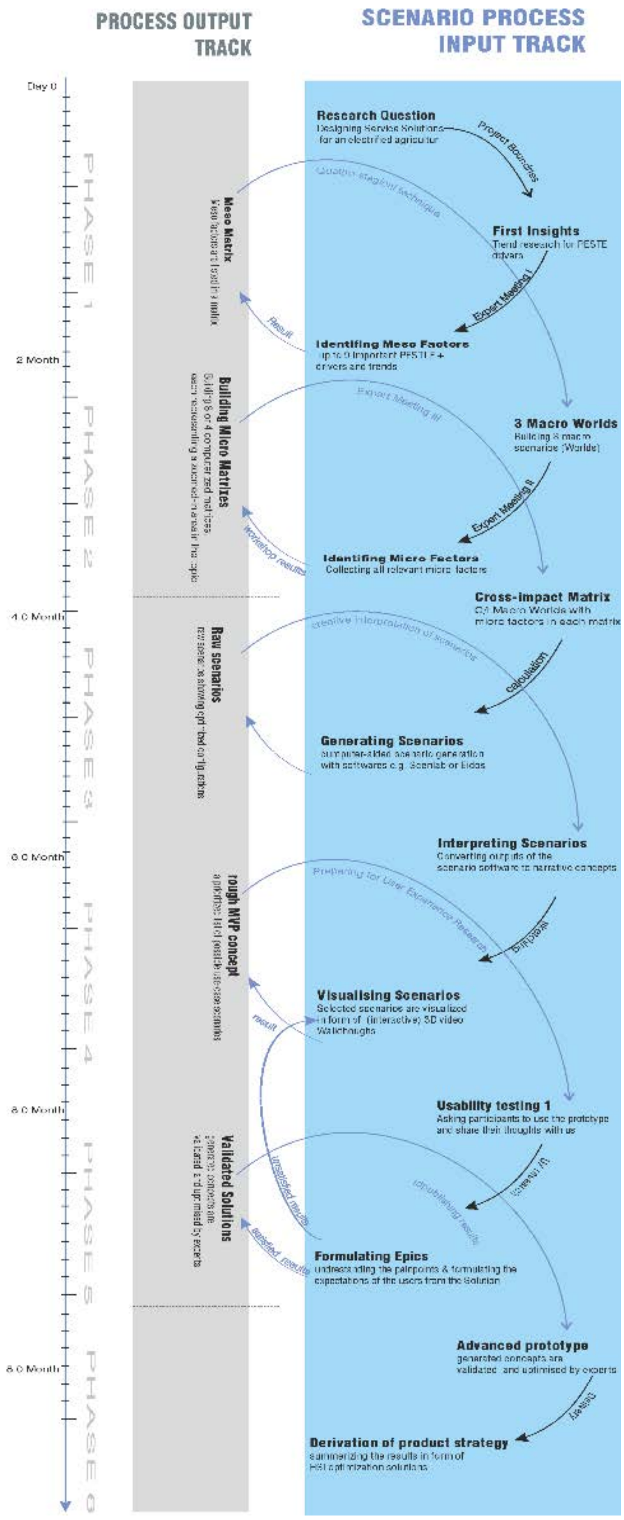

Figure 2: Proposed 10 step designation for trans-disciplinary desicion-making based on scenario tehcnique

Requirement a: running –cross-disciplinary Delphi workshops for identifying 2 most active factors

Goal: cross-disciplinary Delphi workshops

Requirement a: collecting quantitative and qualitative knowledge from different PEST disciplines

Requirement b: research and agreement on the number, phrasing and description of system key-factors (up to 10) and their possible projections (up to 4)

It is possible and is recommended to follow this process in an iterative routine. The process would suit an agile process flow in commercial project managements. Figure 2 illustrates a generic iteration for the 10 steps described above from defining the research question and gaining first insights down to delivering roadmaps and publishing results in a hypothetical 12-month project timing. Rationally, the phases and steps could be adjusted by individual needs based on the timing and the characteristic of the research project.

In the process above, several techniques are barrowed from the foresight research to help us with certain project Goals ending to HIS prototyping for multi-disciplinary decision making. Morphological analysis (Ritchey 2011) works in this approach as the holder on information which is collected via different sources. The cross-functionality between different tools and methods is listed in the table 1.

Table 1: application of forecasting methods in multi-disciplinary option evaluation using scenario prototyping

Project Goals ↓	(qual.)Scenario Technique	Delphi Method/Expert surveys	Morphological Analysis	Scenario visualization / Sc. Walkthrough
Anticipating the future	++	++		
generation of novel solutions	+	+	+	
HIS prototyping	+		++	
Usability & acceptance testing		+	+	++
accelerating collaborative work (Ritchey 2011a)		+		++

Conclusion

Strategic and service design inquiries increasingly have to deal with complex Human-System-Interactions, in which trans-disciplinary agreements on various socio-technical option has to be made. Stakeholder management including prototyping in such cases is essential to generate sound consensus. Within the duality of best practice and efficient practice in this regard, we raise the question whether scenarios and scenario-techniques might be a promising alternative. Qualitative scenarios are epistemologically dynamic story-telling that can ease transdisciplinary discourse about how a desired state might seem. Quantitative scenario approaches enable a systematic matrix-based exploration of the solution space so that no option remains out of sight. On this ground, we encourage designers to consider a mixed qualitative/quantitative scenario technique (such as "*Morphological Delphi*" or "*Morphological Analysis*") as a framework for convergence and reflection in design practice. In practice, one might see also scenarios as an adequate complementary to conventional rapid prototyping approaches for user experience research.

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Enriching synergies in Systemic Design - hybridizing science, design and transformative action

Reframing Systemic Design methodology within a new MOOC on Designing Resilient Regenerative Systems

Tobias Luthe, Haley Fitzpatrick, Justyna Swat, Tiphaine Mühlethaler, Abel Crawford

The main goal of developing Systemic Design has been to seek synergies between design and systems in order to better deal with complexity. Since the need for local people action on designing regenerative systems and cultures has been gaining in urgence, and since neither design nor science nor practice alone can transform such systems fast enough, we intent to enrich Systemic Design methodologies. Adding to the latest discourse on values, direction and currency in Systemic Design, and when it is regenerative, we identify synergies between an extended array of practices: science, systems thinking, design, and transformative action. Motivated by the development of a Massive Open Online course on Designing Resilient Regenerative Systems with its specific module on Systemic Design, we propose some cornerstones of enriching SD and "playing with tensions" while offering this inclusive discourse to the RSD community.

Keywords: enriched methodology, extended synergies, sustainability science, transformative action, systemic design principles

Introduction

Climate change, biodiversity loss and pan-syndemics like Covid-19 are some of today's most pressing complex challenges we as society have to address. Much of our economies and societies prove to be not resilient and regenerative, but exhaustive, vulnerable, and unfair. The goal is to actively restore, to regenerate ecosystems and their services, while transforming our economy to become more circular and more just. We need new knowledge systems and cultures leading to transformative action since "the human impact on earth needs to be fundamentally redesigned" (source).

Scientific knowledge and reasoning are the fundamental tools to base policy and management decisions on, especially in times of crises. But we experience the limits of science when it comes to dealing with highly complex systems that are self-emergent, unpredictable, span across nested scales, depend on societal behavioral transitions, and lack data.

For helping to deal with such complexity, Systemic Design (SD) as relating systems thinking with design has become its own kind of designerly way to deal with complex system, to understand and reconfigure them. But we experience limits of design as well when for example ego-centric angles are employed to direct entryways to deal with such systems whereas science could support relational leverage based on quantitative data, as one example.

Lastly, transformative action is what we need to foster more and faster than at current, since the pressing problems require more urgence in delivering positive impact for regeneration.

What seems to be promising and lacking is the better integration of science of, for and about sustainability (sustainability science), systems thinking, design, and transformative action.

In this paper we report from ongoing work to develop an educational resource entitles "Designing Resilient Regenerative Systems", an innovative and timely Massive Open Online Course (MOOC) that builds capacity in transformative systemic innovation through a combination of holistic consciousness, systems thinking, and cooperative design doing in illustrative real-world cases. One of the MOOC modules is on Systemic Design, i.e. on an enriched array of tools, frameworks and mindsets to hybridize science, design and transformative action. We relate this process of enrichening process SD methodology to the discussion on when SD is regenerative from RSD8 (Swat et al. 2019).

The MOOC as motivator for enriching Systemic Design

This innovative MOOC provides participants with worldviews, systemic design tools, illustrations and translocal social co-design networks - for building their capacity to creatively tackle complex, real-world sustainability challenges. It provides nature-inspired creativity tools of design praxeology as complementary with science programs to actively take responsibility in designing systems that are resilient and regenerative. The governance and spatial scales of regenerative design span from the level of green chemistry via materials, products, architecture, communities, to cities, landscapes, bio-regional economies, to transnational cooperation (Luthe et al., in review).

The applied MOOC didactic concept fosters virtually nudged translocal people action through systemic design doing in illustrative real-world settings across cultural, political, climate and geographic transects, and on different governance scales, such as the MonViso Institute in the Italian Piedmont, Hemsedal community in Norway, the city of Annecy in France, and the Mediterranean Balearic Island region.

This MOOC builds on established teaching in engineering, planning, architecture and different science disciplines while introducing systemic design thinking and doing as topical, didactic and collaborative spearhead in inter- and transdisciplinary, real-world education on a Master level. Further educators in this MOOC are scientists, planners, designers and practitioners of leading European institutions in the field of systemic design, sustainability science, and transition studies, of local communities and large cities.

Scheduled to be offered via EdX for the first time from begin of 2022 on, the MOOC targets students who are eager to learn about the emerging transdisciplinary topic of regenerative systems design, and to develop their scope and skills in systemic design across governance and spatial scales. It equips participants with worldviews, motivation, tools, illustrations and translocal social co-design networks - for building their capacity to creatively tackle complex, real-world sustainability challenges - and foster systemic innovation.

One of the six MOOC modules deals specifically with the essence of how SD in an extended array of actionable methodologies can help to spur fast transformative action for regeneration.

Adding components to enrich Systemic Design methodology

Systemic Design (SD) is framed by the Systemic Design Association as "an integrated discipline of systems thinking and systems-oriented design" (https://systemic-design.net/sda/). So, basically SD is currently discussed as the array of systems thinking and design (disciplines), where its employed design methods distinguish from service or experience design i.e. through addressing greater social complexity and larger scales. The inherent concepts of systems thinking, such as brainstorming, causality, system mapping and synthesis, are integrated with design methods, such as visualizing, ideation, iteration and prototyping, to reconfigure complex (social) systems.

However, through experienced practice in teaching SD in various institutions, and through applying SD as consulting methodology, we identify untapped potential in the integration of current SD practices with more science tools, and with tools fostering transformative action. As part of the MOOC module on SD we intent to provide an enriched array of science and action tools in relation with existing methodologies and their discussed and practiced integration. In the following, we illustrate this approach with a brief overview on prominent SD methodologies and some avenues for further integration of science and of actionable tools.

Prominent methodologies in SD and some examples for new synergies

Prominent methodologies in SD are for example Systems Oriented Design (SOD, Sevaldson 2013), Holistic Diagnosis (Battistoni et al. 2019), Transition Design (Irwin 2015) and the Systemic Design Toolkit (https://www.systemicdesigntoolkit.org/).

SOD is a praxeology framed as the designerly way to work with systems. SOD is positioned between design thinking, design practice, systems thinking and systems practice, leaning towards design practice (Sevaldson 2017). Main components of the SOD toolbox are Gigamapping and the library of systemic relations, of which the author distinguishes social, ecological and material relations. These relations are purely qualitative and identified in a designerly way. One example for new synergies with science tools to add here is social network analysis (SNA), which provides new potential to identify leverage and read the structure within social relations, i.e. the larger and more complex a system is.

Holistic Diagnosis (Battistoni et al. 2019) is a framework within the SD field which could benefit from additional science tools, i.e. supply chain mapping as a first step prior to their assessment stage (Figure 1).

The Systemic Design Toolkit (https://www.systemicdesigntoolkit.org/) promises to co-create interventions to tackle complexity. The principles are high level and rather generic as broader guidelines, such as "Defining the desired future". Further authors provide similarly high level and generic design principles (van der Bijl-Brouwer and Malcom 2020, Jones 2014). SD would benefit from more specific, concrete design principles that better inform transformative action, such as "Design with (the chemical element) carbon" (https://monviso-institute.org/core-concepts/).

In addition to specific science tools and frameworks dealing with complex systems and transformation while lacking in the SD discourse, such as the autopoietic cross-scalar governance spiral (Luthe et al. in review) or the adaptive waves resilience concept (Luthe and Wyss 2016), tools of transformative action are lacking as well. Real-world laboratories are just one example (Figure 1).

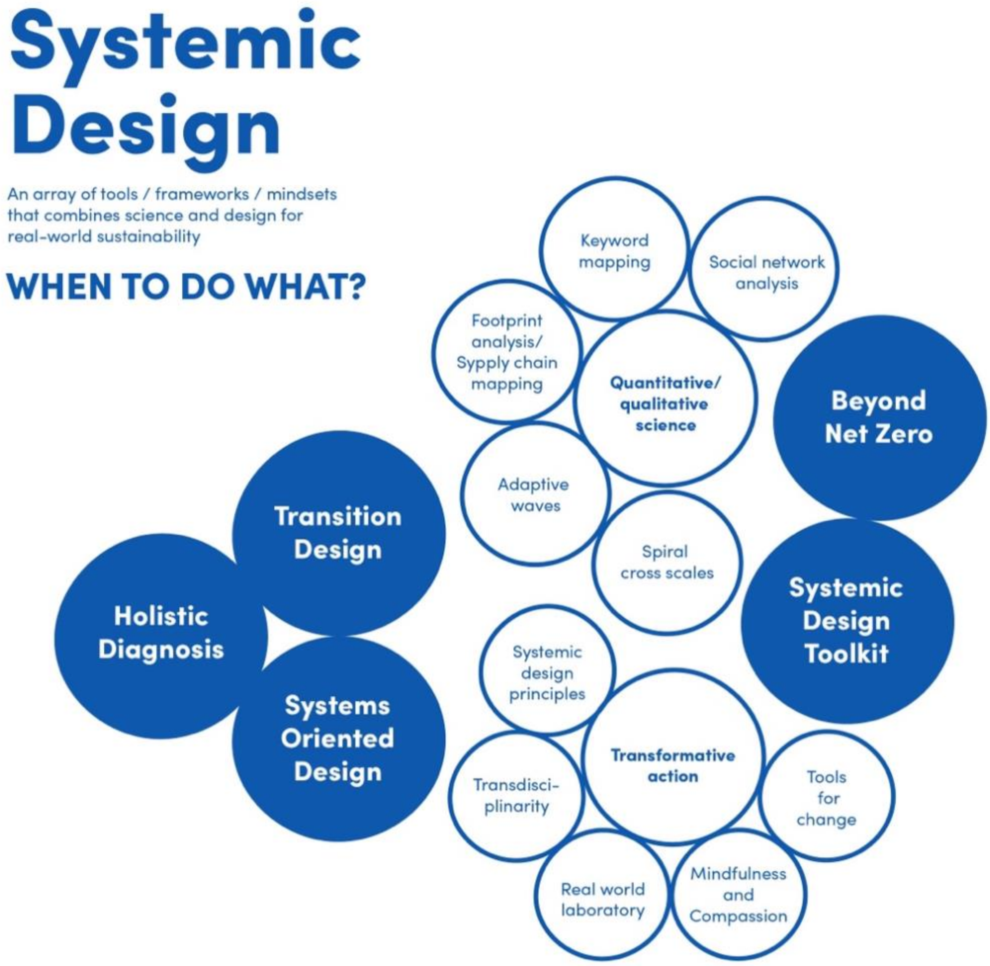

Figure 1. Systemic Design – when to do what? Conceptualizing the logic of the MOOC module on Systemic Design, and its enriching of the current SD discourse and praxis. Blue are examples of prominent SD methods or frameworks. We propose to enrich SD with further tools and frameworks of science, such as social network analysis, supply chain mapping or cross-scalar governance, and with tools of transformative action, such as specific systemic design principles and real-world laboratory experimentation.

Questions to jointly discuss with the SD community at RSD10

The MOOC's modular structure comprises sets of questions that guide the delivery of content and the activation of the participants' learning experience. Related with the module on SD, we currently work with a list of questions, such as:

What is Systemic Design?

What do we need Systemic Design for?

What do we do when we get crazy - when asking only questions - when there seems not "base" or "state" to start from? How to not get lost in complexity?

Where does science provide synergies in systemic design?

What does practice bring in, and what does it lack?

What are designers unknowingly trained to do?

What is different to scientific research?

What does a non-designer need to know and practice to benefit from design thinking and doing?

What does a non-scientist need to know and practice to benefit from scientific reasoning?

In the ongoing MOOC design and the upcoming production of the content, these questions will be answered, and new ones will evolve. At RSD10 we seek feedback on these questions, jointly discuss answers and phrase additional questions both to support the MOOC and advance the discourse in SD – when to do what?

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Track 7:

Debunking Implicit Bias

Chair: Dr. Tom Maiorana

Simulations in Service Design Prototyping

Drone Deliveries with Society-in-the-Loop

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This research-through-design study explores how computer simulations of drone delivery traffic can be used in service design. It investigates how computer simulations compared to a desktop walkthrough can inform the design, and how simulations can be used to facilitate a citizen perspective in service design. A workshop where participants evaluated a simulation of the drone delivery service was compared to a workshop where the participants took part in a desktop walkthrough. The results showed that the participants discussed many of the same aspects, but there was a difference in the perspectives taken. The participants using the simulation took more of a community perspective and discussed dystopian risks, and they also used the simulation to compare distance and speed. The participants in the desktop walkthrough, took more of a customer perspective and a technology perspective. It is concluded that the simulation helped participants gain common ground of dynamic aspects of intense drone traffic, and that the aerial view lifted the perspective from the service encounters and service users to that of the surrounding society.

Keywords: service design; prototype; simulation; desktop walkthrough; drones

Introduction

A future drone delivery service would affect many people in a city. It is likely that the city government would have a regulatory function in the design of such services. The design would require, not only a dialogue with primary users, but also with citizens to ensure that drones can function with current infrastructure and fit into the lives of citizens. This research-through-design (RtD) study aims to explore how computer simulations can be used for citizen engagement in service design of drone deliveries for students in a Swedish university city.

Simulations used as prototypes can potentially function as a divisible object and facilitate collaborative systemic design efforts. They can work as external representations and as such simplify the exploration of ideas and make it easier to both improve concepts and create new ones (Bjørndahl et al., 2019; Kirsh, 2010). Different prototypes are however good at conveying different things (Johansson & Arvola, 2007). For the purposes of this paper, we employ a broad definition and take prototypes to mean manifestations of design ideas of different materials, scope, and fidelity that filter some aspects of the design (e.g., appearance, data, functionality, interactivity, structure), and they can serve the purpose of evaluation; exploration of user experience, needs, and values; generation of ideas; and/or communication between the participants of a workshop (Lim et al., 2008). The fidelity of a prototype can affect participants' assessment of the design (Rudd et al., 1996; Walker et al., 2002).

Simulations can offer a safe way to test a system before it is implemented (Thompson et al., 2008). Simulations in service design is a relatively unexplored area, but they have the potential to visualize multiple simultaneous events with multiple agents and dynamic processes which can be useful in all systems design (Bubna et al., 2019; Caglayan & Afacan, 2021; Lundberg, et al., 2018). There are few studies on how simulations can be used in service design in comparison to commonly used service design prototyping methods. One such method is the desktop walkthrough where participants visualize service concepts by play acting different scenarios in a miniature world (Blomkvist et al., 2016; Blomkvist & Wahlman, 2018). The research questions for this paper are therefore how computer simulations can be used for citizen engagement in the evaluation of drone delivery services for students in a university city, and how such computer simulations can inform the design process in comparison to a desktop walkthrough.

Systemic design typically involves transitions between levels of understanding, from that of physical objects and manifestations, to an understanding of how that affects higher-level values such as safety and privacy. Or vice versa, from a concern for privacy, to assessment of a particular situation. In our work, we have previously used a framework for this that includes six levels (Lundberg & Johansson, 2021; Lundberg, et al., 2018): (1) The particular objects, their status, and what they convey; (2) the objects-in-motion and the properties they gain in use; (3) generic recurring patterns of, for example, movement; (4) generic qualities and trade-offs of services, such as the level of noise that is usually generated by a particular service at a particular place and time of day, versus its societal value; (5) effect goals; and (6) a framing of what goes on, as for example a delivery of a service, a drone that might take photos as it passes over my house, or a drone that might fall down on me as I walk beneath it. The first two levels regard the more physically manifest how of a service. The third and fourth level is a more abstract what. Finally, level 5 and 6 concerns the subjective why of the service, including goals that people have and how they view situations.

Research Method

The study builds on a research-through-design (RtD) approach, which means that design practice and the creation of some artefact is central to the knowledge generation (Stappers & Giaccardi, 2017). The artifact in this study was a drone service for food delivery for students in a university city. This case is instrumental to the investigation of the use of computer simulations of drone traffic in two workshops in comparison to a desktop walkthrough in two other workshops. Excerpts of the audio and video recorded workshop conversations that could be directly related to the simulation or directly related to the desktop walkthrough representations were transcribed in verbatim and analysed using reflexive thematic analysis (Braun & Clarke, 2006; 2019). The first author did the analysis to investigate the discussions that the participants had around the prototypes. The analysis was data-driven and only the explicitly expressed was coded, not underlying assumptions. The analysis had the following steps after the verbatim transcription: (1) Familiarizing with the data by reading and re-reading the material to find patterns; (2) creating codes that fit identified patterns; (3) generating themes from the codes; (4) placing relevant data under each code while also adjusting and refining codes and themes. Writing and analysis took place in parallel. The results are presented with the strongest examples from each theme, translated from Swedish once the process was complete.

The drones service under design had the purpose of delivering fast-food. The design was driven by divergent sketching and the three most promising concepts were chosen for elaboration. One concept was then chosen based on a requirement inspection. A service blueprint, a storyboard, and an assumed persona was created to illustrate the service for the participants in all workshops. These are described elsewhere (Böhm, 2020). The storyboard used as introduction for all sessions is shown in Figure 1.

Figure 1. The storyboard that illustrated a scenario of use in the workshops.

Thirteen participants aged 24–32 were recruited by convenience sampling. There were six participants split into two in the workshops with the simulation and seven participants split into two workshops with desktop walkthrough. Informed consent was given by the participants. LEGO and drawn physical locations were used as material in the desktop walkthrough workshops (Figure 2).

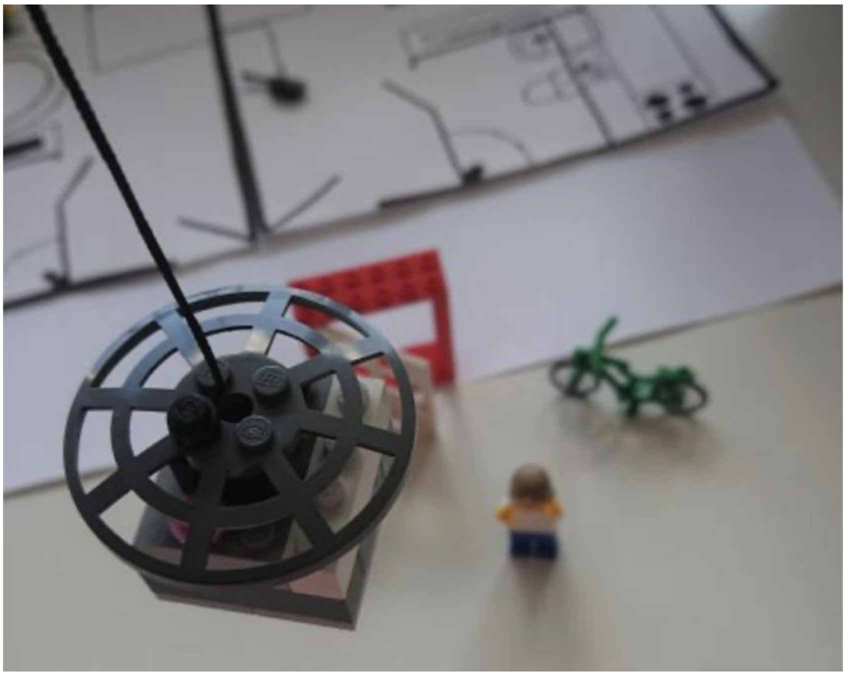

Figure 2. Staging of desktop walkthrough where a drone lands at a customer's home.

The drone traffic simulation (Lundberg, et al, 2018) used in the simulation workshops implemented two services that delivered fast-food from one point to an area in town. The participants could see the drone flying across an aerial view over the city (Figure 3). The number of drones in the air could be adjusted and it was also possible to create areas where the drones were not allowed to fly. Five scenarios of use were discussed in each workshop: Order food from home; the neighbour orders food at the same time; the food is delivered to drop-off point down the street; the food is dropped down by a wire from the drone; and many want to order food on New Year's Day.

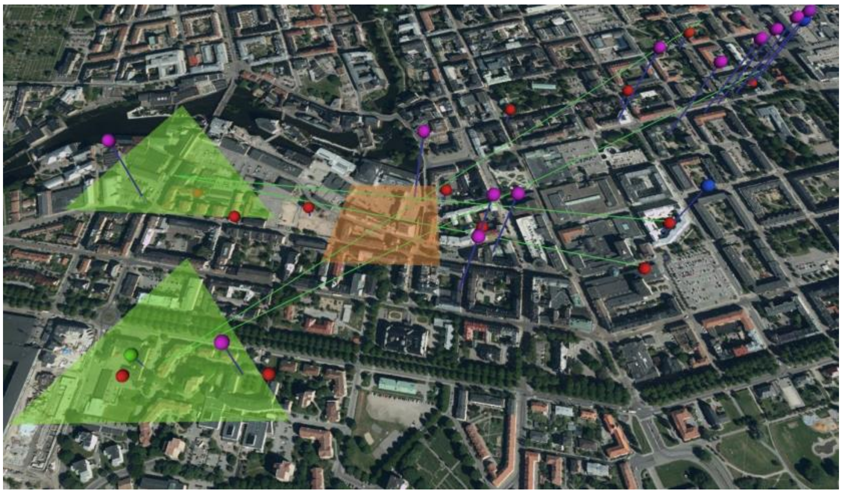

Figure 3. Screen capture from the simulation. Background generated from GSD-Ortofoto25 and GSD-Höjddata, grid 2+ © Lantmäteriet.

Results

The reflexive thematic analysis produced four themes: customer perspective; restaurant perspective; technology perspective; and societal perspective. A comprehensive account is reported elsewhere (Böhm, 2020).

Customer Perspective

The customer perspective covered the sub-themes of delivery, alternative deliveries, uncontrollable variables, and accessibility and ergonomics. Overall, the participants saw many customer experience problems and risks in relation to the delivery, such as theft, weather, and queuing. The discussions in this theme showed how it came naturally for the simulation participants to use the simulation to determine speed and distance and to specifically mark locations in the aerial view. One participant said:

It feels like it could have gone faster. Just because the bridge there is rather cumbersome, and if there's a lot of up-hill and down-hill, which it is there, then you often must bike.

This means that they could contribute with quite specific considerations on, for example, delivery locations, especially if they were familiar with the city.

Desktop walkthrough participants instead discussed how the delivery might be done in more detail, and sometimes thought of possible solutions to the problems they find. The desktop walkthrough seemed to facilitate discussions about accessibility and ergonomics, which was not discussed at all in the simulation workshops. The participants in the desktop walkthroughs used the LEGO pieces to stage, play act, and visualize various issues, such as instability and weather problems:

Yes, it will then be more like this (shows how the pizza is lowered using a wire while it spins) Yeah, here it comes on a wire and just rotates like this and then like 'oh thanks, all the ingredients on the pizza are in a corner.'

Restaurant Perspective

The restaurant perspective comprised the sub-themes of changes for the restaurants and potential problems for them. Both prototype groups captured a solution with delivery rounds where one drone flew to several addresses, which could save time and money for the restaurants if the restaurants have their own drones, as illustrated in the following excerpt from the simulation workshop:

But is it... It's now like a simple point A to point B and then back. But I think if you start adding... all these that have ordered food to different times on the root, then the drone gets to go in a rout around. I think, it becomes more of a delivery truck thing. They will like deliver more than one thing and then go back to the home station.

The desktop walkthrough participants found several potential problems and they were in some cases solution oriented, as in the following excerpt:

D1: Or is it FASTer FOOD support that manages and fixes the drone stuff. I think that this is very complicated because like…
D2: So this is some kind or air traffic control centre? (Points to the customer support that they built.)
D1: Yeah, remote air traffic control of drones sort of.
D3: So there might be cameras here by the door that they have access to.

They considered how the restaurant would need to be designed to work systematically with the drone delivery service. If the restaurants would have to be retrofitted and remodelled for the service to work, it will be difficult for most restaurants. Solutions that do not require retrofitting would therefore need to be considered. Another thing they discussed was mistyping the address, which could quite easily happen.

Technology Perspective

The technology perspective included the sub-themes of functionality, automation, and crime prevention, as in the excerpt below from the desktop walkthrough:

D1: [The door opening] is either automatic and then anyone can catch a drone and go there and get all drones, because it opens automatically from the outside too. Or they would also have to press and then then they will have drones outside hovering outside and waiting to get in until someone presses and opens.
[…]
D2: But, it can be it can be (…) a sensor above. That they must open the garage door to (…) let in, but (…) when it's outside it can be a sensor that automatically opens always to let drones in.

The participants in the simulation workshops discussed for example solar energy, risk of collisions, and accidents, as in the following excerpt:

D1: [It] doesn't feel possible to avoid accidents either. There will be crashes in some ways.
D2: They crash and then fall down on people or make damages to property.
[…]
D3: They will run out of, I don't know, batteries. So (…) some will surely get problems and stay there after someone has taken the pizza out since it doesn't understand like that it should go back. And then there are these things everywhere. And (…) what if it crashes and one of these goes into the water or in the street and risks harming people.

It is possible that these considerations were facilitated by the simulation that visualized many drones on the screen. There seemed to be a lack of knowledge among the workshop participants about how the drones work and what kind of technologies would have been possible to use.

Societal Perspective

The societal perspective covered the sub-themes of attitudes, impact on society, future considerations, and air traffic. This perspective was only present in the simulation workshops, and this appears therefore to be something facilitated by this prototyping method. Seeing the drones from above and being able to see several deliveries at the same time, together with the aerial view, seems to have facilitated on how larger society would be affected by the drone delivery service, as in the following excerpt:

D1: And that it becomes like, I'm thinking about trash, or like the environment and stuff. It'll be like you think you're gonna be bothered and think that it's like, not as pretty. I'm not sure how to explain it. That it feels…
Facilitator: Messy?
D1: Yes.
[…]
D1: I think that I would have been really bothered (…) if you like centrally and there's things going on everywhere. Suddenly, it's above you as well.

The participants also discussed it in terms of a dystopia and in terms of surveillance:

I can imagine that you would have been a little annoyed and think that if you had a house in this where you had worked because you feel that "I shouldn't have anyone looking into my home" like hedges and stuff, and then it starts flying above you all the time. (...) You would just (...) have felt under more surveillance. Even if there hadn't been any camera or anything. [...] It's just this "Big Brother watches" thing. Even though that's not the purpose, but (...) think of China.

Synthesis

Figure 4 illustrates the proportion of discussions spent on different themes. The figure shows several differences between the two different prototypes where the societal perspective was dominated by the simulation groups, while the desktop walkthrough groups had more conversations with a customer perspective, but also a little more restaurant perspective and technology perspective.

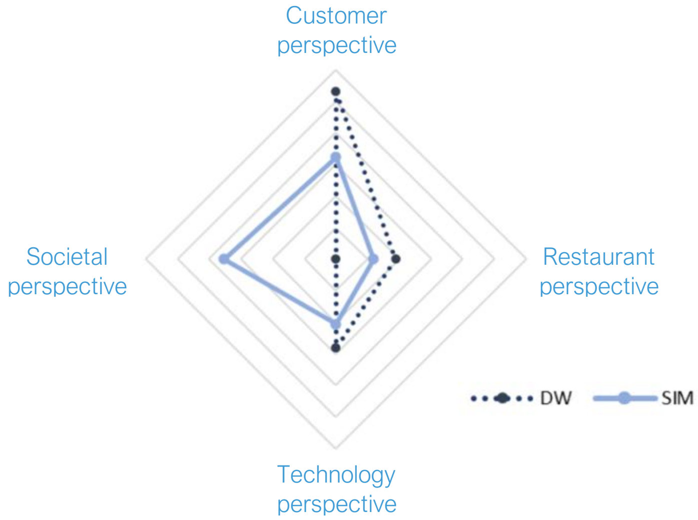

Figure 4. Visualization of how much the different prototype groups, desktop walkthrough (DW) and simulation (SIM), discussed different themes. The figure does not represent any exact frequencies of utterances.

Based on the discussions that took place in the different groups, an analysis was also made of which filtering dimensions (Lim et al., 2008) the different prototypes had. This is illustrated in Figure 5.

Figure 5. Visualization of the filtering dimensions of the desktop walkthrough (DW) and the simulation (SIM). The figure does not represent any exact frequencies of utterances.

Appearance, refer to the appearance of the drones themselves, as well as how drone swarms would be perceived from the ground (e.g., it would look "messy"). Interactivity refers to how people interact with different sub-systems (e.g., feedback, input, operations, output). Functionality refers to the functions that are performed by the designed system. Two of the dimensions (Lim et al., 2008), data and spatial structure, were not touched upon at all and are therefore not included in the figure. The figure shows that there was no major difference in the filtering dimensions between the desktop walkthrough and the simulation. The participants in the simulation workshops discussed a little more about the appearance of the service and a little less about the interactivity.

Discussion

The analysis of the data generated four themes: customer perspective, societal perspective, restaurant perspective, and technology perspective. These four themes are not exclusive but reflect the data from the workshops with the students (other stakeholders would likely have given rise to other themes, such as political and regulatory). The major difference between the two prototype groups was that only the simulation had discussions from a societal perspective. This directed the participants towards talking about both air traffic control (i.e., where drones should not be permitted) and the fear of a surveillance society due to cameras on the drones, both important to reduce the risk that the service evokes negative emotions. The participants in the simulation group thought of it as a dystopian future. The simulation shows an aerial view where several parts of the city can be seen at the same time, and this might have contributed to discussions of societal aspects as well as discussions about distances and particular places such as delivery points. The desktop walkthrough participants probably had a harder time visualizing that many drones in the air and therefore did not reflect as much on this. Instead, they used the physical external representations (Bjørndahl et al., 2019; Kirsh, 2010) in the form of LEGO to talk about how the food would be delivered and received, both by people at the restaurants that sent food and customers that received food. These discussions involved issues regarding which type of sensors the drones had, in addition to ergonomics and interaction, including how it would be received by customers in wheelchairs. This was a perspective that was absent in the groups that used the simulation.

Although the groups in many cases talked about the same things, they discussed them from different perspectives. An example of this is the conversations about queuing, a problem that could occur if several customers living nearby each other orders at the same time. Unlike the desktop walkthrough groups, which discussed this from a customer perspective where the customer would have to wait a long time for the food, the simulation participants talked more about how the traffic would need to be directed so that all drones could get there. This cannot be a result of the professional look of the simulation compared to the Lego builds in the desktop walkthrough. These results are in line with previous research that shows that different prototyping methods are good at conveying different aspects (Johansson & Arvola, 2007) and that it is an advantage that simulations can simulate several events simultaneously (Bubna et al., 2019).

The simulation with its aerial view grounds the discussions in a different way than the desktop walkthrough, based on what is objectively visible and subjectively seen. The aerial view proposes a perspective of the city, rather than a specific location of, for example, receiving a package. This widens the context (or system boundary) of the service, to see how others are potentially affected by it, through its journey from start to landing. Furthermore, the simulation supports imagining things that are difficult to imagine, such as how fast the drones will move, how many drones there will be, for how long drones will be active in an area et cetera. The simulation also routes the drones, for example around geofenced areas, showing where there will be something alike a highway in the sky. The aerial view shows what the drones will pass over, such as roads, parks, and buildings. This provides a means for building empathy, that is, to try to understand how it would be for others, or for oneself, at places on the ground, or in various roles (e.g., as a traffic controller).

Turning to the question of the levels of understanding, from physical objects to overarching goals and frames (Lundberg & Johansson, 2021: Lundberg, et al., 2018), we can discern important nodes of variation in the system under design. The first is the variation in services. What services that are implemented affect not only drone traffic patterns, but also the service users and as well as service non-users. The second is variation in framing. People of different professional and personal backgrounds make different framing of the service, the traffic, associated values, and goals. Given this, although the participants in this study got ideas about the traffic, people with professional training will most likely see other things, for instance if they have backgrounds in air space safety, regulation, urban planning, or running services using other transport modalities. Furthermore, personal knowledge of the places involved can enrich discussions. This can highlight personal goals and values related to the particular places and individuals. We call this engagement of people who are not particular customers or users or operators “society-in-the-loop”. For service design, “society” is a counterweight (or perhaps in some cases an amplifier) to the desirability of the service for a “user” group.

Another variation in the system under design that the simulation could compute and visualize are the things that are somewhat abstract such as "noise" or "risk of x" (where x could be for instance that a drone fails and drops gently to the ground in a parachute or that it disintegrates by design during a hardware failure and small pieces are spread in the wind). This would add things to the accumulation of observable common ground, to which participants could bring their own viewpoints. Selecting what to bring into such visualizations is an important issue in the design of services. The understanding of objects and their use (a set of drones that flies "here") and consequences for higher level goals and values (e.g., how much noise do they make, how much they impede on privacy, how likely are they to collide) can be hard to assess without expert knowledge. Such assessments could be encoded and visualized dynamically as the simulation is explored.

There were major differences between the two types of workshops that cannot be attributed to the filtering dimensions (Lim et al., 2008) of the prototypes. The discussions in each workshop touched upon three of the five filtering dimensions: appearance, interactivity, functionality, data and spatial structure. Appearance refers to the appearance of the product or system, interactivity means how people interact with different sub-systems, functionality refers to the functions that are performed by the designed system, data means the type of data used in the system or how it's organized and spatial structure refers to the arrangement of the interface or other information elements. Both the simulation and the desktop walkthrough facilitated discussion of interactivity, functionality, and appearance (not data and spatial structure). The difference between the workshop types was instead in the perspectives that the prototypes facilitated the participants to take (customer perspective, societal perspective, restaurant perspective, and technology perspective), indicating that the filtering dimensions cannot by themselves explain the differences in the discussions. Adding perspectives to the theoretical model of Lim et al. would make it more nuanced. As in previous studies (Walker et al., 2002), we can see that both the desktop walkthrough prototype with low real fidelity and the simulation one with high fidelity could contribute to the evaluation of the service design. However, different issues were identified depending on which prototype that was used, and these relates to the perspectives that the prototypes facilitated. Besides this, the simulation and visualization could also facilitate a record keeping of such explorations and discussions. If experiences and views of workshop participants could be encoded back into the visualization, then it could become a rich repository of viewpoints (to the extent that people can unpack what is encoded). A first step could be that the services that were explored in a session can be saved and brought back in new sessions. However, more of the discussions must also be represented, to also bring back echoes of the discussions that took place (e.g., frames, goals, values).

Earlier research has shown that simulations are advantageous to use in service design to represent simultaneous events (Bubna et al., 2019). By also seeing the service from a macro perspective as in the aerial view of our simulation, more societal aspects could be explored, and thus more societal problems could be discovered at an early stage. Different kinds of simulations, providing different filters (Lim et al., 2008) on the design might be suitable for different stages of the design process. A hypothesis based on earlier research would be that prototypes with lower fidelity, like a desktop walkthrough, fit better in an earlier concept stage, while prototypes with higher fidelity, like a simulation fit better at a later design stage (Rudd et al., 1996). However, our results do not support such a hypothesis, and consultation with citizens should take place relatively early so that they have a lot of opportunity for input. This discrepancy deserves further attention in future research.

Conclusion

The computer simulation in this study was used for citizen engagement in service design and provided a societal perspective and multiple stakeholder's perspectives (both customer and restaurant in this case). The desktop walkthrough participants did not discuss the service from a societal perspective. Instead, they took primarily stakeholder perspectives and talked also about the technology in more detail, including ergonomics and accessibility issues. We conclude that the simulation was useful for society-in-the-loop design and communication on how and where drones may fly and where possible delivery points should be located. The simulation was not appropriate for discussions on details of ergonomics and interaction between stakeholders and between stakeholders and the drones. Therefore, the simulation worked best with one or more complementary prototypes. The simulation in this case broadened the perspective to non-users of the service. Thus, it serves as a means of empathy to other stakeholders, who may have a (sometimes decisive) say in the realization of the service. It is thus an important counterweight to focusing on the service encounters and the service users. The simulation made it possible to get a common visual point of reference also for dynamic aspects, like movement and speed, that might be hard to collectively imagine in the same way. We also identified avenues of future work into the use of this hybrid prototyping approach: (a) To use it with a varied base of stakeholders diverging in terms of framing, goals, and values; (b) to use it with people with particular experiences of the particular places involved; (c) to visualize particular values connected to the traffic (e.g., noise, risk levels); and (d) to vary the kinds of services involved (also changing the groups who would potentially be users versus non-user society stakeholders).

Acknowledgements

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Designing Data-Informed Intelligent Systems to Create Positive Impact

Design Methods, Questions and Recommendations

J Derek Lomas, Nirmal Patel, Jodi Forlizzi

This paper explores several approaches for designing data-informed intelligent systems to create positive impact. Two contrasting case studies in K12 education are used to illustrate design methods, questions and recommendations. The first case study addresses the poverty achievement gap in America, and shows how product data can be used to identify areas of inequity in digital education. The second case study looks at the unintended consequences of automating data-driven optimization in the context of a digital math game. Together, the two case studies reveal generalizable knowledge that supports the design of intelligent feedback loops to create positive impact. Further, this paper considers both the benefits and limitations of data feedback in complex social-technical systems.

Keywords: DesignX, Intelligent Systems, Smart Systems, Learning Organizations, Cybernetics, Poverty, Education, K12, Artificial Intelligence (AI), Goodhart's Law, Games

Introduction

A Human-Centered Design Perspective on Artificial Intelligence and the Design of Intelligent Systems

Artificial intelligence (AI) has done a marvellous job mastering games like Chess and Go. However, there is a gap in our understanding of how to apply AI for addressing large-scale societal issues such as education. New hardware, better data sources and cutting-edge algorithms are seen as the pathway to the production of more advanced AI systems in education, as this formula has worked in other domains. However, we should be careful — the societal goal is not to create improved educational AI—instead, the goal is to improve education itself (e.g., to enhance the potential for success vis-a-vis students, teachers, administrators and education systems). More advanced AI algorithms do not necessarily lead to better outcomes.

There is a danger in viewing AI as an "algorithm in a box" that can be bought, sold and integrated into an existing system to produce improvements. This leads to a technology-centered solutionism generating hype and deflation. A more nuanced view involves treating AI as a form of distributed intelligence. To explain using an analogy, human intelligence does not just reside in the brain. Instead, human cognition is distributed across the body, across our tools and our social engagements [0].Similarly, AI can be viewed as much more than a disembodied algorithm. Meaningful AI systems should be understood as a distributed intelligence, which necessarily involves people, artifacts, data systems and algorithms.

With these points in mind, we seek to shift perspective from the "Design of Artificial Intelligence in Education" to the "Design of Intelligent Systems in Education". Intelligence can be defined pragmatically through the idea of *success intelligence*, which Robert Sternberg (the most cited authority on human intelligence) defines as "one's ability to achieve success in life in terms of one's personal standards, within one's socio-cultural context"; he further notes that success is to be understood as "a state of well-being within one's cultural context" [0]. If we extend this notion of human intelligence to systems, then more intelligent systems should necessarily increase the likelihood of success and (stakeholder) wellbeing. Otherwise, as Forrest Gump put it, “Stupid is as Stupid Does” [14]. An expensive “Smart Classroom” that does not improve outcomes is, ultimately, stupid.

Sternberg’s idea of success intelligence aligns with the dominant definitions of intelligence in AI, such as the one from Peter Norvig, Google’s Director of Research, “the ability to select an action that is expected to maximize a performance measure.” [15] This definition has provoked much of the thinking in this paper about the role of feedback loops in helping systems to measure their own performance and to maximize performance measures. In this regard, while a previous paper focused on the question, “How can we translate human values into metrics usable by AI systems?” [14], the present paper addresses data feedback loops in social systems.

Notably, Norvig’s definition of intelligence does not entail the use of computers. Although “smart learning environments” typically focus on maximizing exposure to computers [0]), computers by themselves do not make a classroom smart. Instead, at least according to Norvig’s definition, systemic intelligence emerges from actions that improve performance measures; what is implicit in his definition is the fact that many intelligent systems (computational and non-computational) use performance measures in a feedback loop, in order to determine their choice of a successful action.

From this perspective, schools and other organizations are filled with non-computational intelligent feedback loops, which use performance measures to inform actions (e.g., see our discussion on formative assessments and mastery learning, below). In this paper, we highlight the role of *data feedback loops* as a key target for designers in enhancing system intelligence, as well as the importance of aligning performance measures to human values. As such, this paper aims to shift conversations from “designing AI in education” (which implies the use of cutting-edge algorithms) to “designing intelligent systems in education” (in order to focus on the efficacy of data feedback loops). Going beyond the domain of education, this paper seeks to offer a response to the following design research question: “How *should* we design data feedback loops in order to improve meaningful outcomes in complex sociotechnical systems?”

Incorporating Cybernetics and Systems Design

This paper, which addresses the Research in Systems Design (RSD) community, does not focus on AI. However, it does broadly deal with cybernetics, which is the conceptual predecessor to AI (Fig. 1). The field of cybernetics is dedicated to the study of feedback loops (circularity) as well as the use of data to achieve goals (teleology) [0]. The word “cybernetics” itself comes from the Greek *kybernētiké*, or governance.

Fig. 1: Representation of cybernetics as the conceptual predecessor of AI

A cybernetic system involves five parts: sensors, actuators, a goal state, a controller (determining how the actuators should respond to differences between the sensor data and the goal state) and the environment itself (which is treated as a causal part of the system [0]). A simple example is a thermostat, which senses the temperature of a room, compares it to the target temperature, and either turns a heater on (if the temperature is too low) or turns it off (if the temperature is too high). A complex example of a cybernetic system is a designer with a pencil [0]; when designers produce certain sketching strokes on paper, they sense and evaluate them with respect to an internal goal, and then act upon the environment again, in order to shift their sketch to a more preferred state.

Artificial Intelligence, in its very name, implies that, an AI system should refer only to the artificial parts of the system — that is, the parts that do not involve human intelligence. In contrast, a cybernetic viewpoint is useful, because it provides designers [14] with a valuable way to view intelligent systems as a whole; that is, where the system can include humans, computers, artifacts and ecologies. This view is broad, but it also focuses on the effective governance of systems through data feedback loops. Therefore, we find it useful to invoke cybernetics as a starting point for designing intelligent systems in education and other complex sociotechnical domains.

Mastery Learning as a Cybernetic Loop

Why do students fail in school? One reason is that many educational systems are intentionally designed to ensure that a certain percentage fails (e.g., the lowest 20%). However, most schools do not wish to “weed out the weak”; and in this case, student failure is a failure on the part of the school. How, then, might schools help more students to succeed? Numerous researchers believe that all students can succeed in school, but not within the same period of time: some students will simply require more time and attention than others [0]. In order to investigate this view, educational researcher Benjamin Bloom described a set of controlled experiments [0], which compared conventional classroom instruction to classroom-based *mastery learning*[1] or one-on-one tutored mastery learning. Over 90% of the students receiving personal tutoring and over 70% of the students in the mastery learning class reached a level of performance, which could be attained only by a mere 20% of students in the conventional classroom. How was this achieved? To put it briefly, Mastery Learning uses data feedback loops for informing instruction.

Mastery Learning is based on the use of formative assessments to inform decisions about investing time and effort in the classroom. For instance, after providing an instructional activity in class, a teacher assigns students a quiz, to assess whether the instruction was successful. If the assessment data shows variation in student performance, it can help teachers to understand which students or learning objectives need greater attention. Mastery Learning uses formative assessments to govern decisions about when a student can move to another topic: students are expected to continue to receive additional instruction on each topic, until they succeed in the formative assessment. This, in effect, creates a simple cybernetic loop. For a comparison, see the mastery instruction diagram, which uses the same format as the 1960s TOTE (Test-Operate-Test-Exit) cybernetic system from Miller et al. [0].

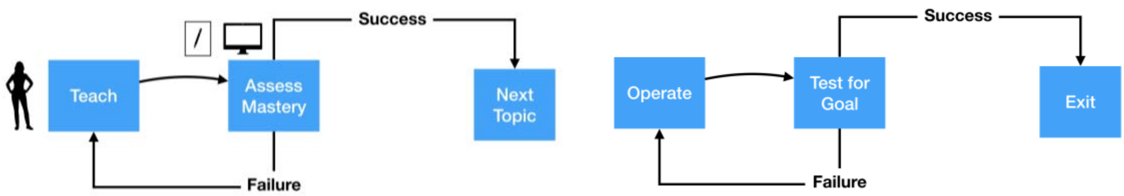

Fig. 2: Mastery Learning as a Cybernetic System: the left part of this diagram shows the TOTE algorithm [0] and the right shows the parallel logic of idealized mastery instruction in a classroom

Mastery Learning is not the only form of cybernetic feedback in education. “Data-Driven Decision Making” involves using formative assessment data to identify student problems and to act upon those problems systematically [0], but it does not require a full commitment to students achieving mastery in each subject. Cybernetic feedback loops can extend beyond individual classrooms, as well, when digital data from formative assessments are aggregated across teachers, in order to provide school administrators with continuous insight (e.g., regarding student or classroom level needs). These data can indicate groups of students or teachers who need additional help, or, it can identify particular learning objectives that create general challenges.

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[1] “Teaching under Mastery Learning and under Conventional Instruction is much the same except for the Mastery Learning feedback-corrective process every 2 or 3 weeks in which a formative test is given to students, followed by corrective instruction, and then by a parallel formative test. The first step in the feedback-corrective process typically begins with the teacher's noting the common errors of the majority of the students. Then, the teacher briefly explains the ideas involved using different illustrations or an approach different from what was previously used in teaching these ideas in the class. A second step in this feedback-corrective process is for groups of two or three students (on their own or under the teacher's guidance) to help each other on the items they missed on the test. A third step is for individual students to refer to the instructional material keyed to the test items that they are not confident they fully understand. This three-step process is expected to be used after each 2- or 3-week learning unit, before the students take the parallel formative test” [0].

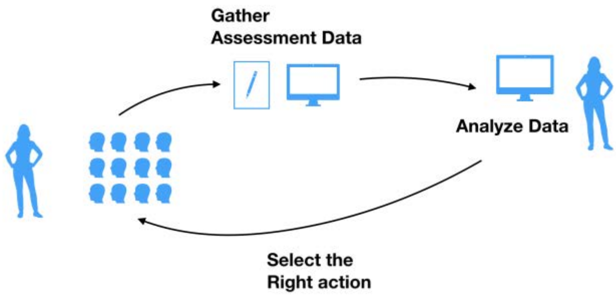

Fig. 3: A model for "Data-Driven Decision-Making" in K12 education [0]: 1. gather assessment data, 2. analyze data to identify problems and their causes, 3. select actions to address those problems

A continuous improvement loop is a data feedback loop, which produces system modifications in response to the measurements of needs. Continuous improvement loops are simple (Fig. 4) and offer a simple heuristic that can guide system designers: *anything that makes it easier to measure or modify a system will facilitate continuous improvement*. The barriers to making changes to a system can be very great – and it can be very painful to try to extract the right data in a timely manner. When it becomes easier to collect outcome data or to make system changes, data is likely to play a bigger role in system improvements.

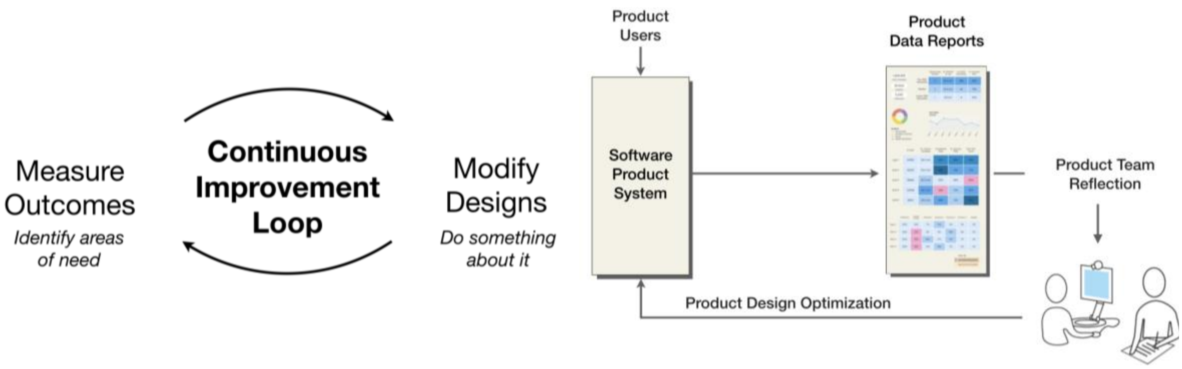

Fig. 4: Left: The basic continuous improvement loop model involves system measurement to gather outcome data about system operation, and the modification of the system with the aim of improving the key outcome measures. Right: A continuous software improvement loop

Case Study #1: Data-Informed System Design for Addressing the Poverty Achievement Gap

How can data-informed designs help produce large-scale social impact? This case study describes the use of digital learning product data, in order to prioritize product improvement goals. It specifically asks: how can we address the poverty achievement gap with data-driven incremental improvements, in a widely used digital learning program? This study has been produced by one of the authors [0].

The issue of childhood poverty in America is immense. Of the world's richest 35 countries, the United States has the second highest rate of childhood poverty, surpassed only by Romania [0]. Nearly 1 in 5 children grow up below the poverty line, and 24% of all schools in America are considered high-poverty schools [0]. Poverty has an enormous effect on academic achievement; this effect or "the poverty achievement gap" is often defined as the average achievement difference between children from families in the bottom 10% of incomes and children from families in the top 90% of incomes [0]. While poverty and race issues intersect, the poverty achievement gap is roughly twice as large as the achievement gap between white and black students (1.2 standard deviations vs .65 standard deviations). K12 performance affects subsequent educational attainment: only 18% of students in high-poverty schools will complete college within 6 years, while this number is 52% for low-poverty schools [0]. Educational attainment affects future income: as full-time workers without a high school diploma have a median income of $25,636 per year (and an 8% unemployment rate) while workers with a bachelor's degree have a median income of $59,124 (and a 2.8% unemployment rate) [0]. Thus, poverty is perpetuated: high-poverty students are less likely to succeed in education, which in turn lowers their future income, and escalates chances that their children will suffer the negative effects of poverty, as well.

These issues are complex, and there is no technological “silver bullet” for creating a more equitable society. Political organization is critical to creating social equity. Amidst this reality, there may well be ways to design systems, which can help contribute modestly to improvements. Data-informed systems designs are particularly promising. In a 2017 review of 196 randomized field experiments, several educational interventions failed to improve the poverty achievement gap; yet, Data-Driven Decision Making was one of the most effective approaches [0]. Further studies have found the approach to be more cost-effective, compared to 21 other interventions [0].

Data-informed system design is well-suited to the nature of complex sociotechnical systems. Design theorists Don Norman and PJ Stappers [0] claim that incrementalist approaches are often more successful in addressing human needs within complex sociotechnical systems. In contrast to ambitious or radical reform, which tends to be expensive and failure-prone, data-informed system design entails the continuous implementation of a large number of small incremental changes.

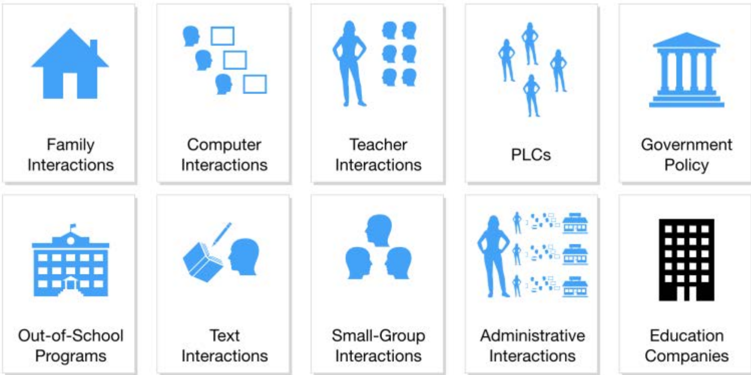

Fig. 5: K12 education is a large, complex, semi-hierarchical sociotechnical system. The icons above represent major components of K12 education, from the out-of-school student experience on the left, to the various kinds of in-school student interactions, to the higher-level interactions of PLCs (teacher groups, often known as “Professional Learning Communities”), school administration and government policy. The focus in this paper is on the role of digital software in K12 education, wherein educational companies have the potential to play a major role in nationwide data-driven improvements.

The Big Impact of Small Improvements on a Large Scale

A world of small, incremental changes may be less satisfying for the ambitions of those who want to “transform” education, but smaller improvements on a larger scale can still produce a major cumulative impact. In order to explore this, we can model the monetary value of new interventions, which improve academic achievement in high-poverty schools.

The total cost of childhood poverty in the USA is believed to be approximately $500 billion per year, as of 2008 [0]. If increased academic achievement enables children to escape a cycle of poverty, then an intervention that successfully cuts the poverty achievement gap in half would be worth $250 billion per year. Improvements in digital curriculum are extremely unlikely to raise student outcomes by 50%—but, they might be able to deliver a smaller improvement to millions of students. Improving the performance of all high-poverty students by 5 percentile points might be worth as much as $25 billion per year. This only goes to show that even small improvements on a large scale could create a big difference.

Fig. 6 shows the effect of poverty (measured in terms of the percentage of students in a school qualifying for a free/reduced-price lunch) on school performance, in a typical online learning system. The higher the poverty level in the school, the lower the average student performance on formative assessments. Reducing the poverty achievement gap means lowering the correlation between school poverty and school performance.

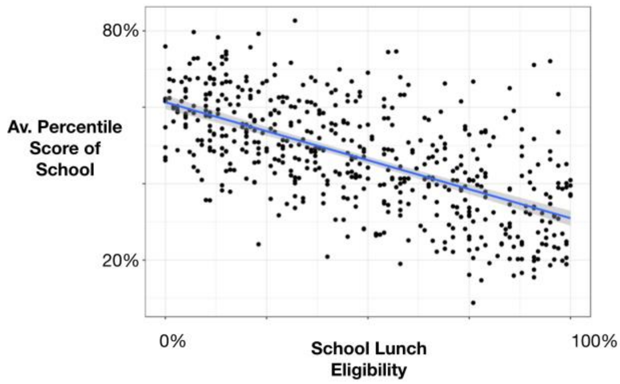

Fig. 6: The data presented here reflect real, observed product data, but are abstracted so as to create anonymity for the products and companies involved. Note the strong linear correlation between the poverty level of a school (percentage of students attending the school, who qualify for a free or reduced-price lunch) and their average percentile achievement on the digital formative assessments in the learning program. Each school is represented by a single dot.

Using Data to Inform Curriculum Improvement

In this case study, our design goal was to help large digital educational companies use data to improve learning products for supporting the needs of high-poverty schools. In order to achieve this goal, we wanted to help companies identify product areas that, if improved, would be likely to have the greatest positive impact on high-poverty schools.

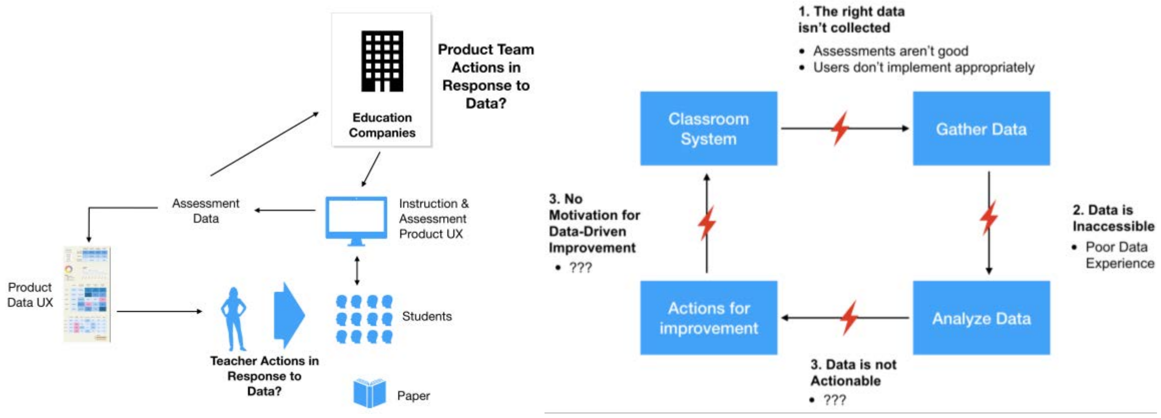

Fig. 7: Left: A data-informed feedback loop exists between teachers and students, via student assessment data. Teachers should have better defined actions in response to data – and likewise, the product teams should have defined actions in response to the data they collect about digital engagement and learning. Note that there is a more rapid feedback loop between students and teachers, which is not mediated by assessment data. This involves processes like empathy. Right: The common barriers to data-informed decision-making in educational products and their root causes are indicated. '???' indicates a root cause that is not understood.

In this context, how did we analyze the curricular data to identify product areas or opportunities for improvement? We first sought to define the product goals and find outcome measures of their achievement. The product goals, simply included mastery on different learning objectives; outcome measures included student performance on the digital assessment items tied to those learning goals. Subsequently, we investigated which learning objectives constituted the biggest needs. That meant looking at the topics, which students struggled with the most (i.e., in which they had the lowest scores). Defining needs as "failed topic performance" would suggest that the worst-performing topics should receive the most attention. However, this is not a sufficient criterion: low-success topics might be viewed as less unimportant. Therefore, we also set a criterion of greatest importance along with that of greatest need. We defined the importance of topics, based on their average correlation with the end-of-year tests. Logically, topics best predicting end-of-year performance are likely to have the greatest impact on end-of-year performance, when improved. Finally, since our goal was to help students from high-poverty schools, we set another criterion: the correlation of school poverty with topic performance. We hypothesize that the biggest impact would be likely to result from improvements in topics that are: 1. most important for success and 2. disproportionately problematic for high-poverty schools.

In order to validate that this process identified relevant topics, we considered the actual material. “Rounding decimals” topped the list: it both predicted end-of-year performance and was highly associated with school poverty. Why might this be? Logically, if a school has overall poor performance on rounding decimals in the fifth grade, this may indicate a general lack of understanding of decimal place values and number sense. This lack of number sense may impede much other grade-level math learning; while students can continue to learn skills for solving math problems, they will fail to understand the logic of the answer if they lack number sense [14]. If students lack place value number sense in the fifth grade, it does not make sense to move on to other topics that rely on understanding place value.

Table 1: The table presents idealized data showing how average school performance on formative assessments (aggregated items by skills) correlates with school-poverty percentages (percentage of students qualifying for free or reduced-price lunch), and correlates with end-of-year tests. Skills with the greatest magnitude of correlation are *likely* to be those that will have the greatest impact on reducing the poverty achievement gap, when their associated instructional resources are improved.

Skills	# Students	# Schools	Correl. with % Poverty	Correl. with End of Year Test
Rounding Decimals	9033	279	-0.62	0.54
Estimating Sums and Differences of Fractions	7192	235	-0.51	0.53
Estimating Sums and Differences of Mixed Numbers	4825	176	-0.58	0.52
Decimal Place Value	8439	279	-0.57	0.49
Solving Problems Using Division	3492	147	-0.49	0.48

Our analysis aimed to reveal topics that should be prioritized for curriculum-design improvements. This finding is limited, because, only a series of controlled experiments could definitively show that making improvements on these prioritized topics is, in fact, optimal for reducing the poverty achievement gap. There is another more fundamental limitation: these data alone are not enough to create meaningful systemic changes. There would need to be organizational processes in companies or schools that were both capable *and* motivated to take actions in response to the data (e.g., by funding curriculum improvements). This is challenging, in part, because there is no strong financial motivation to improve the outcomes of digital education products. In contrast to typical markets, the educational-curriculum market is not primarily driven by efficacy—while companies and their employees want to help students do better, improving outcomes alone is not likely to drive additional product sales. As no one gets paid more when products work better, no actions are taken. This represents a political and economic challenge as much as a measurement challenge.

In contrast, technology companies have often successfully applied product development methods that use data to inform improvement—after all, this is done in the service of creating more compelling products that make more money. Yet, besides differences in incentives, these data-informed approaches have also been difficult to apply within large legacy systems, in fields such as education and healthcare. Several of the barriers to data-informed decision making are presented in **Error! Reference source not found.**.

Case Study #2: The Dangers of Automatic Data-Driven Optimization

A/B Testing Methods

Companies like Google and Amazon run tens of thousands of A/B tests every day [0]. These are controlled product experiments, which randomly assign users to different versions of the product design. Thus, the organization is able to measure the effects of the design on various outcome metrics that it collects, such as average revenue per user. A/B testing relies on a reflective loop, to respond to the outcomes of the tests and modify the product in response. A/B testing can be a powerful mechanism for causally determining the effects of designs on outcomes, but it can be expensive to produce the multiple designs and inappropriate to run in the absence of large numbers of users. Airbnb suggests pitfalls to avoid [0]; while Google offers an alignment approach called “Goals-Signals-Metrics”, and categories of common metrics, which they call the HEART (Happiness, Engagement, Adoption, Retention, Task Success) Metrics [0].

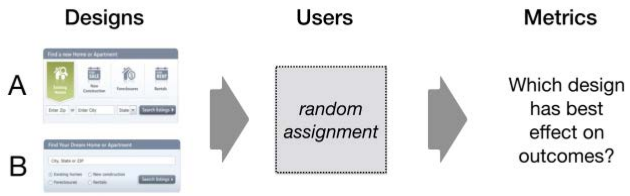

Fig. 8: A representation of the A/B testing method: two different designs, A or B, are randomly assigned to users. Metrics determine which design has the best effects on outcomes; this design is then chosen to be used by everyone.

Success metrics can be used by human teams and AI systems to drive continuous improvement. However, the optimization of metrics can produce unintended consequences when chosen metrics are not fully aligned to intended outcomes and when feedback loops about metric suitability are impoverished. This example shows why systems should be “data informed” but not purely “data-driven.”

In this case study, an online educational game was designed with the goal of motivating students to practice math problems. After being deployed online, the game attracted several thousand students each day; these players were randomly assigned to different game design variations to observe the effects of different designs on key outcome metrics (e.g., duration of voluntary play). To investigate the role of AI in system design optimization, we implemented a multi-armed bandit (a reinforcement learning AI algorithm [0]) to automatically test variations in the existing game parameter space (e.g., time limits, etc). The algorithm was designed to optimally balance the exploration of potential game designs by exploiting the most successful designs; sometimes, it would randomly search the game design space for configurations maximizing metrics (duration of voluntary play time), and sometimes, it would deploy the most successful variations. While the algorithm worked as intended, the system “spun out of control”, and primarily deployed malformed game designs, which maximized the outcome metric, but were misaligned with the original educational intent: the game variations were possibly played for long periods of time, because they were absurdly easy. This shows the pitfalls of having AI systems engage in automatic optimization, without humans as a governing feedback system in the loop. Systemic designers need to design feedback systems for monitoring systemic AI, in order to ensure that the outputs are meaningfully aligned to systemic intentions.

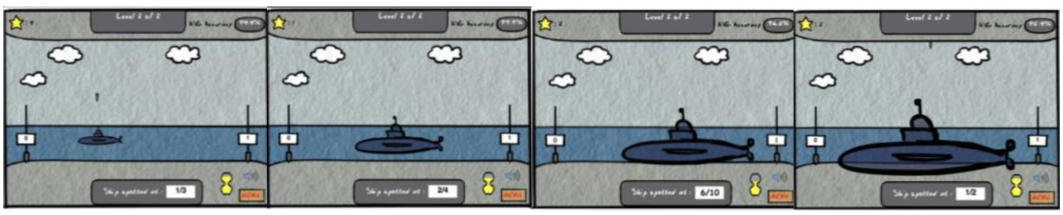

Fig. 9: Several of the game design variations of *Battleship Numberline*

In the first experiment [0], 10,832 players were randomly assigned to 3 different algorithms, each testing 6 different design factors (2x3: target type and target size). This experiment demonstrated that all the algorithms automatically produced design variations, which were more optimal for engagement. However, in a follow-up experiment with 5,849 players, we included some “ridiculously bad” designs. Surprisingly, some of these designs (such as the one with the enormous submarine, above) performed the best. As this resulted in the majority of users receiving the designs, we started to receive phone calls about bugs in the game. We had to explain that it was not a bug — we were just optimizing regarding whatever students were playing the most. It was not that the algorithm failed, rather the metric of success (total trials played) failed — it was not aligned to our “actual” goals of supporting student learning. This example of the runaway algorithm shows the importance of choosing the right overall evaluation criterion (metric for success) for optimization. We might have, for instance, jointly optimized, both for student accuracy in their responses as well as total trials played. However, we wish to make the point that this isn’t merely a matter of choosing better metrics but having a regular and rapid human response to whatever metrics are chosen.

Reflections

The key insight from this case study is the importance of keeping "humans in the loop." Automated optimization is powerful but dangerous. How might we provide a feedback loop about the suitability of success metrics? While we had provided a user experience (UX) to show the performance metrics of different conditions, it was not enough. What we missing was insight into the actual user experience of the designs (i.e., screenshot or links to the different variations). Holistic human judgement would only have been possible by connecting the qualitative experience of the designs and the quantitative metrics.

In addition to UX for system monitoring, data-informed system design needs to attend to ongoing organizational processes for continuing data analysis. It is critical to maintain an alignment between success metrics and the "actual" strategic goals/values underlying success metrics. On the one hand, we accepted a key performance indicator (KPI)_ that was insufficient — we wanted learning, but it was hard to measure; so, we accepted a measure of engagement as a leading indicator. However, we also had *implicit* goals (such as, aesthetic appeal) that would have been violated, when we saw that the submarine was starting to become so large. These implicit intentions only became noticeable while experiencing that version of the game wherein the intentions were violated. We therefore suggest that evaluating metric-goal alignment requires holistic humanistic judgement.

Discussion

These two case studies contribute to our evolving perspective on AI, data-driven design and now "data-informed system design." Our first case study shows the potential for incremental, data-driven design to address complex social problems, but reveals the severe limitations of data, in the absence of organizational processes to respond to data. Our second case study shows the power of fully-automated optimization, reveals the danger of optimizing for the wrong metric, and suggests the need for maintaining a human-in-the-loop for achieving alignment between goals and metrics. By avoiding a blind adherence to quantitative improvement through continuous dialogue with qualitative, humanistic experience, Data-Informed System Design may provide a "second-order" learning loop, which in turn will help avoid the dangerous limitations of a purely quantitative viewpoint.

From Data-Driven Design to Data-Informed Design in K12

K12 education is a large and complex sociotechnical system, with known systemic needs (such as the poverty achievement gap) and known measures of success (such as student assessment performance). As education is resistant to big reforms, there is a need for system-design perspectives that can support the incremental but continuous improvement of positive outcomes.

Data-Driven Design involves *developing* or *improving* a design, based on the measurement of outcome data, particularly indicators of success. For better and worse, data-driven design reduces complex and disputable notions of goal achievement into one or more quantified, numeric outcome measures or metrics. These metrics might emerge from human-generated ratings or rubrics. Alternatively, they might be generated from computational collection methods, such as website analytics or environmental sensors. In any case, it is important that outcome metrics closely align with organizational goals and values. Currently, many in the learning science community are exploring the use of data-driven design to improve K12 educational systems [0]. These "continuous-improvement systems" aim to align strategic goals, outcome metrics and human-computer system processes, for supporting improved learning outcomes. However, some approaches to data-driven instruction have triggered fierce opposition from educators [0], who are concerned about an over-emphasis on test scores, thereby resulting in misleading data and the dehumanization of teaching. These are fair critiques, which should be addressed in a nuanced manner.

If the danger of data-*driven* decisions is that they are inhumane, then one possibility is that decisions should be driven by more than the numbers. Data-*informed* systems semantically leave a place for holistic, qualitative viewpoints. Qualitative insights can help address one of the biggest risks of a quantitative design, namely, a situation wherein the measured outcomes (metrics) do not actually align with the goal, purpose or value of a system, which the metrics intend to measure. If raising students' test scores, for instance, will not actually help them become more successful, then what is the point of such a measure? Stakeholders always need to ask themselves: how well do outcome measures align with our shared intentions for the system?

Thus, we emphasize “data-informed” systems over “data-driven” systems [0,0], so that the opportunities for quantitative improvement do not suppress a more humanistic and holistic view of system design. Data-informed design is presented here in the context of system design, wherein we assume that the data is practically useful, only when functionally integrated into existing organizational systems.

Systemic Alignment as an Innovation Process

A basic heuristic for data-informed design is to ensure that the system is capable of measuring successful outcomes. For instance, **IF** the goal of product X is to develop student mastery on topic A, **THEN** collection of valid measures of student mastery on topic A must be ensured. By defining the data needed, product designers can ensure that their product design is able to collect that data. Subsequently, processes for maintaining systemic *alignment* may help prevent the gaming of quantitative metrics (see section below on Goodhart’s Law).

Systemic alignment involves the explicit documentation and alignment of organizational values, strategies, goals, outcomes and instrumented data metrics. For instance, designers may wish to document strategic goals, which do not have measures, or have measures not clearly connected with a strategic goal. They might try to understand whether successful cases are actually “holistically successful”, or just a numerical success. They might also follow the Goal-Signal-Metrics approach at Google [0].

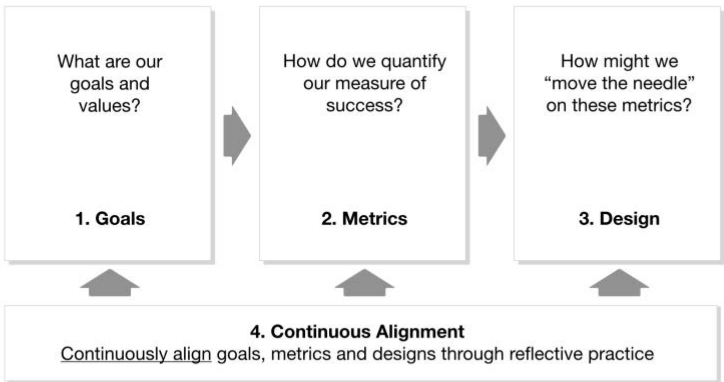

Fig. 10: Systemic alignment is a method for designing new systems to support data-driven design.

A key part of the alignment work is similar to the process of operationalization of constructs in psychological research, to the constructive alignment of learning objectives and assessments in education, and to the operationalization of values in design [0]. Specific measures of quality in the system can be collected through a specific instrumentation of data metrics. Yet, there is a need to explicitly document the alignment between instrumented metrics, the outcomes they are trying to measure, and the relationship between those outcomes and the “real objective.” Positive change in quantitative metrics should result in improved “meaningful outcomes”, which are to be holistically assessed.

When metrics are defined for the success of systemic processes, a system can evolve to make the improvement of the metrics as easy as possible. Designers need to make sure that this facilitation effect is not due to the corruption of systemic goals and processes that the metrics are designed to support. Designers should aim to develop an integrated viewpoint on system needs and opportunities, based on their holistic understanding of the system and the data it produces. System designers should anticipate the organizational barriers to investing in a continuous explicit alignment process, over time. In order to overcome these challenges, designers may wish to connect outcome improvements to specific economic metrics for demonstrating bottom-line value (i.e., to quantify the estimated economic impact of the improvements).

Towards Visionary Incrementalism

Design theorists Don Norman and PJ Stappers refer [0] to economist Charles Lindblom’s theory of large-scale change, which he calls “muddling through.” As large-scale plans are highly prone to failure in large and complex sociotechnical systems, making big plans and trying to execute them is somewhat irrational. Instead, Lindblom advocates for an incrementalist approach of small, continuous improvements. This is fully compatible with approaches [0,0] that drive change by setting a common *vision* for an organization’s future: when a future vision can be realized through an incremental strategy, we call this *Visionary Incrementalism*. For instance, visionary incrementalism may be appropriate when considering how design might address entrenched socio-economic disparities. Designers can play a role in developing and communicating vision, and in helping facilitate the instrumentation of incremental data-informed feedback loops that can help system stakeholders move towards a common and compelling vision, one small step at a time.

Limitations: What Can Go Wrong?

There are a number of important limitations in data-driven design and the use of quantitative measures to define value. When outcome metrics are established in complex systems, there is a tendency for the metrics to be "gamed", producing unintended consequences.

1. **Poor goals (misalignment with values):** Case study #1 is oriented around improving end-of-year test scores, but perhaps in high-poverty schools we should focus more on improving basic factors of student well-being.

2. **Poor metrics (misalignment with goals):** In Case study #2, we maximized the metric of voluntary time on task, but we actually wanted students to be learning fractions during their voluntary time. Measuring learning is much harder than measuring time, but we might have chosen a metric that jointly optimized time and student performance.

3. **Unspecified actions for responding to data:** In case study #1, we found that there is a lack of organizational processes to respond to product data.

4. **Limited incentive for improvement:** Case study #1 refers to the lack of financial incentive to improve educational products.

5. **Mis*leading* data (invalid data) and mis*reading* data (inappropriate analyses):** Much of the data available for data-driven design needs to be validated (e.g., formative assessment scores). Organizations that do not have a strong data culture may treat it inappropriately (e.g., treating the data as more valid than it might actually be) [0].

6. **Unintended consequences:** Accountability can create perverse incentives (e.g., schools encourage low-performing students to drop out or to cheat) [0].

Goodhart's Law

"When a measure becomes a target, it ceases to be a good measure" [0]. This is known as Goodhart's Law, and it represents an important limitation of data-driven design in education and other social systems. Since this law is becoming more well-known, a larger quote is provided below, in order to share the substance of his critique of education and then existing command economies.

"Achievement tests may well be valuable indicators of general school achievement under conditions of normal teaching aimed at general competence. But when test scores become the goal of the teaching process, they both lose their value as indicators of educational status and distort the educational process in undesirable ways… [such as] administering pretests in a way designed to make scores as low as possible so that larger gains will be shown on the post test, or limiting treatment to those scoring lowest on the pretest so that regression to the mean will provide apparent gains."

Goodhart then turns to discuss the *"harmful effects of setting quantitative industrial production goals* [in the USSR, which] *created dysfunctional distortions of production when used as the official goal in terms of which factory production was evaluated. If monetary value, then factories would tool up for and produce only one product to avoid the production interruptions of retooling. If weight, then factories would produce only their heaviest item (e.g., the largest nails in a nail factory). If number of items, then only their easiest item to produce (e.g., the smallest nails). All these distortions led to overproduction of unneeded items and underproduction of much needed ones."*

Goodhart additionally provides his most resonant depiction of the dangers of metrics: the actual use of a "body bag count" to assess success in Vietnam. Goodhart suggests it is "the worship of a quantitative indicator" that causes these sorts of corruptions of intent (e.g., the intent to educate, to produce goods or to win a war).

In the end, Goodhart does not actually advocate against the use of quantitative metrics. Instead, he encourages his peers to "develop ways to avoid the problem". For instance, "the use of multiple indicators, all recognized as imperfect." Further, to avoid the subversion of a measure, he recommended that we "study the social processes through which corruption is being uncovered and try to design social systems that incorporate these features."

Caution about Continuous Improvement Loops

One such social process that can be easily corrupted is "single-loop" learning. Chris Argyris and Donald Schön originally presented the idea of single- and double-loop learning in organizations [0,0,0]. Data-driven continuous improvement loops, e.g., optimizing KPIs in a business, can be dangerous when they only involve a single loop of learning. To give an example, a single-loop learning thermostat will turn on the heat whenever the temperature in a room drops below 68 degrees. In contrast, a thermostat with double-loop learning will first investigate whether 68 degrees is an appropriate goal temperature (e.g., based on, for instance, the season and whether a person is home or on vacation) and, only then, set a goal temperature [0]. Case study 2 demonstrates the dangers of single loop learning, when it leads to blind optimization. For this reason, we recommend that complex sociotechnical systems always use double-loop learning to avoid the corruption of metrics and to promote broader organizational learning [0].

Evaluating System Outcomes: Towards a Humanistic Use of Data

Evaluating holistic alignment requires humanistic judgement. No computer program alone can replace the human social capacity for holistic evaluation. Only humans can sit around and ask: "Should *this* really be our goal?" But neither are computers necessary for systems to be metric-driven in a dehumanizing manner – as shown by the brutality of the body-bag count described by Goodhart. We need ways to ensure that humanistic values and human sensibilities can be in dialogue with our quantitative urge. Humanistic aspirations can be vague—certainly in comparison to the goal of improving a number—but they are an important check on whether goals are being met in an appropriate way. This becomes all the more important in case of computational systems of evaluation and automated optimization.

Humanistic control systems seem critical for overseeing automated system optimizations. Humans in the loop can help mitigate unintended consequences resulting from improving outcome metrics. As designers, we need to consider how to negotiate and balance the role of the qualitative and quantitative in system evaluations. Organizational processes should ideally create a dialogue for successfully negotiating metrics — the holistic values of the organization should be in alignment with their quantitative measures.

To support this, goals and vision also need alignment. Whereas goals need to be measurable, technical, reductive and specific, design visions should convey a quality of experience —they should be holistic, intuitive and usefully vague. The tension between these domains of reason and sense, of quantitative and qualitative, can be extraordinarily valuable when ensuring that human values are being met in earnest. If math scores are increasing but students are feeling alienated by their education, this something may be wrong in the alignment of goals, vision, values and metrics. Developing and sharing a vision can help ensure that data-informed feedback systems stay on track.

When designers consider both visionary experiences ("what will it feel like?") and goal-driven metrics ("what will move the needle on the metrics of success?"), mismatches can help inform revisions. This holistic reflection leans on both intuition and reason. Such a reflective process can help keep goals aligned to values, which is essential for ensuring that data feedback loops produce beneficial effects [0].

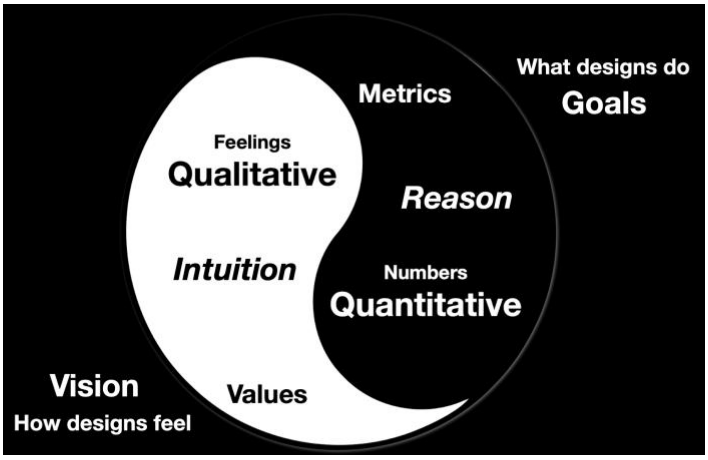

Fig. 11: Data-Informed System Design can benefit from the tension between goals and vision.

Conclusion

This paper contributes to a new perspective on intelligent system design. It describes the potential for data feedback loops in informing continuous system improvement. It reviews several benefits and limitations of data feedback loops in complex sociotechnical systems, such as the risk of an over-reliance on misaligned metrics. Smart systems involve the use of data to inform actions contributing to system success and wellbeing. Cybernetics offers a conceptual framework for a more graceful integration of artificial intelligence and systemic design.

This paper presents two case studies that illustrate the design of data feedback loops in educational systems. Our first case study walks through a potential approach to reducing the poverty achievement gap through incremental, data-informed design. Our second case study shows the power of fully-automated optimization and also reveals the danger of optimizing for the wrong metric.

These case studies show the potential benefits of data feedback loops in educational systems and also illustrate the challenges facing designers. The first case study shows how data alone is insufficient, in the absence of organizational actions to respond to the data. The second case study highlights the need for humanistic judgement to maintain alignment between goals (even implicit goals) and metrics.

Designers should play an important role in ensuring that system outcomes align with sustainable, humanistic values, which can often be expressed well in a design vision. Designers need to be prepared to define and negotiate meaningful metrics of success so that a system can measure the achievement of outcomes, to facilitate human-in-the-loop governance of AI systems, and to map existing system activity in order to understand where to best intervene.

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Appendix

Questions and Recommendations for Designers

The following questions and recommendations may help designers support intelligent data feedback loops and overall system integrity/alignment.

1. **Goals: What are we trying to accomplish?**
   a. Define product strategy in terms of specific values and goals. Additionally, consider articulating an emotionally compelling vision for success (e.g., using metaphor) that offers a more holistic complement to measurable goals.
   b. Define specific measures of goal achievement. Which needles are you trying to move?
   c. Explicitly align goals and measures to show how a particular measure relates to a particular goal and how particular goals relate to core values or the strategic purpose.
   d. Document and characterize other stakeholder needs.
2. **Metrics: How can we measure success in the system?**
   a. Use brainstorming techniques to identify signals (observable behaviors or self-reported perceptions), which serve as indicators when a system is doing well and when there are unmet needs.
   b. Take stock of existing data, asking "what of this data might serve as a measure of system success or system need?"
   c. Document system instrumentation needs so that future data will adequately capture indicators of system success and needs.
   d. What tools, talent or resources are available for analyzing or making sense of system data? Is there a budget to support this?
   e. How might known system needs manifest in the data? How widespread are different needs?
   f. Identify key performance indicators (KPIs) of the system as a whole. What other metrics can serve as leading indicators of core performance?
   g. Which metric would be appropriate as an overall evaluation criteria metric for evaluating the effects of different conditions in a controlled experiment? (e.g., what would be the outcome criterion for A/B testing)
3. **Design: What can and should be done in response to data?**
   a. What would help "move the needle" on specific metrics of success?
   b. Brainstorm and develop potential helpful responses to specific needs.
   c. What are the affordances for action in the system? What *could* be done in response to data? Define the action space and leverage points.
   d. Which existing processes are already in place, which are well-positioned to respond to data?
   e. Are there opportunities to automate processes, in order to make data access faster, broader, or more compelling?
   f. Brainstorm potential actions that would serve as responses to different data scenarios.
   g. Continuous Alignment: "Humans-in-the-Loop"
   h. Ensure regular organizational meetings to review system data and metrics and their alignment to values/goals/strategy.

i. Identify the parts of the system or organization that would be well-positioned to respond to success metrics.
j. Identify potential risks of misaligned values/goals/metrics.

Table 2: Example of Metric-Goals-Strategy alignment chart to support Alignment-Driven Design in a training program for a Digital Curricula

Strategic Objectives	Operational Goals	Outcome Metrics
Successfully transition from paper to digital	"Increase digital platform usage"	• Percent of days average teacher uses platform • % of total teachers accessing platform
	"increase teacher confidence in using digital curriculum"	• Difference between pre-training survey and 3 month follow-up survey to teachers "how confident are you in using digital curriculum"
Enable continuous improvement of curriculum efficacy	Implement measures of curriculum efficacy	• % of instructional resources with post-tests to check mastery
Support data-driven instruction in the classroom	"Increase teacher use of student data"	• % of teachers accessing data tab in digital platform

Designing against oppression

A conceptual framework for an anti-oppressive design praxis

Jessica Meharry and Hillary Carey

Design is often complicit in upholding inequitable structures, allowing bias and oppression to go unchallenged. While there has been substantial progress in challenging the agnostic orientations of design, many still ask, “How do I apply this to my work as a professional?” We seek to address this gap by offering a systematic description of five activity nodes that can inform and transform design practice. This paper connects critical theories to professional design practice by offering a framework for anti-oppressive design praxis. The resulting conceptual model—a scaffolding for bringing a critical awareness of power into design methods—can support designers to take action in their daily design work.

Keywords: design justice, design theory, equity, systems design, political economy

Introduction

Professional design practice has attempted to position itself as well-suited to contribute to wicked problems, which are challenges that are ill-formulated and involve multiple stakeholders with conflicting interests (Rittel & Webber, 1973; Buchanan, 1992; Dust & Prokopoff, 2009). Yet despite these proclamations, most commercial design practice functions with a market focus that is subservient to client interests and profits. Forlano (2017) states that the field of design is "commonly beholden to neoliberal, capitalist economic models that define the individual subject, primarily as a consumer with the power to make choices, but whose agency and participation in communal modes of resistance, and power to counter corporations and governments, has been weakened” (p. 17-18). Inequities, bias, prejudice, and discrimination are all parts of this ongoing cycle, the effects of which can be seen in the unequal impacts of climate change, resource depletion, globalization, nationalism, neoliberal capitalism, automation, deregulation, and global health crises.

Design thinking has not prevented ongoing bias and exclusion in designed products and services, such as the gendered size of smartphones designed for male hands (Criado-Perez, 2019), use of racist imagery in countless advertisements and product instructions (Ly, 2018), and the ongoing creation of inaccessible public space (Otterman, 2019). While there are many factors that lead to biased design, a key is whether systemic and social context are part of design methodologies. We must move beyond traditional “human-centered” practices for design to contribute to actual problem-solving rather than product and service-selling. Systemic design approaches offer tools to provide context, scale, and scope; however, many still lack the specificity of engagement needed to address systemic oppression and injustice. Design’s professional practice still lacks methods and effective means of engagement with issues of oppression and inequity. Because problems like oppression must be understood as part of complex, emergent systems, designing must acknowledge participation in the perpetuation of systemic inequity in new technologies.

In this paper, we offer a way to fill this gap by incorporating social justice approaches and a political economy lens to develop actionable methods for professional designers. Design researchers are arguing for explicit engagement with social justice as a means to avoid reinforcing the inequities of the status quo through the development of emerging technologies (Dombrowski et al., 2016). “Social justice might best be understood not as a single concept, but as a constantly evolving mechanism for thinking through how power, privilege, and access affect social structures” (p. 657). In order to counter systemic oppression and its effects, we must recognize inequitable patterns and develop “intentional action to interrupt inequity and create more democratic processes and systems supported by multi-ethnic, multi-cultural, multi-lingual alliances and partnerships” (National Equity Project, n.d.). With these intentions, the design justice movement (Design Justice Network, n.d.) has built energy and engagement around intersectional difference, creating manifestos and principles that begin to hold design accountable for the "material consequences" of the work.

This paper contributes to the efforts to explore how to put these intentions into practice by offering a conceptual framework for anti-oppressive design praxis—a scaffolding for design methods rooted in a social justice orientation that views systems through a political economy lens.

Current context

Mainstream design methodologies don't name power, bias, or oppression (Aye, 2017; Ortiz Guzman, 2017). Designers are not trained to question their own subject positions and agency within the design process, eliminating a key piece of critical contextual understanding (Kimbell, 2011). In addition, human-centered design's focus on the individual encourages a lack of systemic context (Tonkinwise, 2014, Forlano, 2016). Systems design and Transition Design offer many tools to provide context, scale, and scope; however, they still lack the specificity of engagement needed to address systemic oppression and injustice. Even communities of practice that intentionally engage with societal-scale issues, such as design for social innovation, face the same challenges. As Williams (2019) states, "Social design carries with it many assumptions from design's commercial formations. Among the most powerful and problematic of these is the focus on individualism rather than complex systems like white supremacy and racism" (p. 8). This veil of decontextualized neutrality also masks implicit and tacit power structures embedded in almost all design methodologies.

However, designers operating from standpoints grounded in theories from feminism (Bardzell, 2010), social justice (Dombrowski et al., 2016), ecology (Boehnert, 2018), and critical race studies (Ortiz Guzman, 2017; Ogbonnaya-Ogburu et al., 2020) offer orientations and strategies for designing for more equitable outcomes. Weaving many of these theories together, the design justice movement seeks to tackle intersectional forms of oppression, understanding how design contributes to a societal 'matrix of domination' (Collins (2002) as quoted in Costanza-Chock, 2020). There is excitement around these emerging theories of justice-oriented design, but also confusion about how to apply such conceptual frameworks to professional practice. We believe that the concept of political economy allows for ways to make these social justice ideas tangible.

Political economy

This paper proposes a flexible framework of activities to help connect theory to practice through the lens of power. To develop this, the concept of political economy can be utilized to understand "the social relations, particularly the power relations, that mutually constitute the production, distribution, and consumption of resources" (Mosco, 2009, p. 24). Political economy perspectives analyze the values and priorities that drive behaviors and practices within a system (Boehnert, 2018). This approach also allows for more specificity and intentionality than the more neutrally-oriented "system dynamics" of systems design.

As technology researchers Ekbia and Nardi (2016) propose, political economy's ability to deal with issues of social inequality can offer useful practical and conceptual resources for design and human-computer interaction. Political economy offers a way to move past the dominant paradigm of user-centered design and "needs" in order to more effectively engage with issues of social inequality by making connections to larger concepts and complex systemic problems. Actions of historicizing, contextualizing, and politicizing design action allow us to understand systemic context and actually apply ethics, making ethical stances actionable and tangible (Ekbia & Nardi, 2016).

Research approach

Positionality

In the spirit of feminist collaboration, we offer this framework as co-authors. We come together because of our shared interest in anti-racist design methods and practices. We write from our experiences balancing academia and applied practice, sharing theories of change aligned with bell hooks' statement that theory and practice must be intertwined. In this way, this paper seeks to make critical theory more accessible to professionals.

Based on primary and secondary research (literature review, interviews with professional designers, and exploratory workshops), the first author developed this framework for her dissertation research and is currently testing it through a series of workshops with professional designers. The second author helped to frame the overall argument and theoretical context. We recognize the tensions that may arise when conducting research around race and inequality, and our positionality guides our way of knowing and experiencing our world and the decisions we make as researchers (Milner, 2007). Positionality is relational, dependent on a situated context in which we may have power over another (Friedman, 1995). Both authors, as white, cis-gendered, college-educated designers work to challenge the narrow perspectives on power and oppression we held before deliberately pursuing anti-racist world views.

Research Objective

The hypothesis that follows is that in order to disrupt design's complicity in upholding systemic oppression, designers need to explicitly name and engage with intersectional forms of oppression and the systemic forces that contribute to inequitable outcomes. Using the language of inclusion without attempting to change the drivers of exclusion will continue to affirm and strengthen existing power structures (Benjamin, 2019). A political economy foundation will allow for an investigation of power through design methodologies that professional designers can incorporate into their existing practices.

The research questions that guided the development of this framework include:

- How might we use a justice lens to expand existing design methods to include systemic oppression?
- How might this expansion lead to more consideration of ethics and bias in design methodologies (and eventually more equitable outcomes of design processes and practices)?
- What would happen if, rather than needs and desires, we focus on: control, agency, and power (as a means to understand social justice issues of transparency, autonomy, accessibility, etc.)?

Criteria for the model

The following criteria guided the selection of concepts in this framework:

- *Relevant:* The theories that inform this framework need to be understood through the point of view of design so that they can become translated to professional design methods.
- *Tangible:* This framework is intended for designers who seek to engage with these ideas in their work; however, the terms and discourses should be pitched to a level of rhetorical resolution that is accessible to most professional designers. The terms should be easily translated to tangible action.
- *Adaptable:* The framework should allow for adaptability to an existing designer's practice. It is not a step-by-step methodology but a kind of scaffolding or armature that can be incorporated into existing design processes. The designer can access any portion or all of the framework at any time.
- *Nonhierarchical:* There is no priority for any one element in the framework. Ideally, all elements must be considered and addressed . This may or may not be possible depending on the constraints of a particular project.

Modelling Anti-Oppression Praxis

Based on this theoretical grounding, we offer a conceptual framework for an anti-oppression praxis (Fig. 1). This theoretical framework is the first step in building a personal anti-oppressive design toolbox. There is no one set of methods or frameworks that will work for every context, for every designer. So instead, we offer a set of provocations that can shape the way designers construct and orient their own practices toward fighting oppression and challenging assumptions built into existing design methodologies and client relationships. The depiction of each activity node as related to, and interconnected with, the others represents the adaptable and nonhierarchical nature of the framework. In any given project, a designer might use three critical engagements across different nodes, constellating a unique set of anti-oppressive actions.

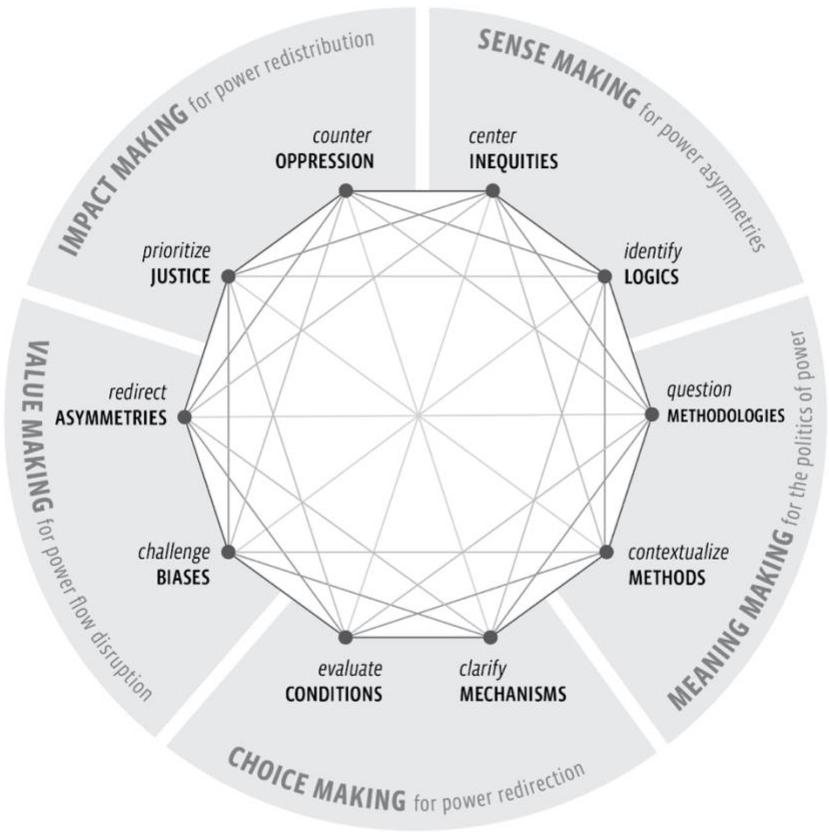

Figure 1. Anti-oppressive praxis with five activity nodes. Illustration: Jessica Meharry

Depending on when the designer becomes involved with a project, they may or may not be able to challenge certain problem framings. Therefore, this framework is constructed around the activities of design which occur throughout the design process: sense making, meaning making, and choice making. In addition, the activities of value making and impact making emphasize design as a political act (Fry, 2011). We then offer a selection of actions that could be engaged within these activities, all of which are focused on shifting understanding and shaping of power relations. This list of suggestions is by no means exhaustive. We have chosen areas that are emphasized in the design justice and political economy research but still lack methods to engage with those areas in professional practice. The rest of this paper will define each of the five activity nodes and ten critical engagements.

Example brief

To illustrate how this framework might be applied to a design project, we will use an example of an existing design project for an internationally renowned design consultancy: *A Holistic, Human-Centered Approach to Managing Diabetes Care* (IDEO, 2020). Following is a simplified design brief for this fairly typical client project, reverse-engineered from the consultancy's website:

- Client: Global healthcare company, a leader in diabetes treatment for over 70 years, known primarily for producing blood glucose meters
- Client's goal: move the company beyond physical devices

- HMW question: How might we move our company beyond physical devices with a first-of-its-kind approach to educating and monitoring diabetes patients?
- Audience: people with diabetes
- Context: 30 million Americans have diabetes
    - The vast majority of these diagnoses are type 2, which is commonly treated through a combination of medicine, diet, and exercise.
    - One of the major barriers to better outcomes is access to trusted information.
    - As little as 15% of people with diabetes receive adequate education from their healthcare providers on managing their disease and making recommended lifestyle changes.
- Stated project outcome: "An end-to-end program that helped people with type 2 diabetes live healthier, happier lives through the power of habit"
- Design firm problem/solution: "Create a comprehensive diabetes management system for the digital age"

In the detailed framework descriptions to follow, we offer a description of each activity node, an example of how the node relates to the example design brief with possible methods that could be used to explore the node, and questions to provoke critical reflection.

SENSE making: Develop an orientation toward power asymmetries

During sensemaking activities of a given design context, designers can develop an orientation toward power asymmetries that can become embedded in the entire design process. To do this, designers could focus on centering inequities and identifying logics.

Center inequities

In order to address oppression and inequity, we must name the problem and engage with it (Constanza-Chock, 2020; Williams, 2018). Systemic views provide more information and context for wicked problems. We suggest an approach to systems thinking as a sociotechnical assemblage (Redström & Wiltse, 2019) that decenters the individual, expands what might usually be considered as social and material agents, and includes inequities as agents. Centering existing structural inequities can ensure that designers account for intersectional differences in accessibility and agency. By orienting to these inequities during the sensemaking process, a consideration of power asymmetries can drive subsequent meaning-making and problem-framing activities.

Identify logics

The tangible concept of logics can be a leverage point for understanding values and priorities through the concept of political economy. Logics are a means to understand how human and nonhuman actors at different levels of a system understand their role in the system and take actions. Institutional logics seeks to bridge the individual to the social system: "Institutional logic is defined as the 'socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values, and beliefs, by which individuals and organizations provide meaning to their daily activity, organize time and space, and reproduce their lives and experiences'" (Thornton et al., 2012, p. 2). Logics allow designers to develop a situated, sociomaterial perspective on design problems and solutions. By understanding logics and their effects, we develop a broader understanding of how oppression is embedded and enacted from macro to micro levels (Hultin & Mähring, 2014).

Example

In the IDEO example of designing a technology for users with diabetes, centering inequities in a system map would require designers to make the inequities as sociotechnical agents more visible. For example, a systems map could include agents such as “access to healthy food”, “long-term stress”, and “lack of insurance.” These agents could be placed beyond the usual stakeholder boundary and examined for how they might impact the traditional design problem space. (For an example of this type of mapping, see Meharry (2021)). Designers could experiment with different kinds of logics connecting agents in the system. If “income inequality” (a variable related to diabetes prevalence) is surfaced and visualized, we might generate alternative design solutions beyond expensive, elite technologies. Examining the logics of “empathy” might lead to questions about power relations between doctors and patients, resulting in more equitable communication strategies for patients.

Reflective questions

- What happens when we turn an inequity into an actor in the system--with agency to act? How does this change our understanding of accessibility, availability, and control (for the user)?
- Does centering inequities cause us to think about different kinds of users? How are inequities affected by these agents? How does that generate different problem framing and change the range of innovative solutions?
- How might new logics shift relationships? What are the many different kinds of logics that could create alternative understandings of context?

MEANING making: Take responsibility for how position determines power

During meaning-making activities, designers use methodologies to shape their understanding of the problem space. Design projects should begin by examining the positionality of the designer in the design methodologies (the collection of practices and procedures) and contextualizing the design methods (the individual tools and techniques within the methodology).

Question methodologies

Designers should routinely interrogate their methodologies for their ability to design against bias and oppression. The methodologies that a designer uses are embedded with a specific, situated set of orientations, assumptions, values, and methods. In general, most of the mainstream human-centered methodologies of professional design practice possess an illusion of neutrality that restricts a designer’s ability to consider the systemic context of oppression (Kimbell, 2011). Design thinking rubrics mask the role of designers as authors even as they are oriented towards the designers’ interests (Rosner, 2018). The positionality of the designer and client--their identities and worldviews--should be surfaced and transparent throughout.

Contextualize methods

Within design methodologies, methods and tools possess the potential for both bias and liberation. Anti-oppressive design necessitates working with existing methods but examining the “neutrality” we perceive in them and acknowledge the politics that are always present in their enactment. Designers might consider methods that are: intentionally anti-oppressive (anti-racist, anti-sexist, anti-ableist, etc. See Smyth & Dimond, 2014, Carey, 2020); user-driven vs. expert-driven (Dombrowski et al., 2016); co-created: and/or focused on system (rather than individual) influence and change (Redström & Wiltse, 2019).

Example

In the IDEO example, a human-centered design methodology was used. This methodology doesn’t account for reinvestigating the problem space the client presents. The HCD methodology allows assumptions about the positive value of new products, new technologies, profit-driven healthcare solutions to go unchallenged. The methods employed are likely to have kept designers in the expert role of deciding which information was valuable and whose voices would be heard in user research. These methods are unlikely to challenge the priorities of the corporate client and the healthcare system— instead focusing on individual interventions rather than disrupting unjust insurance practices.

Reflective questions

- In what ways does your personal position in the world reveal potential for bias? Who has not been considered?
- How might we challenge the "neutrality" of methodologies and methods used? What would it look like if you fully embraced the other nodes within your favorite methods?

CHOICE making: Lead with an intention to redirect power

Often overlooked are the actual actions and choices that designers make, the affordances they create, and the consequences of those actions. Designers are architects of choice; we shape the possibility of choice that is available to us and others. Design is an argumentative process that generates unavoidable trade-offs (Fischer, 2018). As Constanza-Chock (2020) states, "...designers constantly make choices about which users to privilege and which will have to do more work... the point is that these decisions need to be made explicit" (p. 55). These choice-making activities create affordances and disaffordances of design, all of which must be assessed for bias and impact.

Clarify mechanisms

Davis (2021) attempts to operationalize the concept of affordances so that it can function as an analytical tool for designers, technologists, and researchers. She outlines six *mechanisms* of affordance as well as three types of conditions in which those mechanisms become enacted. All of the mechanisms of affordance "are rooted in socio-structural dynamics. Humans design, build, and distribute technological objects and infrastructures. How these objects and infrastructures guide human behavior arises from and is situated within existing social systems." Davis' mechanisms of affordance are actions that determine the agency and power of the user: an affordance can request, demand, refuse, allow, encourage, or discourage action. The specificity of this breakdown offers more accessibility for designers and a means to clarify how design choices may affect flows of power and control for the user(s).

Evaluate conditions

In addition to the mechanisms of affordance, the second part of Davis' (2020) framework is the *conditions* of affordance. This level of operationalization provides space and discourse for the specific, situated context of affordances (Deterding, 2011). This prompts designers to ask, "How does this object afford action, and for whom does it afford it?" The conditions of affordance are: perception (the extent to which the user is aware of the affordance); dexterity (the capacity of a user to enact the functions of an object); and legitimacy (how the user's role in a larger cultural and institutional system determines their power and ability to engage with the object). Feminist Standpoint theory posits that people who are pushed to the margins of systems-- those who are seen as less legitimate--often become wiser to how these structures work than those who are privileged by it. They see the system more clearly because they "break" it (Wylie, 2013, Carey, 2021). These conditions are a tool with which to interrogate the contextual conditions that a given user may experience when engaging with a design.

Example

In the IDEO example, the design solution was an app that intends to help patients monitor their diabetes and live healthier lives. However, it remains unclear how much agency the user has over their interaction with the app and the information that it gathers from the user. By clarifying mechanisms of affordance, we might determine that an interface that is intended to encourage users to eat healthier foods is actually discouraging action from users who may have different cultural food preferences. Looking at the conditions of affordance might indicate that many of the target users do not have access to the app or are unable to use it in the way that the designers intended.

Reflective questions

- What kinds of actions are being requested, demanded, refused, allowed, encouraged, or discouraged? How could design choices and their related trade-offs be made more transparent?

- Are there certain identities or abilities that may find barriers in navigating the designed experiences?

VALUE making: Actively seek to disrupt power flows

As designers begin to iterate between problem framing and solution, biases are generated, maintained, and may go unexamined. These value-making activities begin to embed these biases within the system context of the design, leading to asymmetries of power. Designers can examine how these biases are intersectional and attributable to both human and nonhuman agents and interactions in the system.

Challenge biases

All designs are created with some intention and intended user (Benjamin, 2019). Within sociotechnical development, we recognize that “technology is never neutral but always already embedded with certain biases, values, and assumptions” (Bucher, 2018, p. 35). Feminist design researchers offer us ways to interrogate the doctrines that may inform the design process and lead to biases and inequitable outcomes. These doctrines need to be examined for the principles, assumptions, and biases they regularly generate (Bardzell 2018, Pennington 2018, Wong-Villacres et al 2018). Rosner (2018) identifies some of these doctrines that become embedded in design processes, such as individualism (conceiving of users as a collection of independent individuals), objectivism (the illusion of neutrality embedded in mainstream professional design practices which masks the positionality of the designer and their role and power as authors), universalism (imagining all users as the same), and solutionism (believing that all problems can be solved with a design, often a technical design). In addition to these doctrines, we can think about other kinds of bias generated by these doctrines, including assumption, classification, correlation, decontextualization, depoliticization, privatization, and racialization (Benjamin, 2018; Williams, 2019).

Redirect asymmetries

The lens of political economy provides tools for an examination of asymmetries within a design problem space. Designers can begin to identify consequences and impacts of design action (as well as the actions of other agents) through an examination of asymmetries at all levels within the system, from individual to institutional. More specifically connected to justice and oppression, this is an analysis of asymmetries of knowledge, information, agency and power that may lead to inequitable outcomes (Ekbia and Nardi, 2016).

Example

Even with the sparse amount of information we have in the IDEO example, we can see that doctrines of individualism, objectivism, universalism, and solutionism are present. Most notably, the client’s solutionism demands that they develop a technical solution could be questioned. The clients’ business goals could be explored and reframed to see if there are non-technical solutions that might be more beneficial, accessible and inclusive for a broader range of diabetes patients. An examination of asymmetries could provoke questions about patients’ control over their own data which could be used against the patient’s own interests in some future scenario.

Reflective questions

- What doctrines and biases present in a given context? How might they be challenged and designed against?

- How do knowledge, information, agency, and power flow in your system? How might redirecting asymmetries generate more equitable power flows?

IMPACT making: Determine accountability for power distribution

When assessing the impact and accountability of our designs, we might ultimately focus on justice and oppression. These impact-making activities of design can provide a larger, systemic view of how designers might orient towards justice and anti-oppression— through interpersonal relationships, single projects, firm processes and practices, and client relationships.

Prioritize justice

While the concept of justice or social justice may be too broad to facilitate direct action within a design context, there are qualities or attributes of justice that are more accessible and tangible. Synthesized from a range of justice theorists (Benhabib, 1992; Young, 2013; Dombrowski et al., 2016, Constanza-Chock, 2020), these qualities include: accessibility, accountability, affordability, agency, autonomy, distribution, eligibility, empowerment, enablement, equality, inclusivity, liberty, mutuality, opportunity, privacy, reciprocity, recognition, reparation, responsibility, sustainability, transparency, trust, and well-being. Evaluating designs through these lenses can help explicitly identify and redirect potential areas for bias and inequity.

Counter oppression

An anti-oppressive design praxis seeks to challenge and actively counter oppression. As Dombrowski et al. (2016) state, these multi-level efforts focus on a range of opportunities for change, from scaffolding individual behavior change to structural change in practices and policies. They continue, “For design, enablement might be understood in terms of fostering human capacity or helping people take advantage of opportunities by creating platforms for participation and self-determination." (Dombrowski et al., 2016, p. 663). Constanza-Chock (2020) states that “a design justice approach invites us to reconfigure everything from human computer interfaces to the built environment in ways that will more equitably distribute affordances and disaffordances” (p. 222). Explore how design activities from the micro to macro level can actively work to extend opportunity and remove barriers.

Example

Using the IDEO example, employing justice lenses within any given method might surface the issues around accessibility (How functional is the app for users of differing abilities?), affordability (How is this information accessible to an audience that is high-percentage lower income?), agency (How does the user make the app more personalized for their own cultural identity?), privacy (How much control does the user have over their own data?), reparation (What does the user do when the app isn’t working or doesn’t serve their needs?), transparency (How does the user know who and what is asking for this information?). Examining these qualities can help identify potential for inequity and empowerment.

Reflective questions

- How could our design solutions lead to a more equitable distribution of (the qualities of) justice?
- How might we approach the design problem with an intentionally counter-oppressive approach?
- Would focusing on the needs/desires of the group/collective change how we frame problems? Might it generate possibilities for new connections and alliances?

Discussion

Limitations

This framework is the result of the first author's individual, situated act of translation from theory to practice. It is one interpretation among many possible interpretations. The framework is not intended to be fixed. Many other ideas and arrangements could be added to it (which we encourage others to do). Future empirical investigation is needed to explore the salience of the discourse and further develop actionable methods.

We acknowledge that this framework is one of many simultaneous actions that individuals and organizations need to undertake in order to confront interpersonal, institutional, and structural oppression. Simultaneous efforts need to be made in a range of activities including diverse hiring (Boehnert & Onafuwa, 2016), effective implicit bias training (National Equity Project), and building racial fluency (Daniels et al., 2019). When Ekbia and Nardi (2016) refer to the "socioeconomic drivers of change in the relationship between humans and machines", we recognize that this change works both ways, the humans act on the machines and the machines act on the humans. The interaction creates new interactions, relationships, imbrications, and impacts. We also recognize that the current research approach is etic, and future research will include emic knowledge and interpretations.

Challenges and obstacles

There are limits to how professional designers can use an anti-oppression praxis within capitalist market contexts. Many design researchers question the ability for incremental improvements to change livelihoods "as we remain in thrall of a larger exploitative system" (Ogbonnaya-Ogburu et al., 2020, p. 9). While we acknowledge the need for radical, systemic change, we also seek to offer tools for professional designers who are engaged in these issues who may not have the ability to work outside a capitalist context.

Conclusion

We present this model with an understanding that designers are rarely the only decision-makers involved in a project. But if we are truly going to advocate for "better" designs in the world, we believe that the ideas we fight for should reflect a sense of justice and equity. We feel that the practice of design is just not yet well-equipped to make strong arguments for critical perspectives in many of the spaces we influence. The lack of context and awareness of systemic oppression is a serious gap in design-led innovation that limits its ability to engage with the wicked problem of oppression. Social justice and political economy theories can bridge the gap between ethics and application by informing anti-oppressive work and contributing to theoretical innovations for design practice. Our work here, and ongoing, attempts to make the ambitions of critical and justice-centered theories more accessible and applicable to everyday work.

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Track 8:

Sensing Momentum In System Dynamics

Chair: Palak Dudani

From system to local to system

Design principles to scale for a system in transition

De Lille, C.S.H. & Overdiek, A.

Societal transitions require activities of multiple stakeholders on different systemic levels. Designers and design researchers are often involved in supporting specific interventions and sometimes in enabling and facilitating entire processes. Practices and literature in 'co-creation ecosystems' are a developing field for them to discuss differences and relatedness of micro-, meso- and macro perspectives. Using the case of a three-year multi-stakeholder co-creation project in the retail industry, the paper analyses processes and principles for making impact in design-led transition projects. A transition process with three phases is constructed and four principles for making impact at the various levels were found. Comparing findings with the UK Design Council's 'Systemic Design Framework', the paper suggests process adaptations to scale between the local and the sector/national level. It also contributes to a better understanding of systemic design principles like Leadership, Storytelling and Systems Thinking.

Keywords: living lab, systemic design framework, design principles, co-creation ecosystem, transitions

Introduction – Setting the scene

Transitions in society like the one towards energy-neutrality, to a more regenerative economy or to waste-free production-consumption systems all require activities of multiple stakeholders and on different systemic levels. Designers and design researchers are often involved in supporting specific interventions and sometimes in enabling and facilitating entire processes, from the reframing of an opportunity to the embedding of solutions in existing structures. Thereby innovating and transitioning these very structures. Mostly, local interventions take place in living labs, whereas more systemic interventions target new networks at the policy level (Deserti, Rizzo, and Smallman, 2020). Practices and literature in 'co-creation ecosystems' are a developing field for discussing differences and relatedness of micro-, meso- and macro perspectives (Eckhardt et al., 2021) and identifying stage-related (Kalinauskaite et al., 2021) or overarching (Van der Bijl-Brouwer and Malcolm, 2020) design principles. The challenge of scaling local experiments to the systemic level and connecting microscopic and macroscopic perspectives of stakeholders and users is huge, but also creates tensions which can be productive for finding new design principles to scale for systems in transition.

To propose and discuss design principles for scaling between the local and the systemic level, and hereby add particularly to the understanding of meso level activities in transitions, is the goal of this paper. This paper is a follow up on previous work on systemic design-led interventions in multiple industries such as manufacturing (with servitising transitions), aviation industry (with a disrupting innovation focus and sustainability) and textile industry (new production and digitization). This case brings the learning lessons of previous work towards a three-year design-led research project in the retail industry with a focus on digital and circular transitions. The project aimed at activating small independent retailers to develop capacities for a transition to smarter, more sustainable business models and to collective modes of learning and co-developing regenerative city centres. As designers and design researchers, we facilitated and strengthened emergent properties of these innovation networks, locally and on the national level. To understand how we scaled between the local and the systemic, we used our own research reports, the documentation of stakeholder meetings, the archive with physical artefacts (house style, banners, scenario's, presentations) and media publications about the project as data. We analysed by plotting themes emerging from this data on the project's timeline, revealing principles and their situatedness in the process.

To generalize the findings of this single and contextual case, we relate results to the 'Systemic Design Framework' of the UK Design Council (2021). This framework is the first evidence-based publication to distinguish and visualize comprehensive phases related to design principles for systemic transition processes. In comparison, we identify a key overlooked phase: that of scaling in a system in transition. We are currently in the process of applying the findings of this study in the context of four living labs in circular economy, to further investigate the potential of our model for other contexts.

Case description

Future-Proof Retail (FPR) was a national design-led research program in The Netherlands with more than 50 partners, conducted between May 2018 and December 2020. The consortium for this project started to form in 2017 as part of an initiative facilitated by the Dutch Ministry of Economic Affairs and Climate Policy, called Retail Agenda. Due to digitalization, changed consumer behaviour and unsustainable business models the retail industry is in trouble. Multiple stakeholders from retail branch organizations, municipalities, knowledge institutions, real estate providers and big and small retailers realized that industry changes constitute a complex problem as their ramifications like the decline in small retailing also affect the social fabric of city centres. However, branch organizations which were fragmented, representing different system stakeholders (big supermarkets, small independent retailers, food or fashion retail) and big real estate providers competed for solutions to the problem. At the same time, branch organizations particularly geared to small retailers in trouble reported that they could not reach their constituents with their learning and innovation initiatives. Some innovative municipalities like those of The Hague and Roermond had already experimented with local living labs in shopping streets to overcome this hurdle and try to involve the users of the proposed solutions, small independent retailers and their employees.

Living Labs are defined as "physical regions or virtual realities where stakeholders form public-private-people partnerships (4Ps) of firms, public agencies, universities, institutes, and users all collaborating for creation, prototyping, validating, and testing of new technologies, services, products and systems in real-life contexts" (Westerlund and Leminen 2011: 20; see also Hossain, Leminen and Westerlund. 2019). Our local retail labs focused on the real-life environment, the involvement of multiple stakeholders and co-creation with users, in this case SME retailer and their employees. A design research group from The Hague University of Applied Sciences, in collaboration with two municipalities and divers retail branch organizations, took the initiative and rallied seven other regional Universities of Applied Sciences to head up a design-led research across what became 22 local living labs. The labs co-created and tested activities to initiate and sustain transitions in shopping streets. One lab for example selected and brought affordable technology to the shops and organized experiments together with citizens. Another lab declared a shopping street as a 'circular district' and developed and tested more sustainable business operations. The overall FPR project was set up as a national program of a network of these local living labs with a decentralized governance structure working directly with small retailers to engage them as users and co-create solutions like learning tools and business model innovations, helped by new technologies. 'How can we successfully engage small retailers in living labs?', and 'How can we enable the labs, as well as co-creation and learning in the labs with materials and tools?' were the initial research questions. In May 2018 the project received a two-year funding by the industry's foundation, Stichting Detailhandelsfonds.

After two years, 14 municipalities and 500 retailers had participated in the program. Involved branch organizations and municipalities were enthusiast about the activation for transition the program had achieved and funded it for another year, in order to reflect on and embed transitions with national system players. In the meantime, the 'problem' framing and subsequent research question had evolved to: how can we embed the new co-creation ecosystem in the existing structures? Participating researchers, technology providers, municipalities and students all worked design-led. This means that research was organized around collectively found opportunities for change. Possible solutions were prototyped and tested during subsequent lab activity periods and then shared with other labs. Six living lab 'formats' were co-designed by researchers and system stakeholders to address specific business, social and skills challenges small retailers and employees in retail are facing. Local stakeholders followed the basic principles of these designs, for example introducing affordable technology and experimenting together with employees, but further contextualized activities to local needs and wishes. Eight more labs joined the network in 2019/2020 to test the developed lab formats in other municipalities. In order to combine the various domains of knowledge and methodology, design researchers collaborated with colleagues from the field of social sciences (sociology, education, business). All in all, sixteen researchers were involved and an insights report was released as a trade publication (Overdiek and Geerts, 2020).

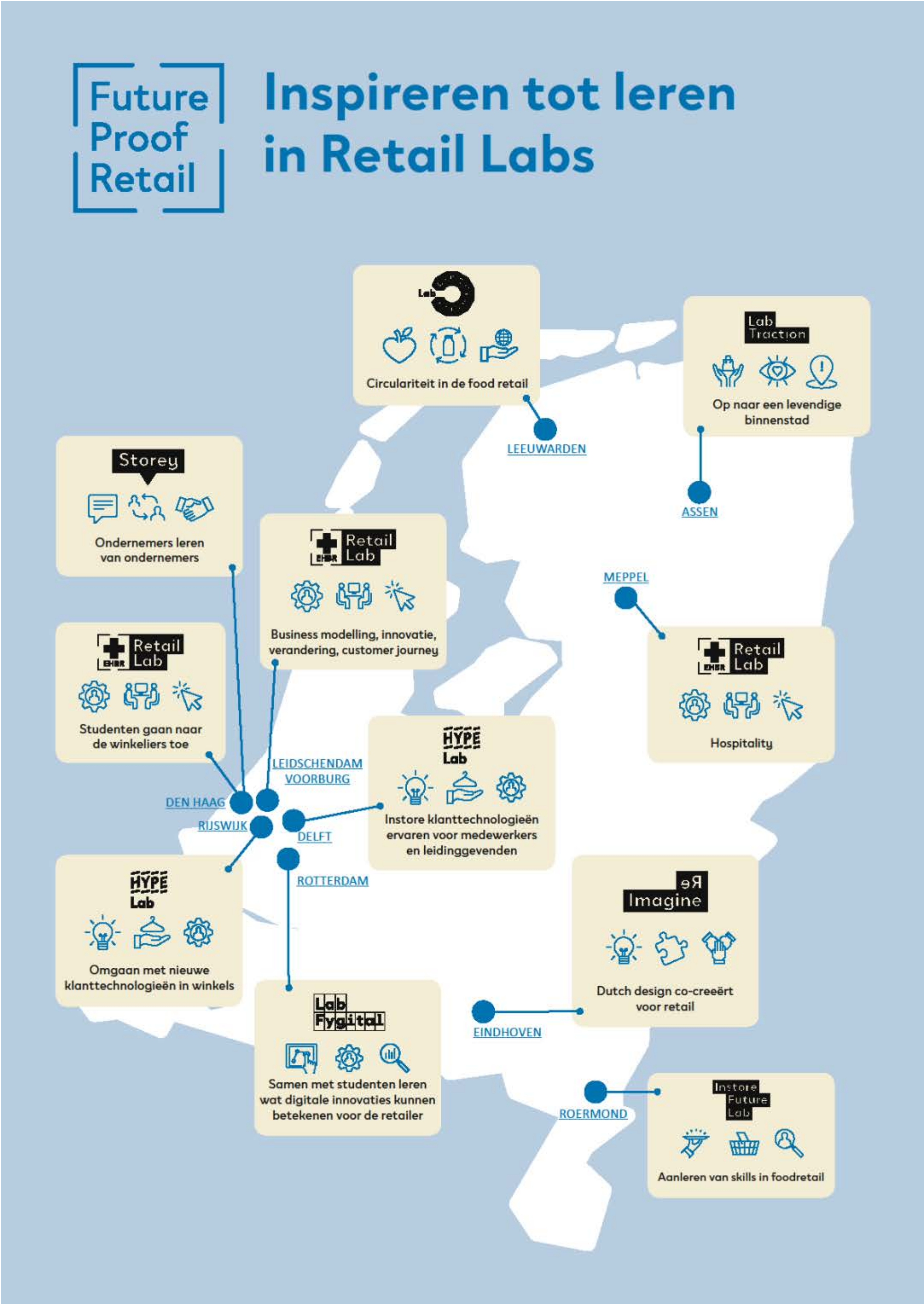

Figure 1. Distribution of the first 11 local Future-Proof Retail labs across the Netherlands

After the conclusion of the FPR program in January 2021, another four local labs have already been organized on regional initiative, 10 more are in planning. Instead of the research groups, local retail advisors together with municipalities and retailers' collaborations are in the lead now. Branch organizations, the national platform of retail researchers and the national council of retail educational programs in higher education are all disseminating knowledge and tools from FPR and supporting the local labs.

From system, to local to system: a model

The approach undertaken in this case was not new. In designing the program approach, experiences were used from earlier work in the manufacturing (De Lille, Stappers and van der Lugt, 2009), textile (Ten Bhömer et al., 2013) and aviation industry (Price, De Lille and Bergema, 2019). The last one resulted in a preliminary model supporting designers to scale within a system. Using the FPR case, this model was further detailed as this program had been able to gain even more impact on the system.

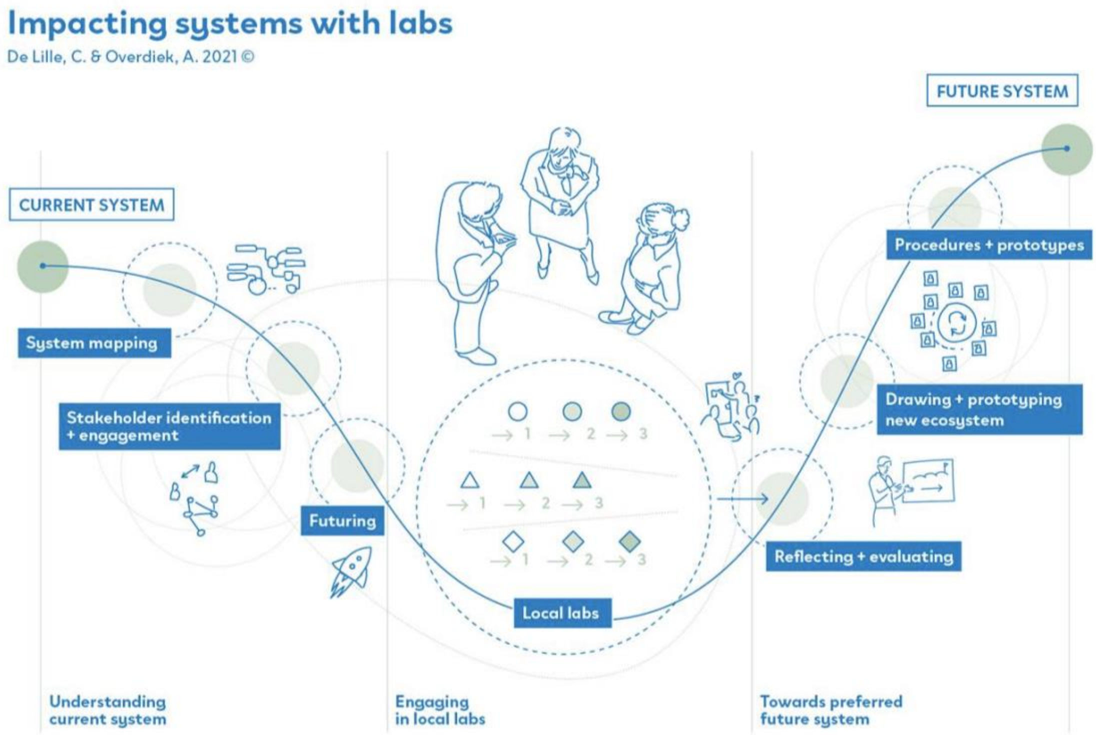

Figure 2. Impacting systems model based on Future-Proof Retail, De Lille and Overdiek, 2021.

This model (figure 2) was developed using the learning lessons from Future-Proof Retail. We found that we had been co-creating in three distinct phases (time on x-axes) between the local and the national systemic level (y-axes): mapping and understanding the current system, engaging and experimenting in local labs where knowledge was made actionable, which led to prototyping, testing and embedding a preferred future system. These phases enable and support to work towards a preferred future, as opposed to a potential of probable future (Dator, 2019) for in our case the retailers, their employees and customers, and the concerned municipalities.

The first phase 'understanding current system' allowed for identifying key stakeholders in the system. Who needs to be on board to make change happen? In this case the branch associations, key municipalities, as well as members of the National Retail Agenda (from the Ministry of Economic Affairs and Climate Policy) were involved and took place in an advisory board where a shared understanding was co-created and strategic decisions were jointly taken. With these stakeholders the main leverage points (Meadows, 1999) were explored and became actionable in the second phase with the local labs.

The second phase 'engaging in local labs' focused on working on primary leverage points in local settings with local stakeholders. These labs enabled us and many small retailers to experience and test new ways of collaborating with each other and technology to help the retail industry to deal with various transitions (such as a more sustainable business model or dealing with technology). In the first phase six potential lab formats (themes, co-creation activities) were identified, each addressing another transition. Out of these six, three proved relevant and impactful, as evaluated by all local partners involved. These three local lab formats were further scaled in the retail industry in the third phase. The third phase 'towards preferred future system' focused on scaling the learning lessons of the previous phases wider in the industry. What started initially with six local labs, ended in 22 lab iterations nation-wide. The project has currently ended, but in this last phase, we were able to make ourselves obsolete. The various stakeholders were supported to take over activities and continue by themselves. The learning lessons have been embedded within the practice of branch associations, municipalities and policy of regional and national governments.

The primary purpose of this model is to offer structure and support for those involved. While at the same time it allows room for adaption to the context of the system, especially when it comes to the second phase where creating and experiencing change in a real-life environment is key. The formats of the local labs are highly depending on prior experiences and existing habits of stakeholders in the context. In this case, shops and shopping centres were the place for local experiments in the form of temporary labs. In other cases (such as in the aviation industry, prior to this case), the local labs had a more permanent nature. Regarding lab co-creation activities, design practices (Calabretta et al., 2016) were central in this approach, such as envisioning, structuring, visualising, aligning, etc.. In the next paragraph we will further expand on the design principles used throughout the case.

Preliminary design principles for impact

Design practices have a central role in the activities undertaken in the above-described approach. Kimbell (2009) describes the nature of design practices, leading towards the distinction between design-as-practice and designs-in-practice. Kimbell endeavours in moving away from the individual's design expertise towards the use of design practices which are *in situ* and in their nature include multiple stakeholders. In designing the approach for the above-described project, several decisions provided the basis for all activities within the project. These decisions have greatly paid off in the achieved impact of the project. Therefore, these decisions might serve as preliminary design principles for future projects. They will be continued in research, such as the project: 'Future-Proof Labs' (2021/2022) which aims to further generalize the findings. In the Future-Proof Retail case, we identified four key design principles which were used in creating its approach. The goal of using these principles was to link the macro and micro level, to make knowledge actionable and to increase the impact of the project. These four design principles are: Distributed Leadership, Storytelling, Labs as Catalysts of Change and Room for Intuition.

Distributed Leadership

FPR is a case of taking and granting leadership. The research groups took leadership in working programmatically. Building the consortium, it became clear that many stakeholders from the retail industry had conflicting agendas and a history of competition. The involved Universities of Applied Sciences emerged as a partner that was perceived as 'sympathetic but neutral' to the cause. For this reason, a research group was asked to take the lead and develop a program, as opposed to merely researching a part of the transition process (i.e. creating a shared vision or testing technology). A decentralised governance structure (Leminen, 2016) was set up, in which the involved local bottom-up initiatives could use their resources to shape the local labs in their preferred way and take leadership on the local level. The lab formats (co-created by stakeholders on the national level) merely determined the theme (digitalisation, circularity) and the specific group of user/retailers (food, fashion, employees etc.) the lab would engage with its real-life co-creation activities. In this way, top-down principles were aligned with bottom-up values, needs and resources. The local lab coordinators (familiar with the involved retailer collaborations and their culture) emerged as important leaders to orchestrate local activities and feedback learnings on the meso level. To ensure learning between the labs, these coordinators formed a national community of practice. Moreover, FPR recognized and granted leadership to influential branch organizations and individuals from the existing system. Representatives of the branch organizations committed themselves to the program by taking seat in the advisory board. Influential individuals were informally consulted. This set-up enabled multiple translations between the individual retailers, civil servants, researchers and technology providers, their organizations and the broader developing transition ecosystem.

Storytelling

In designing the project, several decisions were taken linked to storytelling: the need to timely communicate activities and preliminary results to diverse stakeholders in the retail industry. Capacity was needed for that, so we added a program partner which is a network of designers, such as graphic designers and strategic designers.

They were a core partner with their own financial budget in the project. They helped to create and disseminate stories about the project, such as personal stories of small retailers who experienced the local labs. Moreover, they created a shared 'brand' style for all partners and labs to increase the recognisability of the project and to make visual design a core activity of the program. The designed 'visual identity' allowed local labs to adjust existing designs (logo's, banners, house style) to their local context, while at the same time being recognizable at the macro level. Local labs felt unburdened from the chore to develop visual materials themselves. The style was co-owned, professional and gave stakeholders a sense of pride in being member of the program[1]. Like t, the various stakeholders related to each other, even thought they were geographically, and topic wise dispersed across various transitions in the retail industry.

Storytelling used also metaphors from the retail industry to introduce element of the program. The successful lab formats for example were deliberately called 'franchise', referring to a commonly used practice in the industry, and the first program event was designed in the form of an inside shopping street with project members offering developed tools and materials in their 'shop window'. Together with local municipalities, primarily local media was targeted to reach more local retailers with the outcomes of the project. This was an important driver for the municipalities, to show their network the impact of the project. As a result, media picked up easily on the project, ultimately reaching national media. This aided again in the credibility and embedding of the project. The output of the project (not only numerous articles in media, and plenty of tools, but also books and academic publications) brought the story of the project wider into the industry. Finally, national industry players and other municipalities were invited to 'local lab tours', telling the story from the different local stakeholder perspectives.

Labs as Catalysts of Change

To decrease the vulnerability of a local lab, labs were deliberately a collaboration amongst three types of stakeholders: a municipality, a local university (of applied sciences) and/or a vocational school and a retailer representative (often a manager of a shopping area). These stakeholders were the local team organizing the lab. The labs took place in a pre-defined timeframe, to allow coordinated impact and focus the efforts of the stakeholders involved. Sequencing the various labs also allowed to cascade learning lessons. Because of this, the initial six lab formats quickly narrowed down to the three most successful formats. These three formats were repeated multiple times to further elaborate and detail process and activities. Communication (as mentioned previously with storytelling) was centred around the labs, targeting local media. This supported the labs in their role as catalysts of change. The local lab co-creation activities followed a 'small steps' approach. Micro retailers could for example choose from a menu of technologies which one they wanted to try out in their shop. Or they could try out incremental changes to their business model, like offering sustainable products to new customer groups. Like this, retailers experienced changes in their everyday business/life as opposed to talking about possible changes. Often, it was the small successful changes which encouraged them to think bigger and experiment with more radical changes. Moreover, these retailers' powerful stories convinced critical colleagues to take part in the lab project.

Room for Intuition

In this project, we chose to build in Room for Intuition. Luckily, the funding body of the project allowed us to do so: through reserving a large portion of the project budget for 'unknown' (about 15% of the total budget was reserved for this purpose), as well as focus on goals and results versus describing in detail our planned activities. This enabled us to act on developments as they occurred, grow organically and adjust activities to the local context. To be visible and provide 'low threshold' availability, the labs needed a physical space. When this space was not available, containers could be financed to function as a 'pop-up' location. Another example is that the moment to showcase and translate lab successes to national stakeholders came earlier than we had expected. Thanks to our flexible budgeting, we could follow our intuition, grab the opportunity in organizing a national event and thus achieve mental model changes and related policy decisions at the macro level.

The structure of the project was based on prior experience with similar projects, though they were never of such a scale, with such a complexity and number of stakeholders involved in a short time frame. The authors of this paper were the 'architects' of the project. Deciding upon the project format using their design intuition. Even though design intuition is recognized and documented (such as in Badke-Schaub and Eris, 2014) as "unconscious and mainly inaccessible processes that allow the designer to make quick and often effective decisions without

[1] For FPR house style and storytelling examples please visit www.futureproofretail.nl .

building on explicit rationale” (ibid.: 353), using design intuition in setting up large scale projects is not familiar. Often due to funding bodies which do not leave room for intuitive decisions, especially if a project is already in progress.

Discussion

Our model and design principles show how in a sector transition, microscopic actions in local labs were combined with macroscopic co-creation and decision-making when understanding the existing system and working towards a preferred future system. Using the local labs as Catalyst of Change, the model ‘embraces’ so to say microscopic actions in a local context with individual actors, to deal with large-scale issues encountered by the sector as whole. The principles of Distributed Leadership, Storytelling, and Room for Intuition were used across all phases of the model. The model and related principles thus contribute to the literature of co-creation ecosystems and systemic design by proposing a process in three distinctive phases (figure 2) and by illustrating and suggesting some overarching principles. Especially the third phase is often overlooked in literature as most cases do not reach this phase where findings can be scaled throughout the system. This is one of the key contributions of this study, to shed light on scaling in systems using local living labs.

Limitations to the findings derive from the method of a single case study, even though the model has been gradually built during multiple cases. This case was particular in several ways. Firstly, the systemic scope of involvement of design researchers allowed us to determine and design across the entire transition process and on different levels. The emerging new co-creation ecosystem was ‘enabler-driven' (Leminen, Westerlund, and Nyström, 2012), which means organised and led by universities, as opposed to citizen- or user-driven. For differently driven ecosystems the sequencing of the three phases might for example deviate. Secondly, the cultural and societal environment of the case accounts for particular leadership and communication styles. So the principles suggested in this article must be carefully tested for other cultural contexts.

In order to discuss the findings deeper, we will compare them with the recently published ‘Systemic Design Framework’ of the UK Design Council (2021). This framework was introduced to guide and enable designers in impacting system transitions, particularly the transition to ‘net zero’ energy systems. It proposes four roles of the designer and a transition process with activities following two ‘double diamonds’. What immediately stands out is that our model proposes a three ‘double diamond’ process. The phases explore/reframe and create/catalyse, would be followed by a third diverging and converging activity we would term ‘prototype/embed’ (figure 3).

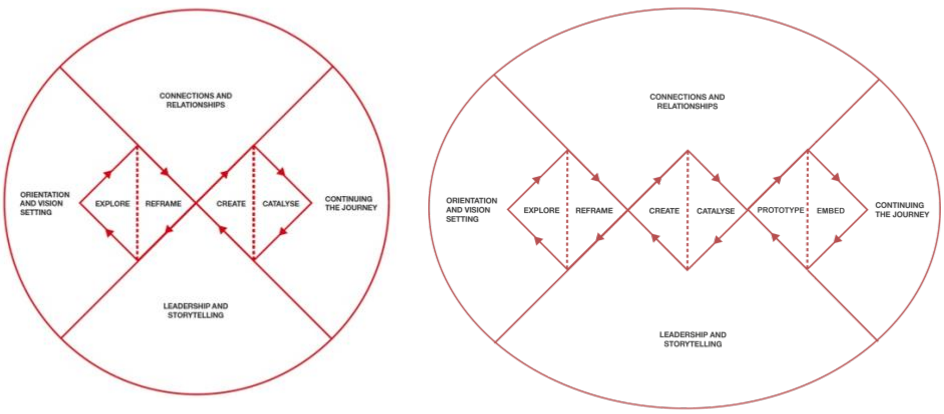

Figure 3. Left Systemic Design Framework (Design Council 2021), right our suggestions for model based on our insights.

The third phase we analysed in our project called ‘towards preferred future system’ (figure 4) focused on scaling the learning lessons of the previous phases wider in the industry. In this phase, system stakeholders co-created together to come to different elements of services designs which would embed the lessons learned in their activities. These designs were prototyped and tested, also in their interaction. Like that, the new ecosystem could be embedded in the ‘old’ system, and we were able, as designers and ‘drivers’ of the transition, to make ourselves obsolete.

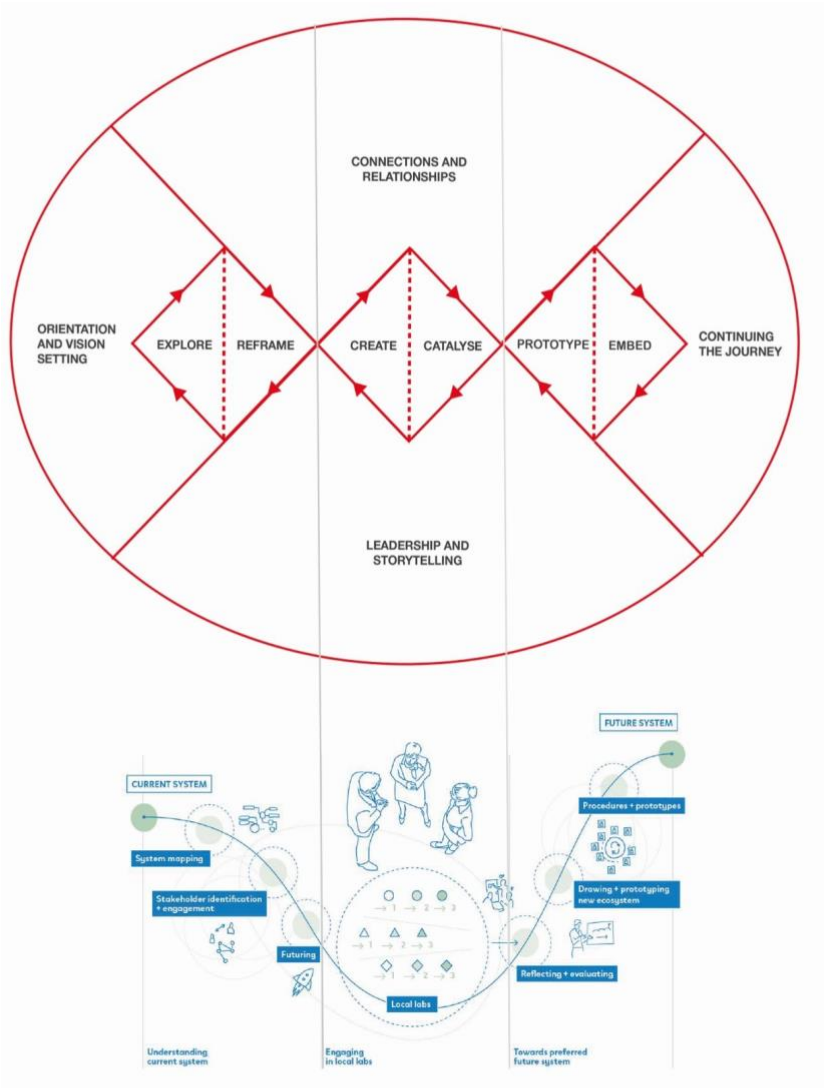

Figure 4. The three phases of the FPR framework (below) and corresponding three diamonds (above).

Moreover, the preliminary design principles we found, fit well with the designer roles the 'Systemic Design Framework' describes: systems thinker, leader/ storyteller, connector/convenor and designer/maker. With our findings, we contribute most to the first two roles. Our principle Room for Intuition, together with the proposition to continually connect the local with the national systemic level, suggests that designer's systems thinking in transitions might be organic and emerging with the new ecosystem, using intuition and close connections to stakeholders as key elements. Lastly, our principles of Distributed Leadership and Storytelling as two separate ones might indicate that leadership and storytelling are not only an individual designer's capacity, but need to be enabled with players on all levels (local, regional, systemic) of the emerging new ecosystem. The Storytelling principle also suggests particular opportunities in using visual design and metaphor for this purpose.

Finally, several questions for further research arise from our analysis. Around the role of the designer as systems thinker the method of identifying leverage points in the existing system, particularly in the first phase of the transition process, needs to be tackled in a systematic way. From a 'dynamic systems' perspective, the found principles should also be analysed in their contribution to 'feedback coordination' (Jones, 2014: 114), an important systems principle. Secondly, we indicated a role of design intuition in the transition process without special expertise in this area. It would be important to develop literature on this topic. Also, the challenge of collecting and analysing data in a project of the Future-Proof Retail scope needs further attention. Last but not least, we realize that the role of the designer, in most cases, might be more limited than our approach suggest. Particularly in regard to the different design principles in this article the question 'what are the limits of design?' might be in place. In how far are key strengths of the design approach endangered when other roles are embraced? And: Where and when are designers better equipped to facilitate transitions in collaboration with which other experts and non-experts?

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Fruitful friction as a strategy to scale social innovations

A conceptual framework to enable the emergence of common ground in multi-stakeholder social innovation projects

Maria Belén Buckenmayer, Milene Gonçalves, Ingrid Mulder

Social innovations are promising to tackle today's complex global challenges, especially when they scale, leading to a higher impact, which can generate a societal transformation. The current work elaborates on scaling deep, a specific scaling strategy aiming to shift cultural values, mindsets and beliefs. However, applying this strategy in practice is not straightforward. Therefore, we first aim to develop an actionable strategy that supports social innovators in their scaling efforts. Our research findings show that scaling deep can be defined as an (1) internal transformation process, (2) a social process, with (3) friction being an enabler for change. Second, these insights inform a framework that makes scaling deep more actionable and helps social innovators to use fruitful friction as a strategy to scale deep. The current study adds a new viewpoint to the scaling deep context and presents a concrete starting point of the scaling deep strategy by linking it with the creation of common ground.

Keywords: Social innovation; Multi-stakeholder collaboration; Common ground; Scaling deep; Framing

Introduction

New approaches to overcome complex societal problems of today are the need of the hour, especially to enable the transition to a sustainable future (Abbasi et al., 2019). Here, social innovations - new practices that address complex societal problems while meeting social needs - are promising. As such, social innovations can present new ways to tackle global problems on a local scale, which can create a transformation at a systemic level while shaping societal beliefs, routines and behaviours. Societal transformation is a complex and interwoven innovation process, as it connects many socio-technical realms. Westley and Antadze (2010) argue that in order to reach a broader impact, innovations have to scale their innovations across organisations, contexts and society. In other words, the focus of scaling social innovations lies on increasing their impact on a societal level in order to tackle the social or environmental issues they aim to address with their innovation (Davies & Simon, 2013).

There are a variety of well-known strategies and approaches to scaling an innovation (e.g., Westley & Antadze, 2010). Moore and Riddell (2015) identify three overarching categories of scaling that facilitate innovations to increase their impact and enable systemic change: scaling out, scaling up and scaling deep (see Figure 1). Scaling out focuses on reaching a greater number of people and replicating an initiative. Using the metaphor of a tree, scaling out can be seen as seeds of a tree being scattered. Scaling up refers to the changing of laws and policies, which, in the context of the metaphor, can be depicted as the biological structure of a tree that gives boundaries and provides a frame to grow or act. Lastly, scaling deep refers to mindset changing within a context, where values, beliefs, relationships and cultural practices are transformed. Like Figure 1 shows, scaling deep can be represented as the roots of a tree. The roots ground the tree in the soil and create deep connections with other trees. They are invisible from the surface but strengthen it and make it resilient. Scaling out and scaling up happen at the surface, visible and tangible for the actors involved. Conversely, scaling deep is a process that is intangible, invisible and hard to grasp.

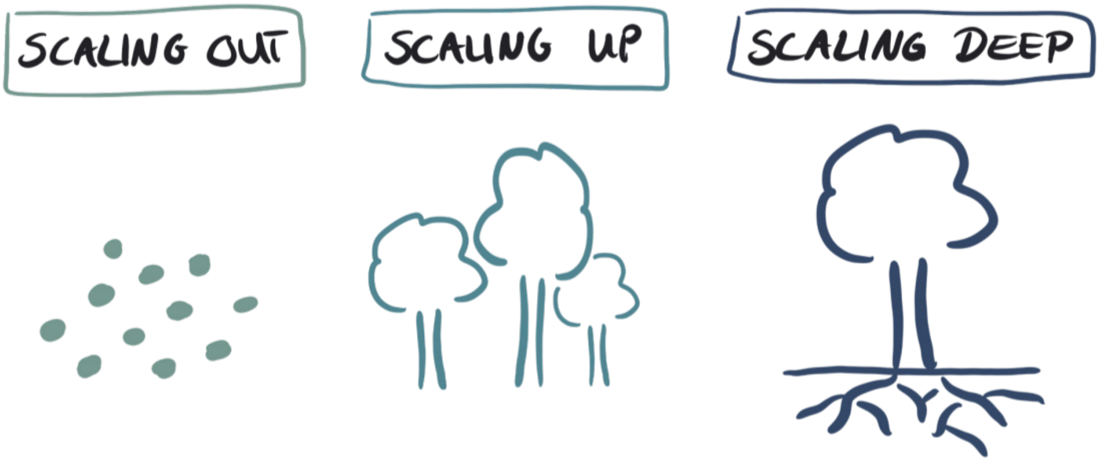

Figure 1. Three scaling strategies after Moore and Riddell (2015). This paper focuses on the exploration of the scaling deep strategy.

While scholars (e.g., Moore & Riddell, 2015; Strasser et al., 2019) realise that all three strategies are important to apply in order to reach systemic change, there is an uneven amount of knowledge and resources available, comparing scaling deep with the other two strategies to support their application in practice. Scaling deep is (by definition) about change and transformation. However, what exactly should be changed and transformed and how can this be achieved? Several studies (e.g., Westley & Antadze, 2010; Lyon & Fernandez, 2012) provide a sophisticated overview of steps and approaches to apply scaling up and scaling out strategies. Nonetheless, because of its invisible and intangible nature, there is no clear understanding of how scaling deep can take place and how social innovations can apply it. This gap in knowledge presents the need to further explore this field and provide clarification and new ways to make the scaling deep strategy more tangible and applicable.

The context of social innovations

Social innovations do not act in silos but are woven in a web of different stakeholders, partners, organisations and communities, a complex system where these actors are involved and engaged (De Koning et al., 2019) (see Figure 2). Building networks and communities is one important condition for social innovations' success. In those so-called diffuse projects, where tasks and ownership are spread between multiple people from different organisations there are often no clear responsibilities and there are a lot of uncertainties about the process and outcome (Yee & White, 2016).

Figure 2. Social innovation stakeholders, divided into three categories: community, network and strategic partner.

The division of responsibility and decision-power in public sector organisations and projects are often unclear (Yee & White, 2016). Figure 3 shows that the diverse backgrounds, expertise and expectations of actors involved in social innovation projects often means that people have their own goals, language and way of thinking and those aspects might not always align with each other, which can cause a lack of a shared understanding and lead to misunderstandings.

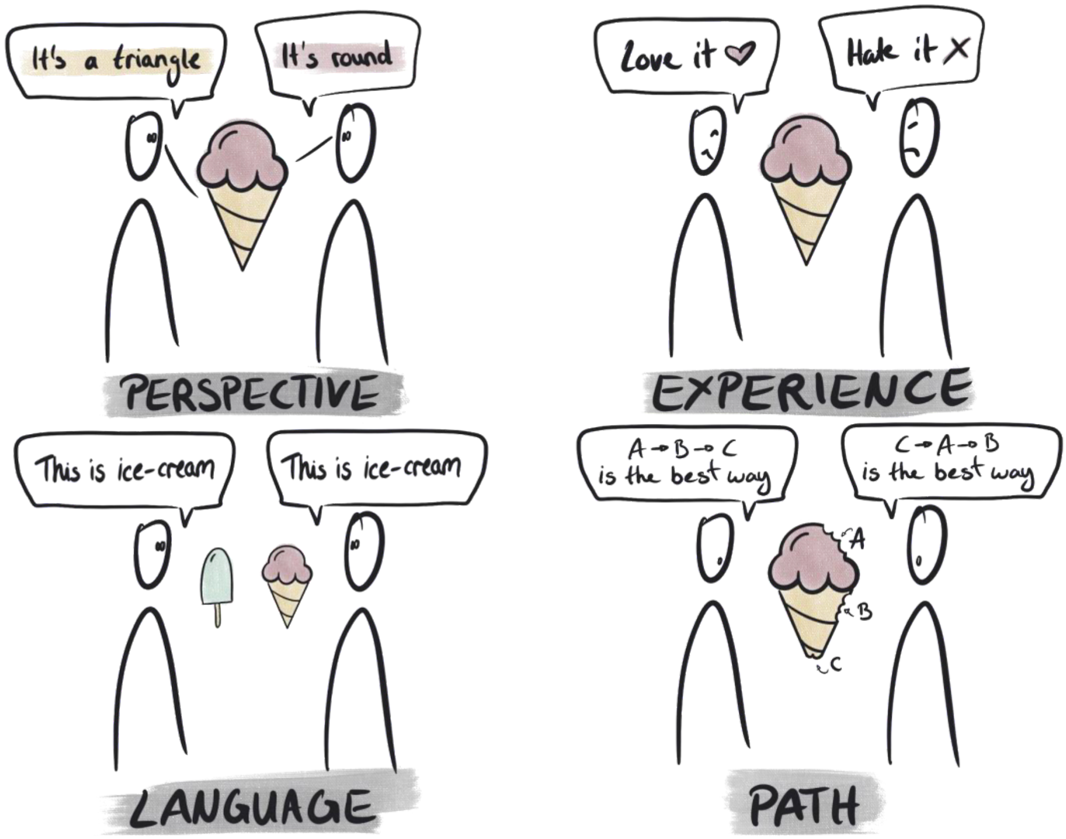

Figure 3. Four main factors that can cause misunderstanding between innovators and their stakeholders.

As stated by literature, reaching some level of a common ground between stakeholders is an important aspect when dealing with complex problems within multi-stakeholder projects (Beers et al., 2006; Bromme, 2000; Moor, 2018). This is particularly relevant in the scaling phase of social innovations, when trust-based relationships are built with a variety of new stakeholders. Although, common ground is defined as "a common cognitive frame of reference between the partners of interaction" (Bromme, 2000, p.119), the relational component is key. Frames help people to diagnose, define and make sense of a situation and can be seen as principles, rules or patterns that every person has (Dorst, 2011). In addition, shared understanding can be divided into shared meaning and shared agreement on this meaning. The ongoing process of creating new understanding and reaching shared agreement on new meanings seems to be a prerequisite for collaborative learning (Mulder, 2004). Moor (2018) and Beers et al. (2006) argue that establishing a common ground is a process that should happen deliberately and that common ground needs to be made explicit. Beers et al. (2006) emphasise the importance of making individual perspectives explicit to reach a common ground. Hereby, it is not only about sharing but also about seeing similarities and differences to gain an understanding of the varying viewpoints. In the current work, we aim to trigger the process of creating new understandings, by integrating different viewpoints.

The role of design in social innovation

Design, being a discipline that has evolved from creating products and services towards one that enables change through new ways of working and looking at things (Manzini, 2014), has expanded to include collective problem-solving approaches (Dorst, 2011). Designers help to tackle complex societal problems by supporting social innovations, governments and organisations in their way towards a sustainable future. Meroni (2008) highlights the ability of designers to facilitate strategic dialogues by asking the right questions and triggering conversations. As such, they are able to direct stakeholders towards a shared understanding and vision.

The current work explores the phenomenon of scaling deep and aims to understand how design can facilitate the emergence of common ground and enable social innovators to make use of the scaling deep strategy. The corresponding research question is: *How can design be used to transform the abstract and theoretical concept of scaling deep into a more tangible approach?* The objective is to achieve a change in relationships and cultural roots to create a deep transformation that builds trust for productive long-term collaborations amongst social innovators and their stakeholders. At first sight, common ground, scaling deep and design may not be directly connected. In the following sections, we will demonstrate that there is an opportunity to combine those aspects into a framework that allows social innovators to build a common ground with stakeholders as one way to enable scaling deep. Given that scaling deep is an abstract and intangible concept, the current work explores one of many possible ways to define an actionable strategy that supports social innovators in their scaling journey. In the next section, we set the context of study and present the methodology used, which allowed us to derive insights and build a framework, to better understand scaling deep and its potential. We will conclude with the proposition of a framework to scale deep in a more actionable and fruitful way.

Methodology

The current work is part of a larger programme called DESIGNSCAPES. The DESIGNSCAPES consortium brings together cities, industries, small businesses and research actors to better understand how design tools and methods can strengthen grassroots initiatives, public sector organisations and policymakers to innovate. During the period of the current research ten, social innovation projects in Europe that aimed to scale their innovation from one context to another were supported financially and with training modules by the consortium. The collaboration with DESIGNSCAPES enabled us to gain a practical perspective into the scaling journey of social innovators. Although all ten pilots were invited to join, four of them were engaged more actively in the current study.

For the construction of the conceptual framework the main research question has been divided into two sub-questions, which are as follows:

Sub-RQ 1: What does scaling deep mean and look like from a theoretical perspective?
Sub-RQ 2: How does, or can scaling deep look like from a practitioner's perspective?

This division allowed us to explore the phenomenon of scaling deep from a theoretical and practical perspective. The goal was to understand the context of scaling social innovations and identify opportunities.

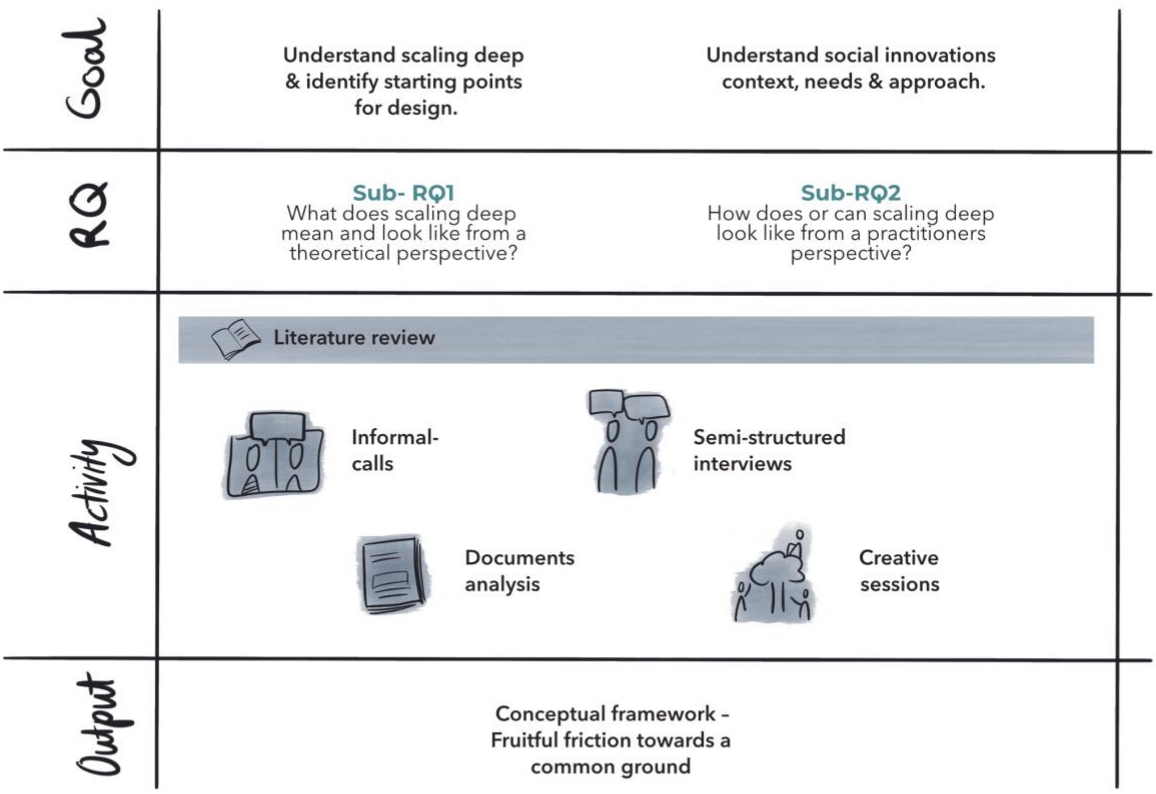

Figure 4. Overview of process and methodology used.

As shown in Figure 4, to explore scaling deep from a theoretical perspective, a literature review was conducted to understand the basic concepts relevant to social innovations, system change, societal transitions and the new role of design. To understand scaling deep from a practitioners' perspective different qualitative research activities were performed. This encompassed semi-structured interviews, informal calls, document analysis and creative sessions with the cases. In particular, the creative sessions were used to test and evaluate the framework in practice and to develop it further into a toolkit that can be used by social innovators. Thus, this framework allows them to practically apply the scaling deep strategy. These research activities enabled us to understand the context of social innovations and their ways of scaling. In addition, we identified the main struggles social innovators face when scaling.

We conducted four semi-structured online interviews, via the video calling platform Zoom, with different DESIGNSCAPES cases. After initial get-to-know each other calls, cases were interviewed in a semi-structured way, each interview lasting about 1-1,5 hours. An interview guide was prepared for each interview, but relevant topics were pursued when appropriate. The semi-structured interviews allowed us to get an in-depth understanding of the cases projects, their needs and concerns when entering the scaling phase.

In order to support and converge the research, a document analysis was carried out. Different documents related to the DESIGNSCAPES cases (e.g., DESIGNSCAPES application forms, cases websites) were analysed to enrich the understanding of the context of the social innovations and scaling stage, in addition to the qualitative interviews.

Besides the interviews and additional information, different creative sessions with cases were conducted, which informed the creation of the conceptual framework. Three creative sessions were held online using the collaboration platform Miro and the video calling provider Zoom. Each of the sessions lasted about 1-2 hours.

The data was analysed using the method of inductive thematic analysis which allows identifying patterns of meaning across a qualitative data set in a systematic way (Braun & Clarke, 2012). By applying this method to the data collected during the different research activities we identified recurring patterns which together with the literature led to the main insights that will be presented in the next section.

Main insights on scaling deep from a practical and theoretical perspective

The research reveals three main aspects of scaling deep that we consider important when aiming to translate this strategy into something tangible and facilitate a transformation process to create a shared understanding between social innovators and their stakeholders. The following insights inform the construction of the framework.

Scaling deep is an internal process

Scaling deep has been identified as an internal transformation process that starts with becoming aware of one's own implicit, intangible frames and ways of thinking leading to willingness for change. Being an internal process means that the change can not be forced onto someone but needs to happen within the person. Nevertheless, we discovered that people can be triggered to reflect and become aware of different perspectives.

In literature, scaling deep is loosely defined by the interchangeable use of the following concepts: mindsets, values, beliefs, attitudes and opinions (e.g., Moore & Riddell, 2015; Strasser et al., 2019). Figure 5 aims to bring a more nuanced overview of how these concepts relate to each other.

Figure 5. Definition of the different terminology used in literature when describing scaling deep.

A mindset is created in an iterative process through new experiences, information or interactions and is constantly shaped by the mindset of others. Gupta and Govindarajan (2002) as well as Buchanan and Kern (2017) describe that the more conscious we are of our way of thinking, the more openly and likely we will change our mindset, especially if we have the right skills and conditions. Creating a favourable situation in which a person can reflect on their mindset is a first step in enabling a mindset shift (Paunesku, 2019). Consequently, the more aware we are of our mindset the more open we are to allow different perspectives and the more likely we are to change our mindset. This also means that a person can be prompted to change their mindset by another person through various interventions, creating a certain environment or even through subtle nudges like using a specific language (Rissanen et al., 2019). However, the decision to change still lies within the person, which makes scaling deep an internal transformation process (see Figure 6), where becoming aware of your own way of thinking is the first step to change. The question that arises from this observation is if and how individual frames can be made explicit and expressed. Here, the creative sessions were used to explore different ways to do so.

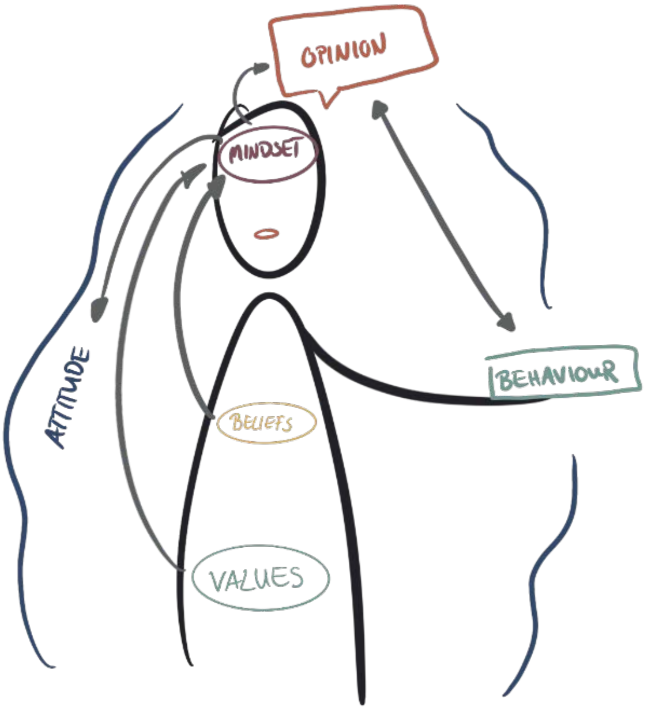

Figure 6. Changing values, mindsets and beliefs is also an internal process that starts with becoming aware of those implicit aspects.

Scaling deep is a social process

Mindset is only one part of the complex cognitive process that forms and influences our thinking and behaviour. Frames (e.g., Dorst, 2011) or mental models (e.g., Vink et al., 2019; Van der Bijl-Brouwer & Malcolm, 2020) are similar concepts. Frames, being defined as a set of assumptions, implicit values and goals that define what people consider important and how they perceive situations are very much connected to the notion of mindsets, values and beliefs. Likewise, these concepts are hard to identify and express, as they are implicit, tacit, intangible and subconscious (Hey et al., 2007). The frame formation process by Hey et al. (2007), illustrated in Figure 7, highlights that the creation of shared frames, based on the integration of different viewpoints, at the beginning of a new project between project partners allows for better collaboration.

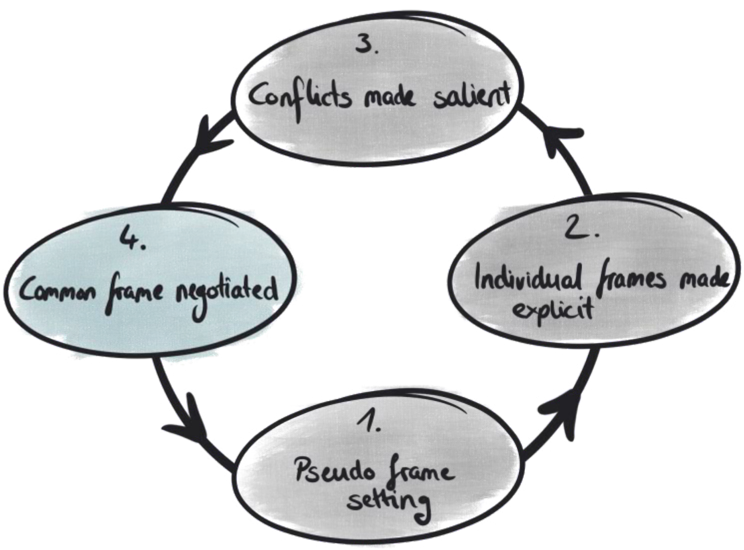

Figure 7. Creating a common frame is important at the beginning of a new project. Process visual adapted from Hey et al. (2007).

In this process (1) pseudo-frame setting refers to the initial understanding of the project (e.g., the project name or mission statement). However, individual frames are not expressed yet. (2) Individual frames are made explicit in an ongoing process throughout the project and happen when members express their point of view or expectations during team interactions. (3) Conflicts are made salient when different or conflicting frames emerge and are made explicit. Once differences in individual frames emerge the creation of common frames (4) can take place. With a common frame, we refer to alignment of the individual frames in the first place, rather than that all frames need to overlap completely or reach total agreement. Instead, as indicated by Hey et al. (2007), a shared understanding early in a project ensures a productive collaboration. Building on Hey et al. (2007) frame formation process, we conclude that being confronted with new information and experiences in interaction and communication with others allows us to make implicit frames explicit and see new connections, which enables an internal transformation. This makes scaling deep a social process (see Figure 8), that is about expressing and integrating individual and collective perspectives in interaction and communication with others.

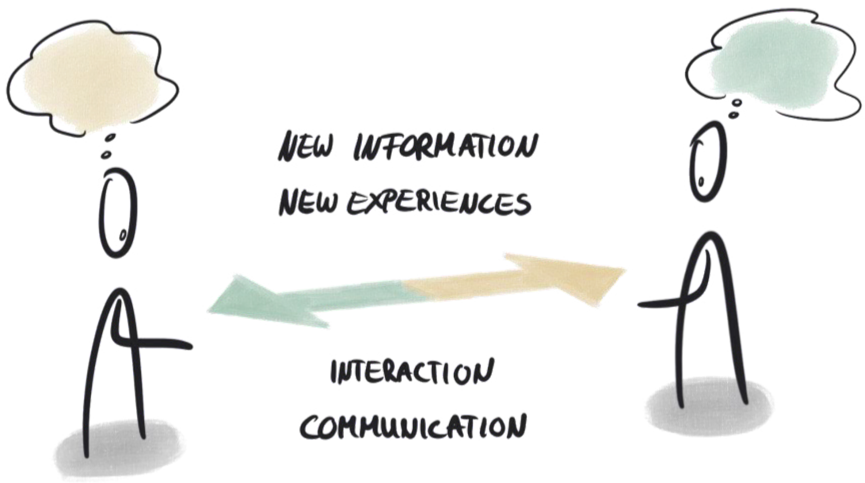

Figure 8. Scaling deep is a social process that is enabled by new information and experiences.

As such, we conclude that the primary goal of scaling deep in the context of social innovations is not changing people's mindset but allowing them to become aware of their way of thinking. In this way we can acknowledge and appreciate new perspectives and identify similarities and differences amongst peoples' mindsets. Those steps facilitate finding a certain level of a shared understanding that builds the base for trusted collaborations.

Friction as a catalyst for change

The role of conflict and conflicting frames seems to be an essential topic to enable change. Many scholars have acknowledged that friction (referring to inconsistencies, conflicts or confronting perspectives), when dealt with, can facilitate self-awareness but also the emergence of a common understanding (see Van der Bijl-Brouwer, 2018; Dorst, 2011; Greenhalgh & Papoutsi, 2019; Hey et al., 2007; Strasser et al., 2019; Vink et al., 2019).

One significant cause of change in mental models is a persons' detection of an inconsistency. When a person reaches an impasse with their existing mental pattern, they are likely to revise their related mental models to some extent (Vink et al., 2019). That refers to the step 'conflicts made salient' in Hey et al' framing process (2007), as shown in Figure 7. A person's realisation that others have different perspectives causes a conflict because it goes against their current worldview, assumptions and principles and makes them question those (see Figure 9).

Even though differences in values, needs, goals and vision can create troubles and hinder progress, Strasser et al. (2019) argue that if the conflict is deliberately addressed it can "generate new levels of mutual understanding, empathy or alignment about goals". Likewise, Dorst (2011) sees conflicting frames as a necessity rather than a hurdle for problem-solving since the friction results in a reframing of the problem situation. Dealing with those paradoxes is what Dorst recognises as a key design capacity.

Hence, friction can be a catalyst rather than a barrier for change. The potential here lies in deliberately triggering and addressing friction to deepen individual awareness and collective understandings. However, collective understanding is not that people simply agree, but that they are aware that their viewpoints differ and can still work together because they have a common goal.

Being confronted with different perspectives facilitates people to become aware of their implicit frame. However, for this friction to become fruitful, it needs to be made explicit and addressed. We propose that addressing friction in the context of scaling deep provides an interesting starting point to enable social innovations to scale deep.

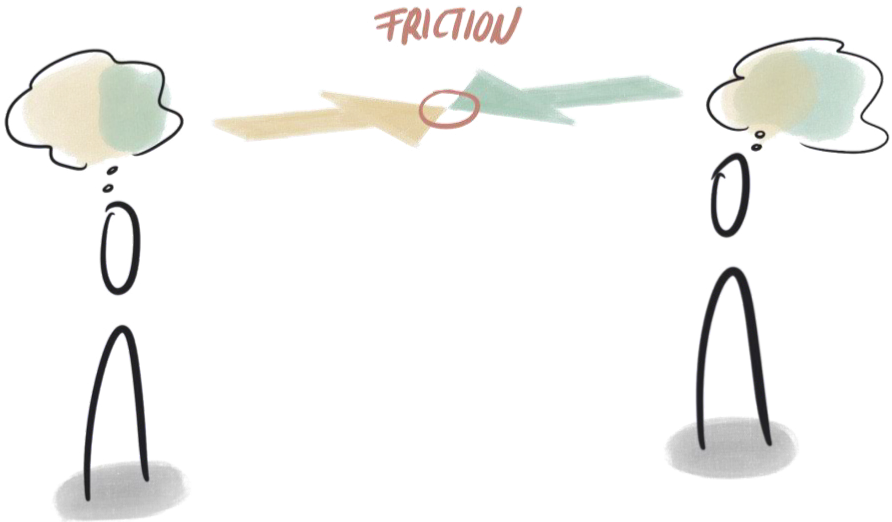

Figure 9. Scaling deep can be facilitated by friction.

Scaling deep redefined

In conclusion, scaling deep is an internal transformation process where implicit, deeply rooted values, beliefs, ways of thinking and world interpretations are addressed and questioned which can lead to their transformation. The change should happen within the individual and cannot be forced onto someone. However, interaction with others can enable the shift to happen. Figure 10 shows how our insights inform the (redefined) process of scaling deep. The process starts with (1) becoming aware of one's own implicit frame, which needs to be made explicit (2) to allow friction between others' frames to emerge (3). Conflicting frames facilitate that different individual frames are transformed (4) by the integration of different viewpoints.

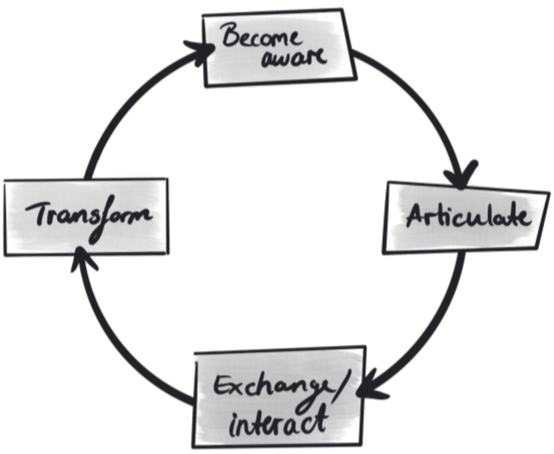

Figure 10. The scaling deep process.

Thus, scaling deep is a process that, in the context of social innovations, needs to happen in collaboration with stakeholders to raise awareness of differences in perspectives regarding a project and create alignment with stakeholders on a conceptual level. The shared understanding forms the basis for productive collaboration (Moor, 2018) and therefore greatly influences whether scaling efforts are successful.

Fruitful friction towards common ground

Summarizing the insights of the research into a conceptual framework allows us to create a better understanding of the scaling deep process. Figure 11 illustrates the resulting framework, which constitutes a process of how fruitful friction is used to create common ground.

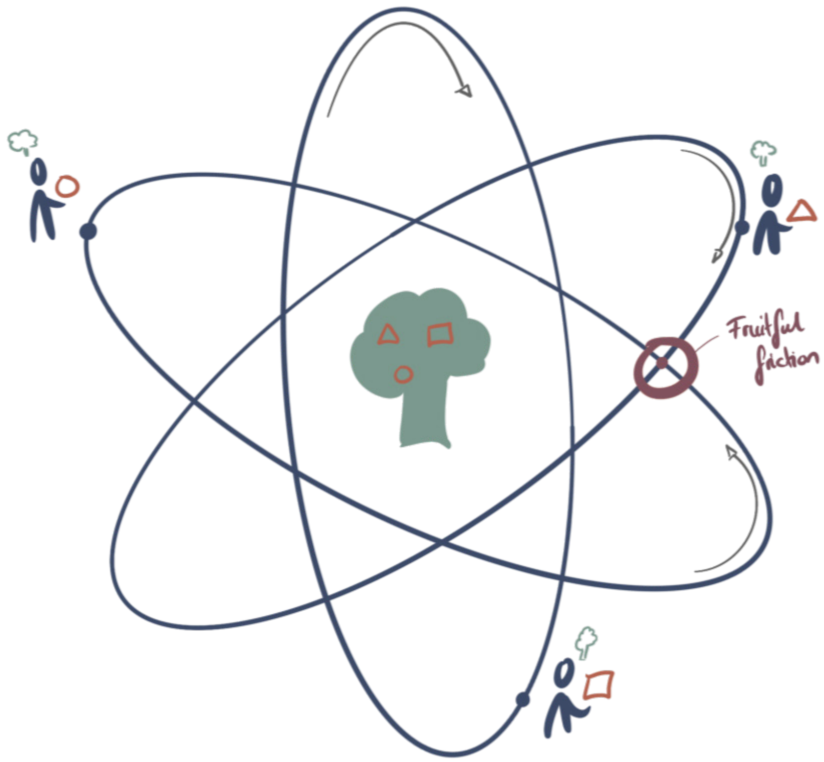

Figure 11. Overview of the conceptual framework. The green tree represents the common ground that is shared by all actors involved.

To better understand the conceptual framework, the metaphor of an atom with electrons and a nucleus is used as follows.

The electrons – actors

In the ecosystem of social innovation, multiple stakeholders and partners need to be involved for innovation to be scaled. The different actors in a social innovation project are represented by the electrons which are in constant movement, moving around the nucleus. Each of them has their own routines, goals, ambitions, organisational structure, resources, views on the problem and solutions.

The nucleus – common ground

In the middle is the nucleus which is the shared vision that they are all working towards and what unites them. The nucleus represents the shared understanding, it is what all of the individuals have in common and what builds the base for their collaboration.

Collision points – fruitful friction

Collision is what enables fruitful friction and also symbolises when fruitful friction can happen. Namely, when new stakeholders meet and their individual frames are expressed, which may lead to the exploration of common ground.

Fruitful friction is the process of causing friction deliberately to engage people in a fruitful sense-making activity that facilitates the emergence of common ground. The friction has two purposes (or forms): First, it is used to trigger people and make them aware of their implicit individual frames. Second, the expression of conflicting frames allows seeing similarities and differences in frames, enabling the integration of different viewpoints, which may lead to the emergence of a shared understanding.

Common ground established in a co-creative way can build co-ownership, acceptance and facilitate actors to embody change (Paton & Dorst, 2011; Puerari et al., 2018). In other words, it is aimed to trigger friction deliberately, to enable people to express their implicit frames and facilitate the emergence of a shared understanding.

Our observations and interviews, coupled with literature review, revealed that a core aspect and starting point of scaling deep is to create fruitful friction, to make people aware and open to acknowledge different perspectives. Then, it is important to translate those into a common ground, which captures an emergent shared understanding. Figure 12 explains the five phases of the process of creating a shared understanding.

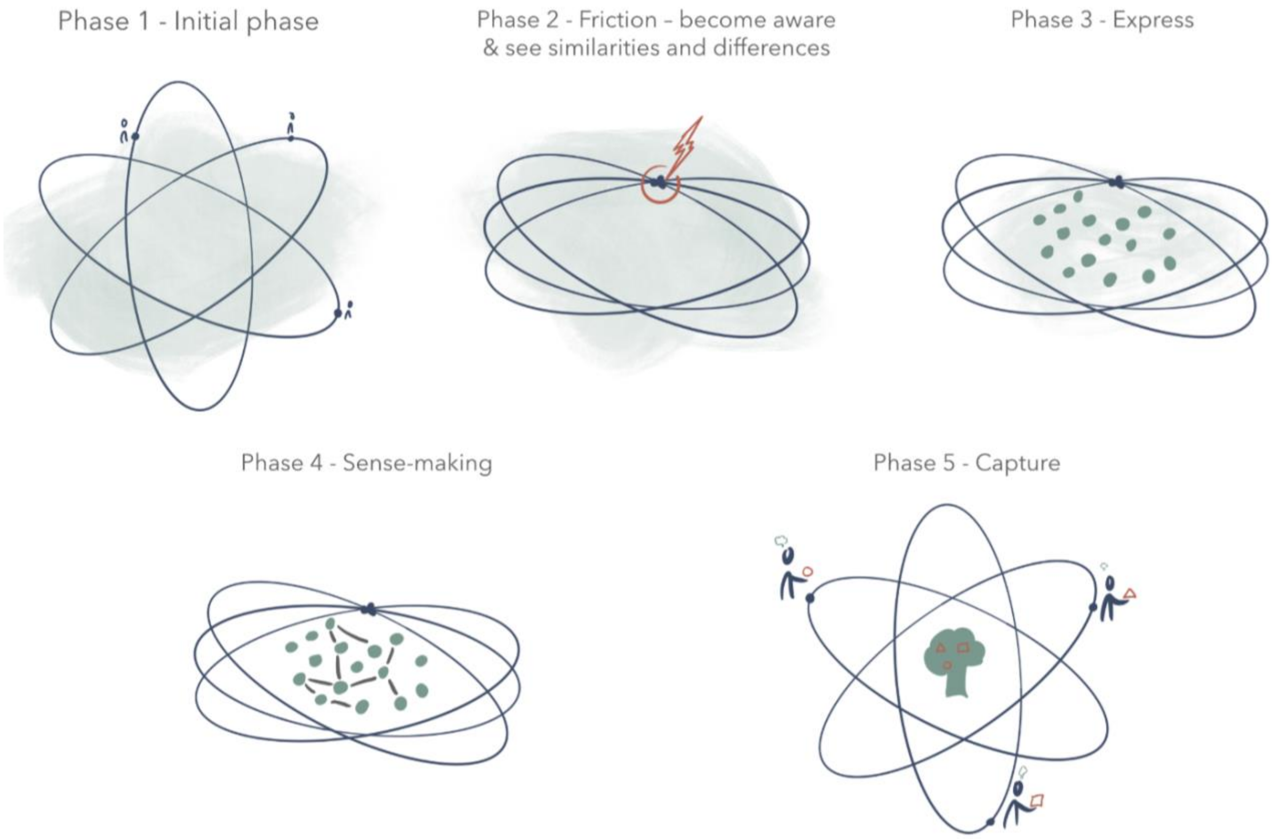

Figure 12. Five phases of the conceptual framework to create a shared understanding using the concept of fruitful friction.

Phase 1 - Initial phase

At the beginning of a new collaboration, there is no clear understanding, everything is blurry. Everyone has a vague idea of what unites them and what makes them different but it is not yet expressed or clear to themselves and to others. Actors in the project have not deliberately talked about their goals and ambitions, their way of looking at the problem and solution.

Phase 2 - Friction – become aware & see similarities and differences

When actors come together friction is triggered to make people aware and reflect on their own way of thinking as well as how others think. This stage is focused on individuals' personal reflection in interaction with others.

Phase 3 - Express

This phase is about expressing the individuals' perspective and acknowledging the different frames to identify similarities and differences.

Phase 4 - Sense-making

Being aware of the different viewpoints is what enables the collective sense-making where a new connection is made and new meaning emerges. Here is where a shared understanding is formed and co-created.

Phase 5 - Capture

The newly formed common ground should be captured verbally and visually in order to make it actionable for the project. Once this stage is completed, actions can be derived.

For the purpose of evaluating whether this framework indeed facilitates stakeholders becoming more aware of their implicit frames, helps recognising other peoples' frames and leads to changing mindsets, we have developed a toolkit that incorporates these steps into actionable activities. When those tacit, intangible concepts are expressed, friction and conflicting frames may be revealed, which starts the reframing and collective sense-making process that facilitates the emergence of common ground. Friction is hereby an important lever to trigger change, as long as it is fruitful. This means that expressed differences (which may reveal conflicting frames) can be considered and transformed into a new preferably collective understanding about basic concepts of the project like a shared goal or path. Although the focus of this study lies on the development of the framework, the work of Buckenmayer (2021) provides more details about the toolkit.

Discussion

The aforementioned framework is relevant for the scaling deep process and social innovations in different ways. The framework uses friction deliberately to make people aware and express their own frame, which is the first step towards a mindset shift. This builds on the notion that friction, rather than being a barrier for change, can instead be an enabler (Dorst, 2011; Hey et al., 2007; Strasser et al., 2019). With the framework, we lay out one way how the occurring friction can become fruitful and contribute to internal transformation processes. Especially in multi-stakeholder projects, friction is often inevitable. Therefore, it is relevant to deal and address this friction deliberately to create awareness of conflicting ways of thinking and openness for change. The multitude of perspectives that are often not explicitly expressed may cause misunderstandings and trouble collaborations. Here, the framework can give explicit guidance to trigger fruitful friction to enable a change in mindsets and scale deep.

The framework uses collective sense-making as a way to reach common ground, which has been indicated as an essential step to tackle complex, multi-stakeholder projects (Moor, 2018; Beers et al.,2006). Greenhalgh and Papoutsi (2019, p. 3) state that collective sense-making should be encouraged by "ask questions, admit ignorance, explore paradoxes, exchange different viewpoints, and reflect collectively". Following this notion, the framework makes an apt approach to scale deep. Aligning on a common ground is one possible way to create ownership and acceptance and makes it an important aspect for social innovators scaling efforts. The level of alignment however is not fixed but fluid. Here in particular, the designer's ability to deal with paradoxes and dilemmas to guide the process is valuable (Ozkaramanli, 2017). In this way a common understanding, which reveals a collective mindset, can be established.

The process shown in Figure 12 demonstrates one way how social innovation can engage in combining scaling deep with reaching a shared understanding with stakeholders. The benefit of creating a shared understanding while at the same time engaging in scaling deep makes this process more practical for the social innovation context. It presents a structured way to make use of friction fruitfully to reach a certain level of common ground. Nevertheless, in this paper the framework remains conceptual. To increase the actionability of the presented strategy the framework has been used to inform the development of a more hands-on approach with practical steps for social innovators. A toolkit and workshop format were developed to enable social innovators to conduct an online workshop with stakeholders (Buckenmayer, 2021). With this toolkit, implicit frames can be made explicit and a shared understanding is co-created. The first evaluation sessions showed promising results proving that the framework facilitates developing a tool that helps social innovators to act.

Conclusion

The ‘Fruitful friction towards common ground’ framework presents our approach to use fruitful friction as a strategy to scale deep. The research insights and framework contribute to the body of knowledge on how design can enable social and urban innovation. In the academic design field, the notion that tension and friction in today's complex world are unavoidable and therefore needs to be dealt with is more and more recognised (Dorst 2011; Greenhalgh & Papoutsi, 2019). The potential that lies in paradoxes and conflicting frames has been recognised by many authors, such as Dorst (2011), but also by Fokkinga and Desmet (2012), with their concept of negative rich experiences to trigger positive outcomes.

The framework shows one way to make scaling deep more actionable and tangible for social innovators by putting it into a more context-related process. The framework provides a more concrete application of the scaling deep strategy by relating it with the creation of common ground, which is a need for multi-stakeholder projects such as social innovations. In this way, the relevance of scaling deep becomes more clear for the actors involved in a social innovation project.

While the study shows promising results, the field still offers a lot of opportunities for further research. This paper could not explore how deep and elaborate the level of alignment should ideally be. Likewise, alignment can take very different forms, reaching from a shared language towards having common goals. Further research could explore these variables, thus sharpening the framework and enriching its theoretical foundation.

The collaboration with DESIGNSCAPES allowed this project to accompany different social innovations in their scaling journey. The interviews and research activities provided a snapshot into innovators projects and scaling efforts. However, scaling social innovations is a process that takes longer than the time this project lasted. Accompanying social innovators in a more long-term oriented research could enable to gain a more holistic view of the complexity of this process and allow to gain deeper insights into social innovation to identify patterns that recur over time. Those insights could allow a more strategic use of scaling deep strategies and understand the interconnectedness with other scaling strategies. It can be concluded that the current work contributes to understanding the role of design for social innovation, and adds a new perspective to the scaling deep context. We have identified one way to support social innovations in their scaling journey by using fruitful friction as a strategy to scale social innovations.

Acknowledgement

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Balancing acceleration and systemic impact

Finding leverage for transformation in SDG change strategies

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Acceleration increases the rate of progress toward system transformation.Systemic outcomes are durable impacts from coordinating foundational changes. We studied the form, leverage, quality, and effectiveness of theories of change in the 35 Joint Programmes of the UN's Joint SDG Fund. We conducted four analyses on programme strategies: (1) Classified types of Theories of Change, (2) Analyzed cases to identify the most effective JP Theories of Change; (3) Defined how leverage could accelerate the SDGs and their targets for social protection; (4) Analyzed cases to show leverage in the JP's change strategies. We argue that programmes with systemic theories of change and that show effective leverage will be more effective in accelerating achievement of social protection. We advise designers of complex change strategies adopting these systemic design tools to formulate strategies for systems-level change. Our analyses identified important tensions in the pursuit of acceleration. While goal acceleration is a means to an end, acceleration can become the goal; we must balance by design for long-term systemic impact. These desiderata are relevant to large-scale transformation contexts such as SDG programmes, climate change strategies, and other contexts where leverage can both accelerate and reach systemic program goals.

Keywords: acceleration, systemic change, strategies, leverage, sustainable development goals (SDGs)

Introduction

The Sustainable Development Goals (SDGs) were adopted by the United Nations (UN) General Assembly in 2015. The concept of the SDGs is to hold a platform of comprehensive, universal, worldwide shared goals (to be implemented by all countries, including the so-called developed ones from the global North). This includes 17 interlinked goals as a part of "a plan of action for people, planet, and prosperity" (United Nations, 2015, p. 1) to be implemented by 2030. Nearly half the timeframe determined to achieve these goals has elapsed since the SDGs were adopted—and yet, progress to date has been insufficient (United Nations, 2021).

The SDGs are a hallmark example of the scope and scale of challenges that the discipline of systemic design may help address. This study presents a systemic design analysis of the portfolio of 35 programmes in the Joint SDG Fund (https://www.jointsdgfund.org). We analysed the programmes' theories of change and leverage to assess the potential for acceleration with catalytic effects, i.e. to produce change across sectors and social systems. We provide an overview of acceleration in the contexts of systemic theories of change and leverage analysis. We then introduce the Joint SDG Fund and its programmes, with an overview of methods used in our analyses. Last, we summarize our results and discuss their implications for SDG target achievement, acceleration of systemic change, and tensions that systemic design may address in complex change programmes.

Towards Systemic Acceleration of the SDGs

In systemic change, acceleration is defined as the identification and use of catalytic initiatives to multiply the speed of progress towards a desired change goal (United Nations, 2017). In 2017, the UN Development Programme published a guide to pursuing acceleration—the Accelerator and Bottleneck Assessment (ABA) tool—with five steps: (1) identify accelerators that enable progress across the SDGs, (2) identify interventions that drive progress on these accelerators, (3) identify bottlenecks to acceleration, (4) identify solutions to these bottlenecks, and (5) implement and monitor these solutions (UN, 2017).

The ABA tool provides a straightforward guide to identify high-yield actions for complex change programmes. The process defined in the tool is somewhat systemic. The authors suggest that designers identify multiple catalytic accelerators that facilitate progress on different parts of the change programme, then identify interventions that act on multiple accelerators (UN, 2017). By identifying these chains of interventions, programme designers can develop theories of change well-positioned to accelerate progress on multiple goals.

The ABA tool approach, however, does not use the structure of the system at hand to inform the selection of accelerators. In this work, we sought to demonstrate the use of systemic design (specifically the technique of leverage analysis; Murphy & Jones, 2020b; Murphy & Jones, 2018) to identify strategies for *systemic* acceleration in the Joint SDG Fund programmes. Leverage analysis is an approach to investigating systems for key strategic features, such as leverage points and bottlenecks. A leverage point is a phenomenon which, if changed, changes a relatively large change throughout the rest of the system (Meadows, 1997). In turn, leverage points are key to the acceleration of systemic change, such as achieving progress on the SDGs. Conversely, a systemic bottleneck is a phenomenon through which many other changes in the system must pass. It is important to consider both types of phenomena in a transformation strategy. As we argue, programmes designed to address both functions will maximize their potential for accelerating change across the whole system.

Towards Systemic Approaches to Theories of Change

Theories of Change (ToCs) articulate the assumptions and logic of a change programme (Funnell & Rogers, 2011). ToCs are typically represented by a log model (commonly called a "logframe"): a visual flowchart of how planned actions affect objectives and outcomes, which eventually lead to an ultimate impact the intervention aims to create. When done well, they provide a variety of valuable functions. For instance, they render visible the mental model of change initiatives, allowing all stakeholders to see themselves in the work. They encourage change designers to articulate, challenge, and test the assumptions at the core of their initiatives. They provide a clear set of waypoints or measures that can be used in monitoring and evaluation efforts. By providing a simple way of communicating these aspects of the complexity involved in change work, ToCs have become common in social innovation and philanthropy (Jones & Murphy,2021; Murphy & Jones, 2020c).

In recent work, however, we have criticized conventional theories of change (Jones & Murphy,2021; Jones, 2020; Murphy & Jones, 2020c; Murphy & Jones, 2020a). As described above, ToCs are often represented as models of one-way change pathways. While ToCs are usually developed to address complex issues, they usually fail to capture the feedbacks, side effects, and other systems structures common to complex systems. We propose alternative approaches to ToCs that account for these ideas that are so crucial to systemic change. In this work, we examined the ToCs embedded in the Joint SDG Fund's portfolio of programmes, clustering the ToCs into categories and comparing these groups to qualify their potential for systemic acceleration.

Study and Methods

Context: The UN Joint SDG Fund

The UN Joint SDG Fund was launched as a global, multi-sectoral vehicle for policy innovation and financing for acceleration of the progress on the SDGs and the 2030 Agenda for Sustainable Development (https://www.jointsdgfund.org). Its core mandate is to invest in solutions that produce transformative results that catalyze change across systems, sectors, and industries. The Joint SDG Fund aims to facilitate the design of policy innovations for accelerating progress on specific SDGs (Rava, 2019). The Fund is led by the Deputy Secretary-General and managed by an inter-agency UN committee.

The first portfolio of the Joint SDG Fund (https://www.jointsdgfund.org/integrated-social-protection) was launched in 2020 with the overall investment of USD 102 million over two years. It includes 35 Joint Programmes (JPs) in 39 countries that are implemented with stakeholder collaboration across more than 11 sectors, and with the involvement of more than 600 partners (including national and local governments). The JPs are expected to deliver transformative results at scale by innovating over 100 policies through systemic approach. They intend to accelerate the progress across 53 SDG targets and produce new solutions in the space of social protection of the most vulnerable, i.e. solutions that "leave no one behind" (LNOB; 2018; Rava & Kurbiel, 2020).

In this work, we analyzed 35 full JP documents, 35 annual reports, and mid-term reviews of the portfolio. The JP documents contain extensive descriptions of strategy, expected results, and plans. The mid-term and annual reports document the progress from the first year of implementation and plans for the second, and final, year.

Analysis and Results

Theory of Change Typology

Each JP included their Theory of Change (ToC) in their initial proposals, visualizing the proposed actions of the JP within the structure of their strategies for change. An analysis table was structured using the SDG JP's data and categories, which included the following information:

Table 1. Analysis table of the Joint Programme Theories of Change.

Country, Program Title, Country size/geography (for clustering)	
Description, Approach, Target Groups, UN Agencies involved, Priority SDGs	
Theory of Change Model type	One of 4 types (including "other)
Assumptions & Leverage	Quality of & reference to assumptions Indication of leverage in any actions / outcomes (Y/N)
ToC fit to SDGs	Whether the ToC references the SDG / targets in the model

The coding for this assessment was made by identifying a limited number of criteria for each JP, by analysing the ToC models included in the original JP documents.

All 35 programmes were reviewed from the perspective of their descriptions of ToCs. The first assessment was to determine and categorize by the type of ToC. The working theory associated with this analysis is that more complex, deeply-reasoned Theories of Change would be associated with higher complexity programmes, that recognized the necessity for considering multiple dimensions and factors in the change programme, and that these factors might be reflected in their performance. In short, we might expect better-quality ToCs to be associated with either a) higher complexity conditions than most and/or b) better performance due to the recognition of systemic and reinforcing factors in the programme's social environment.

Theory of Change Typology

The simple analysis at this stage only took into consideration the ToC format. We did not analyse actual content or internal dynamics (i.e., the relative quality of relationships between an action to output to outcome). However, even such a top-level analysis has never been completed to our knowledge, with a set of strategy models associated with major change programmes. There are several leading theory of change advisors that publish ideas and developments, but their primary emphasis is on strategic communication to donors, and not analysis addressing more complex systemic logic. There is usually an attempt to simplify the ToC so that it can be used for programme communication and evaluation purposes. This purpose must be considered in our context as well.

Four Sensemaking Logics of Transformation

While we continue to explore the literature and study the various formats that represent ToCs, there are four models to which most ToCs can be assigned:

1. **Action–Outcome**
2. **Influence Pathways**
3. **Complexity Process**
4. **Movement Coordination**

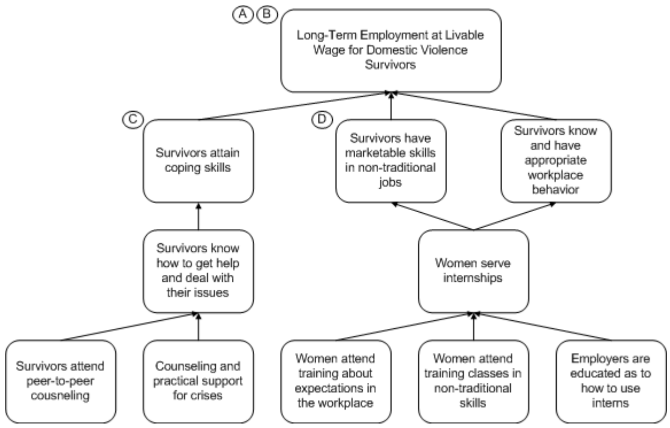

Figure 1. An example of an Action–Outcome model.

The **Action–Outcome Model** includes the classic logframe, but not all Action-Outcomes are logframes.The standard ToC model is presented as a series of stages and directed links (arcs) between action steps and the proposed outcomes of actions toward change.

- Simple steps
- Communicates clearly
- Can be linear yet systemic
- Forward or back-logic

A distinguishing feature of most standard logframes is a series of stages of different types of activities or effects. These are typically located from the bottom-up in the order from most foundational and initial (assumptions), and near-term (actions) to the later-stage outcomes and impacts.

- Assumptions
- Actions or Activities
- Outputs or Results
- Outcomes or Effects
- Final Result or Impacts

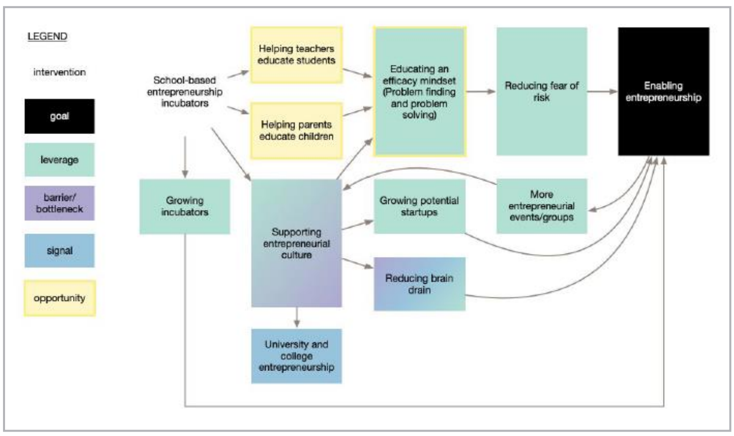

Figure 2. An example of an Influence Pathways model.

The **Influence Pathways Model** uses directed arcs to indicate pathways of reinforcing action or influence on successive actions. The main visual difference from Action-Outcome is the lack of formal stages, but instead using a more freely-connected set of relations similar to complex system models. The influence pathways enables a more systemic (complex) network of relations, but is not systematic in the sense of structured forms as the logframe. Characteristics include:

- Simple formalism of boxes and arrows
- Directed graphs are meaningful influences

- Can show influence networks, or cycles (reinforcing sets) or loops
- Supports progressive abductive reasoning or identifying leverage
- Forward logic based on relational mapping, i.e. "progress on A influences significant progress on B"

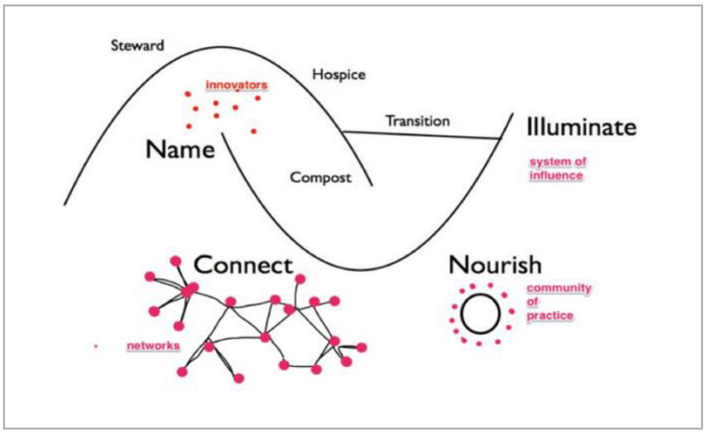

Figure 3. An Illustration of the Complexity Process model.

A **Complexity Process Model** shows a more fluid of pictorial theory of change that describes the process of change within a complex environment. We can consider these models "complex ToCs within a complex field." In most cases these are hybrid graphic models, using iconic imagery and directionality to present an abstract model of change in a complex system.

The well-known Berkana[1] ToC is considered a complexity model, showing an existing complex system (the down-turning curve) is displaced by the upturning curve of a new system.These are complex, nonlinear processes with unpredictable outcomes, yet the processes are considered viable to due the coordination of synergistic resources toward an intended telos, or direction.

While there are no standard formalisms in a complexity model, the distinctions include:

- Representations of different external system factors
- Some depiction of complex interactions, or conflicts, representing barriers to change to overcome
- Indications of complex system dynamics or interactions, whether using system models (e.g. the Panarchy adaptive cycle) or freehand graphic representations (such as in a Rich Picture).

The **Movement Coordination**, as suggested by the label is a theory of change model that represents a network of related change initiatives as social movements. The ToC is based on many movements reinforcing one another, as represented in this example from the McConnell Foundation. The Movement style is more relevant to within-country and regional social change projects, for programs working with NGO coordination, organic social change projects led by citizens, and supported by social philanthropy.

[1] The Berkana "Two Loop" theory of change was formulated with Meg Wheatley and Berkana Institute, and has been adopted by many programs as a complex yet natural model process change. https://stream.syscoi.com/2018/02/28/our-theory-of-change-the-berkana-institute/

Figure 4. An example of a Movement Coordination model.

We can also identify in the sample at least one simple logic, or even "no apparent" logic that merely indicates the proposals of activities within a JP.

Programme Analysis

A summary analysis of ten joint program ToCs was conducted to assess the potential performance improvement of ToCs. A rapid evaluation of the ToCs across all 35 JP plans, clustered the models by categories that represent the degree to which significant attributes of complexity reasoning are apparent.

Selection of Sample Joint Programs

Ten joint programs were identified to represent a range of types, of social protection approaches, and performance outcomes. All had significantly different contexts and initial conditions, that might influence the effectiveness of a given ToC approach, as well as performance to plan.

Model Clustering

A clustering analysis of the total set of 35 JP models sorted out the set according to a) a determination of the general *type* of ToC (whether a traditional logframe or a systemic or atypical type) and b) their categorization according to the four ToC *models* based on system logic, noted above.

Number of ToCs by Type

The types were determined by characterizing elements of the ToCs from their descriptions.

- 20 Standard Logframe or logic model
- 5 Graphic Logframes
- 7 Systemic types (one of the three systemic models defined above)
- 3 Other (custom or indeterminate)

Number of ToCs by System Models

The models were determined by clustering the ToCs according to the systemic logic represented by the JP descriptions. In most cases, the standard logframes are directly defined as Action-Outcome. The "Weak A-O" are traditional logic models with poor inter-model linking characteristics. The Influence Pathways and Complexity models were the most "systemic" of the ToCs,

- 20 Action-Outcome
- 3 "Weak A-O"
- 4 Influence Pathways
- 3 Complexity Process
- 5 Simple, or no apparent logic

- o Movement coordination

The purpose of this classification was to identify the best candidates for further analysis of effectiveness or correspondence to outcome based on the assessed reasoning and representation of complexity in the Theory of Change.

Standard Logframe Type

Most of the Joint Program theories of change were conventional change logic models, presented in a framework known as the logframe (logic framework). These are tables showing, from bottom-up: Activities, Outputs, Outcomes, to Goal.The Goal state was often the SDGs or targets proposed in the plan.

Theory of Leverage for the UN Joint SDG Fund Portfolio of Joint Programmes

We sought to understand the Joint SDG Fund's JPs as a system of targets. Discovering the structure of this system will illustrate how the Joint SDG Fund's SDG accelerates the SDGs as a whole. Additionally, exploring this system's features—especially its leverage points and bottlenecks—may provide some insights useful in future planning and programme design.

We first adopted a baseline logical framework for Social Protection. This framework establishes an initial causal structure for the JPs and their selected targets. The chosen framework was first used in the Joint SDG Fund's 2019 Annual Report, "Setting the Foundations." (https://www.jointsdgfund.org/article/setting-foundations-2019-progress-report)

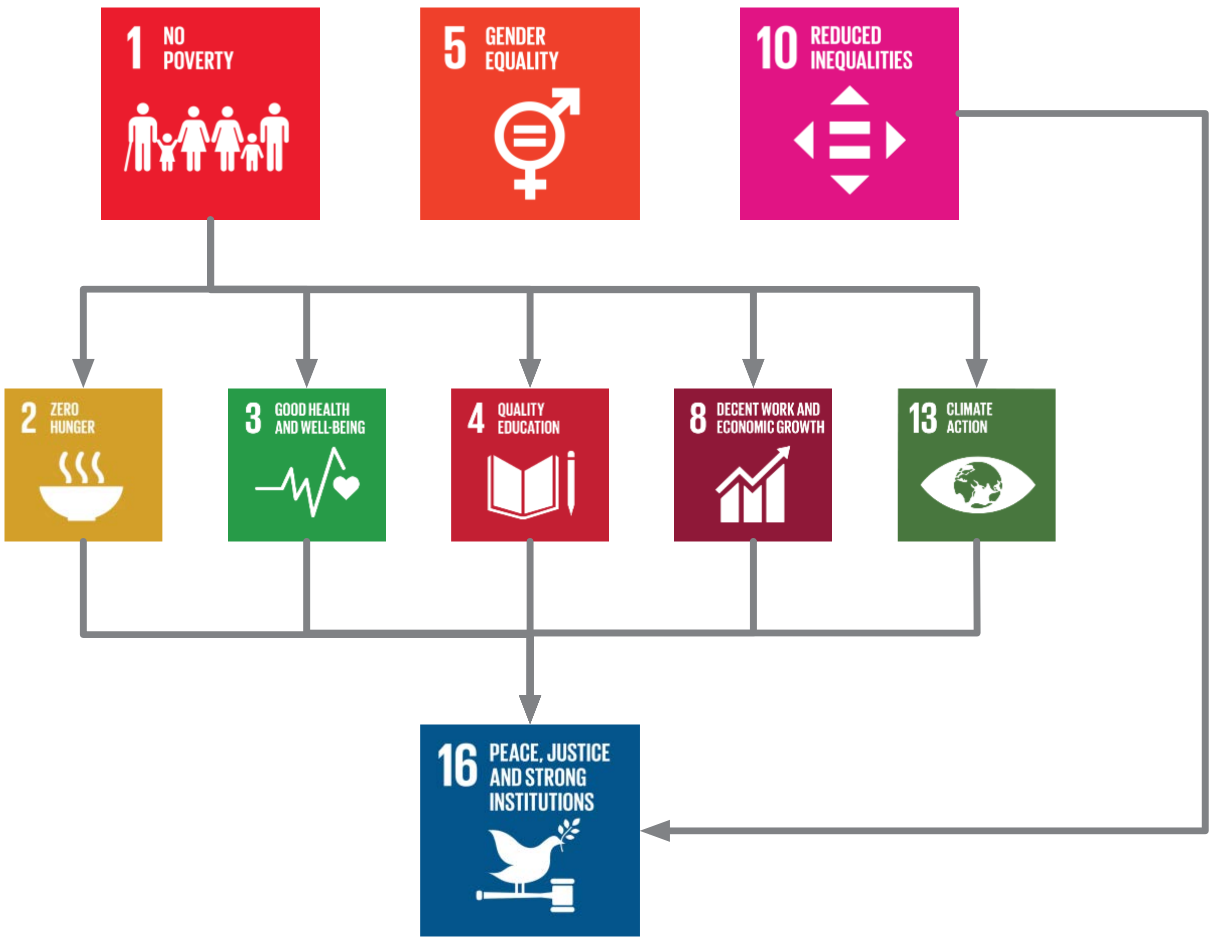

Figure 5. The baseline logical framework for Social Protection used in this study.

Modelling the SDGs and their Targets

The online systems modelling software Kumu (https://kumu.io) was used to create an interactive data-driven models of the SDGs and targets[2]. The baseline framework was modelled in Kumu as an influence diagram, making connections between the goals according to the arrows in the framework.

Modelling JPs Target selection

Next, we used the initial proposals from each JP to identify the priority targets each country selected for their overall strategy. These selections represent the targets and—by proxy, the SDGs—that each country sought to accelerate through the JP. Each of these Targets was added to the Kumu model and causally connected to the appropriate goal. Metadata was added to targets to indicate which countries chose them as overall priorities.

Establishing causal complexity

To appreciate the complex causal structure of Goals and Targets, we drew on Le Blanc (2015). We adapted Le Blanc's model by drawing connections from Targets selected by JPs to other Goals. For instance, according to Le Blanc's analysis, progress on Target 1.3 ("Implement nationally appropriate social protection systems and measures for all, including floors, and by 2030 achieve substantial coverage of the poor and the vulnerable") directly supports goal 10 ("Reduced Inequalities") as well as Goal 1 ("No Poverty").

After including the Social Protection baseline framework, the JPs' selected Targets, and Le Blanc's linkages between Targets and Goals, the model contained 56 different phenomena (9 Goals and 47 Targets) with 88 connections between them. (We did not include SDGs 11 and 17 and their associated targets in this analysis, as causal relationships between these Goals/Targets and the rest of the model were not provided by either our baseline logical framework or by Le Blanc's analysis.)

Leverage analysis

We conducted leverage analysis to investigate the complex causal structure of the resulting model. In our approach, we used graph theory algorithms to identify Targets that are potential leverage points and bottlenecks. These algorithms evaluate the connectivity of the system by giving relative scores to Targets that e.g., are more well-connected to the rest of the system, or that are often found on paths between other Targets. The exact measures we used are described in the Results section below.

[2] This model is available for further exploration, and its data may be exported in .xlsx or .csv formats for use in other applications: **https://www.kumu.io/systemicdesign/lnob-v2#jp-toc** For an interactive walkthrough of this report and model see: https://systemicdesign.kumu.io/lnob-jp-leverage-analysis-model?token=9V9L3uJHxw6VZ9sX

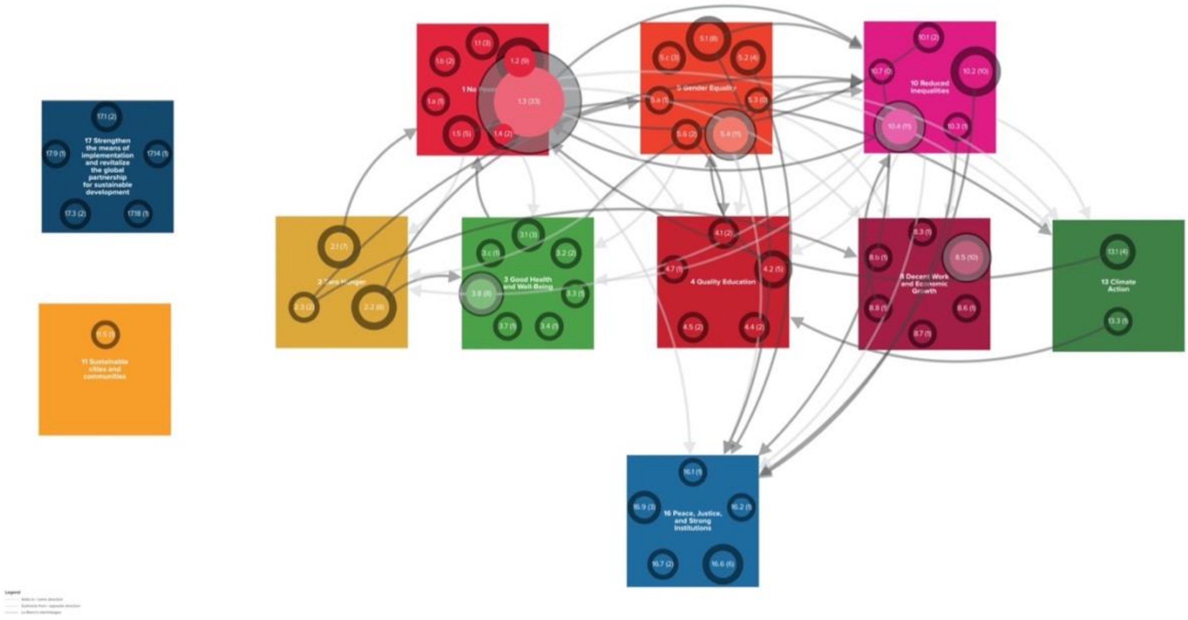

Figure 6. JPs' selected SDG Targets across the baseline logical framework

The JPs collectively selected 53 unique Targets. Because the selection of targets was not informed by the logical framework above, a good test for whether the framework included and structured appropriate SDGs is whether the JPs selected Targets from those Goals. Indeed, most Targets selected by JPs came from the goals above.

Leverage points

Recall that a leverage point is a place within the system where a little effort yields more change throughout the rest of the system. To identify high-leverage targets in this system, we used a weighted reach measure. This scored each Target and Goal by how quickly change would propagate from it to the rest of the system, weighted by how well-connected each phenomenon is to other well-connected phenomena. We identified six candidate leverage points: SDG Targets 10.4, 10.1, 2.2, 2.3, and 5.1. These are illustrated in the figure below.

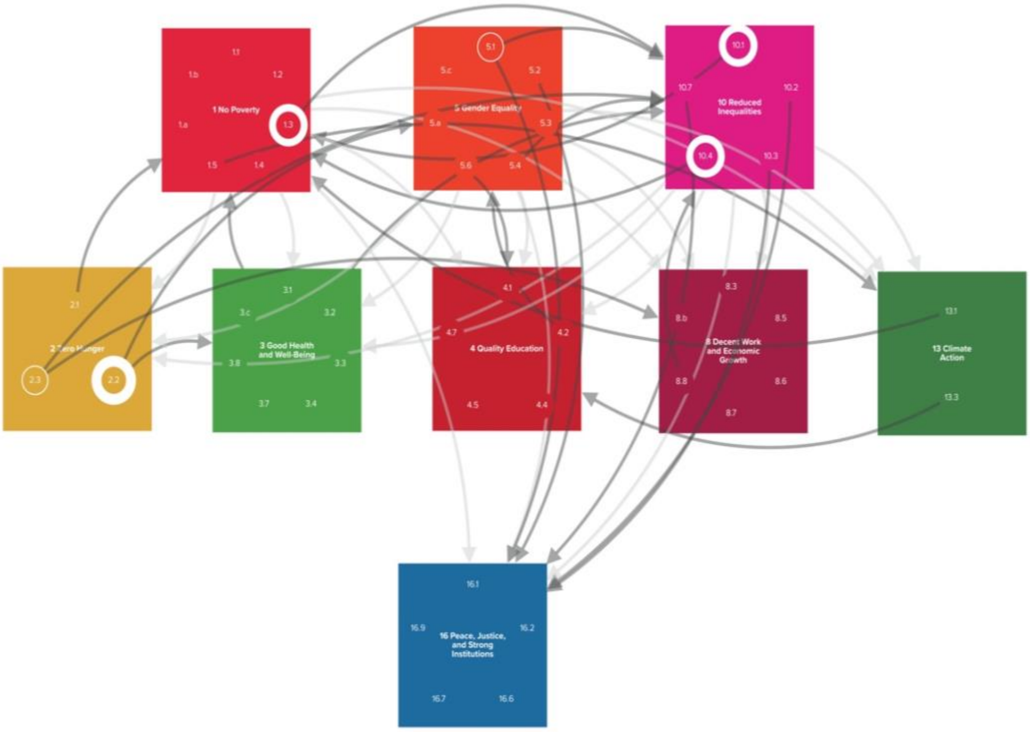

Figure 7. Highlighted leverage points across the system of SDG Targets.

It is important to remember that leverage points are not necessarily the most "powerful" or "important" phenomena, but rather phenomena that, where change can occur according to the causal structure we have mapped of change propagation, effort placed on changing these factors will likely yield progress elsewhere in the system (relative to change in other phenomena). Thus, the Targets listed above are indicative of potentially high-yield strategies for SDG acceleration. It is possible that JPs addressing these Targets early on may see greater systemic progress as a result.

Bottlenecks

A systemic bottleneck is a phenomenon between many other phenomena. To identify potential bottlenecks, we used a betweenness measure, which scores phenomena according to how often they appear on the shortest path between every other phenomena in the system. In other words, for the system to change overall, changes that happen throughout the system likely "pass through" these bottlenecks. In turn, it may be strategic to address these bottlenecks in initiatives that aspire to systemic change.

We identified six potential bottlenecks in this system of Goals and Targets: 4.2, 8.8, 2.2, 13.1, 10.1, and 10.4. They are illustrated in the figure below.

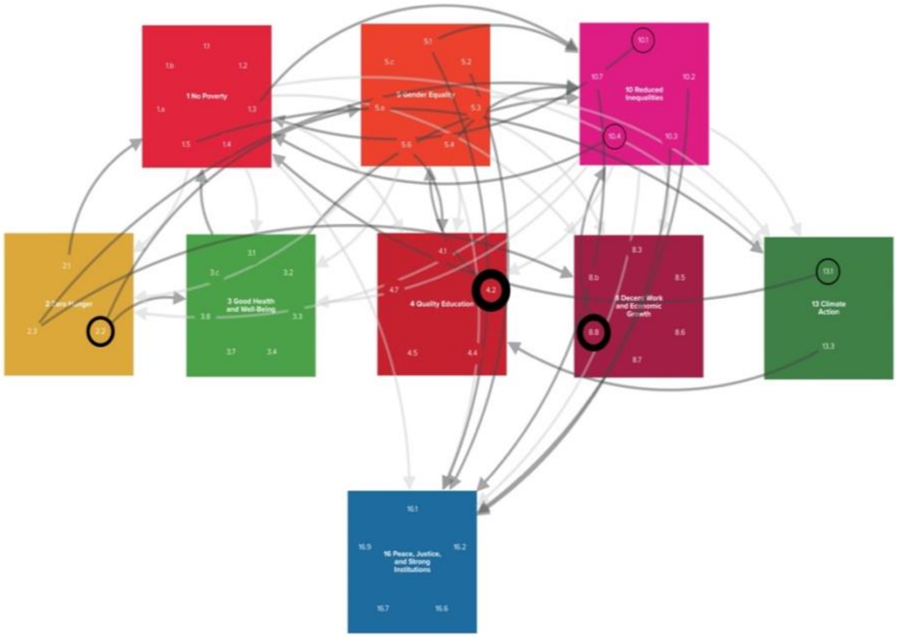

Figure 8. Highlighted systemic bottlenecks across the system of SDG Targets.

An implication of bottleneck phenomena is that no matter how significantly another part of the system may be changed, systemic progress may be limited if bottlenecks are not addressed as well. Thus, a given country's Social Protection strategy that aims to accelerate this portfolio of Goals and Targets should consider the state of the above phenomena in the country's context. If the strategy focuses on other Targets, but these aspects of the system are not in good condition, the strategy may not lead to sufficient systemic change.

Case Analysis of Systemic Theories of Change

To investigate the JP's Theories of Change further, we conducted a case-based analysis of several specific JPs. A defined set of criteria for evaluating systemic theories of change was articulated by analysis of the represented, expected and preferred qualities across the program cases. These principles help assess systemic qualities that might help us evaluate the fit of a model and to compare effectiveness. We identified nine important elements that should be included in a systemic theory of change, and for which we assessed the sample in the context of SDG acceleration.

1. **Degree of integration** – How well do the components of the ToC align together (internal coordination) and how well do they integrate with or address external environmental forces or contingencies (external?)

2. **Identifies systemic risks to performance** – Does the ToC present substantive risk potentials that reveal foresight into potential programme outcomes? Scores are Yes/No, and "Some are indicated."

3. **Presents relevant complexity** – This aspect of the ToC comes from unique aspects of the change model, and it's clearly a judgement as to whether sufficient "complexity" is disclosed. We look for whether the ToC shows awareness of real-world complexity in the JP activities and outcomes.

4. **Identifies specific SDGs** – Scored Yes/No as to whether specific prospective final impacts of the JP model were identified, and if so whether at the SDG target level.

5. **Relevant representation of acceleration toward impact on SDG targets** – A judgment is made as to whether specific activities or outcomes are indicated as contributing to SDG acceleration.

6. Identifies leverage or key factors / activities notably responsible for acceleration. Yes/No

7. **Reveals influence relationships between activities or across the set of outcomes** – Are well-defined connectors or pathways defined for a series of events? Yes/No

8. **Some degree of feedback between activities and outcomes** – This is perhaps very rare, and only seen in some ToCs where cross-connecting lines across activities are found. Expect No/Some/Maybe

9. **Is evaluable via GUIDE criteria** – Patton evaluation principles: Guiding, Useful, Inspiring, Developmental, and Evaluable

Public disclosure is not provided of further details from the case studies here. The summary analysis showed that only seven of the 35 ToCs distinguished complexity or systemic relationships as assessed by these criteria in the planning logic. Most were purely functional, linear logic models or representations of the development plan.

Leverage Analysis of Joint Programme Change Strategies

Last, we conducted a case-based analysis of the theories of leverage of four JPs. These case study analyses investigated each JP's systemic change approach and their potential for the systemic acceleration—especially in terms of progress towards the JP's selected Targets. The goal is to identify the key levers and bottlenecks for whole system change at scale, and to assess the degree to which the JP addresses these phenomena as a proxy for its systemic acceleration potential. We propose that a JP that addresses systems-level phenomena with a leverage-based strategy will be better positioned to accelerate progress on its chosen targets.

Ideally, we would have conducted this analysis on systems models that were created by the teams behind the JPs. Unfortunately, none of the cases included a systems-level understanding of the JP and the issues it targeted. So, these analyses are illustrative of how this approach may enhance future JPs ability to accelerate the SDGs and their Targets through systemically-informed strategy. In other words, insights are not intended to apply to the JPs immediate operations but to inform each country's Social Protection change strategy over time.

Phenomenological Analysis

First, we conducted a deep reading of each JP's strategy, reviewing the Overview and the JP's graphical representation of its Theory of Change. During review, we highlighted phrases or concepts that referred to specific phenomena operating in the system at hand. The goal of this step was to identify every possible significant phenomenon influencing the JP and its goals. This step results in a list of phrases extracted from the report that capture the system's phenomena.

Phenomenological conversion

The tokens from phenomenological analysis are directly excerpted from the text of the JP docs. In the second step, we abstracted these phrases into systems phenomena. For instance, one outcome in a programme strategy states "At least 1,400 children under 12 months are benefiting from a new integrated package of welfare services ...." We converted this to the "Number of recipients of integrated welfare services, including the new MECG, early childhood wellbeing services, and support for birth registration." Then, we identified and combined converted phrases that referred to the same phenomena. For example, we had identified multiple tokens that referred to the government 's capacity to implement the JP. These were combined.

Each of the unique phenomena resulting from this step were modelled as elements in Kumu.

Causal inference

Next, we inferred direct causal relationships between these phenomena based on our understanding of the JP. This resulted in an influence diagram showing the systemic structure of the phenomena modelled in the previous step.

Graph-based leverage analysis

We applied graph theory algorithms to evaluate the structure of the resulting model to identify potential candidates for leverage and for systemic bottlenecks.Phenomena were scored by their systemic reach (how "close" they are to every other element in the system) weighted by eigenvector scores (how connected each phenomena is to other well-connected elements) to reveal potential leverage. High eigenvector-weighted reach scores suggest that change will propagate quickly from the given phenomenon.

To reveal potential bottlenecks, we scored phenomena by their *betweenness*: the more often a phenomenon sits on the shortest path between two other phenomena, the higher its betweenness score. High betweenness scores therefore suggest phenomena that sit between the paths of change throughout the system.

Evaluation

The results of leverage analysis were then used to analyse the JP's strategy. The leverage points and bottlenecks resulting from leverage analysis were compared with each JP's Results Frameworks, Work Plans, and Risk Management Plans. These plans were used as concrete illustrations of the actual initiatives, actions, and measures the JP would be using. In other words, they represent the operationalization of the Theory of Change (and the JP in general).

In our comparison, we assessed the degree to which the leverage points and bottlenecks we identified were directly addressed in the three plans to identify potential weaknesses in the JP's attempts to generate systemic change. Scores were assigned from "weak" to "strong," indicating how well a given JP addresses potential leverage points and bottlenecks in their plans—indicators of the JP's potential for systemic acceleration.

Results

The degree of complexity and the scope of phenomena captured by the systems models we were able to generate from each JP varied widely. One JP's model contained 27 phenomena and 49 connections; the second, 29 phenomena and 80 connections; the third, 48 phenomena and 128 connections, and so on.The third JP's systems model not only had more phenomena and connections, but these phenomena seemed to account for broader aspects of the system than those modelled from the other JPs. This may indicate the JP was more effectively designed to facilitate systemic change. Evaluating the role these attributes play in the JP's systems change strategy was not explicitly part of our evaluation, however. Perhaps in future studies we may use the quantity, depth, and breadth of phenomena in the modelled systems as a rough method of gauging how each JP appreciated the complexity of the systems they sought to change.

Each JP generally addressed some of the identified key phenomena, but not all of them. The gaps indicate potential weak points in each JP's potential for systemic change. Most of these weak points are addressed at least indirectly. However, if the evaluation we have presented represents valid conclusions about the state of these systems and the strategies of the JPs, addressing them directly may enable deeper impact in the systems they aim to change.

An important limitation of this work is the constraint of inference. Certainly, if each country's planners were to develop their strategies with a systems approach, they may have come to different conclusions. So, we have not presented an ecologically defensible systemic understanding of these issues. We acknowledge that we are likely missing substantial contextual understanding and expertise necessary to make proper judgments about the causal nature of the systems and their environments in these countries. Instead, we have presented what might be, as a systemic design proposal. Our approach shows that it is possible to appreciate the complex structure of these systems, to embed in that structure the change we aim to make, and to then be strategic about how we go about making that change in order to accelerate progress.

This, then, is the most important takeaway from this analysis: these JPs were not necessarily designed with systemic change in mind. Indeed, the JPs focus on implementation and operationalization of initiatives *only* within the scope of the JP. Rarely are the long-term systemic consequences of programming directly considered. The Sustainable Development Goals and their Targets, however, are clearly large-scale long-term phenomena. Acceleration of our achievement of these Goals and Targets must take large-scale long-term contexts into account. It was generally challenging to infer the causal relationship between the JPs and the SDG Targets they were supposed to address, likely due to this disconnect between JP planning and systemic acceleration of the SDGs.

Ultimately, we propose that future JPs should take systemic theories of change and systemic leverage into account to develop strategic approaches to SDGs acceleration and systemic change.

Discussion

The study presented was based entirely on a rapid collaborative research project conducted jointly by the authors in association with the UN Joint SDG Fund. While the relevant findings have real significance for the country joint programmes analysed and the SDG programme overall, we believe the methodology, evaluation approach, and analytical framework to be highly relevant to the systemic design community.Several general recommendations apply to perhaps any transformation program considering systemic design methods and systemic theories of change.

A significant tension we can recognize is the conflict between means and ends as suggested earlier in the discussion, with respect to the desirable tools of acceleration to achieve targets more effectively for systemic impact. It is well-known among program evaluators that attempts to accelerate complex projects can be counter-productive, as it risks focusing resources on single avenues for change that may be misleading. Planners will often accelerate entire projects and major goals, whereas leverage analysis aims to locate more particular actions that might have influence across multiple targets. Systemic reasoning must be used to identify these counterintuitive leverages for acceleration. Otherwise, single-purpose objectives may be accelerated in schedule or objective without accomplishing ultimate impacts.

Another tension is the capture of transformation planning by the very idea of acceleration as a good in its own right. With the pressure to achieve significant responses to the SDG targets, the desirability of acceleration (in each country situation) can lead to a risk of an accelerationist mindset to hasten outcomes. We propose leverage analysis and systemic theories of change as an ethical orientation to determine the most effective, "natural" points of acceleration that can be discovered uniquely in each social ecology and can be determined by the felicitous relationships of SDG targets to each other. While acceleration is a means to an end, it can become a goal in itself, and its pursuit must be balanced by an analysis of long-term impact and consequences.

Strategies for accelerating systems change

We are confident that even the most thoughtfully prepared ToC models using conventional descriptions inherit the format and logic from a much earlier generation of change programs. The UN is now dealing with goals and intended outcomes of programmes dealing with higher-complexity issues than can be adequately modeled. We find a tension with the necessity to communicate transformation proposals effectively to a mixed group of funders and reviewers, with realistic pressures to keep these models as simple as necessary. Design planners might be dissuaded from risking higher complexity models, but these might also communicate much more effectively the knowledge of real complexity in the programme.

The criteria developed for assessing the effectiveness and communicative potential of theories of change can be employed as guidelines for many programme types. These criteria are associated with the most critical functions of the ToC and could also be used as advance proposal guidelines, as checklists for new ToC or programme change goals.

The benefits to designing a systemic theory of change approach (a modeling framework and set of evaluable criteria) would potentially help with all types of transformation proposals in the emerging model of philanthropy funding for system change programs. Funders should be requesting systemic theories of change to get a better grip on the approaches to deal with higher complexity in system transformation.

Without some model of the most significant leverage and contributions and relationships, program leaders are left to guess at which levers and actions would integrate to sustain a program strategy. A systemic theory of change is not a guarantee or single solution, but it could become a necessary tool in the leadership and decision-making in systems change.

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Track 9:

Recognizing Trouble For Changemaking

Chair: Dr. Josina Vink

Design by Doing in Louisiana Farmers Markets:

Adaptive Cycles, Learning and Innovating in the Time of the COVID-19 Crisis

Mikal M Giancola, MPH, Eve C. Pinsker, PhD

In March 2020, the Louisiana Healthy Communities Coalition (LHCC) funded two farmers markets to adapt after COVID-19 halted in-person operations. Consumption of healthy foods at farmers markets, especially among poor and minority communities, is a subsidized public health priority in the US (USDA, 2021). Funding supported marketing, adopting online platforms, and farmer incentives. An initial study examining the changes in these farmers markets during COVID-19 investigates if innovation occurred, the factors that influence innovation, the types of learning that facilitated innovating, how COVID-19 influenced learning and innovation. More broadly, the paper discusses how public health institutions can support innovation as co-creators. Qualitative methods were used to analyse documents and transcripts (Miles, Huberman, & Saldaña, 2020). A modified Holling's cycle served as an analytic model to understand how innovation after a crisis unfolds over time (Fath, Dean, & Katzmair, 2015). Analysis showed during COVID-19, LHCC support resulted in multiple innovations supporting short-term resilience. The discussion demonstrates learning over time addresses the tension between design of interventions as an initial, strategic planning process vs. iterative cycles of co-creating, learning and co-evolving.

Keywords: PSE change, farmers markets, innovation, learning

Introduction

This case study of Louisiana farmers markets discusses underlying issues related to innovation and systemic design: to what extent can social innovation be intentionally "designed" in a guided, stepwise fashion? "Co-creation" is often invoked as a model for participatory design processes, but what does this mean about how participants and facilitators need to learn from each other, in a complex adaptive process of learning and co-evolution? As public health practitioners acting as facilitators worked with farmers market managers and other partners on this project and reflected together through multiple cycles of discussion and action, from planning and initial design to implementation and evaluation, and adaptation and innovation, initial efforts resulted in consequences both planned and unplanned. What does this tell us about how we can facilitate the kind of co-learning that leads to successful innovative responses to complex challenges? This work is embedded in multiple tensions: between individualism and public good, between innovation and regulation, and between top-down approaches to planning and design in contrast to an emphasis on continued cycles of improvisation and learning.

Public Health and Systemic Design

Public health as a field has charged itself with the daunting task of maintaining and improving the public, communal, and societal conditions that support health in individuals and communities, whether that means taking necessary steps to halt the spread of infectious pathogens, assuring access to clinical preventive measures such as vaccines, decreasing environmental toxins, or assuring that all members of the human population have access to what is required to maintain health, including safe conditions for physical activity as well as healthy food. Within the field of United States (US) public health, there is an increasing need to address the broad contexts of the requirements and resources for health. The systemic nature of structural and social interconnections has prompted discussions of the "social determinants of health" – housing, jobs and income, education, the built environment, sustainable food systems, racial and ethnic discrimination vs. equity, etc.

(Liburd et al., 2020). Following that logic, public health must involve itself in community and societal levels of intervention and social innovation. Since 2006, there have been increasing calls for the role of systems science and systems thinking in designing and evaluating such interventions, from complex system modelling and network analysis used as research methods, to systems thinking approaches in community participatory action research and leadership training for public health practitioners (Leischow & Milstein, 2006; Rowitz, 2005; Welter et al., 2021). At the systems thinking and practice end of this spectrum, the inclusion of designing social interventions in the current public health agenda intersects with the emerging field of systemic design (Nogueira & Schmidt, 2021).

Policy, Systems, and Environmental Change(s)

The recognition in US public health of multiple levels of socioecological context, (referred to as "the socioecological model" (SEM)) as well the role of the social determinants of health (SDOH), has led to current efforts to develop systemic approaches to planning intervention. In the last two decades, policy, systems and environmental change (PSE) strategies have been increasingly promoted by the US Centers for Disease Control and Prevention (CDC) and adopted as part of designing and planning US local and state public health interventions (Asada, Lieberman, Neubauer, Hanneke, & Fagen, 2018). Designing, adopting, and adapting PSE interventions often faces the tension of deciding when a problem can be addressed by a change in processes that can be controlled within an organization or in agreements between organizations as opposed to requiring new or amended legislation, whether at the level of local ordinances or at state or federal levels. Innovations often come up against existing regulations that need to be amended – for instance in some US jurisdictions legislation on the use of SNAP cards providing food assistance (discussed below), needed to be amended to permit their use at farmers markets, when earlier regulations only permitted their use at grocery stores. Digging deeper, however, the tension is not just between institutional vs. legislative approaches to change, but between bottom-up, community-based experimentation and learning as the source of innovation vs. top-down policy debates informed by expertise that may come from evidence divorced from community context and not reflect the perspectives of those most affected by the policies.

Andre Noguiera and his colleagues' work on food waste in Chicago shows a route to mediating the tension between top-down and bottom-up approaches to policy change:

> "The shift from a linear progression of steps to a discursive set of modes with a clear structure of content to navigate between them presents a reframe to conventional practices of policy design. Rather than considering policy design a project, with a clear beginning and end, this approach suggests that changes in contexts will result from a continually evolving, socially informed set of interventions that are adaptive, public, and relational in their dynamics. . ." (Nogueira & Schmidt 2021, p. 13)

Nogueira and his colleagues used "participatory prototyping," with the involvement of multiple stakeholders over several years, to develop and implement new approaches to food waste in Chicago. The cases of farmers' market innovation in this case study, in contrast, did not have the benefit of the time, resources and design expertise that went into Noguiera et al.'s work, which included a planning process leading up to a 2 and a 1/2-day conference involving 130 participants and 35+ organizations, and follow up communication supporting prototypical experiments in the food system (Nogueira & Schmidt, pp. 9-13). The Louisiana farmers market leaders did not have the luxury of learning about design models, and they were struggling to get food to people who needed it in the rapidly changing and challenging context of the pandemic. Both cases however show the importance of "learning by doing" (ibid, p. 15) as opposed to coming up with design solutions at one go. This however emphasizes the importance of learning, highlighted here through discussion of the evolution of the Louisiana farmers market innovations, catalyzed by the COVID-19 crisis.

The Context for Intervention

For better or worse, crises generate optimal conditions for systemic change because the assumptions and functions of the prior system are neither applicable nor viable (Watzlawick, Weakland, & Fisch, 2011). COVID-19 forced many systems to innovate or perish, especially those related to food systems because they were among the most affected by new norms governing interactions. COVID-19 is stark reminder of the close interconnectedness or human beings with ecological systems, especially the food system that is essential to health and life itself (Attenborough, 2020).

Protecting local and regional farmers markets from collapse is important on many levels. Most relevant to this case, farmers and farmers markets were responsive to local needs for fresh foods when the global food supply-chain was disrupted, and grocery store shelves went empty. Local farmers enhance ecological resilience by producing diverse varieties of fruits and vegetables, in contrast to monocropping (Costello et al, 2009). Other benefits of local food producers, when compared to industrial agriculture, include a reduced carbon footprint from a shorter transportation chain, and reduced refrigeration times for produce (Olson, 2019). Local food also is handled by fewer processors than industrial sources, reducing opportunities for contamination (Marusak et al., 2021). Contemporary public perceptions of farmers market customers are associated with people with wealth and privilege, and many low-income individuals do not use farmers markets because they perceive prices to be too high (Freedman et al, 2016). However, subsidized farmers markets (i.e., support through the Supplemental Nutrition Assistance Program (SNAP)) are used as an evidence-based, public health strategy to address insufficient consumption of fresh fruit and vegetables in the US (Kahin, Wright, Pejavara, & Kim, 2017; US Department of Agriculture (USDA), 2021).

In March of 2020, when the COVID-19 stay-at-home order ended in-person gathering, a ripple effect ensued. The interconnected local and cultural, tourist economy in Louisiana, halted. Farmers markets ceased operations, and they had no outlet for their products. Many began feeding their crops to their livestock. In response to the crisis, the Louisiana Healthy Communities Coalition (LHCC), the state's health coalition, issued requests for proposals ($3,000 or less) to support food systems to implement PSE change. Among the awardees were two farmers markets that used technology to innovate operations with contactless inventory, payment, and delivery. The markets also promoted themselves on social media. This paper addresses the following questions using the documents available from the mini-grant funded projects as evidence:

1. Did the farmer's market initiatives promote innovation in the food system?

2. What types of learning facilitated innovation? What other factors were facilitating innovation?

3. How did the situation with COVID-19 affect the ability of stakeholders involved with the farmers markets to learn and innovate over time?

Methods

Qualitative methods were used to conduct a systematic document review of program records (Grant application, grant report, evaluation survey, and presentation). Documents and audio transcriptions were stored in MaxQDA©, a software for computer assisted qualitative data. Documents were organized by the dates in which they were submitted, and after an initial reading, reflective memos were written.

After organizing and reviewing the documents, several qualitative analysis data display tools were used to trace and visualize the evolution of learning that resulted in sustainable innovation for these farmers markets. A time-ordered matrix reflecting how the project work unfolded over time was created with Microsoft Excel©. See Miles, Huberman, & Saldaña (2020) on time ordered matrices as a qualitative analysis tool; see the appendix for the matrix. In the matrix, the document type and date are listed at the top of columns horizontally. Vertically on the left, the constructs innovation and new growth were listed from the modified Holling's cycle. The Holling's cycle is a model based on research from ecological systems responding to human, climatological, and other influences (Gunderson & Holling, 2002). It was modified by Fath, Dean & Katmair (2015) to highlight applications to the resilience of organizations and social systems. The Holling's cycle constructs reflect stages in un-learning and learning in collective responses to crisis (cf. Kurt Lewin's model of organizational learning as including "unfreezing" and "re-freezing"). Additional learning-related constructs were included in the matrix, as necessary behaviour for advancing to the next step in the modified Holling's cycle. To complete the time-ordered matrix, pertinent passages from the documents were pasted into the cells related to the corresponding constructs.

Next, the time-ordered matrices were transformed into event-state network diagrams (Miles, Huberman, & Saldaña, 2020). Event-state network diagrams visually communicate events and the processes that contributed to them over time. Then, documents were coded with MaxQDA© to support thematic analysis, using a hybrid approach to coding (Fereday and Muir-Cochrane 2006). A codebook was created using a priori codes derived from the study's conceptual framework and emergent codes based on induction from the data. After coding the documents, time-sequence inconsistencies were observed between the initial event-state network diagrams and the actual sequence of events; those were revised. Finally, an iceberg analysis was applied to the data as an analytic framework to reveal underlying values and mindsets (Hall, 1976; Meadows, 2010).

This qualitative analysis is part of ongoing work: the intention is to use this analysis as part of ongoing action research cycles where preliminary findings are fed back to stakeholders to prompt discussion about recommendations for further action. The results displayed are from the two farmers markets. Only one market's data is presented here because the findings were similar for both, but the more robust data was from the Crescent City Farmers Market. The differences could be an area for further investigation but are not the topic of this paper.

Results

The time-ordered matrix was transformed to a table for easier comprehension (See the appendix for the original).

Table 1. Summary of the time-ordered Matrix.

Points in time are shown vertically, down the page. The document type and the date it was created are in the left column. Learning related constructs used in the analysis are in the middle column. Condensed summaries of data and/or illustrative quotes are in the right column.

Document Type (Date)	Construct	Condensed Data and/or "Quotation"
Grant Application (April 2020)	Innovation	Market partners developed and tested aggregating farmers' products for home delivery (FA&D). LHCC funds software, marketing SNAP/MarketMatch, branding, and farmer incentives.
Grant Report (June 2020)	Innovation	Market workers used personal protective equipment and practiced safe food handling. Marketing for SNAP/MarketMatch, via Facebook and Google ads, and branding.
Grant Report (June 2020)	Social Learning	The market communicated with other markets via coalitions sharing resources and lessons learned.
Evaluation (August 2020)	Innovation	Partnership and resource sharing was vital (shared refrigeration, delivery, etc.). The grant gave the market the ability to experiment and build out other service lines such as the drive-through model. Targeted advertising brought in customers
Evaluation (August 2020)	New Growth	Partners came together to develop and test aggregating farmers' products and distribute them to customers via safe, home delivery.
Evaluation (August 2020)	Deutero Learning	"The ingenuity of our individual staff members who were able to change roles was critical."
Evaluation (August 2020)	Other Learning	Farmers learned to do wholesale. The Market staff were trained in food handling and COVID safety.
Presentation (January 2021)	Innovation	"Contactless" distribution was important. The farmer incentive encouraged flexibility. The drive-through model became more popular than home delivery; in-person market re-emerged, and people order online first.
Presentation (January 2021)	New Growth	The Market implemented curb side pickup, in-person modified, and home delivery. The Market has a larger newsletter distribution, it communicates to customers via Constant Contact, and that facilitates customer management. "Support local" messaging was meaningful.
Presentation (January 2021)	Deutero Learning	"We continue to evolve and adapt. So, we've got kind of three or four different operation models now."

Table 1 focuses on answering the research questions 1 & 2; did innovation occur and if so, what types of learning were present during innovation? At the earliest date in April of 2020, the farmers markets proposed to use grant funding to support a technological innovation they decided to adopt given their new circumstances. They used funding to create demand through marketing and maintain supply with incentives for farmers; farmers needed a nudge to adapt. By June 2020 markets reported that they had adopted technology, and the additional grant funding gave the market the flexibility to try multiple distribution modalities at the same time. While it had social media channels already, this was the market's first experience with paid boosting- a further adoption of an innovation to create product demand. Market workers also had additional training in food safety- learning other knowledge and skills for adapting. Ongoing conference calls were a vital contributor to new partnerships and the recombination of resources. By August 2020, evaluation results showed new organizational arrangements, new partnerships, and high levels of collaboration. Market staff demonstrated the ability to change roles as needed, to learn by doing, and learn from doing. Practicing and publicly communicating COVID-19 safety around food was ongoing. Finally, when the grantees presented in December 2020 and January 2021, they demonstrated an adaptive mindset and were using multiple operational models -- "we continue to evolve and adapt, we've got kind of three or four different models now," and had further adopted technology, Constant Contact, for customer resource management (CRM) and insights. Although it does not appear in the table, the market applied for and received additional grant funding to grow its MarketMatch program for low-income customers.

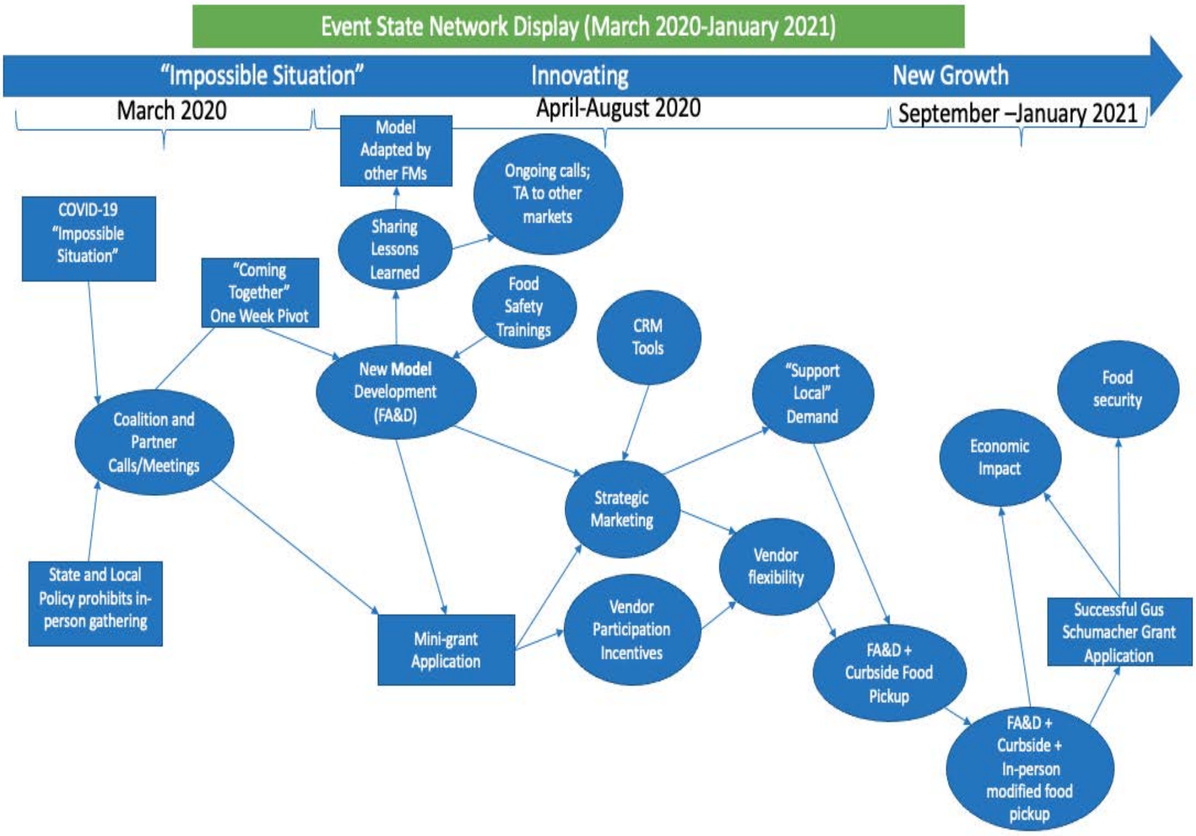

Figure2.: Event-State Network Diagram for the Crescent City Farmers Market

The matrix was translated into an event-state network display, shown in Figure 1. This shows events in rectangles as key moments in time. Processes that contributed to the events are represented as circles. The arrows represent the contribution of the process and events to each other during the timeline at the top of Figure 1.

Figure 1 shows the evolution of events from crisis, or in the words of a grantee "an impossible situation," through key episodes of innovating and new growth, reflecting the modified Holling's cycle. It demonstrates the impact of systems governance, or legislative policy, where the authority of the state halted the system. First, markets leaders hosted calls to discuss the "impossible situation," where new models were shared, developed, and implemented on an ongoing basis. The LHCC mini-grants and other resources were critical to the development, failure, and growth of innovative models. To remain viable, the market transformed its role from hosting in-person markets to a food aggregation and delivery (FA&D) hub. As scientific knowledge of harm reduction from COVID-19 evolved, so did the market models. The models started with FA&D only and went to simultaneous FA&D, curb side pick-up, drive-through, and modified in-person markets. Paid social media drove demand and the market worked closely with vendors who ultimately were selling out of their products. The market applied for grants successfully to institutionalize the new modalities. This had a local economic impact by keeping funding local, it reduced food insecurity, and facilitated consumption of fresh fruits, vegetables, and fish.

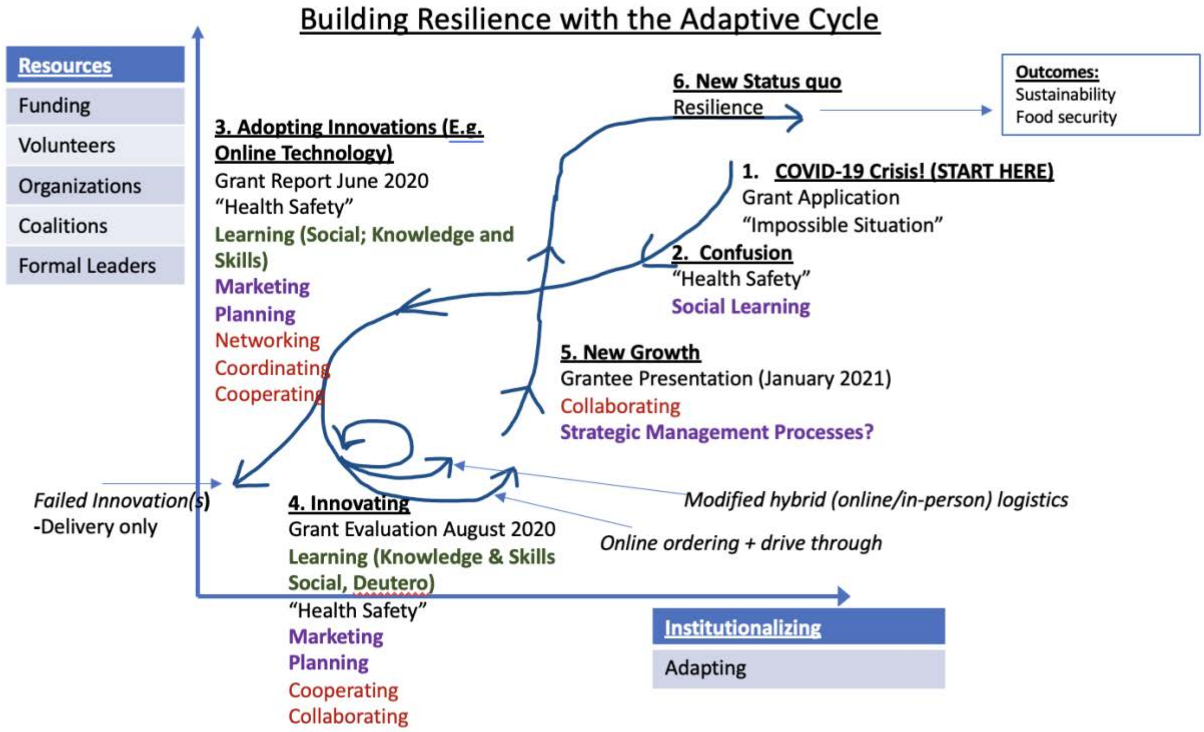

Figure 2: Visualization of Learning Using the Modified Holling's Cycle

Figure 2 shows the events and processes reflected in the event-state diagram summarized by stages of the modified Holling's cycle and the key co-learning and co-creation processes that underpinned them.

The Modified Holling's Cycle:

1. In March 2020, because of COVID-19 crisis, in-person gathering at farmers markets was halted by elected officials, creating an "impossible situation" for markets and farmers. Looking for pathways forward, the markets applied for a grant from the LHCC in April of 2020.

2. After the initial crisis and accepting the prior status quo was no longer viable, the farmers markets had to make sense of the new situation. They did it together by participating in ongoing conference calls (including videoconferencing) with food access coalitions locally, state wide, and nationally. They also engaged in social learning within their own market by working closely to identify possibilities to consider for later experimentation and adoption. "Health Safety" was an emergent, grounded construct and frequent phrase of vital importance.

3. The markets began experimenting and adopting existing innovations. Many markets have training in safe food handling, so market staff adapted easily to adding protocols for personal protective equipment. The contactless technologies for inventory, logistics, and delivery required market staff to learn knowledge and skills to operate them. The farmers and market learned to wholesale with each other. The market staff learned to use paid advertising techniques with social media. Initially, the new FA&D model came together through local networking on calls, then coordinating resources and activities (e.g. freezer space, deliveries, etc.), and ultimately cooperation between organizations merging certain operations to get fresh food to the public. Market managers set short-term goals and objectives for the innovations. Volunteers showed up to help with whatever was needed on an ongoing basis. The initial innovation was food delivery only, and while it is currently an option, it did not grow significantly as a service line.

4. Building on adopted innovations, the market began innovating altogether new models of food distribution including delivery, modified in-person pick-up, drive through, and a modified in-person farmers market. None of these modalities existed as such before COVID-19, never mind simultaneously. Market staff learned to experiment and develop new models together, in some regards the local food system was at stake- these are requisites for deutero learning to occur (Visser, 2007). Market staff further shared that learning with other markets via food coalition meetings and likely learned from

sharing. The broader feeling of the importance of supporting the local community was also evident in the success of using social media marketing with "Support Local" messaging. Photos on social media clearly communicated the health safety precautions the markets were implementing to the public. The market management balanced the demand needs of customers, who were literally at hoarding, with the supply local and regional farms had to offer. Unfortunately market staff reported, with great concern, that initially the people with the most resources were the first in line to buy fresh fruits and vegetables.

5. As SNAP dollars and recipients expanded, the farmers market focused marketing efforts on SNAP eligible demographics and expanding MarketMatch dollars thereby doubling SNAP purchases for low-income people and families. The market successfully applied for a Gus Schumacher grant that expanded MarketMatch by half a million dollars. By January 2021, the presenter (to the coalition) reported increased local customers, increased revenues overall, adopting additional innovations (e.g. Constant Contact) to do more targeted marketing, and extended grant funding. The initial, home delivery model, is now used for customers with limited mobility, the immunocompromised, and those without access to transportation. Operating multiple business models has required a high level of collaboration with other organizations, farmers, businesses, volunteers, and local government (e.g. traffic logistics for curb side pick-up, use of public spaces).

6. The new status quo is characterized by variety. The markets demonstrated resiliency through learning and adaptation.

Discussion

At the onset of COVID-19, farmers markets initially innovated the food system by adopting online technology; an option the market managers had considered in the past aspiring to increase market efficiency. COVID-19 accelerated the adoption of online technologies (logistics, inventory, and payment) because of its low friction and "contactless" capacity for transactions. After a literature review, it appears other markets in the US did the same (Mittal & Grimm, 2020). Literature also supports using social media to inform community members about market operations and programs (e.g. SNAP), however markets typically do not have funding for this- possibly due to restrictions on public funding for SNAP programs (Nuss, Skizim, Afaneh, Miele, & Sothern, 2017; Skizim et al., 2017). The markets engaged in marketing and collaborating with partners to adapt to ever-changing circumstances and resource availability. The markets used social media to display their "Health Safety" practices of mask wearing and food handling to help customers feel safer about buying local food. Markets reported an increased customer base.

Both markets appear to have innovated and built organizational resilience because suppliers (farmers) learned to sell in new ways and customers (buyers) adapted to new purchasing modalities. From an organizational sustainability perspective, the farmers markets adaptively and strategically managed this new relationship between supply and demand. This contributed to short-term resilience and will hopefully contribute to market sustainability. Given the ongoing pandemic and high baseline level of natural disasters in Louisiana, the new status quo may be unrecognizable or a continuation of the present.

Different types of learning were evident at different parts of the cycle. Social Learning and Deutero Learning were theory-based constructs initially utilized in the codebook. Social learning happens when peers are sharing and/or developing ideas together for common understanding, planning, and ultimately actions proposed or happening in the future (Jones, 2008; Wenger, 2010). Social learning appeared at and between the group, market, and coalition levels. The markets engaged in social learning with group support for adoption of initial innovations. The Crescent City Farmers Market also became a source for social learning for other farmers markets in the state that were adopting and adapting many of the same innovations. Learning new knowledge and skills to adopt the innovations was necessary for implementation. Learning these technical skills and training others to use them (e.g. online inventory platform) was part of the innovation process. This knowledge carried forward within people and across to others. Learning knowledge and skills was a theme emerging inductively from the data indicating that individuals learned how to do new things (Welter, Todd Barrett, Davis, Lloyd, & Rose, 2020).

Building on past learning appeared requisite for the appearance of deutero learning. Deutero learning is, most simply stated, "learning how to learn" (Bateson, 2008; Visser, Max, 2003). However, deutero learning is always contextual (in relation to others and/or the environment), and that context typically is interwoven with the values of the person needing to adapt (Visser, 2007). Deutero learning in this case, led to innovating new models altogether in a rapidly changing context.

Conclusion

What does this case tell us about designing social interventions in public health, and how to respond to the tension between designing an intervention at the outset and the need to respond to new possibilities as events unfold, especially when living through chaotic times? The documented importance in this case of learning, including learning how to learn (deutero-learning) in supporting re-design and innovation, leads us to recommend that would-be leaders of social intervention – whether they are public heath practitioners, designers, or funders – need to support continuous cycles of design, implementation, and evaluation. These cycles must allow for some attempts or experiments to fail, in the service of learning and adaptive evolution. Using the Holling cycle as a tool lets us see this and could help facilitate discussions among stakeholders that would be more supportive of new alternatives and promote resilience through chaos. The idea of repeated cycles is similar to the call for "agile" approaches to management that came out of software design. However, as opposed to change efforts within a single organization, a greater variety of "actants" are involved in social interventions, which means greater challenges for including a wide range of actors and perspectives.

Systemic designers ought to draw on the efforts of the past 15 years to apply systems approaches in evaluation by Williams and Iman, and Patton (Patton, 2010; Williams & Iman, 2007). Evaluation practitioners working from a systems perspective have expanded their role to involvement in design and facilitation of design conversations (e.g. developing Theory of Change, cf. Breuer et al. 2016) at the outset of an intervention, as well as support for reflections along the way through data collection and presentation of preliminary analyses to stakeholder groups. The Systemic Design Toolkit could be extended by utilizing some of the tools used by systems-oriented evaluators. Conversely, systems evaluators could benefit from some of the tools in the Systems Design toolkit.

Researchers play the role of someone who recognizes and analyses patterns of meaningful relationships and factors underlying the sometimes chaotic and random-seeing cascade of events. Then they feed back this information on patterns to the stakeholders representing the larger system, supporting collective participation in sense-making and the determination of next steps, in action research cycles (Ivankova 2015). Ethnographers, designers, and evaluators can all potentially play this sort of role (it is a role well-suited to developmental evaluators, cf. Patton 2011). One of the implications for the design of social innovation is that given the complex, nonlinear processes involved in this sort of work, building in multiple opportunities for shared systematic reflection is important. The advantage of information for supporting course correction to respond to constantly changing context as well as the need to recognize opportunities for scaling up and out through, for instance, recognizing and communicating best practices means that this sort of analysis and feedback is more than an academic exercise.

Those interested in methods may question why we utilized documents as data sources as opposed to interviews. Interviews will be part of the larger work; the documents are a small pilot piece. Documents can provide rich sources of data and, at least in public health work, are often under-utilized. In this case, one of the authors, Giancola, was present at some of the activities that generated the documents and hosted the presentations. Furthermore, his knowledge of and involvement with the stakeholders supports the analysis presented here. The close attention to concrete data required by formal qualitative analysis of documents provides support for validity of findings, checking and countering uncritical or unexamined assumptions that the researcher may have initially held. In the current environment, with so many people confronting daily challenges that demand their time, utilizing documents as opposed to trying to schedule interviews has the additional advantage of lesser burden on participants. When utilizing documents as data sources to support ongoing development of an intervention, or evaluation at any point, it is important to further strengthen and validate preliminary analysis through interactive discussions with stakeholders. This is projected to happen in the future development of this project. Such qualitative analysis-based discussions have the potential to extend further learning and strengthen a participatory design process.

Appendix:

Table 3. Time-ordered Matrix for the Crescent City Farmers Market

I Dates -->	Apr-20	Jun-20	Aug-20	Jan-21
Document Type	**Grant Application**	**Grant Report**	**Evaluation**	**Presentation**
Adaptive Cycle	Summary	Summary	Summary	Summary
Innovation	Partners developed and tested aggregating farmers' products for home delivery. LHCC Funded marketing SNAP/MarketMatch, branding, and farmer incentives	Market workers used personal protective equipment and practiced safe food handling Marketing for SNAP/MarketMatch, via Facebook and google ads, and branding.	Partenership and resource sharing was vital (shared refrigeration, delivery) The grant gave the market the ability to experiment and build out other service lines such as the drive-thru model Targeted advertising brought in customers	"Contactless" distribution was important The farmer incentive encouraged flexibility The drive-through model became more popular than home delivery; in-person market re-emerged and people order online
New Growth			Partners came together to develop and test aggregating farmers' products and distribute them to customers via safe, home delivery;	The Market implemented curbside pickup, in-person modified, and home delivery The Market has a larger newsletter distribution, it communicates to customers via ConstantContact, and facilitates customer tracking "Support local" messaging was meaningful
Learning				
Social		The Market communicated with other markets via coalitions sharing resources and lessons learned		
Deutero			"The ingenuity of our indivual staff members who were able to change roles was critical"	"We continue to evolve and adapt." So we've got kind of three or four different operation models now. -Presenter
Other			Farmers learned to do wholesale The Market staff were trained in food handling and COVID safety	

Table 1, in the left had column, focuses on the innovation and new growth constructs from the modified Holling's cycle. At the earliest date in April of 2020, the farmers markets propose to use funding for an innovation they had already decided to adopt. By June 2020 the markets had time to adopt and adapt their innovation and they were sharing they challenges, successes, and "lessons learned" with other markets via ongoing conference calls. Market workers also had additional training in food safety- learning knowledge and skills for change. When the grantees presented in December 2020 and January 2021, they have adopted and adaptive mindset- "we continue to evolve and adapt, we've got kind of three or four different models now."

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Troubling care - A critical look at the systemic shift toward healthcare digitization

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Amid recognition that care is contentious and highly political, conscientious design in healthcare systems cannot simply work blindly toward what is thought to be 'good care'. Systemic design must grapple with the inherent conflicting values in care. This paper works to 'unsettle' care by exploring the tensions amid the evolving landscape of the Norwegian healthcare system. We attempt to embody Haraway's idea of "staying with the trouble" in a design process positioned within a systemic transition toward digitization in healthcare. Drawing on 14 months of fieldwork, we explore the contradictions and plurality of lived experiences in this context through textual and visual collages that intentionally juxtapose divergent values of care. This paper exposes an entanglement of troubles which include: knowing by measuring/experiencing through sensing; the situated view/the isolated view of the patient; and helping the dependent/coaching the independent. This research highlights that one important way of caring in systemic design might be to hold on to the troubles in the thick present, rather than reconciling or re-framing to solve emerging either/or tensions.

Keywords: Care; Trouble; Tensions; Digitization; Healthcare

Introduction and theoretical background

As design enters into the complex space of care, the 'politically-neutral' practice of creative product and service development is confronted by questions of human valuing that differ between people (Jones, 2013). *Care* has many meanings with inherent tensions between them: for some, care is self-less charity, while for others, it is reciprocity; care can be seen as paid labor, or thought to be incompatible with this; care can be about a warmth of connection, or a matter of discipline (Mol, 2008). Care is something "people shape, invent and adapt, time and again, in everyday practices" (ibid, p. 4). While care is omnipresent and a universal human need, it is also highly contentious (Puig de la Bellacasa, 2017). As such, scholars are calling for a politics of 'unsettling' care to stir up what is all too often sedimented when we think about working toward 'good care' (Murphy, 2015).

We see the need for design to move away from an emphasis on technofixes under the banner of working toward "good care" and instead create room for making trouble in care. Drawing on Haraway, we use the term *trouble* to denote entangled contradictions, multiplicities of meanings and a plurality of ways of being in the world. The aim of this paper, therefore, is to share a half-baked exploration of how design might start to unsettle care by exploring the patterns of tensions in emerging worlds within the evolving landscape of the Norwegian healthcare system. Drawing on situated knowledges from engagements in a long-term design research project in the Norwegian healthcare system, we muddle messy stories of thick presents that reveal "unfinished configurations of places, times, matters, meanings" (Haraway, 2016, p. 1).

Within Norway there is a great deal of excitement about and investment in digital solutions that will help more patients and reduce costs (Melby et al, 2019). Hospitals and municipalities are increasingly adopting new decentralized models of care to serve patients in their homes aided by digital technologies. These new models of care include emerging practices, such as medical distance follow-up, where patients connect through video conferencing for follow-up appointments (Aune & Aanestad, 2017) and home hospitals, where in-patients receive hospital treatment in their own home (Andersgaard, 2020). In this particular study, we zoom in on the troubles amid experiences of using remote care plans, where healthcare providers offer in-home support, guidance and monitoring to patients in their homes. What unfolds in this situated exploration is not an easy answer of a preferred future, but rather lingering and intertwined questions about differing values of care amid systemic shifts.

Messy-dology

The context of this research is set within the Center for Connected Care (C3), a long-term research and innovation initiative supporting a systemic shift within healthcare systems in Norway from centralized care in hospitals to distributed care in homes and communities. This research focuses on the use of remote care plans and the larger shift toward digitization of healthcare, explored in collaboration with system stakeholders. The stakeholders involved in the design research include two hospitals, a municipality, three health technology companies, two research universities, two classes of master students at The Oslo School of Architecture and Design (AHO) as well as patients and family members.

Our approach departs from a motivation to explore how design can work toward troubling care by delving into thick presents to better understand the tensions that exist within care systems. There is potential in bridging a systemic lens with theories proposed by Haraway as it holds value for systemic design. Approaches like GIGAMAPPING (Sevaldson, 2011) and Rich Design Research Space (Sevaldson, 2008) work with complexity and open up the mess of different realities, but they can be further strengthened by helping guide designers to stay with the trouble. Often in the analysis phase designers and design researchers have a tendency to move towards synthesis or a convergence of oppositions. The proposed approach leaves room for ongoing interpretation by immersing oneself in tensions and attempts to keep friction between different values of care. Taking a systemic lens and simultaneously staying in the thick present adds value when designing with the conflicting values in care. This research study was guided by the following research question: how can we understand care systems in a way that holds the contradictions and portrays the plurality of lived experiences amid systemic transitions?

In this study, we created visual and textual collages (see figures 2, 3 and 4) drawing upon our collective experiences over the course of 14 months. The foundation for our study includes 40 in-depth, semi-structured interviews, 44 informal conversations and 13 workshops. The majority of the workshops were held digitally, with a few exceptions held in-person. These workshops were generally attended by the same 12-16 people from our project partners. The interviews focused on different themes within the systemic transition like remote care plans, role of informal caregivers and cultural sensitivity in healthcare services. Being an active participant in the design process by conducting interviews, workshops and conversations gave us an embodied understanding of the context. After this, we identified non-exhaustive interview samples to move towards a smaller constellation of interviews. We re-read the selected transcripts from the interviews with patients and healthcare staff which focused on digital care services, and highlighted quotes that in themselves held a tension, or conflicting ways of viewing care or being cared for. Our intention was to seek contradictions across different stakeholders involved within similar care services. We then placed it on a Miro board (see figure 1) where we simultaneously worked with the quotes and images we found representative of the tension. From this we would write a summary and continue looking for quotes in the transcripts which helped to understand and expand on a particular finding. We then decided to use the format of collages. By combining text and visuals the collage opens up a reader to move into an interpretive way of reading an analysis. When one sees multiple things in juxtaposition, different things arise for different people based on their context and situatedness. The collage turns into a curated mess to wade in.

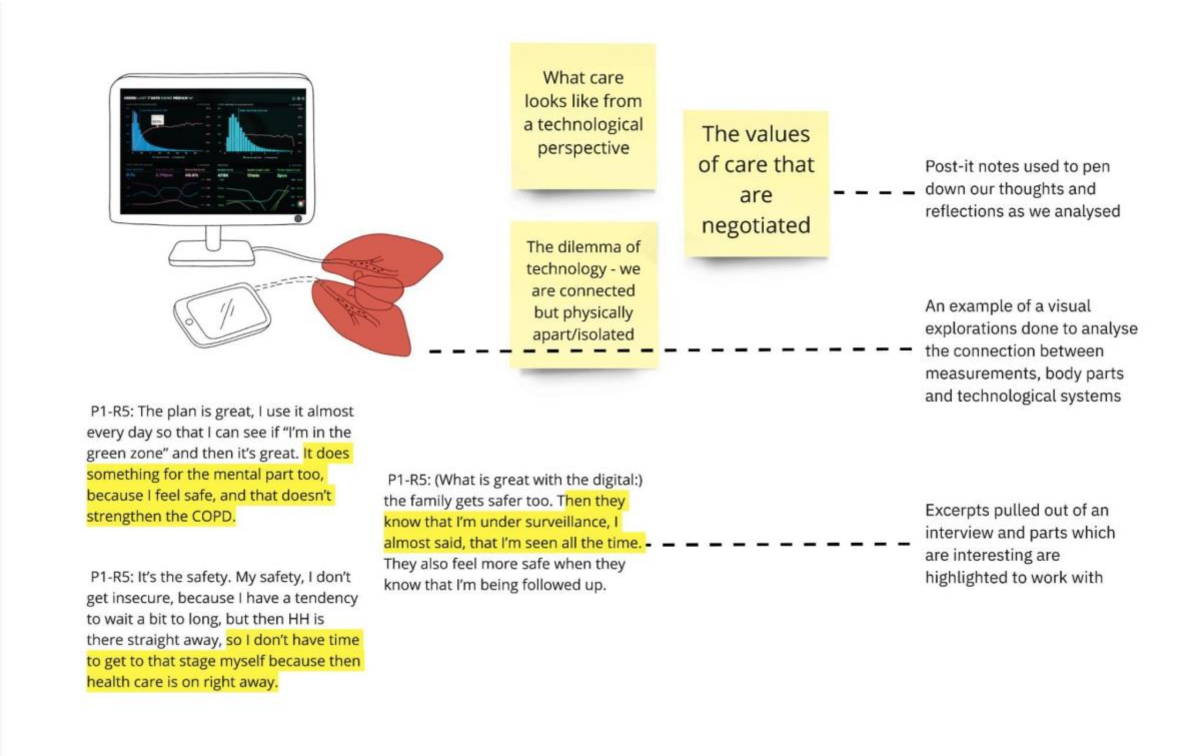

Figure 1. Screenshot of the Miro board showing how the interviews were used as material during the analysis (image of screen has been adapted from photograph by Luke Chesser).

This study explored textual and visual collages as a means to hold the contradictions and different realities that co-exist when working with systems transformation. The collages are attempts to stay in the 'thick presents' and capture the pluralities and conflicts of lived experiences. The process was structured into making three collages, two visual (see figure 2 and 3) and one textual (see figure 4), that were based on our gathered experiences from the interviews and workshops, drawing out and working with quotes from the material. In the textual collage (figure 4), we combined quotes from the interviews and workshops. Using theory as provocation helped us see the tensions between the multiple realities. The textual collage is typeset in three different fonts using different colours to indicate the three different realities of care (a nurse, patient and nurse-designer) being brought in contrast to each other. In figure 2 & 3, the quotes are combined with copyright free images found on the internet that were picked apart and pieced together to form new constellations. This became a way of thinking through making. The visual collages use juxtaposition and draw explicitly on the spaces in between the different realities portrayed, as a way to open up the experience of the tension for others. For example, in figure 2 we worked with images of medical measuring devices, hands which indicate touch, background of a table which could belong to a home as elements. These images were composed together with quotes from a patient, nurse and designer about the implications of using the remote care service. In figure 3, we worked with images indicating measurements, a representation of a person's lungs, interconnections between devices and body parts, and two backgrounds, one from someone's home and the other from a remote care response center. The images were combined together with quotes from a patient and a nurse. The collages try to go against the sleek and descriptive aesthetics often used to portray systems by combining the gathered data with abstract representations. In this way, they do not aim to portray an objective reality. As Haraway puts it; "It matters what matters we use to think other matters with". The resulting collages are an attempt to hold the contradictions and tensions, stay with the trouble and create materials to think within the thick presents (Haraway, 2016).

Figure 2. Visual collage by Shivani Prakash (adapted from photographs by Annie Spratt, Jonathan Borba, Mockup Graphics, Naomi August, Roberto Nickson)

Figure 3. Visual collage by Felicia Nilsson (adapted from photographs by Robina Weermeijer, Beth Macdonald, Luke Chesser, Linus Mimietz, Chris Ried, Adam Birkett, Anand Thakur, Helsehjelpen, Mockup graphics)

Patients need to take responsibility for their own health. The remote care plans are designed in a way to shift some of the responsibility of care onto the patient.

Some patients begin to see the value of remote care in a few months. Overtime, my team is able to create a sense of safety for the patient and their family. They need to see that we will be there for them when a measurement goes wrong. The patient needs to know themselves and their chronic disease. My team also gains an understanding of the patient through the monitoring. We begin to understand if such-and-such symptoms are normal or far from normal. I see some of my patients have become very well acquainted with themselves and have gained more responsibility for their disease. We are taking away the touch, but at the same time we see our patients in a different way. I think that they feel the same way, that we are listening more to them than we would have if we were home care and visited them every day.

But some patients are not really pleased that we don't work during the weekend. They feel unsafe that we are not sitting in the control room and monitoring them. Patients feel that they won't get a phone call if something went wrong. But that's the part of responsibility and knowing yourself. But, keep in mind, that every patient is not able to take responsibility for their chronic disease through these remote care plans. Some patients lose interest in monitoring and tracking their symptoms. In such cases, we are not able to extend any support. I need to spend my time on the patients who are interested in using the technology. You see, motivation is a key factor.

The nurses wanted to sign me up for a remote care plan. They are still testing the technology. It's all wireless, so it seemed less messy when I said yes to using their remote care plan. All I needed to do was measure two aspects daily. The measuring included recording my oxygen levels and blood pressure once in the morning. I reflected back on my daily routine. There can be space for two measurements.

After a few weeks, it felt great. A nurse called me every time a measurement shifted and checked-in on me. They weren't there during the weekends. But I'm healthy enough to be left alone. If I'm having a bad day, I know I can have two bad days before I need to get nervous. The plan is great, I use it almost every day to see if "I'm in the green zone" and it does something for the mental part. I feel safe, and that doesn't strengthen the COPD.

And then it's about how I feel. I wrote to them when I felt dizzy, and bang they were at home with a blood pressure monitor for me. Then they contacted the general practitioner and got me an appointment. I think it is very reassuring because I feel in control. If something happens to my body that I have no control over, I become very insecure. But now I can go into the plan and see my symptoms and which measurements I can take. I'm very fond of the remote care plan and I use it a lot.

There may be errors in measurement or solution. But the nurse can take a video call and check-in with the patient. If the patient looks fine then there may be a fault in the equipment. The nurse must rethink by assessing the patient from a distance. My experience is that they fix it well, but have to think and work differently.

But we need to proceed cautiously as somethings may go wrong sometimes. A patient may not really be in the yellow zone, and they may have consequences if they then do 'yellow' activities. There are human failures on equipment or assessments made by the health personnel. For now we chose to move away from automation for that security. But when things start to get more secure with the current system, then we can start thinking about it again.

Figure 4. Textual collage by Shivani Prakash including quotes from a patient, healthcare staff and developer

An entanglement of troubles in care

We examine the specific implications of the digitization of the remote care service and the effects of this transition on the connected systems. Through this approach, tensions, negotiations and troubles begin to become visible as we examine a shift from physical care planning to a remote model of care delivery. We see an entanglement of three troubles emerging from the making of the collages and they are unpacked below:

1. Knowing by measuring / experiencing through sensing

"We begin to understand if such-and-such symptoms are normal or far from normal", shares a nurse. The healthcare professional continues to build an understanding of a patient based on their individual symptoms gathered by measuring overtime. The understanding of one's body is designed into being dependent on a set of measurements which indicate a 'normalcy' of the body where the patient works toward staying in a particular zone. There are three zones in the plan - green, yellow and red - each indicating the severity of the patient's symptoms. Meyer (2003) argues that in care settings a knower can often become alienated from their body and their senses due to colonial healthcare practices. For example a patient described, "Sometimes I can feel that I have pain and then I check the measurement and it says it is fine and then I can calm down."

What are the consequences of creating a dependency on understanding the body through these 'zones' and remote measuring devices? Willis (2006, p.70) describes how "we are designed by our designing and by that which we have designed". In this context, the remote care plan begins to design the patient's knowledge of their chronic illness based on a zone. *Knowing by measuring* guides the patient to have a 'green' day if they are in the green zone and do green activities. For example a patient described, "the plan is great, I use it almost every day to see if I'm in the green zone". But we need to be aware of technological and human errors in measurements as a designer-nurse working on the service pointed out, "A patient may not really be in the yellow zone, and they may have consequences if they then do 'yellow' activities."

2. The situated view / the isolated view of the patient

Today the basic version of the digital remote care plan is designed to be used by the patient, a nurse and a general practitioner with the possibility of adding family members. A nurse will begin by setting-up a remote care plan for a patient through a physical meeting. Once the plan is set-up, the patient can live more independently and not be tied to the physical location of the healthcare service. Once the patient is at their home, the plan creates an isolated, individualist view of the patient's social setting for the healthcare professional. "My team also gains an understanding of the patient through the monitoring", said a nurse. The healthcare professional cares through controlled contact. A nurse will only reach out to a patient if a certain measurement is below the line of 'normalcy'. Based on their assessment, they may make a home visit which allows the nurse to have a situated view of the patient. A patient shared their experience, "It is very reassuring. Measured and 2 minutes after Helsehjelpen was on the phone with me. My saturation was low".

This sense of safety is created overtime based on the experience of follow-up calls and visits. If a patient does not hear from a nurse, then the patient should assume that they are doing fine. But how should a patient know that they are doing okay? A nurse shared, "some are not really pleased that we don't work during the weekend because they feel unsafe that we are not controlling. They don't get a phone call if they get something wrong. But that's the part of responsibility." On another note, several family members benefit from knowing that their loved ones are doing okay and that a healthcare service 'has the patient's back'. This might lead to the family members not needing to frequently connect with the patient directly. As a patient shared, "'Then they know that I'm under surveillance', I almost said. That I'm seen all the time".

3. Helping the dependent / coaching the independent

A nurse shared, "So, by using this [remote care] plan, that also raises the responsibility and awareness for the patient." It does so by transferring some of the responsibility of care onto the patient. The distribution of the labour of care is an ongoing negotiation between the patient and the healthcare provider. But this division of labour is troubled when a patient is not able to help the nurse by taking their measurements and reporting their symptoms. Another nurse shared an example, "I'm like, why didn't you tell us that you had a sore throat? You know that's a symptom. But he doesn't see it that way. He is a man, and he's stubborn, and it will go over, it's just a sore throat." If a patient doesn't report any measurements, the nurse will immediately call them to check on them. The patient needs to quickly adapt and become an expert in creating a symptom-based understanding of their chronic illness. But if they fail to do so, it could result in multiple trips to a hospital, which is what the remote care service is designed to avoid.

For some patients there is validation in the measurements that helps reduce their burden of self-care. “If I have a bad day, I know I can have two bad days before I need to get nervous. Then the [municipal remote care service] staff are on it straight away.” In this context, there is a tension in the role of healthcare professionals between being a coach and being a helper. On one hand, as described by a nurse, they might “handle patients with ‘their hands behind their back’, wanting them to do as much as possible on their own, while other nurses would say ‘let me help you’.” The staff continued by sharing some of the resistance to this shift: “some workers are sceptical because of the fear of losing warm hands, and distrust in technology in general.” Questions arise around dependence and independence. What happens when some patients want or need direct help? Who holds the burden? If healthcare providers do not take on that burden, who is it passed on to? The views on these shifting roles and responsibility held by designers and developers also influence how remote care plans are shaped. One technologist shared, "in the end the only person that can affect their own life is the patient themselves, it's difficult for us to force the patient into doing something.”

Discussion

In our design research, we attempted to share an entanglement of troubles emerging from a systemic transition within the Norwegian healthcare system. It is a shift which is embraced and accepted as a utopic future. We have begun to trouble this context of digital healthcare which is generally seen as unproblematic. By using theory to understand ongoing changes, juxtaposing images and quotes from interviews, we noticed that this analytical process enabled us to be more reflective about the context we are working in. Based on our learning from troubling this hard-to-critique space, we would like to share the following points for discussion and reflection in systemic design.

1. Wading in tensions

While arriving at the entanglement of troubles, we saw ourselves oscillating between different facets of tensions. We were immersed in the present to the extent that we saw tensions dissolve, but then again, we saw contradictions emerging. For example, the remote care plans are enabling patients to live more independently by distributing the labour of care. But then with what value of care are they doing so? Sustaining a tension in one direction could have major risks for society. Attempting to stay in the thick present, we wade in tensions amid conflicting realities rather than neutralising multiple realities by arriving at a reconciliation between the tensions. Through unpacking the ongoing unsettling by technology, we realise that there is no objective reality in this transition and that we are only able to capture some realities. Our understanding of the multiplicities of care is limited by our own situatedness.

2. Messy learning processes

During a follow-up workshop conducted together with the partners, one of the healthcare providers reflected on the importance of considering the potential negative aspects of remote care, even though the participant’s work is focused on implementing and developing this service. The process helps participants to understand perspectives at tension within their own work. We see this tension-based understanding offering our partners approaches to move away from a one-sided perspective of this systemic transition and begin embracing the multiple realities that exist with their care contexts. Staying with the trouble has implications for the narrative of the story. Rather than ending with a shiny conclusion, we see this exploration as a messy ongoing learning process. Through our explorations, we attempt at offering the stakeholders a platform to engage with tensions, thick presents and troubles about their work contexts and thereby, embed the learnings within ongoing design processes in organisations.

3. Caring by keeping the friction

This work raises questions for us about how shifts in systems are ‘teeter-tottering’ between different values in care. The care that is scalable often gets amplified in our society. This need to care efficiently is entangled with caring for fragile, unpredictable bodies which need varying amounts of care. If care holds values contradictions, then designing in care needs recognition of these different tensions. By staying with the trouble, we question what value of care designers are enacting or should enact within this systemic transition. By attempting to bring in a critical view of how technology is designing us back, we raise questions about the lived experiences and realities that are being amplified through this systemic shift. Amid these entanglements, we suggest that one key way for systemic designers to show care could be by keeping the friction, which means not reconciling the either/or in the tensions between different values of care but rather holding onto them throughout the design process. Inspired by Haraway, we suggest that 'it matters with what care we care for our systems of care'.

Acknowledgements

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My Wellness Check

Designing a student and staff wellbeing feedback loop to inform university policy and governance

James Derek Lomas with Willem van der Maden

"My Wellness Check" is a wellbeing assessment system designed to help universities systematically support student and staff wellbeing. In this paper, we present a narrative describing the human-centered design process used to develop a context-sensitive wellbeing feedback system within a large technical university during the COVID19 pandemic. We share quantitative and qualitative findings from the first 2 feedback cycles, where wellbeing assessments were sent to over 30,000 students and staff. By involving community members and decision-makers in the qualitative data analysis, we successfully translated results into administrative policy and community action. Our ongoing design research project highlights the desirability and feasibility of wellbeing feedback loops within large complex systems.

Keywords: Wellbeing, designX, complex sociotechnical systems, cybernetics

Introduction: Wellbeing Objectives in Education and Society

Many complex systems use measurement and data to support improved outcomes. In the case of schools and universities, measures of student performance are gathered in various ways to assess overall system quality. One central aim of many educational systems is to enable students to perform well on meaningful and benchmark assessments. To support social equity and human development, we suggest that educational systems should also explicitly aim to support the overall wellbeing of their students and staff. The reason that large, complex educational systems should add wellbeing to their educational objectives is simple: education that enhances wellbeing is of intrinsically higher quality (Hattie et al., 2019; (Hawthorne et al., 2019), and optimizing systems for wellbeing is the morally right thing to do (Harris, 2011).

A personal reflection from one of the authors, Lomas: when my daughter started kindergarten in the Netherlands, her teacher told me: "It is hard to learn well when you don't feel well." Her role as a teacher, as she explained it, was to support the wellbeing and growth of all students. Her notion was based on the idea that when students are feeling well, they will naturally grow and flourish. Her idea is not unique—it is well supported by many psychological theories, such as the notion of "organismic integration" in Deci and Ryan's theory of intrinsic motivation (2010). It has been proposed that deficits in wellbeing may undermine learning and performance due to the presence of negative thoughts that can disrupt working memory (Hattie et al., 2019). Thus, wellbeing may be like an oil that enables the smooth function of large, complex socio-technical systems. When students and staff are well rested, well fed and well exercised, the educational system itself will be more effective (Riberto et al, 2016). Yet, our daughter's teacher didn't just view wellbeing as an input to the education, she saw it as an objective of education. To the extent that she could, she wanted her teaching to contribute to her students' wellbeing. Is that a reasonable objective for educators, or is her case simply unique to a Montessori Kindergarten teacher in the Netherlands? It seems that education may be of intrinsically higher quality when it enhances a student's present and future prospects for wellbeing. It is, of course, a choice whether we should make student wellbeing a formal objective of our educational systems. But, if we do, then should we also systematically assess wellbeing, like we assess other educational objectives?

Moreover, the objective of supporting student wellbeing might be insufficient. The wellbeing of staff may also be critical for facilitating optimal environments for learning — as it has shown to be in several studies (for review, see Adler, 2016). Unfortunately, there have not been nearly enough studies on the role of wellbeing in learning and in teaching— far more are needed (see Grabel, 2017 for review and Yu et al, 2018 for investigation in a university context). Yet, one need not wait for sufficient empirical efficacy studies to take a position that educational institutions should systematically support the wellbeing of its people — one can arrive at that objective philosophically, as an a priori principle of what "good" organizations do: they promote wellbeing.

> “That action is best, which procures the greatest Happiness for the greatest Numbers; and that, worst, which, in like manner, occasions Misery” (Francis Hutcheson, 1725, Inquiry concerning Beauty, Order, Harmony, and Design)

In fact, there have been many recent calls to shift national government priorities to the maximization of human wellbeing (Danielli et al, 2020), rather than, say, the maximization of economic growth. "Gross National Happiness" is one such indicator (Veenhoven, 2007), but in recent years, there have been numerous measures developed to assess various aspects of wellbeing (Mizobuchi, 2014, Kramer, 2010, Wang et al, 2014). These calls have been amplified following the massive social-economic disruptions caused by the onset of the COVID-19 pandemic. For instance, researchers at Utrecht University introduced the Better Well-being Index (BWI) to provide an alternative and better indicator to take society’s complexity and multidimensionality into account than GDP (van Bavel & Boschma, 2021).

This paper describes a university-wide implementation of wellbeing feedback loops in order to support student and staff wellbeing during the COVID19 pandemic. We share evidence that we believe may help other institutions apply practical Human-Centered systems design approaches to implement cycles of wellbeing assessment to support governance and policy. We also show how wellbeing assessment data can inspire community-led design projects that contribute directly to positive action.

Cybernetics Perspective on Incremental Improvements in Complex Systems

Creating change in Universities is difficult due to their size, complexity, diffuse management structure and their tendency for consensus-based decision-making. The challenge of designing for large, complex socio-technical systems has been described by Norman and Stappers as DesignX problems (2015). As large, overarching plans have a tendency to fail, the authors advocate for a formal method known as "muddling through": small, incremental changes at many levels of the organization. In this section, we describe My Wellness Check as a cybernetic “wellbeing feedback loop” that can assess wellbeing and inform responsive action (Lomas, 2021; Dubberly and Pangaro, 2019 and 2010; Beardow et al, 2020)/ These feedback loops are visualized in Figure 1.

Within the university, our work focused on three overlapping stakeholder groups: university administration (e.g. policy-makers, academic board, deans), staff (e.g. teachers, researchers, PhDs, support, and admin) and students. We conceptualized each assessment/action cycle as a series of feedback loops that can occur at different levels:

1. A feedback loop to inform actions by the administration (e.g., to create new policy)
2. A feedback loop to inform actions by the researchers (e.g., to improve the survey)
3. A feedback loop to inform actions by the student/staff community (e.g., where reflecting on issues affecting their peers prompts local change)
4. A feedback loop to inform individual actions (e.g., where reflecting on one’s own wellbeing deficits motivates change).

In theory, these loops would all have a virtuous and/or stabilizing effect–i.e., improve wellbeing in detrimental situations and promote situations that are already conducive to wellbeing. Our hypothesis was that wellbeing-data feedback loops could help universities "muddle through” and make incremental improvements to address wellbeing.

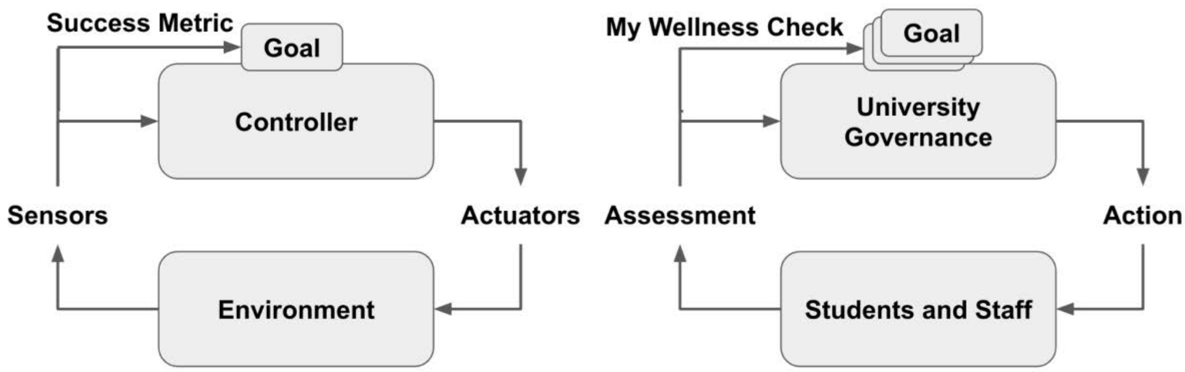

Figure 1: A cybernetic system involves a feedback loop that includes sensors, actuators, goals, control logic, and the environment. The system uses the actuators to adapt the environment to optimize a sensed signal of success (a measure signalling the goal state). For example, a thermostat senses the temperature of a room and turns on a heater until the temperature exceeds a goal state. In our case, we used My Wellness Check to assess wellbeing in students and staff; these data were used to inform university governance, resulting in actions and policy that were intended to measurably improve student and staff wellbeing. Notably, the participatory process we used meant that there was a practical overlap between the university governance and the population of students/staff. Further, there was not a single metric that served to indicate the goal state.

Design Research Questions

How might we design wellbeing feedback loops that can help institutions optimize for the wellbeing of their students and staff? It is easy for survey data to be collected and sit on a shelf. How might we assess the wellbeing of students and staff in a manner that results in directed institutional action? That is, how might we effectively translate data into action?

Personal Narrative

> *In this section, the first author J. Derek Lomas will share a personal narrative describing his experience contributing to the implementation of a wellbeing assessment loop at TU Delft. This personal approach is intended to share the underlying motivations and the practical methods that were used to enact the My Wellness Check system at scale. While personal stories aren't common in scientific publications, expressing the narrative from an "I" perspective also emphasizes the fact that we, as designers, are active participants in the system, not merely impartial observers.*

I began thinking about wellbeing assessment in 2017 when I designed a prototype to support wellbeing assessment during cancer care. My father had been diagnosed with an aggressive cancer and, despite otherwise exceptional care, the medical system was not well-attuned to the factors of wellbeing that I had been encountering at the Delft Institute of Positive Design (DIoPD). For instance, he wasn't seeing any friends—that sort of thing just wasn't on the doctor's radar. Because I knew he wouldn't fill out a wellbeing survey himself (it would annoy him—I asked), I envisioned how my mother might regularly report on various aspects of his wellbeing. So, I designed a prototype system, *Zensus*, to help caregivers assess overall patient wellbeing (Beardow et al, 2020) using an approach called Ecological Momentary Assessment (EMA). In short, these are simply messages sent to a smartphone on a regular basis. The prototype was designed to provide a calm and empathic feeling — it used various motivational design elements to enhance participant engagement. The purpose of the program was to gather data about a wide variety of patient wellbeing needs in order to help medical caregivers support more holistic care. It also aimed to help patients and caregivers directly by providing a structured reflection on different factors of wellbeing. When my father passed away in 2018, I took a break from my focus on cancer care. For instance, might a context-sensitive wellbeing assessment system help Alzheimer's patients and their caregivers? Or, could it help counselors help school children in high-poverty schools? (Lomas, 2020) Or, perhaps, even to help support wellbeing reflection in marriage therapy?

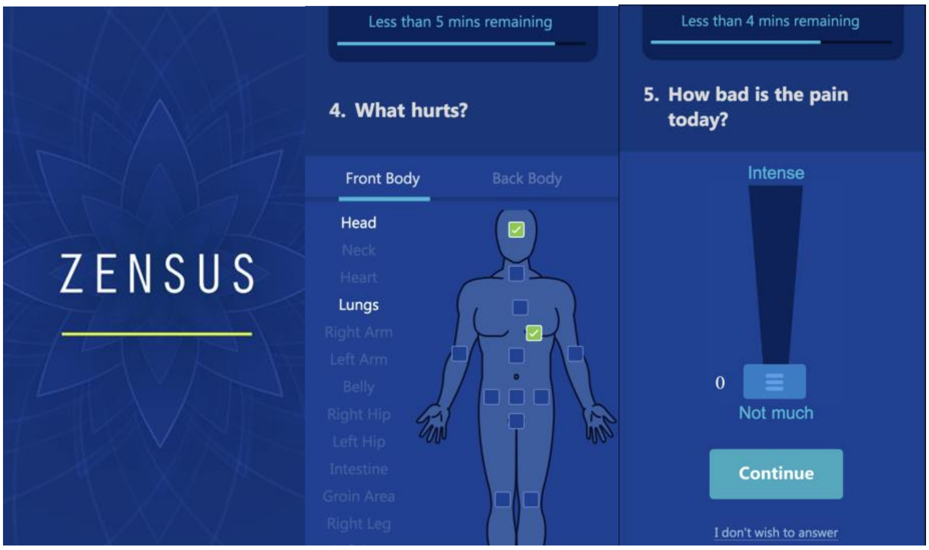

Figure 2: The Zensus prototype system for a "5-minute wellbeing check", designed for cancer patients.

One thing I felt strongly about was that my research team and I should have the experience of wellbeing assessment ourselves — that is, we should "eat our own dogfood." So, to pilot the Zensus wellbeing assessment system, 5 colleagues in our research group participated in a collective self-assessment of wellbeing. First, we assembled a large set of wellbeing assessment items in an online spreadsheet. These items were selected from a wide variety of validated wellbeing assessments, such as the Positive Emotion, Engagement, Positive Relation, Meaning, and Accomplishment-Profiler (PERMA profiler; Seligman - Butler and Kern, 2014), the Psychological Wellbeing Scale (PWB) (Ryff -Kállay, 2014), Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) (Clarke et al, 2011), the short version of the World Health Organization Wellbeing Index WHO-5 (Topp, 2015) among others. In that spreadsheet, all participants were able to vote on the items that they themselves desired to answer in their own survey. Based on the results, the 15 items with the most votes were subsequently presented to participants 3 times weekly for two weeks. This initial study allowed us to observe changes in our own individual wellbeing— and also gave sensitivity to the tedium of responding to a well-intentioned survey on a regular basis.

This work took place just before the onset of the Covid-19 pandemic. As the world braced for massive societal changes, I wanted to help do something useful. I saw numerous academic groups create new ventilators or design open-source 3D printed protective wear. What could a group of human-centered designers do to help? We decided that "needfinding" was a special competency of human-centered design; needfinding seemed critical amid so much social change. On that basis, we simplified and redesigned Zensus to create *My Wellness Check*. We expected that we could use the system to "check in" on people's wellbeing and to understand their needs—at a global scale.

The next step was to recruit members of the public to sign up for regular wellbeing checks. To promote engagement over time, we tried to make the system short and enjoyable. We selected just 12 items and focused on ones that we had previously found personally useful to ask ourselves. Lastly, in striving for inclusivity, we translated the items into four languages (English, Dutch, Mandarin, and Spanish). With a little press, over 1000 participants signed up to submit wellness checks 2 times per week for 12 weeks. As data started pouring in, we learned a great deal about the many changes people were facing. However, we also realized that we were not in a strong position to *actually do anything to help* the people in our study. It was uncomfortable reading stories of suffering; all we could do was to assess needs— we couldn't do anything to address them.

Then, an opportunity emerged to provide a wellbeing assessment system at our own university. Based on our work with the general public, we were asked to provide the Wellness Check system for the staff (6000+) and students (25,000+) of TU Delft, a large technical university in the Netherlands. From the beginning, we emphasized that our purpose was not merely to measure — it was to inform university action. This purpose was shared by our colleagues.

This marks the end of the individual narrative. The next section describes the human-centered design process that helped realize these intentions.

Designing Prototype 1

The selection of items for initial wellness check combined items from validated assessments and new items that were more specific to the university context. While "off the shelf" measures of wellbeing exist, these measures were obviously not designed to support the specific needs of university students and staff during a pandemic. Nor—and this is a critical point—were any existing measures explicitly designed to support institutional action.

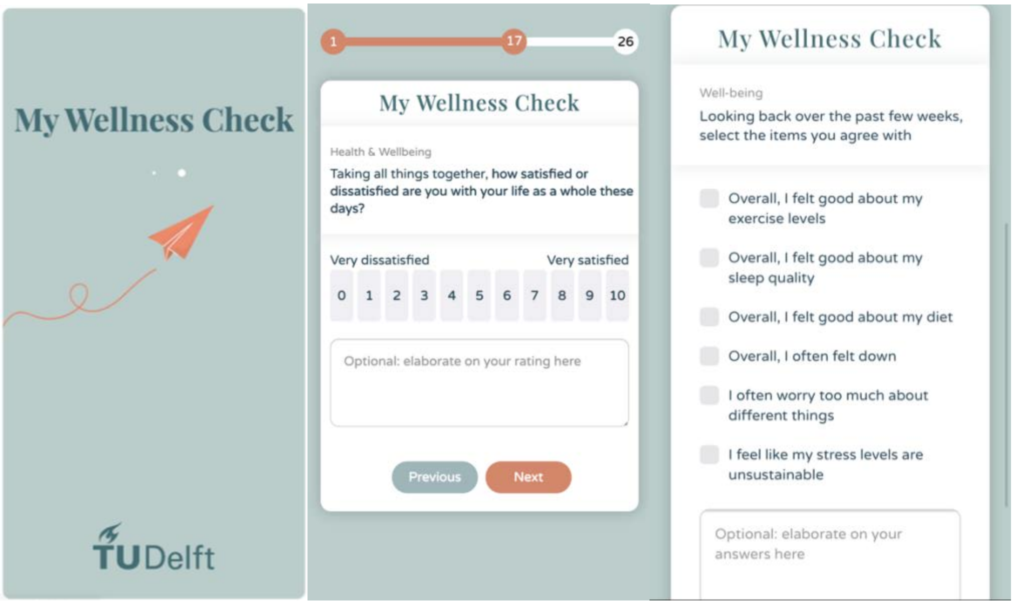

Figure 3: The user experience of "My Wellness Check" on a mobile device. We aimed to provide a pleasant and low burden assessment experience that combined quantitative and qualitative responses. Many items featured checkboxes that only gathered a cutoff response rather than a scale (right).

It was our goal to flexibly assess human needs as they were articulated to us by various members of the community. For instance, we knew that many students were stuck at home in small rooms with insufficient space for working and many staff members had children at home and lacked a home office. We subsequently showed that satisfaction with one's home working environment was highly predictive of overall wellbeing—yet, no assessment of wellbeing (that we had discovered) included this as a factor. To be sensitive to the context, we felt it was necessary to take a syncretic and practical approach to wellbeing theory and sought to assess mood, physical health, mental health, social health, life satisfaction, financial stress, belongingness, satisfaction with the university, and various other factors that were relevant to the covid-19 pandemic. We assembled existing wellbeing assessment items from a broad variety of wellbeing assessments: WEMWBS (Tennant et al., 2007), PERMA-profiler (Butler & Kern, 2016), Satisfaction with Life Scale (SWLS) (Diener et al., 1985), Harmony In Life Scale (HILS) (Kjell & Diener, 2020), WHO-5 (Topp et al., 2015), PWB (Ryff & Keyes, 1995), Wisconsin Longitudinal Study (WLS) (Piliavin & Siegl, 2007), Midlife In The United States (MIDUS) (Brim et al., 2004, 2019), and National Survey of Families and Households (NSFH II) (Springer & Hauser, 2006).

How did we focus the data collection to inform institutional action? To support actionability, we aimed to collect information that quantified different wellbeing deficits (e.g., exercise) such that we could model their contribution to overall life satisfaction. Further, we sought to collect rich written text that provided the "voice" of students / staff in order to give qualitative insights regarding needs and ideas about how the university could help. Further, we aimed to create a positive assessment experience that was low-burden, enjoyable and engaging to participants.

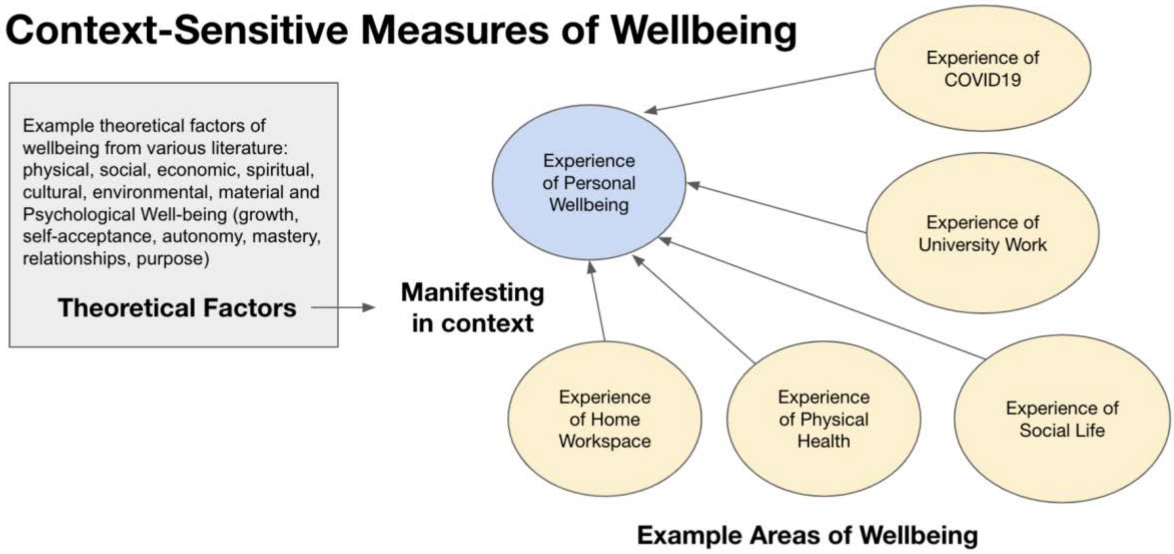

Figure 4: Showing how complex theoretical models manifested within a measurement context. This helps illustrate our orientation towards a syncretic model of wellbeing and our focus on context-sensitivity.

Prototype 1 Evaluation and Iteration

To evaluate the questions, bachelor and master-level students in the Human-Centered Design faculty recruited 10 students to participate in a user experience evaluation of the questions in the survey. Zoom sessions were held with each participant individually. Participants were asked to think aloud as they took the prototype survey, sharing their perceptions and attitudes. They were also asked to rate each item on the survey for relevance, value and burden/difficulty. This method of observing others as they filled out the survey was repeated a number of times, as we made iterative improvement to the survey. The user experience (UX) data did not have a mechanistic effect on the survey (that is, we did not ask the participants to vote on items so that we would simply select the most favored items). Rather, the UX feedback was used broadly to give us greater empathy into, for instance, how tired participants would be after a certain number of items or what types of question phrasing seemed awkward, irritating or confusing.

Final Survey (First Cycle)

The final survey included a total of 19 questions: 3 questions about demographics; 6 scales (ranging from 0 to 10); 4 checkboxes; and 2 free-response questions, 1 multiple choice question, and 6 Likert-scales about their questionnaire experience. The latter were introduced as an experiment to test whether contextualized assessment would yield a better experience. This experiment is discussed in detail in van der Maden, Lomas & Hekkert (under review). As each checkbox question contained multiple items, the survey included a grand total of 79 items. The factors included in the survey included questions on: Life Satisfaction, Belongingness, Competence, Autonomy, Physical Health (including Sleep, Exercise, Drugs and Alcohol, Nutrition), Finances, Motivation, Engagement, Purposefulness, Anxiety, Depression, Loneliness, Optimism, Personal Growth, Study Performance, Remote Education, Mood, Home Environment, Corona Measures, University Support.

Procedure

The procedure was similar for both students and staff. Each group individually would receive an email in both Dutch and English that invited them to participate in the study. The email contained a link that led them to an online version of the survey that could either be completed on a tablet, phone, or desktop. A reminder was sent in each instance except for the fourth iteration of the student survey. The welcome text of the assessment provided participants with information about the anonymity of their data, the fact that the assessment was compliant with GDPR standards, and thus provided them with enough information to give their informed consent. The research population of this study included 25,572 undergraduate- and masters level students and over 6,050 staff at TU Delft. All data were anonymized.

Table 1: An overview of the different iterations of wellbeing assessment conducted at TU Delft. #Q refers to the number of questions included, #I refers to the number of items included, and CR to the completion rate. From van der Maden, Lomas & Hekkert (under review).

Iteration	Date	*n*	CR	#Q	#I	Experimental factors
Staff 1	Jun. 2020	2776	85% (2328)	24	56	-
Student 1	Jun. 2020	3150	81% (2604)	25	79	-
Student 2	Nov. 2020	3409	80% (2841)	26	82	Different versions and branching
Staff 2	Dec. 2020	1826	89% (1622)	22	76	-
Student 3	Mar. 2021	2877	77% (2221)	19	55	Validation questions
Staff 3	Jun. 2021	2376	84% (2006)	25	49	-
Student 4	Jun. 2021	2062	80% (1719)	19	79	Questionnaire experience and different versions

Quantitative Data Analysis

As of September 2021, we have conducted four cycles of wellbeing assessment for students and three cycles for staff. Table 2 shows the main scales that were collected by students and their changes over time while Figure 6 shows changes in their responses to checkboxes.

Table 2: An overview of data gathered in four iterations through scaled items about student wellbeing at TU Delft. Each scale could be answered with a score from 0 to 10. For life satisfaction, physical health, and studying at home 0 would represent the worst score; "Very unsatisfied," 10 the opposite: "Very satisfied." For mood these would represent "Terrible" and "Excellent" respectively.

		June 2020	October 2020	March 2021	June 2021
	n	2604	2841	2221	1719
Measure	**Statistic**				
Life Satisfaction	*M (SD)*	6.4 (1.9)	6.0 (1.8)	5.3 (2.0)	5.9 (2.1)
Mood	*M (SD)*	6.3 (1.9)	6.0 (1.7)	5.5 (1.9)	5.9 (2.0)
Physical Health	*M (SD)*	6.9 (1.7)	7.1 (1.6)	6.3 (1.9)	6.5 (1.9)
Studying At Home	*M (SD)*	5.5 (2.2)	5.7 (2.1)	5.3 (2.4)	5.4 (2.5)

Table 3: Showing the proportion of students clicking "yes" to agree with statements presented as checkboxes. This shows, for instance, the 20 percentile point drop in students stating that they feel part of a community (expressed in % Chg.) From van der Maden, Lomas, Hekkert (under review).

		Percent saying yes				
		Jun. 2020	**Oct. 2020**	**Mar. 2021**	**Jun. 2021**	**% Chg**
Belongingness	I feel part of a community at [university]	44	28	20	24	-20
	I often feel lonely	31	40	42	36	5
	I feel like I belong at [university]	57	41	41	38	-19
	It often feels like no one at [university] cares about me	21	21	25	24	3
	I often feel like I don't have anyone to talk to				18	
	I feel that my fellow students care about me and each other				39	
	I have a good bond with one or more of my fellow students				67	
	I would feel comfortable letting a professor know if I need help				26	
Overall Wellbeing	Overall, I felt good about my exercise levels	45	44	34	44	-1
	Overall, I felt good about my sleep quality	52	51	48	46	-6

	Overall, I felt good about my diet	61	62	54	53	-8
	Overall, I often felt down	46	46	59	44	-2
	I often worry too much	58	65	58	58	0
	Overall, I felt good about the amount of time I spent outside			26	43	
	I feel like my stress levels are unsustainable				39	
Studies	I feel confident about graduating on time	50	45	42	42	-8
	I am generally optimistic about the future	61	56	51	53	-8
	I am happy with how I am performing in my studies	63	50	48	50	-13
	I am satisfied with my study/life balance	39	31	19	25	-14
	I feel capable at what I do			35	39	
	I feel motivated to finish my current study program			57	58	

Another helpful data analysis technique investigated the items that best contributed to regression models of overall life satisfaction. This revealed the exceptionally strong contribution of satisfaction with the home environment and certain checkbox items; Table 4 and 5 outline these analyses based on staff data from December 2020. This revealed that the most predictive factors seemed to be Fatigue, Stress, Loneliness, Optimism, Belongingness, Engagement, Work/life balance.

Table 4: A tabulation of a regression model predicting life satisfaction) based on all items in the survey. The items displayed were significantly higher in predicting life satisfaction than others in the survey. The overall predictive value of the mode was R^2= .56. The capitalized rows represent scaled items, while the others represent checkbox items. These data come from the second (December, 2020) staff survey (n=1622). LogWorth represents a value that is transformed from the *p* value by based on a chi-squared test, making it appropriate for graphing.

Item	LogWorth	*p*
TU DELFT EFFECT ON WELLBEING	14.894	>.000
COPE WITH WORKLOAD	12.828	>.000
RATE WORKING FROM HOME	9.867	>.000
I often feel lonely	6.756	>.000
I am generally optimistic about the future	5.12	>.000
PHYSICAL HEALTH	2.933	0.0012
I often feel too tired to do my job effectively	2.549	0.0030
I am planning to take off time over the end-of-year break	1.968	0.0171

Table 5: A tabulation of a regression model predicting life satisfaction) based on the checkbox item in the survey. The items displayed were significantly higher in predicting life satisfaction than other checkboxes in the survey. The overall predictive value of the mode was R^2= .42. These data come from the second (December, 2020) staff survey (n=1622). LogWorth represents a value that is transformed from the *p* value by based on a chi-squared test, making it appropriate for graphing.

Item	LogWorth	*p*
I often feel lonely	8.503	>.000
I often feel too tired to do my job effectively	6.779	>.000
I am generally optimistic about the future	6.24	>.000
I often feel like my stress levels are unsustainable	4.968	>.000
I often feel like I don't have anyone to talk to	2.935	0.001
I have sufficient social interactions with people	2.103	0.008
I am satisfied with my work/life balance	1.936	0.012
I feel engaged and interested in my work	1.521	0.030

We also compared internal groups, like international students and staff versus dutch natives, or the change in overall wellbeing in different departments across the university (Table 5).

Table 6: Results following the second iteration cycle, broken down by language. The capitalized represent scaled items expressed in mean (*M*) and (*SD*). The range of these items was from 0 (“Very dissatisfied”) to 10 (“Very satisfied”). The other items represent the percentage that agreed with a given statement.

Selection of Questions December, 2020	**English Students**	**Dutch Students**	**English Staff**	**Dutch Staff**
Number of Respondents	*776*	*2351*	*425*	*1183*
LIFE SATISFACTION *(M, SD)*	5.5 (2.1)	6.1 (1.7)	6.0 (2.0)	6.6 (1.6)

SATISFACTION WORKING FROM HOME *(M, SD)*	5.6 (2.7)	5.7 (2.0)	5.8 (2.3)	6.4 (2.1)
I am happy with how I am performing in my studies	26%	58%	--	--
I often feel disconnected from my family	39%	14%	37%	15%
I'm part of a student association	18%	43%	--	--
I feel like I belong at TU Delft	23%	47%	29%	48%
I often feel like I don't have anyone to talk to	36%	13%	23%	12%
I often feel lonely	56%	34%	39%	21%
Overall, I felt good about my exercise levels	28%	49%	38%	50%
I feel like my stress levels are unsustainable	43%	24%	41%	10%
I am satisfied with my work / life balance	21%	34%	27%	49%
Overall, I felt good about my sleep quality	41%	54%	45%	54%
It often feels like no one at TU Delft cares about me	31%	18%	--	--
I feel part of a community at TU Delft	19%	31%	23%	35%
I am generally optimistic about the future	48%	58%	42%	55%
My home working environment is not ergonomic and I can feel the negative effects on my body	48%	44%	50%	36%
I have rearranged my room during corona	30%	25%	39%	61%

Community-Led Qualitative Data Analysis using "Wellbeing Design Workshops"

The first wellbeing assessments were gathered in June 2020, near the end of the 2020 school year. To support institutional action, we took special care to recruit decision-makers to help us read over the thousands of written responses. We involved over 40 persons in this qualitative analysis. Although the written responses didn't need this many participants, the broad involvement of stakeholders (all from within the university community) seemed to help facilitate responsive action. The stakeholders included students elected to the student council, staff counsellors (including psychologists and employees involved in mental health coaching), deans and various other students and staff.

All of these individuals were invited to participate in a “Wellbeing Design Workshop”. The aim of the workshop was to identify the needs and ideas that students expressed about the various topics that could be discovered. Prior to the workshop, each participant was put in a subgroup with a broad overall topic. These topics were identified through statistical factors analysis and included: Unhappiness, Affected by TU Delft, Discrimination, Finances, Home Architecture, International Students, Low Physical Health, TU Delft support, and Uncategorized. Then, participants of the workshop were sent ‘homework’: a subset of about 200 free response data that they needed to analyze, extracting quotes showing unique needs and ideas.

For example, here are two responses indicating needs: *“Being on campus helps, seeing people enjoying the place. I'm missing spontaneous conversations and plans.*” and *“I moved to the Netherlands just before the corona outbreak gave me too little time to make a network of friends and without social events there is little chance of connecting with someone.”* The next two quotes share ideas: “*I feel better when I see others that are managing and are able to reach their goals”* and *“It would be nice if there was always a link for online office rooms or a link for online coffee breaks where people from tu delft could enter anytime and work with someone or have a break together there...”*

During these Zoom workshops, we provided an introduction and a recap of the quantitative results. Participants were put in ‘break out rooms’ with the task of synthesizing the needs and ideas identified in their homework text responses. The synthesis entailed the grouping of needs, ideas and quotes into subtopics. The document that was produced was the main deliverable of this workshop. After 45 minutes of work, later they were invited back into the main room where we asked the participants to structure the ideas in terms of urgency and difficulty. This was done on a virtual whiteboard environment called Miro. Participants were sent back to their breakout room where they finalize their deliverable and prepare an elevator pitch of the most important findings of their group. Each group summarized their findings in a short document. The workshop lasted a total of 90 minutes including breaks.

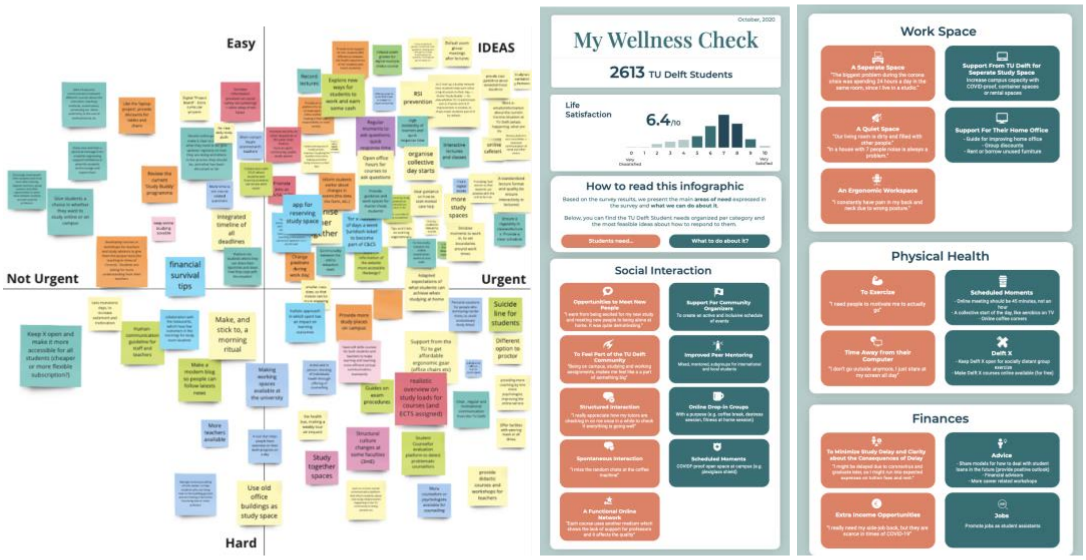

Figure 5: Left, a synthesis of ideas on two axes: from hard to easy and from urgent to not urgent. Right, a combination of quantitative data, quotes, needs and ideas were presented in a campus infographic about student and staff wellbeing needs. This shows part of an infographic about student needs and what to do about them. This was generated from the synthesis of the first cycle of My Wellness Check and sent to all student-facing staff and students. Its long format was designed for scrolling mobile devices.

Following workshops for students and staff, the synthesized documents were clustered together into themes. Findings were then presented to the executive board of the university; some findings were then further communicated to Deans for implementation in local policy. Other findings, like the above infographic (figure 5), were shaped by communication staff for mass deployment to the university community. Reports were also disseminated to the TU Delft Community (Van der Maden et al, 2021) and the broader network of engineering universities in the Netherlands (Lomas et al, 2021).

Discussion

We hypothesized that wellbeing feedback loops can help universities (large complex socio-technical systems) "muddle through" and make incremental improvements to address wellbeing. Did *My Wellness Check* result in meaningful changes in university governance? Having presented to the executive board multiple times, we believe so. Some changes were small, like in the tone of administrative emails (based on the finding that optimism for the future was so important). Some were expensive: for instance, based on the finding that the home environment strongly impacts wellbeing, the university funded a program to provide staff with more ergonomic chairs and desks. Based on the requests for spontaneous social contact, a program was initiated to randomly connect new PhD students together. A "Wellbeing Week" was organized based upon input from the survey. Many other small, incremental improvements were likely made throughout the university. Yet, it is a limitation of this paper that we can only very roughly document these changes. There were also opportunities for design: several masters projects in Human-Centered Design were initiated to help with the current situation. One student, for instance, developed a personalized recommendation system to help students redesign their living space on a budget. Another student re-envisioned the "Digital Campus Life" and designed a system to match up students online.

Reflection on what worked well

Our quantitative data show that our approach enabled various factors to be measured over time and enabled prioritization of underlying factors. The community-led "Wellbeing Design Workshops" were a very successful approach to help spread the burden of qualitative data analysis. The checkbox item format worked well to collect broad information with minimal decision effort. We were happy to have used consistent 0-10 scales as this simplified data analysis. Choosing a core item of "Life Satisfaction" (Diener, 1985) was very helpful for enabling analyses of contributing factors (e.g., home environment predicting life satisfaction). In the end, the most consistently valuable qualitative data were statements that gave 1) insight into people's needs and struggles, and 2) ideas about what could be done about it.

Reflection on what was challenging

Sometimes the complexity of the data analysis was overwhelming. For instance, it was easy to add new questions to the survey and often difficult to know what to do with the data that returned. In one case, we randomly assigned students to 7 different variations, each of which provided a full set of scaled items to investigate validated constructs in the wellbeing literature. In the end, when analyzing the data, we thought: "Oh dear, what were we hoping to find?"

Reflection on Participant Motivation

What motivated the participants to contribute their data to the university? The staff may have felt an obligation to contribute, but what was in it for the students? We assume that it is because they want their voice to be heard and to make a difference on policy. Some may have wanted to vent, some may have wanted their feelings to be heard, while others may be simply curious about the survey. Some may want to learn more about their own wellbeing. Some may feel that they are doing a favour to a university that they care about. Tapping into motivation is crucial for gaining a strong voluntary response rate. One limitation of all of our findings is that we cannot know about the population we don't reach. Perhaps future policies will randomly select a smaller group for paid participation, if only to ensure that the distributions are roughly similar.

Limitations

Even as we sought to take a human-centered approach, we only rarely engaged in more in-depth investigations of what the COVID-19 pandemic was like for individuals. But, even as we seek to support a large-scale process, there should still be opportunities to bring in greater depth.

Our survey is still not sensitive to changes that might be made at a university level. For instance, it is not appropriate for measuring whether actions taken are having the desired effect. In this way, it fails to provide a tight cybernetic feedback loop, as desired. Yet, in any data-responsive system, it is important to interrogate the outcome measures (e.g., "is this really measuring the outcome we want?") because optimizing data metrics can easily lead to unintended consequences. In large systems, it is easy to forget that the data are signals regarding underlying qualities — and, typically, it is the quality that is desired, not the signal. In the end, we avoided a strict orientation towards singular metrics (like "Life Satisfaction") and instead sought to inform decision-makers and community members with a broad slate of measures and quotes to help improve sensitivity. A proper cybernetic feedback loop may not, in the end, even be desirable. And yet we still find the notion of a society that optimizes for wellbeing to be a powerful vision for the future and continue to consider how continuous improvement loops of wellbeing optimization might be implemented in various settings.

Future Assessment Opportunities and Challenges

Should We Ask Everyone or Take a Sampling Approach? A key question with large-scale wellbeing assessments is whether it is better to try to reach everyone or whether it is preferable to randomly select a subset of persons to get a representative sample. Smaller, randomly selected groups could be sampled multiple times per year (i.e., pulse sampling) to better monitor the ups and downs of community wellbeing over time, such as during the dark of winter. A sampling approach might produce greater motivation if participants feel they are responsible for representing their peers. Further, not everyone needs to respond to the same items: different random groupings of students/staff can be assigned to different free response items. This can help spread participant burden while still allowing many different items to be asked. And yet, there is an ethical equity component to wellbeing assessment that may make it objectionable to limit wellbeing assessment to a select few. People may want their voices to be heard, particularly if the outcomes of the assessments are intended to inform policy. This remains an open question.

Multiple Levels of Wellbeing Assessment: Our aim in this study was to measure wellbeing at a level of the entire university. However, wellbeing items can also be embedded into classroom assessment cycles to gain more insight into the general struggles that students are facing. For instance, teachers can ask 0-10 rating questions like "How well do you think you are doing in the class?" and "how well are you doing outside of class?" Qualitative free text questions can also be included, like “what are your needs?” and “what do you think could be done to support your needs?”

Checklists of Healthy Academic Environments: There may also be alternatives to sending out surveys to gather data from people in a community. Instead, it may be possible to systematically gather the typical features of healthy university cultures and social environments. These properties could be shared in a structured way to community leaders. For instance, a simple checklist might be provided to department deans to self-assess whether they are supporting pro-social behaviors, like “regular brown-bag lunch presentations” or “randomly assigning newcomers to meet.” Future research could document typical pro-social behaviors in healthy university social settings.

The Politics of Wellbeing Assessment: The survey design was continually adjusted based on the influence of various stakeholders in the university. That is, the design was, in a sense, political. This is no surprise, as it was intended to be used in a governing institution. While this may be viewed as a limitation, embracing the tension of politics in a measurement process may have contributed to the overall success of the program. This is because success is not just based on the success of deployments or the efficacy of measurement nor even in the creation of positive user experiences — success was based on the actionability: that is, causing the university to actually take actions based on the information gathered by the survey. To be clear, this is why the survey didn't ask about age, gender or ethnicity— various stakeholders felt that a wellbeing assessment would be more easily adopted at scale if it didn't immediately become a potential source of division between groups. That may be wise. (As a compromise, we included a question asking about discrimination). Wellbeing assessment should, in some ways, be a political act—it will need to be political if organizations (or even governments) adopt wellbeing as a core social aim. For better or worse, this political involvement distinguishes action-oriented assessment from typical efforts to assess wellbeing in a purely scientific context.

Conclusion

TU Delft Wellbeing Assessments are now run quarterly for all staff and students. Some survey items remain consistent (in order to measure changes over time), while other items cycle in and out. The assessment data from each cycle thus impacts the assessment in the next cycle. The measurement of wellbeing produces a kind of tension—can something so important as wellbeing be reduced to a number? We have embraced this tension by making full use of both quantitative and qualitative data — and by placing full emphasis on promoting positive action rather than merely “accurate” measurement. We believe that wellbeing is an important objective in university education. We expect that wellbeing will be assessed more regularly in the future, as a feedback loop, in order to contribute to more human-centered institutional governance. Institutions need to know: what are people’s needs and how might we help?

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Track 10:

Transforming Design To Engage With Complexity

Chair: Prof.dr. Gordon Rowland

Jane Addams and Ecosystems Design: What might we learn?

Danielle Lake

This paper argues Jane Addams's engaged philosophic activism offers insights into how systemic designers might engage with and communicate about wicked problems. I show how her participatory and situated approach to design traces complex histories and geographies, offering transdisciplinary strategies for designers addressing systemic crises. She is remembered as one of the most powerful social reformers of the twentieth century, contributing to the design of innumerable processes and systems to address labour rights, immigrant rights, women's rights, and children's rights, peace, food justice, and more. While her ecosystem design efforts have been recognized across a swath of fields and sectors, designers have yet to carefully examine how her approach to design might offer strategies for designing across complex, adaptive systems. After exploring the role of design in wicked problems, I explicate Addams's approach to wicked problems and design, highlighting the essential roles of relational, historic, and geographic mapping, aesthetic disruption, reflexive feedback loops, and sustaining situated engagement across diverse communities. I conclude by suggesting the combined force of these practices can cultivate design pathways for transdisciplinary design efforts aimed at addressing wicked problems.

Keywords: Jane Addams, systems design, wicked problems, aesthetic disruption, relational revolution, historic and geographic mapping, transdisciplinarity

Wicked Problems by Design

"The world is on its way to ruin and it's happening by design" (Monteiro 10).

The term "wicked problems" is not new to the Relating Systems Thinking and Design community. Coined in the 1970's to convey a category of problems that moved beyond complexity, such problems abound and require design efforts that move beyond disciplinary-bound, technoscientific interventions. These problems can be witnessed through persistent and systemic racial oppression, global pandemics and epidemics, and limitless environmental crises. As large scale, interconnected social messes, such problems cannot be solved (Rittel & Webber, 1973; Brown & Lambert 2013). Indeed, the term 'problem' is misleading since such social messes transcend boundaries, are in constant flux, and are interpreted through divergent and conflicting worldviews.

As the spring 2021 issue of *Touchpoint* emphasizes, many dominant design tools and methods not only fail to address wicked problems, they also contribute to them. Design has been a catalyst and contributor to these crises. From colonial systems to systemic racism, public health, and our food and transportation systems, we have "designed the world to behave exactly as it's behaving" (Monteiro 10). When understood as "an intentional world-making practice," we see how design shapes both individuals and the environment (Vink 2021; Fry 2017). Current social technologies (i.e, Twitter and Facebook) are prime, modern examples of the powerful role such designs play in reshaping our inner and outer worlds. These innovations did not take into account the situated embodiment of diverse peoples living together across complex, evolving systems (Wetter-Edman et al., 2018). And while originally lauded for their value, they have led to incredible harm. In addition, dominant design narratives surrounding many innovations tend to hide the inherent tensions and failures within the process and its outcomes.

The design world is calling for a fundamental reimagining, demanding designers reconsider not only the theories and assumptions undergirding their work, but also that they seek out and integrate approaches and knowledge from other domains. Many practitioners and researchers are now arguing design efforts require more collaborative, context-sensitive, and far-sighted design efforts (Birgit 2021; Buchanan 1992; Brown & Lambert, 2013; Dixon, 2020; Grimes, Vink, Harvainen, Rittel & Webber 1973; Vink 2021). Ecosystems design, for instance, provides diverse communities with opportunities to cocreate situated responses to each unique situation (Vink, 2021; Duan et al., 2020; Ansari, 2016). Indeed, across design fields we see movement towards more liberatory, equity-centered, and ecosystems-aware design practices that seek to redress these problems by intentionally operating at different levels of scale (Anaissie, Cary, Clifford, Malarkey, & Wise, 2020; Culver, Harper, Kezar, 2021; Creative Reaction Lab, 2020; Constanza-Chock, 2020; Escobar 2017; Vink, 2021b). One of their first goals is to frame how design has shaped internalized mental models that feed into institutional rules, norms, and beliefs. These approaches visualize how institutional arrangements are created and sustained through "multi-actor exchange systems" (Vink et al. 2020, 2; Vargo and Lusch 2016) that operate to constrain and encourage certain ways of acting and being. The goal is to design internal and institutional structures and processes, so they support situated needs as they emerge over time.[1]

Responding to this call, this paper argues Jane Addams's engaged philosophic activism offers insights not yet fully explored by designers committed to engaging with wicked problems. I show how her participatory and situated approach to design traces complex histories and geographies, offering transdisciplinary strategies for designers addressing systemic crises.

Jane Addams: A systems designer?

Jane Addams and Hull House are often remembered for their community organizing work in the late 1800s and early 1900s. Based in Chicago, their efforts crossed the United States and spanned the globe. They were instrumental in the design of labor rights, immigrant rights, women's rights, and children's rights within the United States as well as international peace and food justice efforts (Knight 2010; Seigfried 1996; Fischer 2013). Addams was the first woman to win the Nobel Peace Prize and an advisor to three US presidents. Her efforts and the efforts of Hull House have been studied and replicated across an impressive array of fields (including sociology, philosophy, education, political science, and a diverse array of service fields). Designers, however, have not yet closely examined her work.

Addams's approach to design aligns with ecosystems design efforts. She authored narratives, speeches, and books and cultivated local, national, and international networks intentionally created to invite others into the iterative (re)design of social systems. As a part of the settlement movement, she also imagined and created Hull-House and its programs. Her efforts opened opportunities for situated, relational designs that sought to address the needs of diverse communities, leading to a swath of legislation and alternative institutional arrangements. In line with systems change models, her designs changed the flow of resources, transformed social practices and influenced government policies; they also cultivated relationships, shifted power dynamics, and disrupted mental models. Her goal was to spark and sustain opportunities for designs situated in and responsive to the needs of diverse communities. While her design efforts were instrumental across many social movements and have had lasting impacts across the world today, she has consistently been misread, and misinterpreted (Fischer, Lake, Whipps 2019). She has also been overlooked by design practitioners; overshadowed by the work of Pragmatists John Dewey, Charles Sanders Peirce, William James, and George Herbert Mead.

While John Dewey is especially given credit across the design field (Buchanan 1992, 2009; Dixon 2020; Vink 2021; Schön 1992; Wetter-Edman, Vink, & Blomkvist, 2018), historians, biographers, and philosophers studying Addams and Dewey have long noted that much of Dewey's philosophy on design was informed by his relationship with Addams. Dewey's private correspondence explicitly reveals how his philosophy was in truth cogenerated in dialogue with Addams. Scholars also note that much of his philosophy was informed by Hull House's innovative social experiments (Knight 2005; Pratt, 2002; Siegfried, 1999; Stengel 2007). Whipps, in particular, has argued for the need to examine their contributions to social change in tandem in order to better uncover the value of their "innovative methods of democratic change" (2019, p. 314). Informed by Hull House's design efforts, Dewey saw democracy as a continuous process of "social and political reconstruction." He began in and with the

[1] In order to generate and sustain systems change, actors engage in "recursive feedback loops" (Vink et al., 2021a, 5, 8). Opportunities to "loop" emerge through generating awareness of embedded institutional arrangements, acting to shift problematic arrangements, and then observing, reflecting, and reconsidering the subsequent changes (Vink et al. 2020 8; Schön 1992).

commitment that we are situated, embodied, and fallible. He emphasized the role of aesthetic experience in imagining and designing our world and committed to iterative, melioristic interventions. As articulated by Dixon (2020), "Dewey sees inquiry—or, more particularly, the identification and resolution of problems—as a transformational act which reconfigures the world in which we find ourselves" (p. 25).

While Dewey's value to the design world should not be dismissed, it is worthwhile to explore what we might have to learn from Addams.[2] Addams, for one, more directly engaged in ecosystems design efforts on the ground than did the founding pragmatists. As a white, educated, upper class woman of her time, she also held a complex array of privileged and oppressed social identities that provided unique design opportunities and problematic biases designers today can learn from.

Addams's efforts to address the sewage crisis within Chicago and across urban spaces serves as an initial and powerful illustration of the need to embrace evolving complexities, wrestle with tensions, and acknowledge nonideal tradeoffs throughout design processes. In *Twenty Years at Hull-House*, Addams documents the wicked dimensions of the situation: explicating the pain points she and fellow ward residents are confronted with because of gender discrimination, inadequate infrastructure, cultural norms, ineffective laws, inept services, and corruption. She also links these complexities to other systemic barriers emerging from housing and tenement practices, public health regulations and norms, transportation failures, educational practices, and labor policies, noting that it is the collection of these "subtle evils" that are "often most disastrous" (195). She notes how such conditions not only fueled a staggerling high death rate in the ward, but also familial abuse, addiction, and crime.

She emphasizes the paradoxes within the situation as well, noting that the garbage boxes were simultaneously a site of horror and disgust to outside visitors, "the first objects a toddling child learned to climb," and "the seats upon which entwined lovers sat." Indeed, for long-time residents, it was all too easy to "forget the smells" and the scene (186).

In "Public Activities and Investigations," she also visualizes irresolvable tensions by mapping the attitudes of city officials (resistance), diverse residents (a mixture of outrage, apathy, and loss), service providers (defensiveness), and those far removed from the daily realities (judgment, disdain, and indifference). The scene and smells, along with suffering and the resistance are emphasized, painting a multifaceted picture of both the devastating impacts and the banality of the situation.

Addams operates as a mediator, catalysing Hull-House and its' residents to engage in ecosystems mapping in order to assess these complexities. In their first two months of their investigation, they found 1,037 violations of the law, ousted three city inspectors, moved violations into the court system for review, and successfully advocated for significant increases to garbage removal services (187-8). In partnership with researchers they were also able to draw out direct links between the ward's horrifying death rate and the sewage. Despite these and many more "successful" interventions, she emphasizes how the situation was still dire after three years of effort. Addams documents innumerable challenges to their efforts to redesign services, including social norms (discouraging women from advocating for matters outside of the house), a commitment to narrowly framed, short-sighted solutions, a lack of transparency and oversight, indifference, resistance, and ineffective regulations (Alpaslan & Mitroff, 30-33). She also highlights the role of institutional lag and human tendencies to deny, simplify, and blame others, to move along the path of least resistance, showing how these situated realities exacerbate efforts to design ameliorative systems change.

While just one example, her efforts to map the challenges of garbage collection demonstrate her awareness of designing responses to wicked problems. As I document in the following sections, they also provide strategies for those interested in pursuing a more equity-focused ecosystems design approach. By further explicating the above

[2] On the other hand, unravelling the role of design in Addams's work is complicated. While her writings consistently and vividly convey her awareness of wicked problems (Lake 2014), they do not clearly reveal systematic explanations of her approaches to addressing them. Thankfully, scholars across fields have been studying Addams's pragmatist social change methods and exploring their relevance to current issues for quite some time (Fischer 2020; Whipps 2019; Deegan 2000; Knight 2005).

example alongside many others, I show how Addams acted as an ecosystems designer in order to ameliorate the wicked problems of her time and place.

Addams's Methods and Strategies

Frame & Reframe

Addams's approach to design embodies a lifelong commitment to critical reflexivity. Defined as the process of "cultivating an awareness of the multiplicity of social structures internalized by oneself and others," critical reflexivity is essential to an ecosystems design approach (Vink, 2021). As a commitment to iteratively frame and reframe situations, it requires one to seek out and stay within the doubt and uncertainty of the milieu, while holding on to critical hope. Doubt opens the door for feedback (i.e., to frame the situation), while critical hope generates the willingness to revise and redo, practices that are more likely to support and sustain institutional arrangements that redress situated social messes. For instance, while Addams was deeply committed to labor reform and played a critical role in reshaping labor practices, she also takes great pains to understand the impact such reforms have on others. She emphasizes the suffering these laws would cause to families desperately trying to make ends meet, saying the potential impact was "never absent" from her mind. She immersed herself in the situation, attending "as many mother's meetings and clubs among working women as" she could and reflecting that these spaces were essential for generating shared understanding (11).

Indeed, a review of her work clearly demonstrates how she sought to design across complex, intersecting and evolving systems through creating and leveraging "embedded feedback loops of reflexivity and reformation." Such loops require a keen awareness of the situation, one's situatedness within the milieu, and a willingness to return and redo (Vink, 2020, 8). *Twenty Years at Hull-House* can be read as a recounting of the evolving complexities, tensions, and nonideal tradeoffs, and setbacks inherent to an ecosystems design approach. Returning to the example of sewage and public health, for instance, she emphasized the challenges women in the neighborhood faced in mapping the garbage and sewage violations. The work was physically grueling, culturally frowned upon, and an addition to their already heavy labor and familial commitments. She highlights how these mapping efforts led to the removal of three city inspectors within the first few months and yet also notes how the conditions in the ward seemed largely unchanged even years later (188). The goal is to work with residents of the ward, city officials, researchers, policy makers, and outside constituents in order to shift mental models, to "make room for other ways of knowing and being" (Vink 2021).

In general, she sought to generate accountability for the wicked problems of the time by facilitating "a constant unsettling among those implicated." To take a separate example, Addams sought to shift the dominant narrative around political corruption in Chicago by resituating the issue. The dominant narrative of the time centered blame for corruption on the willingness of many to receive bribes. Addams pointed out how privilege isolated a few from the need to accept bribes and made it all too easy to assign blame (110). By prompting privileged community members to situate themselves, explore the complexities, and then reconsider their position, she was generating aesthetic disruption in order to "reconceptualize and relocate" the problem (111). While these design efforts begin with aesthetic disruption, they also require a willingness to explore the relational, historic, and geographic dimensions.

Exploring through historic, geographic, & Relational Processes

Addams's ecosystem design approach was informed by her deep commitment to engage across political, institutional, and regional boundaries. She was willing to situate herself in relationships, to see and listen. Along with a nuanced awareness of the particularities on the ground, her efforts were also deeply infused with a complex understanding of the situation, specifically the tracing of both the historical roots of situations and their current manifestations.

Addams argued that we cannot design effective responses to social challenges until we figure out "what the people want and how they want it" ("Subjective Necessity" 22). The initial placement and design of Hull-House was an invitation to members of diverse communities to come together in "fellowship," to create "simple human relationship[s]" with others ("Subjective Necessity" 16). She emphasizes the need for a sustained being-with across differences. She intentionally finds a location for Hull-House that is between Italian, German, Polish, Russian, Canadian-French and Irish immigrant communities, describing it as the creation of a place for "ongoing negotiations'' between "heterogeneous groups."

In place of isolation and simplification, her efforts were informed by an abiding commitment to attend meeting after meeting across coalitions. She saw these efforts as essential for designing ways for diverse people to live and work with one another, writing that such embedded "daily living... is of infinitely more value than many talks on civics for, after all, we credit most easily that which we see" (Addams 190). Addams not only took this approach in her own philosophic-activist commitments, she also consistently warns readers about the dangers of designing in isolation from others. She writes about the Pullman Strike, for instance, noting that Pullman's efforts to build an entire town for his employees fueled "cruel misunderstandings," drove even greater divides, and generated unnecessary suffering (Democracy and Social Ethics 68-70). This focus on being with and coming to know others is combined with the need for a "humility of spirit and a willingness to reconsider existing institutions" as essential for designs that moves us towards peace (1932/2003, p. 339).

Addams's efforts to explore the complexities of each situation did not only rely on understanding the lived experience of diverse others, they also sought to orient the issue within its place. Hull-House generated and sustained space for a diverse community. By situating itself along dividing lines, it operated as "an ongoing space for cultivating humility and reflexivity across difference." For instance, Addams brings trained Russian-Jewish cloakmakers and untrained American-Irish young women who usurped their positions for less wages to Hull-House to design a way forward together. She emphasizes the strong separations between the two groups, the devastation to their livelihoods, and the very real need for employment as well as their opposing commitments to individualism and socialism. She writes that "these two sets of people were separated by strong racial differences, by language, by nationality, by religion, by mode of life, by every possible social distinction." The only thread of connection between the groups was the enormous "pressure upon their trade" ("Settlement as a Factor" 51). Hull-House becomes not only the place they meet; it acts as an interpreter between the two. Within the pressures and tensions of this situation, she saw an opportunity to find "the moral question involved" ("Settlement as a Factor" 53) and design a way forward. This form of mediation can unveil hidden tensions and pain pints and help designers resist simplistic responses to complex social challenges.

In addition to initiating codesign efforts between constituencies, Hull-House also played a primary role in mapping the complexities of its surrounding region (Kish 1991). These efforts included careful study, data collection, analysis, and photography. Hull-House residents created social surveys that visualized the conditions of the communities around the settlement and prompted timely policy changes. These mapping efforts were essential to reform efforts. As Whipps writes in this volume, almost every successful reform initiative at the time was undergirded by these participatory mapping efforts (2021). Referring to only one example, Addams's commitment to relational and geographic mapping was instrumental to the City Homes Association. The association involved an incredible array of diverse people and organizations, generating an incredible amount of reform (Twenty Years at Hull House, 171).

Addams's commitment to mapping included tracing the complex histories that led to the current situation. While exploring the role that residents played in the city's garbage and sewage challenges, she documents the cultural traditions and practices residents brought to an incredibly congested housing crisis. While outside visitors were appalled that residents were permitted to sustain cultural traditions that exacerbated the situation, Addams and Hull House were "nested in realms of experience," able to perceive the challenges from "the inside out," and thus reframe them (Diethelm, p. 169). She employs this same approach when addressing the problems of domestic service: She maps the histories and complexities of these institutional arrangements in order to highlight how the situation fundamentally "belongs to the community as a whole" and thus must be addressed by "members of the community together" (Fischer, 2019, 76).

This form of participatory ecosystem design aligns with current advocacy work across design fields to situate oneself in place in order to generate ethical and viable designs that respond to the complexities of the situation.[3] They press back against design frameworks that dismiss the designs of Indigenous communities and women (Tunstall, 2013; Vink 2021). They incorporate a form of empathy that moves beyond awareness and the arousing of an emotional response, towards a relational, embodied, and action-oriented form of empathy (Jamal et al. 2021).

[3] As Dielthelm points out, design requires one move beyond scientific research; it mandates "a unique, socially constructed, culturally complex perception" (169).

Generate and Prototype

Addams's approach to creative generation within complex, living systems harnessed relational, historic, and geographic immersion, but also "synthetic imagination" (Fischer, 2020, 64). Immersion remains necessary for seeing the interdependencies and evolving complexities within the systems; synthetic imagination is necessary for integrating insights across diverse domains and generating a vision. Synthesis is, in fact, described as one her greatest gifts (Knight, 2010, 93).

Systems thinkers and design practitioners may value exploring the role of synthetic imagination in the *process* by which she designed and in her *designs* themselves. Her narratives, for instance, are designed through synthetic imagination and to prompt it in others (i.e., they generate reflexivity and open opportunities for reformation).[4] As the details outlined above highlight, she wrote to prompt her reader to reconsider how they think, feel, and respond to these situations. Hull-House also emerged through these processes and operated to encourage synthetic imagination in others. Opening in 1889, it consistently designed and prototyped institutional arrangements to support situated, relational generation and action. In Addams's own words, it generated "*unexpected*" and "*romantic*... discoveries *in* actual life" (202). It was also the creation of a place to design and prototype more embodied and imaginative "habits of caring" across differences in order to design a better society (Hamington 2004, 92-93). With neighborhood residents, Hull-House codesigned incredibly experimental *and* more common institutional arrangements, including dozens of classes, but also an open-air school, a reading room, an interpretation bureau, a post office, public bathrooms, a labor museum and more (Addams 2002: 26). Institutional arrangements at Hull-House were emergent, fluid, and experimental. The goal was to "co-create context-sensitive knowledge... into effective interventions" (Lake, 2020, 44).[5] *Twenty Years at Hull House* showcases examples of how such places can design collaborative efforts among diverse community members, various organizations, and surrounding locations.

Generation of alternative institutional arrangements through synthetic imagination and collective-action is often a slow, messy process. Addams's warns of this throughout her work, noting as well that the outcomes of our designs cannot be seen in advance and are most often nonideal. She was consistently aware that her "best efforts were most inadequate"(Twenty Years, p. 259). She designed with "human capabilities and frailties'' in mind, believing that "incremental alterations in moral sensibilities and imagination" were essential for prompting and sustaining valued change (Fischer, 2019, 12-13). Given that design thinking research is showing prototyping, testing, and iterating are underutilized aspects of the process, this aspect of her work is particularly worthy of closer analysis (Liedtka & Bahr, 2020). This approach reminds us that inclusive and sustainable innovation tends to come from the "adjacent possible," from creative, but also viable possible futures that hover at the edge of current systems (Johnson, 2010, 31). Her efforts to design with-and-across through iterative prototyping are also essential for addressing the limitations of implicit bias, cultural tropes, and individual habitudes.

Returning to Hull-House's efforts to get the garbage collected illustrates the need for--and value of--iterative prototyping, testing, and revising. Addams readily admits that their initial efforts only "slightly modified the worst conditions" (187). However, reflexive feedback loops led Hull-House to conduct systematic investigations across the ward and with diverse stakeholders (187). They launched a swath of prototypes over a decade in order to disrupt and create institutional arrangements that improved conditions; they cultivated relationships both across the ward and from farther afield; they also successfully shifted power structures; designed and prototyped new positions, mapped housing and sewage challenges, generated resource flows, and shifted mental models, launching a swath of comprehensive reforms. Their designs ultimately helped to lower the death rate of the ward from third in the city to seventh.

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[4] Addams's writings can also help systems thinking and design practitioners reconsider communication strategies as design interventions that can foster transdisciplinary collaboration on wicked problems.

[5] According to Addams, "the only thing to be dreaded in a Settlement is that it lose its flexibility, its power of quick adaptation, its readiness to change its methods as its environment may demand. It must be open to conviction and must have a deep abiding sense of tolerance. It must be hospitable and ready for experimentation" ("Subjective Necessity for Social Settlements, p. 22-23).

Conclusion: Cultivating Change

According to systems designers, cultivating valued systems change requires sustaining reflexive feedback loops that move designers through framing, listening, and understanding systems as well as defining, exploring and intervening (Jones & Van Ael, 2021). More participatory, situated, and emergent processes are still needed. Addams offers a vision and a set of strategies for shifting design practices. She reminds designers that the systemic redesign of institutional arrangements emerges in part through "intimate knowledge of the experiences of the beneficiaries." Cultivation requires a "long residence among;" it requires time to develop relationships and explore the tensions from a variety of angles (Addams, 1910, 10).

Researchers of complex systems change and innovation agree. They emphasize that valuable design interventions require a willingness to sustain relationships across differences in order to cultivate trust and a shared vision across constituencies (Centola, 2021 83; Burns, Machado, and Corte 2015; Cattani, Ferriani, and Colucci 2015; Johnson 2010). Creative action requires a willingness to wade into uncertainty (Menger 2001), engage in conflict, collaborate across difference, step outside of dominant norms, risk making mistakes, and adjust decisions based on the outcomes of such actions (Farrell 2001; Liedtka and Bahr 2019; Parker and Hackett 2012). As we have seen, Addams, Hull-House, and its residents lived these practices out. Hull-House efforts were also focused on cultivating a "sensitivity to interrelatedness" and "a respect for thresholds" (Vink 69). Addams's design efforts ultimately led to generations of social change activism as well as the successful implementation of labor laws, women's rights, immense educational reform, and more. The brief vignettes highlighted above demonstrate that cultivation requires boundary spanning designers and institutions.

Addams designed places, processes, and opportunities to prompt situated social change. She sought to uncover the complexities of each situation in relationship with others and pursued relational-iterative action. In many ways, she was a master of sparking and sustaining disruption (Seigfried 45). According to Vink (2021), Addams's approach is valuable "for the project of redesigning design," because it emphasizes the need to "cocreate lasting infrastructure that supports ongoing collective reflexivity amid plurality." In contrast to dominant design efforts, she was also very much aware of the limitations of our designs. Rereading Addams as an "ecosystem" designer relevant to our design efforts today offers those interested in resituating design a more embodied, emergent and situated approach.

Thus, designers and changemakers might value exploring both her design process *and* her design artifacts as they seek to themselves engage ecosystems design processes and create designs that cross boundaries and alleviate wicked problems.

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The Other Side of Design: Tension Manifolds and Collective Action

Goran Matic and Ana Matic

Systemic issues feature dynamic complexity that challenges cognitive, contextual, spatial, and temporal perceptions within 'social messes' (Ackoff, 1974) and 'super-wicked problem' (Levin et al., 2012) environments. Systemic designers thus find themselves working with tensions endemic to paradoxes, breaks in scale, value (or goal) conflicts and heterogeneous contexts. These differences may yield opportunities for design exploration when considered as spaces of praxis. Tensions within such spaces often make collaboration and collective action challenging – yet can also be considered as a type of design medium. This paper proposes the concept of 'tension manifolds' – and explores the potential for enabling design within systemic issues, with the goal of reframing tensions as a type of design affordance that enables collaboration and collective action in multi-stakeholder environments.

Keywords: systemic design, design tensions, collaboration, collective action, field theory, tension manifolds

Introduction

To enable collective action through transdisciplinary collaboration in multi-stakeholder environments, we explore the 'other side of design' – focusing on the conglomerate of dynamic tensions between the stakeholders, organizations and entities engaged in the context of a complex social challenge (Matic, 2017) – as a conceptual ontology at the intersection of 'problematiques' (Christakis, 2006), 'social messes' (Ackoff, 1974), 'wicked problems' (Rittel & Webber, 1973), 'post-modern complexity' (Cilliers, 2008), and the 'super-wicked problem' (Levin et al., 2012) environments.

We term such conglomerates as 'tension manifolds' – multi-dimensional structures postulated to be dynamic yet semi-stable, ontogenized by the needs of diverse socio-cultural actors that continually strive to maintain relative equilibrium through the processes of change; while simultaneously attempting to maximize self-reflexive constructs such as autonomy, mastery and purpose (Pink, 2009).

The homeostasis within 'tension manifold' structures is postulated to be established through the tensegrity principles (Marsico & Tateo, 2017) between the socio-affective forces (Massumi, 2002) that dynamically emerge between the involved actors; who engage in reflexive discoursive practices (Zienkowski, 2017), and create a type of cybernetic circularity (Krippendorff, 1994) which 'holds' the emergent tensions in-place.

In this sense, the homeostatic tensions – that are in a dynamic yet temporary equilibrium – become an opportunity for considering the 'other side of design'; where, instead of designing only for the spaces that the actors inhabit, we re-position design towards the tension spaces between the actors themselves, and the tensegrity relationships that hold them in-place.

Systemic issues imply perceptive shifts that can be experienced as uncertainties around value transience (permeability or stability of existing relationships), temporal effects (perception of time-scales), and phase-changes (likelihood of paradigmatic alterations) from the perspectives of the involved actors. Systemic issues can also be considered as existing within liminal spaces (Van Gennep, 1909) that necessitate employing stakeholder strategies capable of enacting liminal transitions (Turner,1966) – while enabling salutogenesis (Antonovsky, 1996).
Yet effectively designing liminal transitions within systemic issues can also be challenging without considering the structure of tensions and dynamic forces between the involved stakeholders, actors, and participants. This

paper proposes the concept of 'tension manifolds' as an invitation towards a reflexive practice in design and posits questions for further research and exploration.

1. Engaging complex issues

When diverse stakeholders engage a complex issue, they often perceive different aspects of the challenge and its presupposed enclosing environment. This is in part because what's identified as a 'single' issue is likely related to several interacting systems – each of which can be considered separately, in a way that may be of differing interest to the affected parties.

Participants tends to perceive the 'parts' of a complex issue they are most exposed to – which both frames the boundaries of their understanding and limits it, due to the specific properties that each way of 'looking' embodies. The varied perspectives tend to lead to differences in understanding – that might be identified as 'polarities' to be managed (Johnson, 1992), or benefit from dialectical thinking approaches (Basseches, 2005).

At the same time, stakeholders often attempt to definitely understand the evolving systemic issues to enable adaptive responses. In this process, participants must negotiate the *cognitive*, *contextual*, and *cooperative ambiguities* (Matic, 2017) – in the absence of being able to perceive the totality of a given challenge. Since the it is not possible to perceive the entirety of a given systemic issue – as per cognitive and contextual limitations imbued in the dynamics of 'wicked problems' (Weber & Rittel, 1973), 'super-wicked problems' (Levin et al., 2012), 'social messes' (Ackoff, 1974) and the 'post-modern complexity' (Cilliers, 2008) – an attempt to formulate a well-informed strategy creates dynamic tensions.

This introduces stresses that affect perceptions of relationships and influences the stakeholder understanding of their own situation – which informs the subsequent orientations towards the possibilities of collective action.

2. Design as focused on 'external' perceptions

The process of engaging systemic issues is further challenged by the stakeholder ability to focus on different ecosystemic scales – such as, micro, mezzo or macro (Liljenström & Svedin, 2005) – where, there is no guarantee that participants are exploring the identical aspects of a given challenge or opportunity space.

Within the over-arching systemic issue, the stakeholders can 'look' at different complex sub-systems and experience very specific 'homeostatic pressures' in their desire to maintain some semblance of equilibrium and stability. The stakeholders are not likely to be able to definitely compute an ideal future or a deterministic adaptive strategy, since the systemic issue changes are dynamic – while the act of expanding understanding iteratively alters the possibilities of action.

At the same time, stakeholders are likely to experience a necessity to act in order to start adapting – while working to address some aspects of a broader systemic issue.

To this effect, stakeholders comprise the best understanding of the systemic issue possible to actuate effective action, which creates a type of homogenized sense-making surface that represents a current, unified understanding of a given systemic issue. This generalizes perceptions in Deleuze's rhyzomatic sense (Holland, 2013; Semetsky, 2003) through the principles of 'difference and repetition' (Williams, 2013) that lends a sense of universality – while simultaneously lacking in specificity that might apply to each stakeholder's individual experience.

This drives the design towards the 'external' aspects of a systemic issue – where, the identification of key affordances has been compressed into a certain kind of a representative homogenized design surface, as a non-dynamic 'snapshot' that begins to inform the subsequent design approaches.

3. The 'inside' of design – towards the 'tension manifolds'

While the engaged stakeholders are focused on the 'external' aspects of a given systemic issue – describing the challenge as it appears within the context of best current understanding – a significant portion of the design challenge is also situated on the 'inside' of the stakeholder experience and the design process itself.

From this perspective, the 'inside' of the design challenge is comprised of the evolving tensions that the stakeholders experience in relation to the systemic issue, as they dynamically attempt to maintain their sense of equilibrium and homeostasis amid the changing circumstances (of their 'snapshot', or design surface).

How might this dynamic space on the 'inside' of design be understood, to possibly assist in the process of engaging systemic issues?

Field Theories

The stakeholders within a systemic issue can be said to be participating in shared experiences that can be understood through the lens of field theory (Lewin, 1942; Martin, 2003) – where social experiences can be analyzed with topological concepts.

Space, as a core construct in topology is of interest to mathematicians – who "understand sets and spaces in terms of their constituents, or more precisely, in terms of the relations among the aggregates of elements that form subspaces" (Carter, 1995).

The ability to describe effects between diverse objects and relationships in the context of a shared field influenced a range of disciplines, including gestalt psychology – which aspires to "help individuals and groups to change their perception of themselves and the situation in question, which, in turn, they believe will lead to changes in behaviour" (Burnes & Cooke, 2013).

Subsequently, field theories have been evolved by Pierre Bourdieu (1975) and others, in diverse areas. These include critical discourse studies and collective learning, arguing that novel approaches are required to enable "continuous reflection on the adequacy of existing conceptualisations of the social" (Forchtner & Schneickert, 2016); in the study of interdisciplinarity, arguing for a view of science as a "set of forces that shape struggles among scientists and struggles that reproduce or transform those forces" (Panofsky, 2011); in communication studies, focusing on "how to understand the media both as an internal production process and as a general frame for categorizing the social world" (Couldry, 2003); and in political science, to explain concepts such as modern hegemony in international relations (Nexon & Neumann, 2018).

The field theory approach also led to a change model attributed to Lewin (Cummings et al., 2016) that has subsequently become both controversial and influential – consisting of the 'unfreeze', 'change' and 'freeze' stages.

Whether Lewin directly authored it or not, the model has garnered widespread use. Yet, when immersed in systemic issues, stakeholders may not always be able to apply this approach – as complex environments dynamically change. An attempt to 'freeze' the situation sufficiently to create a temporarily stable environment almost immediately starts departing from the evolving change dynamics (and therefore our systemic 'snapshot') – which forces stakeholders to concede to the superior change forces, increasing chances of abandoning the initiative.

Tensegrity as a Field Aspect

At the same time, stakeholders in systemic issue environments often appear to be 'locked' into sets of tensions – which emerge as the result of the 'push and pull' relationships that immerse participants to varying extents.

Although dynamic in nature, such tension structures exhibit homeostatic properties that retain their overall integrity under pressure. This can be aptly related to the phenomena of tensegrity – where certain structural elements are 'pre-loaded' with stress, while others are 'compressed' in a way that influences perception (Cabe, 2018).

Diverse stakeholders attempting to engage in collaborative strategies become subject to a social field situation. The actors engaged within a systemic issue are exposed to sets of tensions that are 'pre-loaded' with stress, while contending with 'compression' forces elsewhere – in such a way where the 'degrees of freedom' available for individual or collective action (Poteete et al., 2010) are effectively limited.

Tension Manifolds

In a field theory sense, tensegrity structures can be said to 'curve' the spatial medium around them.

Because the tensegrity structures that inform the spatial curvatures are homeostatic and exhibit properties that are resilient to change, we may choose to term such curvatures as "tension manifolds" – that represent sets of tensions that stakeholders experience within an evolving systemic issue. Yet these sets of tensions tend towards homeostasis – as part of an attempt by the stakeholders to maintain an overall state of dynamic equilibrium within a systemic issue.

While the evolving experiences of the systemic issue dynamically create new sensemaking pressures (Weick, 1995), the 'inside' of the tension manifold alters at a reduced rate – as the stakeholders evaluate perceived external changes in relation to attempting to maintain equilibrium. This difference in rates of change can be thought of as a 'change differential' that can be utilized in design processes within systemic issue contexts.

While it may be compelling to think about the challenge-space as something that is primarily 'out there', the stakeholders tend to focus on achieving their own homeostasis in response to the pressures of an external challenge. Thus, the stakeholder actions have two components – the *adaptive response* to an external adaptive pressure, and the *homeostatic response*, as an attempt to maintain own sense of structural integrity; as per Figure 1:

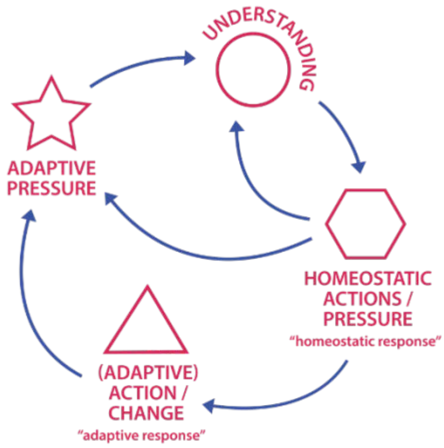

Figure 1: Adaptive and homeostatic responses

This effectively introduces two different design challenges - that are related yet not identical.

A common assumption might be that in working towards addressing systemic issues, we attempt to align collective action strategies towards an 'objectively' perceived, 'outside' challenge. At the same time, the engaged stakeholders temper their adaptive responses with the homeostatic response –focused on addressing the subjectively perceived, 'inside' challenges.

This presents an opportunity to leverage the 'other side' of design – and focus on the 'inside' comprised of the varied tensions experienced by the diverse stakeholders. This approach entails approaching manifold topologies as an active design medium in enabling diverse stakeholders in systemic issue contexts.

4. Tension manifolds' as a design medium

Manifolds are a set of topological objects that describe a range of possible geometries.

Complex manifolds (Carter, 1995) extend the notions around Euclidian spaces, moving away from Newtonian mechanics to enable descriptions of spatial curvatures – that were instrumental in enabling theoretical concepts such as Einstein's space-time construct.

Certain classes of manifolds have features that may not exist in Euclidian spaces – such as the concept of 'self-intersection'. To describe their shape, complex manifolds utilize concepts of 'maps' and 'atlases' that can outline various regions of their topological spaces. This aligns well with systemic design methods – and enables mapping conversational constructs and cybernetic concepts that include notions of recursion and reflexivity.

Reflexivity and Geometry

In social sciences, reflexivity "is considered in terms of acts of interpretive movement" (Zienkowski, 2017) where, "social actors, organizations and systems throw reflexive loops around themselves, around others, as well as around spatial, temporal, linguistic, cognitive, social and historical dimensions of contextual reality".

The relationship between reflexivity and interpretation – and especially in cyclical processes involving the observer and the relationship with contextual reality – has been explored extensively in cybernetics (Krippendorff, 1994) as relating to design; delineating a "substantial relation between cybernetics and design in terms of the circular, conversational structure that they both share" (Sweeting, 2015). Yet reflexive or self-intersecting phenomena can be challenging to 'map' in purely Euclidian geometries. For instance, parallel lines never intersect in Euclidian spaces – whereas, in curved spaces lines that are parallel in one region might eventually intersect in another region of space.

Tension Manifolds

As an extension, 'tension manifolds' are postulated as multi-dimensional objects that exist in complex geometries. In this sense, they can be considered as more versatile in terms of spatially relating diverse, yet interconnected phenomena experienced by stakeholders. In this sense, 'tension manifolds' might be more akin to the proverbial story about the elephant – where, different people might be attempting to infer the shape of the large animal by touch, while arriving at quite different accounts that describe alternate yet very much valid first-hand experiences.

Manifolds can be helpful as an analogue for 'mapping' different stakeholder experiences within a particular systemic issue – since they allow for the 'view' of each region of 'space', as inferred by each stakeholder, to be dramatically different, yet entirely valid; dependably on the position within the space they are exploring (on the topological surface), the direction of their 'looking', and the characteristics of their perceptive cone (describing 'how' they are looking).

In addition to being able to integrate seemingly disparate views into a single cohesive structure, manifolds may also be useful as representative surfaces in that they can support the concept of continuity of experience within complexity. This translates well to the identity psychosocial structures (Marcia et al., 2012) that tend to be continuous, and stakeholder sensemaking processes that lean towards the cohesive. As such, manifolds have an imbued potential for describing emergent phase-changes in psychosocial landscapes – that may be considered as 'liminal transitions' (Turner, 1995).

While the 'external' stakeholder adaptive strategies may change, the 'tension manifolds' describe dynamic conglomerates of compression and expansion forces associated with the stakeholder core adaptive / motivating goals – that have a greater degree of resilience to change then the 'outside' adaptations. From the stakeholder perspective, the 'outside' adaptations are a means of achieving the 'inside' adaptive goals, in a specific context – defined by the perceived boundaries of a systemic issue.

'Tension manifolds' may be utilized to describe tensions as a certain type of psychosocial 'fascia' – a 'connective tissue' between the stakeholders, their experiences of a systemic issue, and the associated adaptive responses. In this sense, the shape of a 'tension manifold' corresponds to the experienced adaptive pressures within a systemic context, and any changes that stakeholders make within their own adaptive responses and constitutive relationships. From this perspective, 'tension manifolds' emerge out of the reflective, recursive process of stakeholders interpreting their experiences around the perceived potentiality for change in their constitutive relationships.

The ‘tensegrity’ aspect of tension manifolds can be considered as the container of the dynamic forces as experienced by the stakeholders. Within formal structures – such as a church, a bridge, or a skeletal system – the more complex a tensegrity structure, the more degrees of freedom it is likely to have. The size of movement within a tensegrity structure might depend on the stimuli-induced dislocation, the degrees of freedom between the constitutive elements, and the active forces within the tensegrity structure itself.

The ‘specificity’ aspect of tension manifolds can be considered as the container of the cyber-semiotic (Brier, 2010) ‘curvature’ – which describes differentials in experience between different stakeholders. The more specific and differentiated stakeholder experiences are, the more ‘curvature’ there is in a tension manifold – since, differing cyber-semiotic perspectives generate alternate ways of ‘looking’ at and perceiving the world. This is at odds with common tendencies to make systemic issues ‘universal’ in their character, and explanatory in reductionist terms.

5. Leveraging tensions as design affordances

Systemic Issue Challenges

To effectively adapt to systemic issues, stakeholders and participants often need to transform in some way – which can be considered as a transition in liminal spaces (Turner, 1995), and component of ‘liminal journeys’.

However, this transformation is hindered by the challenges in context understanding, and in perceiving a 'stable’ future that the stakeholders and participants are transforming towards – which effectively prevents the enactment of ‘liminal rites’ and restricts the degree to which salutogenesis (Antonovsky, 1996) can be designed for.

Tensions as Strategies

Design methods can take the inherent affordances of ‘tension manifolds’ into account when engaging systemic issues – to simplify the ‘liminal journeys’ for the stakeholders involved by leveraging three distinct strategies.

Strategy #1 – Alter the ways of looking. The first strategy is to identify places where the position, direction, or characteristics of ‘looking’ may be altered for the participating stakeholders, to allow for a different emergent character of their ‘perceptive cones’. Because of the involved cybernetic circularities, any alterations in the perceptive act of ‘looking’ changes the orientations of the stakeholders – thus creating additional possibilities for collaboration and collective action that may be imbued into the systemic issue context.

Strategy #2 – Identify tension structures. The second strategy is to identify the areas of extreme ‘curvature’ within the tension manifolds – as areas of topology with the greatest contrast between the assumed ‘universality’ of the design medium and the actual ‘specificity’ as experienced by the stakeholders involved. Such identified areas can be targeted for further exploration via systemic design processes – to help reduce any ‘change differentials’ between the exigencies of the adaptive responses, against the stakeholder tendencies of gravitating towards homeostatic responses.

Strategy #3 – Define inflection points. The third strategy is to identify inflection point opportunities within the associated tensegrity structures – as places where the ‘pre-loaded’ tensions and the 'compression’ relationships may be altered to allow greater degrees of freedom for the participants involved. Due to the dynamic nature of tensegrity structures, systemic designers must take care to proceed cautiously – as alterations in constitutive relationships through a design instrument might compromise the cohesion of the stakeholders involved.

6. Use case

RSD3: “Saving Lives by Design”

A useful example of designing with tensegrity structures – that can be analyzed through the lens of “tension manifolds”, as an expression of differential perceptions between diverse stakeholders – is Bhaskar Bhatt’s project presented at the Relating Systems and Design (RSD3) conference in Oslo, Norway, in 2014, entitled “Saving lives, by design: Using systems thinking To combat maternal mortality In India” (Bhatt, 2014).

This project tackles the complex issue of maternal death in India, by engaging a variety of diverse stakeholders over an eight-month period. The research uncovered several key stakeholder groups – including physicians, obstetricians, public health experts, Accredited Social Health Activists (ASHAs), rural midwives, and patients (pregnant mothers) – with compelling, yet not always aligned perspectives.

The project identified that the key stakeholder perspectives could be aggregated into three broad groups – between which there were significant tensions. The medical support personnel felt that the exploration space ought to be guided by technical solutions. The physicians and specialists valued approaches that featured improved care delivery methods. At the same time, the government and public healthcare experts felt that stronger policy approaches are likely the most promising element of any comprehensive solution approach.

The three key identified perspectives – those of physicians (clinical interventions), support personnel (technology), and public health experts (policy approaches) – represented sets of dynamic tensions that generated diverse and potentially incompatible solution spaces, that seemed as mutually exclusive.

Yet through the engagement, the design team was able to work with the inherent tensions and inflect the stakeholder perspectives in such a way as to identify common ground – which helped to generate several cohesive solution approaches that successfully addressed the core challenges and resulted in saving lives of women.

An analysis through the lens of tension manifolds as tensegrity structures is as per Table 1:

Table 1: 'Tension manifolds' stakeholder engagement analysis

Stakeholders	Alter ways of looking	Identify tension structures	Define inflection points
Physicians	Introduced diverse perceptions of the underlying issues around maternal mortality from the perspectives of other clinical specialists – and related them in terms of impact and priority.	Practitioner preferences for specific care solutions – that implied interpretative 'key causes' of the maternal mortality – was identified as a key tension structure.	Defined enhanced support of clinical procedures with new technologies along with availability of novel diagnostic tools as key inflection points for medical practitioners.
Support personnel	Surfaced the relationships between clinical interventions, environmental conditions (spaces where delivery takes place), and the technology / equipment – as relating to maternal mortality.	Difficulties with the equipment and key treatment components – such as the viable transport of an anti-coagulant drug in a hot climate – was noted as a key tension.	Defined opportunities for a heat-proof medicine transport ("battery operated oxytocin cooler"); "protein urea tester" & "a cellphone powered non-invasive anemia detector".
Public health experts	Related experiences of involved health-care practitioners in comprehensive, visual ways – demonstrating key challenges that may impact policy responses.	Challenges in policy formulation that effectively address diverse healthcare participant challenges was identified as a key tension structure.	Defined policy response opportunities as instruments of supporting new technologies and healthcare delivery methods (i.e., in rural areas).

Conclusion

Systemic issues feature dynamic complexity that challenges our static perceptions, limiting effective action within the 'super-wicked problems', 'social messes' and other complex social phenomena that are increasingly becoming an exigent priority for design. Thus, systemic designers are called to enable the exploratory work within dynamic tensions created by seemingly contradictory forces – such as paradoxes, differences, and breaks in context, scale, values and goals, among others – to create opportunities for exploration that help emerge enhanced outcomes. Although challenging, this can become a space of praxis – conceptualizing 'tension manifolds' as a design medium where the reflexive exploration can be harnessed to identify design affordances capable of enabling multi-stakeholder collaboration and collective action.

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The Failures of Prototyping

A Call for a New Definition

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Design thinking is increasingly used to address more complex, systemic challenges. Yet one of its core elements, prototyping, has been underutilized in these dynamic contexts. In order for designers to make a meaningful impact on complex, interconnected, and systemic problems, we need to expand the way we conceptualize the practice of prototyping. This paper highlights the way prototyping is conceived through academic and industry literature and illustrates the ways the current understanding limits the efficacy of this practice for systemic challenges. A new definition that harnesses practices from design thinking, participatory design, and critical making is proposed. This new approach aligns with the Breaks in Scale theme by demonstrating how microscopic and macroscopic perspectives can coexist. This revised conceptualization unlocks the full potential of prototyping by shifting the focus from validation and evolution to a tool for learning that will help designers to address systemic challenges in ways that are faster, less risky, and more creative than our current approaches.

Keywords: Systems, Prototyping, Complexity, Design Thinking, Wicked Problems

Introduction

If designers are going to make good on our claims that we can have an impact on increasingly complex, interconnected and systemic problems, we need to ensure that our processes are fit for the task. Prototyping, a central part of design thinking, is one powerful, but currently underutilized approach to creating systemic interventions. Design thinking is a human-centered approach to problem solving which has been applied to domains ranging from physical objects to governmental policies (Kelley and Kelley 2013; Brown and Katz 2009). Most elements of a design thinking approach – empathy for stakeholders, challenge framing, generative thinking, and an emphasis on thinking through doing – continue to work for the “wicked” problems that so many of us are eager to address (Norman 2019; Manzini 2015; Buchanan 1992). There are many examples of how design thinking has been used for systemic challenges, and while many of the case studies do mention prototyping, they fail to tease out the nuances of using this practice for more complex contexts (Bjögvinsson et al. 2012; Mintrom and Luetjens 2016; Kimbell and Bailey 2017). Simply put, our approach to prototyping is outdated and insufficient for the systemic challenges that design is otherwise poised to tackle. The prototyping approach designers have used to develop a toothbrush will not help us create interventions in dynamic, interconnected systems. Yet, without a more nuanced understanding of the shortcomings and possibilities of prototyping we will continue to underutilize this essential practice. Harnessing elements of design thinking, participatory design and critical making can help to shift our thinking about prototypes from a contained concept to a tool for learning. Doing so will allow designers to address complex, systemic challenges in ways that are faster, less risky, and more creative than our current approaches.

Public awareness of prototyping has been growing since the early 2000s when design thinking, innovation, and start-up culture became part of a mainstream vernacular. In this context, prototyping was positioned as more efficient way to develop and launch products in a competitive marketplace. The broad notion of prototyping continues to gain currency to this day, but not enough attention has been given to the way this critical skill has been defined (Brown, Katz 2009; Brunner, Emery 2009; Kelley, Littman 2001; Martin 2009). The last several years have seen an abundance of literature on the topic, but despite the fact that many of these texts are solely dedicated to the topic of prototyping, few shed light on the potential for using the practice at the systems scale.

From the practitioner perspective Todd Zaki Warfel's Prototyping (2009) and Kathryn McElroy's Prototyping for Designers (2017) cover many of the key aspects of the practice as it applies to design of software, interfaces, products and services. While some of the principles they illuminate can be applied to prototyping systems, neither of them explicitly mention using prototypes for this purpose. Jane and Mark Burry's (2016) Prototyping for Architects also calls out familiar themes, but, predictably, this work focuses on the practice from an architectural perspective. Rethink! Prototyping (2016) edited by Gengnagel, Nagy and Stark is the culmination of multi-year project that explored the ways prototyping can be reimagined and potentially redefined across several disciplines. Although one of the central themes of this project was to reimagine a definition of prototyping, the work hews closely to object-centric projects in architecture, engineering and product design. Discussions of complex systems are rooted in complex product systems and fail to broaden the definition to a point where the practice can be used to explore unbounded challenges where the constraints are in flux. Works such as Brown and Katz's (2009) Change by Design specifically notes how design thinking is used to address systemic challenges, but they offer little in the way of details about how prototyping plays a specific role in these complex problems. The most comprehensive approaches to prototyping have come from the fields of participatory design, anthropology and critical making (Suchman et al. 2002; Ratto 2011; DiSalvo 2014). Halse et al's Rehearsing the Future (2010), Ehn et al's Making Futures (2014) and Kimbell and Bailey's work (2017) provide examples of how prototypes can be used to explore complex systems, but a more explicit examination of the practice and an articulation of how to employ it are is still necessary if we are to get the most out of this way of working. Given all of this work, there are consistent themes that emerge around the common conception of prototyping.

The current understanding of prototypes

The concept of a prototype is not new. Its use in Europe dates back to the 1600s and comes from Greek "proto" and "typos", which translates into the first form or first of its kind. (Gengnagel, Nagy, Stark 2016). From this early definition we can see the ways the current understanding has been widely interpreted and varied in its definition (ibid). However, in much of the academic and practitioner literature on the subject, several consistent elements emerge (Bødker and Grønbæk 1990; Brown, Katz 2009; Buxton 2011; Calvillo 2010; Chi 2015; Floyd, 1984, Gengnagel, Nagy, Stark 2016; Halse 2010; Kelley, Littman 2001; Kolko 2017; Martin 2014; McElroy 2017; Warfel 2009). How then, are prototypes currently understood today?

- *Prototypes are about speed.* While some prototypes may take minutes and others will take years, the prototype is always a faster mode of exploration than a fully resolved offering.

- *Prototypes mitigate risk.* They help designers avoid mistakes at later and more costly phases of the product development cycle.

- *Prototypes communicate.* They become a way for the members of a design team, users, partners and others to surface new forms of understanding, misconceptions and ways of thinking that are far more powerful than verbal or visual assets alone.

- *Prototypes are incomplete.* They describe the final product, but they are not finished products in-and-of themselves.

- *Prototypes are instructive.* They help creators learn how to improve upon a design.

- *Prototypes validate.* They help teams understand more about the viability of an idea.

- *Prototypes are iterative.* They follow a linear (albeit often meandering) path from rough idea to a more refined concept.

These aspects of prototypes are beneficial for bounded challenges where designers have an accurate understanding of the context, control over the output, and a modest time savings can translate into a competitive advantage. However, when designing for complex systems and wicked problems, the design landscape looks very different. In the systems context this way of prototyping is deeply inadequate.

Systems, complexity, and wicked problems

The most meaningful challenges we face as a society are systemic in nature. Climate change and racial inequity are some of the most iconic example of this set of problems, but similar intractable, interconnected, dynamic, and highly complex issues are all too common. Global pandemics, homelessness, and the opioid crisis can all be justifiably described as systemic, complex, or wicked. This work draws on the scholarship in the systems and complexity domains in order to illuminate the ways in which the nature of systemic issues expose the limitations of current design thinking processes in general, and, specifically, prototyping. The work of defining systems is beyond the scope of this article and has been thoroughly addressed elsewhere (Bar-Yam 1997; Kurtz and Snowden 2003; Meadows 2008; Senge 2006; Buchanan 2019; Collopy 2019). My intention is to highlight the aspects of systems which make them such a vexing context for our current notion of prototyping. In order to do that, I approach systems from the perspective of a designer who seeks to create change within this pluralistic, daunting, and layered medium. Designers looking to design for complex systems must ask themselves: *How do we prototype when:*

1. *The design constraints are in flux (Senge 2006; Meadows 2008; Ricigliano 2012)*
2. *The range of issues and influences will change with each prototyping iteration (Kurtz, Snowden, 2003)*
3. *We are under intense time pressure (Levin et al. 2012; Rittel and Webber 1973).*
4. *The problem spans mediums, constituencies and disciplines (Manzini 2015)*
5. *There are many stakeholders and each have different perspectives and ideas of what is "right" (Rittel and Webber 1973; Buchanan 2019; Body, Terrey 2019)*
6. *Meaningful solutions require action from distributed groups (Manzini 2019)*
7. *Potential solutions cannot be evaluated in isolation from the context of the challenge (Kurtz, Snowden 2003)*
8. *The challenge cannot be solved, only influenced (Rittel and Webber 1973)*

This set of constraints highlights the radically different landscape of designing for systems. So, then, how can a designer prototype in this context? It is all but impossible if we adhere to a traditional conception of the practice.

The problems with the current definition

Most aspects of prototyping are still effective for exploring systemic challenges. Speed, communication, learning, and risk mitigation are all still highly beneficial. However, in a systems context, the emphasis validation and evolutionary iterations become deeply problematic.

The validation trap

Prototypes are widely acknowledged as tools for exploration, learning, validation, and testing. Unfortunately, a disproportionate focus on validation and testing skews the ways we think about their potential as tools for learning. Christiane Floyd's work, coming out of computer science is foundational and recognizes the value of a prototype as an exploratory tool (1984). By linking learning with prototyping, Floyd opened up space within this practice for discovery and understanding and her influence is obvious throughout the prototyping literature on the subject. Unfortunately, Floyd's view on the educational aspects of prototypes does not go far enough to make it useful in a systems context. Learning, according to Floyd, is focused on the thing itself, and is used to evaluate the success of the concept rather than *also* being used as a way to more deeply understand broader context in which it exists. This drive to substantiate the efficacy of a concept is less problematic in bounded challenges where the context is well understood and stable. But when designing for unbounded, complex situations, a reliance on the validation becomes counter-productive. Rob Ricigliano describes this way of thinking as "self-defeating" for complex systems because it lures teams into responding to complexity with *inflexible*, *short-term*, and *fragmented* mindsets (2015).

The role of validation in prototyping is not inherently problematic, but when the act of prototyping becomes *only* about validation, we fall into a trap that blinds us to the broader context and undermines our ability to use prototypes as a way to quickly explore interventions in complex systems.

The evolution anchor

While the validation trap diminishes learning potential, the presumption of prototypes as evolutionary is equally problematic in the ways it limits our ability to explore systemic challenges in radically reduced time frames. When a solution space is reasonably proscribed, even for complicated problems like creating a self-driving car, an iterative and *linear* approach is sufficient. In those scenarios, a design team has a sense of their final output and they can use each successive iteration to get closer to that goal. Iteration A leads to iteration B which leads to C and so on. The broad consensus is that each prototype builds on the last and, despite some expected dead ends and detours, the path from early idea to more refined concepts adhere to a rough trajectory (Chi 2012; Kelley, Littman 2001; McElroy 2017; Martin 2014). These prototypes follow a *progression* from rough (low-resolution) iterations of an idea to more refined (high-resolution) versions of the solution. Unfortunately, this way of thinking severely limits our ability to prototype minimal risk and time.

To address this issue we need to disentangle iteration from evolution. The two terms are often conflated and it is assumed that each successive iteration will build upon the last. This constrains the creative ways a team can approach an issue and slows down their ability to explore an aspect of the challenge with speed and efficiency.

In order to explain this idea in a more concrete way, imagine a young couple who is considering having their first child. They want to understand as much as they can about the sacrifices and rewards that would come with making such a huge life change. They start by spending time around other couples with young children. After that initial experiment, they decide to look after a friend's child for an evening. In this way, they are increasing the resolution of their prototypes. With each iteration they gain more knowledge and increase their level of commitment. But while these explorations are useful, the couple still has the nagging feeling that some of the knottier questions are not yet answered. How will this affect their relationship? Will things change as it becomes real? What will it be like to experience all of this over the long term? These types of questions will not be answered by more babysitting. The couple has come up against the limits of what they can learn from prototypes that evolve from low to high resolution. In order to continue to gain understanding (without a massive investment or risk) they will need to separate their learning from progressive iterations. They do this in a way that breaks from an evolutionary conception of the prototype. They get a dog.

The prototype (getting a dog) is a non-linear iteration. The dog will never become a child. Despite this, the experience of getting a dog can teach them far more about how the system (their relationship) will respond to a significant change that they would not ever be able to fully comprehend with theory and planning alone.

In this case, the couple has managed to get more learning about the system as a whole, without a major increase in risk and commitment associated with prototyping in a progressive, linear way. The fact that the dog is decoupled from a child in terms of output, but deeply linked in terms of what it can teach them, means that this act of prototyping can be far more rapid and instructive than if they were focused on the output of solution (in this case, a child). By exploring the challenge in this way, the act of prototyping can be far more nimble and responsive than prototypes that follow a progressive path. That speed and flexibility is critical when dealing with complex systems.

Tramp bikes as an illustration

So is it really possible to think of prototyping in a way that could be used to address super wicked problems? Oddly enough, the way BMX freestylers learn tricks can be a useful illustration of how we might have an expanded understanding of this practice (Maiorana, 2014).

Freestyle tricks are the types of athletic feats one might see at the X-Games where riders launch themselves off a ramp, flip the bicycle in seemingly impossible orientations, and then land. These tricks are an instructive analog as we think about creating products, services, experiences and designing for systems. They are highly complex, dynamic, incredibly risky, and impossible to do half-way.

In order to learn how to do these manoeuvres, BMX riders developed a clever solution called a "tramp bike". Like many low-resolution prototypes, the tramp bike is modest enough to escape notice. It is a bike frame with no wheels, pedals, chain, or brakes (https://en.wikipedia.org/wiki/Tramp_bike). In isolation, the bike cannot be ridden. However, when it is placed on top of a trampoline - the name was shortened to tramp - riders can bounce up and down in order to get enough clearance to explore a variety of manoeuvres. The bike exists only to support a rider's efforts to learn a new move. Put another way, the tramp bike allows the rider to *prototype* a trick.

On a BMX track, a rider can only attempt one jump every few minutes. With a tramp bike, she can easily attempt 200 tricks during that same time. In doing so, she has simulated the most critical aspect of the actual trick, the moment she is in the air. This concept draws on the notion of the leap of faith assumptions made popular by *The Lean Start-Up* (Reis 2014). This narrow focus allows the BMX rider many more opportunities to learn about the complex and nuanced interaction between her movements and those of the bike. With this rapidly acquired understanding, she is prepared to attempt the actual trick in far less time than if she had simply attempted the full trick from the start.

The tramp bike is a process innovation that supports learning by allowing any BMX rider with little more than an old bike and a trampoline to quickly perfect and explore dangerous tricks through increased iterations with less chance of getting injured. Without a tramp bike, the rider needs to jump high enough to orchestrate an elaborate manipulation of the bike and then position it underneath her before she lands. The physics of this trick make this impossible to do slowly but separating the issue of clearance from the idea of riding a bike unlocks tremendous progress in one part of the system. Once the rider has figured out this portion of the challenge, she can reintegrate that learning with the elements necessary for the complete trick. All of these benefits are realized because the riders have decoupled the most challenging parts of the trick from the full maneuver.

The tramp bike is instructive as we return to our definition of prototyping. It serves as an example of how we can prototype in a way that allows for the rapid exploration of dynamic design contexts. To do this we need to rethink how we define the practice.

Prototyping: A more expansive definition

In order to utilize prototyping to explore complex challenges, we need to recast the prototype as *any intervention that enhances our ability to learn about an aspect of a design challenge with minimal risk, investment, and time*. While this expanded definition encompasses existing notions of prototyping, it also contains several distinctions that make it far more appropriate when thinking about designing for complex systems.

The first significant departure is that a prototype can be ***any intervention.*** This counters the assumption that prototypes manifest elements of a completed concept and expands the possible forms a prototype may take. This shift can be incredibly liberating and makes it possible for prototypes to be as modest as a meeting invite or music selection. These everyday activities become prototypes when they are crafted with intention and a goal of learning. While this practice in and of itself may not be so rare, it is far less common to refer to designed interpersonal experiences as prototypes. Yet, that is precisely what happens at the d.school, the Hive at the Claremont Colleges and the growing number of organizations where the role of prototyping is used explicitly as a way to explore culture and relationships. By expanding what we think of as constituting a prototype, we increase the creative ways in which this practice can be applied.

Although learning is widely recognized as part of prototyping, the scope of that inquiry is almost always limited to the designed artifact. In contrast, when ***enhanced learning*** becomes the reason for the prototype, we invert the traditional dynamic from *learning (as a way to make a better artifact)* to *artifact (as a way to get better learning)*. This shift still accommodates an exploration of the artifact but, critically, it expands the scope of inquiry in ways that are essential for unbounded contexts.

Seen in this way, the prototype moves from a discrete object to something with a far more fluid sense of utility. This expanded thinking about prototypes has been addressed in much of the related work from the field of participatory design. In *Working Artefacts: Ethnomethods of the Prototype,* Lucy Suchman counters the object-focused aspect of the practice and highlights the ways they can also be used to understand an emerging sense of context (2002, 172). Suchman's description of "mutual learning" relates to the participant's practices, but it is significant in the ways it highlights the role of the prototypes as an intermediary object that helps to transmit information between the designers, users, and contexts. In a similar vein, Carl DiSalvo addresses this issue in his work on critical making, noting that prototyping "is dialogic in that its structure is one of exchange and its purpose is the discovery and elucidation of the conditions or factors of a design."(2013, 23). Suchman and DiSalvo each highlight the ways prototypes can be used in service of something greater than the evaluation of the object itself, but it is worth noting that their work also references a transmissionary quality that is essential for prototyping in more dynamic domains where *sensing* and *responding* are necessary for effective action (Snowden and Boone, 2007).

The scale and complexity of systemic challenges make it impossible to quickly explore within a complete design context. By highlighting that a prototype supports the exploration of ***an aspect of a design challenge,*** this new definition relaxes the constraints implied by progressive iterations and offers the team additional license to explore the broader context. Prototypes can then be used to help a team define or redefine a challenge. Although this aspect of prototyping is not widely covered in the design thinking literature, it is well practiced in the d.school's teaching. It is most apparent during the testing phase when students are challenged to use prototypes to simultaneously evaluate two criteria: *How well are we solving the problem?* and *Are we addressing something worth solving?* These two questions bring focus to the solution and the frame (Klebahn, Utley, Segovia 2014). While the first question is common in prototyping, the second helps designers avoid getting too wedded to their solution and creates space for continued learning about the user, context, and systems in which it exists.

The final piece of this proposed definition, ***minimizing risk, investment and time,*** adheres closely to the current understanding of the practice, but there are a few key distinctions that make these elements better suited to wicked problems.

In a systems context the scale of problems and far-reaching capacity of solutions mean that the role of ***risk*** is much greater than in more bounded challenges. While much has been written about the ways prototyping can reduce costs and investment, far less has been shared about how to limit liability for the broader participants and users. A systems context requires prototypers to minimize potential negative impacts to a community by creating what Snowden and Boone describe "safe to fail" environments (2007). To this end, systems prototypers must reduce risk not only for their business, but for the broader community of stakeholders, much the way participatory designers have employed the concept of *infrastructuring* (Karasti, 2014; Hillgren, Seravalli and Emilson 2011).

Prototyping with as ***little investment*** as possible limits the potential costs from the perspective of the design team and is widely addressed in existing literature, but limiting investment also has implications for who gets to design. It makes prototyping more inclusive by making *creativity*, not capital, the dominant prototyping currency.

As an example, we can look at the efforts of Rebar in San Francisco. They were curious about the idea of transforming parking spots into small public spaces. To explore this potential in a traditional way a team would likely develop a report filled with costly analysis and lobbying efforts aimed to sway the numerous stakeholders who would need to approve the project. Few people have the resources to take on such an ambitious and time-consuming challenge. Rather than follow that path, Rebar utilized a prototyping approach. Their only investment was a pocket full of quarters, sod, a potted plant and a bench. They paid for the parking space and prototyped the first parklet. The modest prototype in 2005 quickly gained traction across the world and is now a global phenomenon (Schneider 2017).

The Parklet example demonstrates the ways in which creativity can empower domain outsiders to explore and realize potential futures. In doing so, they embody what Ezio Manzini describes as design-*bricoleurs* who "reassembl[e] preexistent objects" and "decontextualize" and "reinterpret" them (2019). This approach also addresses one of the shortcomings of coalition building efforts that rely on engagement from "powerful strangers" (Emilson, Hillgren 2014). The limited investment allowed Rebar to do more with less. By decreasing their reliance on support from those in power, they were able to get a first version off the ground, which built momentum and influenced the local government in a way that is unlikely through traditional channels.

The final piece of the revised definition, ***speed*** remains a critical part a prototyping practice. Our ability to quickly explore solutions and contexts is particularly pertinent for systems challenges and super wicked problems like climate change or the current global pandemic where there is limited time in which we can take meaningful action (Levin et al. 2012; IPCC 2019). Faced with these dire situations, designers must be able to maximize what David and Tom Kelley describe as "cycles of learning" in increasingly compressed timeframes (2013).

Implications for a new definition

Adopting this more encompassing view of prototyping will require some shifts in the way designers approach this practice. It calls for ways of working that allow for seemingly conflicting approaches to co-exist.

Prototyping requires humility. Unfortunately, hubris is far more common than humility in so many "innovative" organizations where prototyping is synonymous with mottos like "fail fast and break things"(Taneja 2019). Prototyping is an act of power. Designers need to see it as such and employ this practice with a sense of responsibility (Manzini 2015). Diego Rodriguez sums it up in this way, "Prototype as if you are right. Listen as if you are wrong"(2009). Rodriguez's directive challenges designers to recognize their limitations and use prototyping to both put forth an idea and step back to see what they are learning about the system through their efforts. Put another way, if designers can maintain a humble posture, the prototype can then be used as more of a dialogic tool (DiSalvo 2014). With this approach, designers can both advocate and inquire, which support conversations infused with learning that are a necessary part of institutional and systemic change (Senge 2006).

Prototyping requires curiosity. A sense of curiosity is a well-established quality of effective learners and creative individuals (Gruber, Gelman, Ranganath 2014; Hagtvedt et al. 2019). Designers' sense of inquisitiveness often manifests in the why and what if and how questions, outlined by Warren Berger, but we often lose the depth of that interest after arriving at a solution (2016). To prototype in highly ambiguous, uncertain contexts, it is essential for designers to stoke curiosity and continually revisit the why and what if questions.

Prototyping requires responsiveness. As central as learning is to the revised definition of prototyping, it only matters if the designers continue to create interventions that are imbued with this increased understanding. That is, the prototyper must be responsive. Manzini describes this way of working as "generating a positive circle between action and reflection" (2015). In a systems context, where information about the design challenge is continually unfolding, an ability to respond is far more critical than traditional contexts where sufficient understanding of the context allows planning to take more of a central role.

Prototyping requires commitment. Systems are always in flux. They are entities with a past and a future (Senge 2014). Yet we often design as if the current moment is the only one that matters. This approach is akin to assuming a ballerina can fly because we see a picture of her during the middle of a leap. When prototyping for systems, we need to commit to the act of prototyping, rather than expect that we have the right answer (or the right direction) without taking the time to allow the system to respond. Snowden and Kurtz note that in "un-ordered" environments, "instead of attempting to impose a course of action, leaders must patiently allow the path forward to reveal itself. They need to probe first, then sense, and then respond"(2007). These three actions could easily be another way of describing what it takes to prototype with this expanded definition. But to do so, a prototyper needs to be committed to the very different postures of proposing action and evaluating and then responding with a more refined understanding.

This process takes time. In this regard the prototyper must again hold two very different ways of being. On the one hand, she must maintain a sense of speed and urgency, moving as fast as possible to increase her understanding, but she must do so in a way that does not come at the expense of the dialogical aspects of the process.

Conclusion

Prototyping is as necessary as ever, but the popular conception is far too limiting to address our most pressing issues. By proposing a more expansive definition, I hope to highlight the assumptions and shortcomings of the current understanding so that we can evolve this practice to meet the needs of the growing set of complex, systemic challenges.

The survival of our species is dependent on our ability to accomplish unprecedented feats of collaboration, engineering, and behavior change in a limited time. It will necessitate the ability to act quickly, while listening and responding with a sensitivity to context and communities. Incorporating these concerns, a systems prototyper should be designing experiments that shed light on a possible path forward and illuminate the larger context and potential alternatives. The ability to decouple an intervention from the complete solution is one way to do this. These efforts can create tremendous learning in dramatically reduced time frames, but the insights they yield must be evaluated with a critical lens that takes into account the distinctions between contexts.

Risk can never be fully retired. At a certain point, the decoupling that yielded speed during prototyping must be reintegrated into the larger context; the BMX rider tries her trick on the track, a product team invests in tooling, and a policy team launches at scale. These steps come with an unavoidable sense of risk, but it will be greatly reduced by the prototyping in a way that brings learning and action into the forefront of this practice.

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Track 11:

Transforming Dominant Paradigms Through Action Research

Chair: Dr. Peter Jones

CO-DE|GT BETA

The 21st Century Economy App for CrossSpecies CoLiving

Marie Davidová, Shanu Sharma, Dermott McMeel, Fernando Loizides

This work-in-progress paper is referring to the CO-DEIGT mobile application, that is being developed in Synergetic Landscapes unit of the Master of Architectural Design at the Welsh School of Architecture in collaboration with the School for Computer Science and Informatics at Cardiff University, UK, the School of Architecture and Planning Bhopal, India and the Auckland University of Technology, New Zealand. This app is searching for a synergy across an urban ecosystem. It intends to generate a sustainable, scalable token economy, where humans and non-humans play equal roles, earning, trading and being paid for goods and services to test such potentials for future economies underpinned by blockchain. This work diverges from dominant economic models that do not recognise the performance of and the limits to material extraction from the ecosystem. As a result of such misconception, we are facing mass extinction, that necessarily leads to the collapse of such economic systems. Therefore, this work applies systemic approach to urban environment performance for the future Post-Anthropocene communities and economies.

Keywords: systemic approach to architectural performance; mobile application; urban ecosystem; token economy; post-anthropocene

Introduction

Spotswood et al. in their review point out that several species benefit more from urban than other environments. Although some don't, this may be attributed to suboptimal adaptions necessary for their survival (Spotswood et al., 2021). This situation needs to be reflected by architects and urban designers that engage with the urban environment and its connectivity, habitats, and edible landscapes. However, such parameters are related to larger complex socio-technical and economic systems. The recent independent review on the economics of biodiversity ordered by the British Government written by Dasgupta points to the clear dependency of economy and ecosystem (Dasgupta, 2021). For example, we clearly cannot harvest vegetables without plants and pollinators or wood building materials without trees and forests. This needs to be reflected in our economic models that should integrate *other than human* creatures. In the 21st century, a coffee machine can have a blockchain wallet and process decision making (Cathlow, Garrett, Jones, & Skinner, 2017) or a river can obtain a legal personhood, being acted by Maori people on its behalf (Hutchison, 2014). The two years of annual Synergetic Landscapes unit is relating several dependencies within an urban complexity, such as the human and non-human communities, circular economy, token economy, material techniques, natural materials and biocorridors for edible and habitable landscape for all (Davidová, 2020c). At its initial stage, there started to be a discussion on how such cross-species edible and habitable landscapes can be tokenised within blockchain (Davidová & McMeel, 2020). In its second year, these relations are being integrated in a CO-DE|GT mobile application prototype through gamification for the Grangetown community of Cardiff, Wales, UK. The work is integrated within a larger Grangetown focused Community Gateway project (McVicar, 2020) managed by Cardiff University. Today, the area is home to generations of Welsh and Welsh Somali, Bangladeshi, African/Caribbean, Pakistani, Indian, European, British and multi-ethnic Welsh-language communities, constituting Wales' most ethnically diverse electoral ward. Containing super-output areas ranked within the 10% most deprived areas overall in the Welsh Index of Multiple Deprivation, Grangetown addresses key challenges in areas of poverty and health through well-established Church, Mosque, Temple, public sector, third sector and voluntary networks (Cardiff Research Centre, 2011; McVicar, 2020; Welsh Government, 2014).

Methodology

The work is grounded in the Systemic Approach to Architectural Performance methodology that is combining codesign through gigamapping (see Figure 1 and Figure 2) and prototyping (see Figure 3); and such relations with larger complex systems (Davidová, 2020a) (see Figure 2). It is part of Systems Oriented Design (Sevaldson, 2018) that is integrated into a Real Life CoDesign Laboratory. Real Life CoDesign Laboratory is a non-reductionist laboratory, where the prototypes and events are applied and tested through real life performance and interaction in the living environment and its agents (Davidová, Pánek, & Pánková, 2018). The methodology deals with and synergises the 'prototypical urban interventions' (Doherty, 2005) through physical object prototypes and their DIY recipes (see Figure 4), the virtual prototypes such as apps (see Figure 7) and public events that promote the prototypes for their DIY reproduction (Davidová & Zímová, 2018).

This paper focuses mainly on the process of developing the city-gaming mobile application CO-DE|GT that aims to encourage community participation in replicating DIY recipes of prototyping using a token-based blockchain model. To understand and translate the complexity of the living system of Grangetown community towards active participation of stakeholders for collective wellbeing using gamified experience, we conducted a 5-day online workshop within the student groups (9 students). The workshop firstly, provided a theoretical overview entangled interdependencies of local interaction and the global behaviour. Secondly, provided hands-on tasks of observing, understanding, and addressing the complex entanglements of the community stakeholders. We designed a simple framework for systemic inquiry of the micro entanglements between networks of stakeholders (humans and non-humans) in the existing community and later proposing an intervention to encourage active participation in the community.

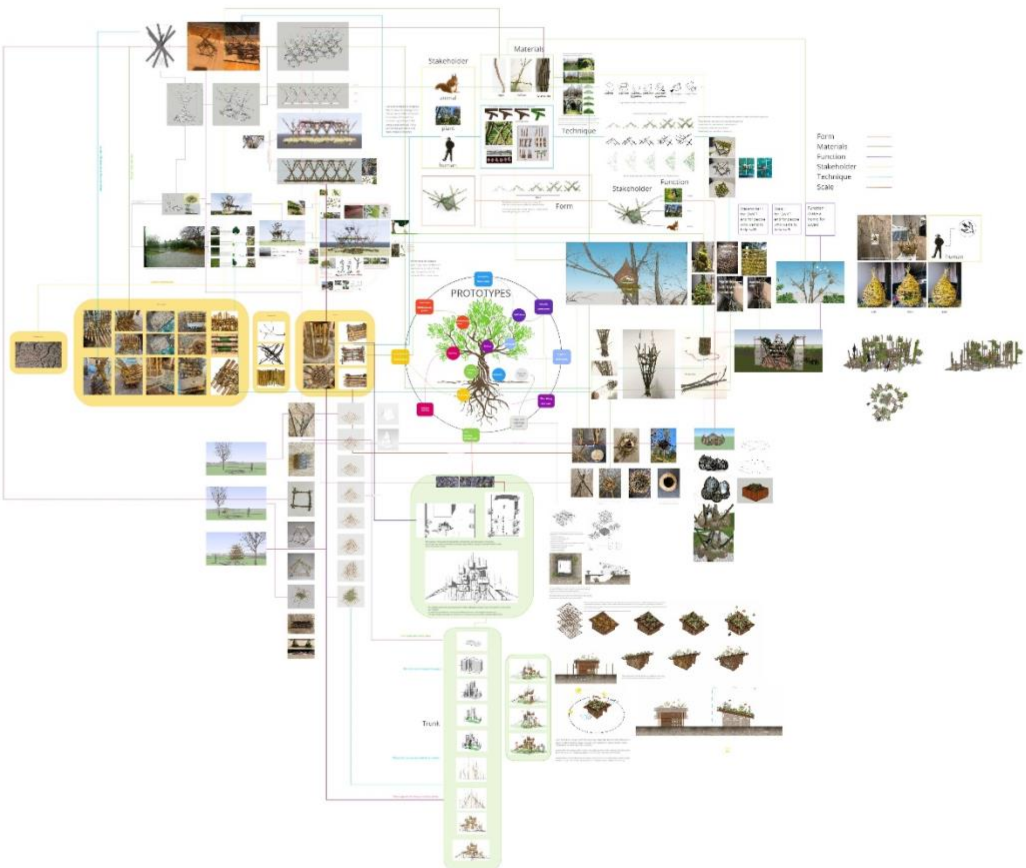

Figure 1: The WIP prototyping gigamap (Synergetic Landscapes Unit, 2021)

Figure 2: The larger systems relating prototyping WIP gigamap (Synergetic Landscapes Unit, 2021)

Figure 3: Vermicomposting - A lens to Biocentrism prototype with visualised future scenario (Alghunaim, 2021)

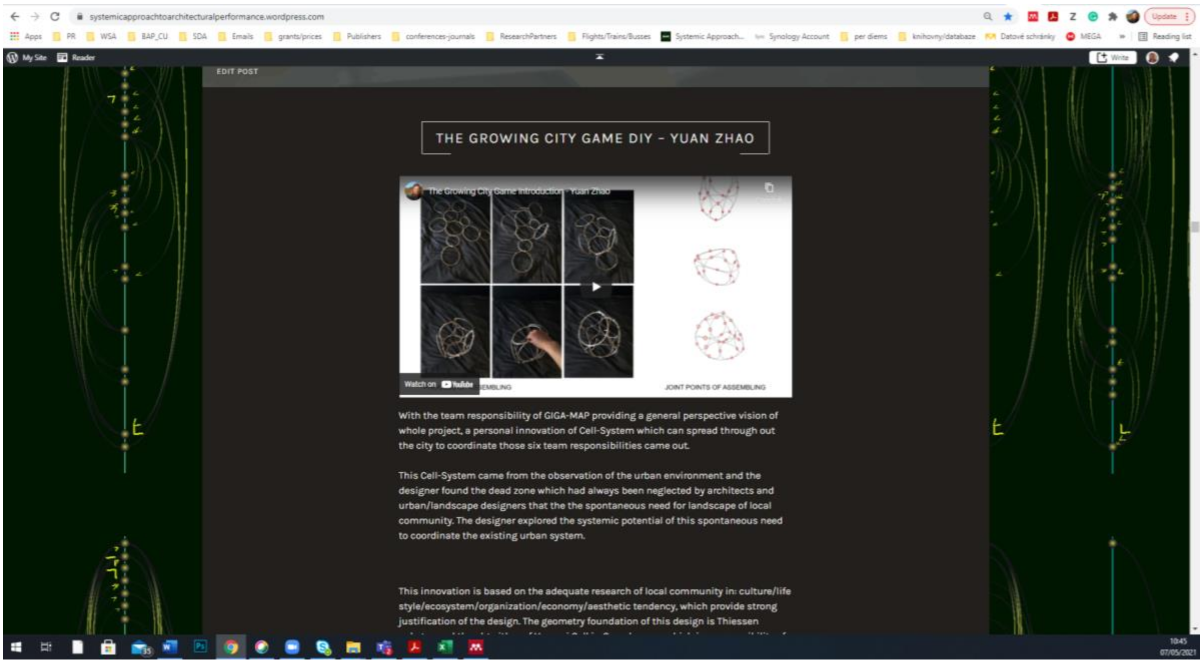

Figure 4: DIY recipe (Zhao, 2020) on SAAP blog (Davidová, 2020d)

Day 1 framework was divided into 2 simple tasks of defining local problems that one wants to address: Observing, Collecting, and Organising insights about the significant issues of various locations of the Grangetown community (see Figure 5). Later, each group was asked to identify two most important stakeholders/actor human and non-human stakeholders that are of primary importance to address the concern.

Figure 5

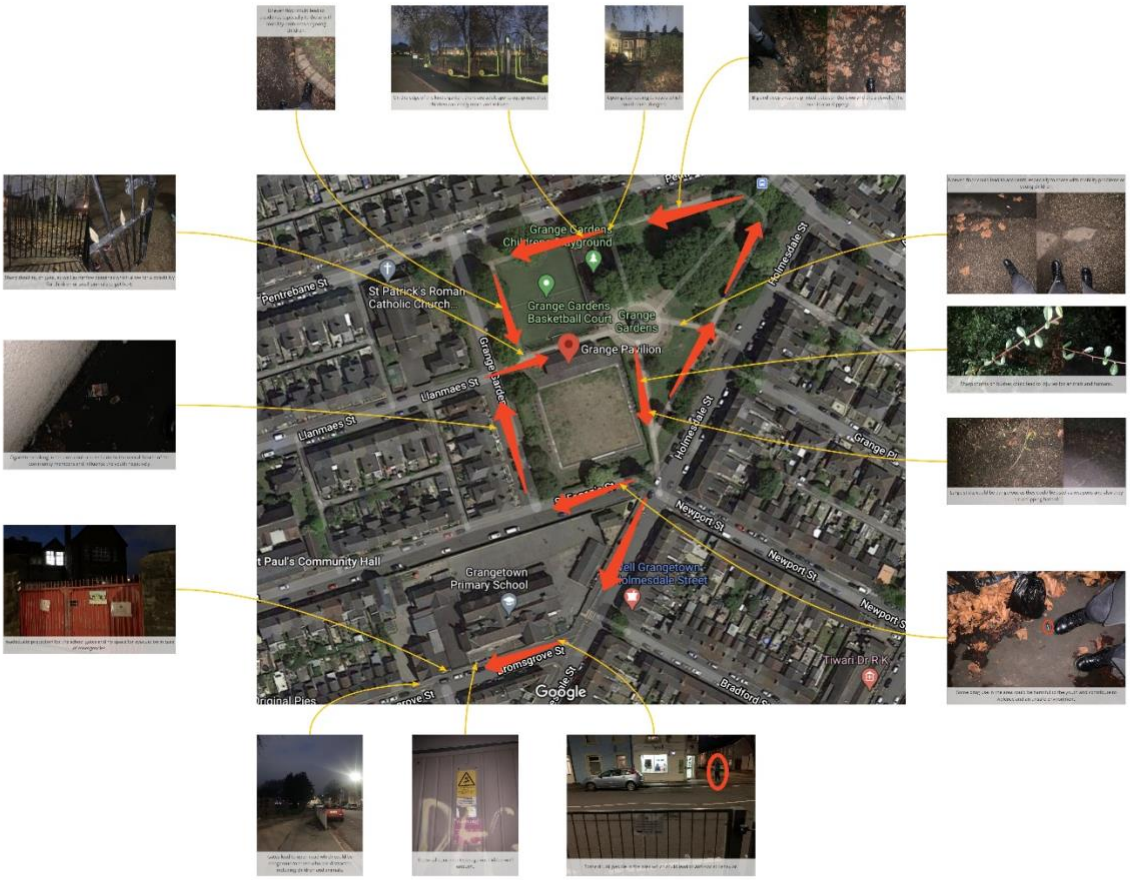

Figure 5: Spatial mapping stakeholders and their issues in Grangetown community of Cardiff (Rules of Entangled complexity workshop by Sharma 2020)

The next task was to map the dynamic interdependence and interactions of stakeholders. In this task group members explained the different nature of interdependency between human and non-human stakeholders such as shared resources, shared artefacts, shared environment, types of interaction and so on. Each group was asked to reiterate and refine the work for the next two days on the Miro board. Finally on the last day of the workshop, we introduced Game Design Canvas (see Figure 6). The canvas gave directions to think collectively about the micro details of the stakeholder interdependency into the game mechanics. The canvas is divided into five layers of detailing as follows:

- First layer defining the goal of the game: explaining the purpose of synergised actions of human and non-humans. Further in the layer participants were asked to explain explicitly the goals of human and non-humans.

- The second layer onwards canvas is designed to map the duality i.e., positive, and negative implications of human and non-human interdependencies and synergised co-existence. Participants explained the advantages and disadvantages of non-human from Humans and vice versa.

- The third layers focused the collective attentions of the group to ideate upon simple actions of human that may create positive Impact on non-human stakeholders and vice versa. Likewise, this layer of the canvas proposes to collectively ideate on actions of human that may create negative Impact on non-human stakeholders and vice versa.

- Fourth layer proposes to ideate for shared resources such as shared artefacts, built space, shared environment, shared natural resources etc that can be optimised to create a positive impact on human and non-humans. Similarly. ideate upon the shared resources that can create negative impact on human and nonhuman wellbeing.

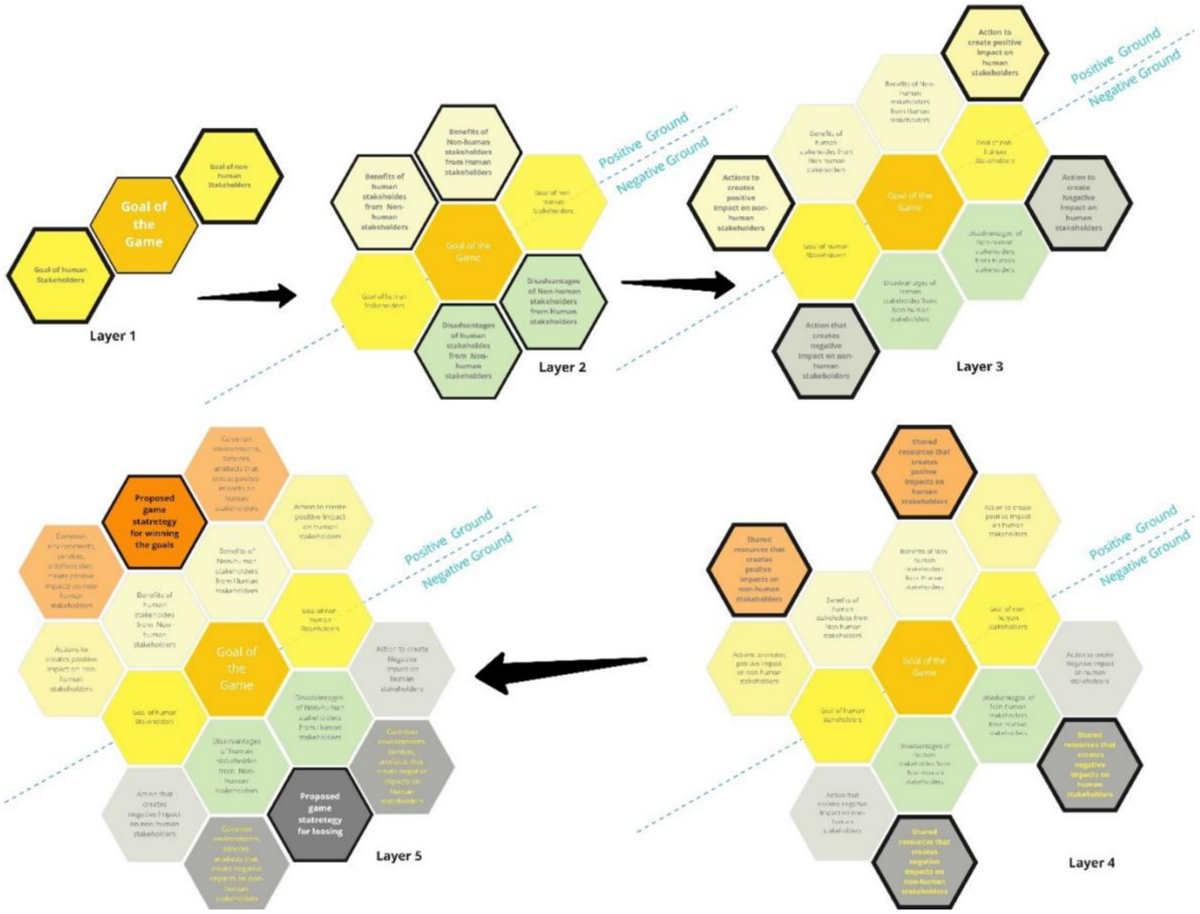

Figure 6: Layer-wise representation of Game Design Canvas (Sharma, 2020)

Based on all the previous information of the canvas this layer inquiries about the conditions of winning and losing the game. This is a crucial decision for designers that can provide a collective vision towards the tangible outcome of collective actions of human and non-humans. This is further expanded to propose various levels with explicit winning and losing conditions of the game where initial level may sensitize the people about the issues of collective wellbeing Grangetown community. The tasks of the initial level may encourage people to know about the context well. Advanced levels of the game to encourage people to interact and perform simple actions of reproducing DIY Recipes in the real world to create a positive impact. In the further advanced levels, the game must promote active participation of the players to perform higher lever tasks at individual level as well as the community level. The WIP application has been tested on community stakeholders that were wondering in neighbourhood, the larger variety, the better. The total number is about thirty. Based on their responses, the app has been constantly updated.

The CO-DEIGT Mobile App

The CO-DE|GT application's (Synergetic Landscapes, 2021) aim is to lower the disbalance across different disadvantaged human and non-human stakeholders. It enables submission of—and volunteering in—different tasks that are assigned tokens as a payment. To gain tokens, one first completes certain tasks. Once someone 'earns' tokens and they are deposited in their wallet, they can assign or create tasks for others. When others compete those tasks, they are paid from the assignee's wallet. At the app's starting point, only the Synergetic Landscape unit's members have tokens. They are assigning tasks for people to reproduce their designed prototypes (i.e. bat or bug hotels, etc) for expanding cross-species habitable and edible landscapes. These prototypes are to be built from natural materials that can be found in the location. Therefore, to join the system does not require any initial investment (Davidová, 2020b). Whilst giving the tasks, the related members of the cross-species community are rewarded. Therefore, for planting a tree, one must pay the pollinators. This way, the pollinators gain their tokens, and they might be buying their habitats. Since the pollinators cannot use the app, they are acted on their behalf by the community members. Thus, the application is questioning the traditional winning and losing concept of traditional games through layering multiple systems and cross-relating their systemic relations.

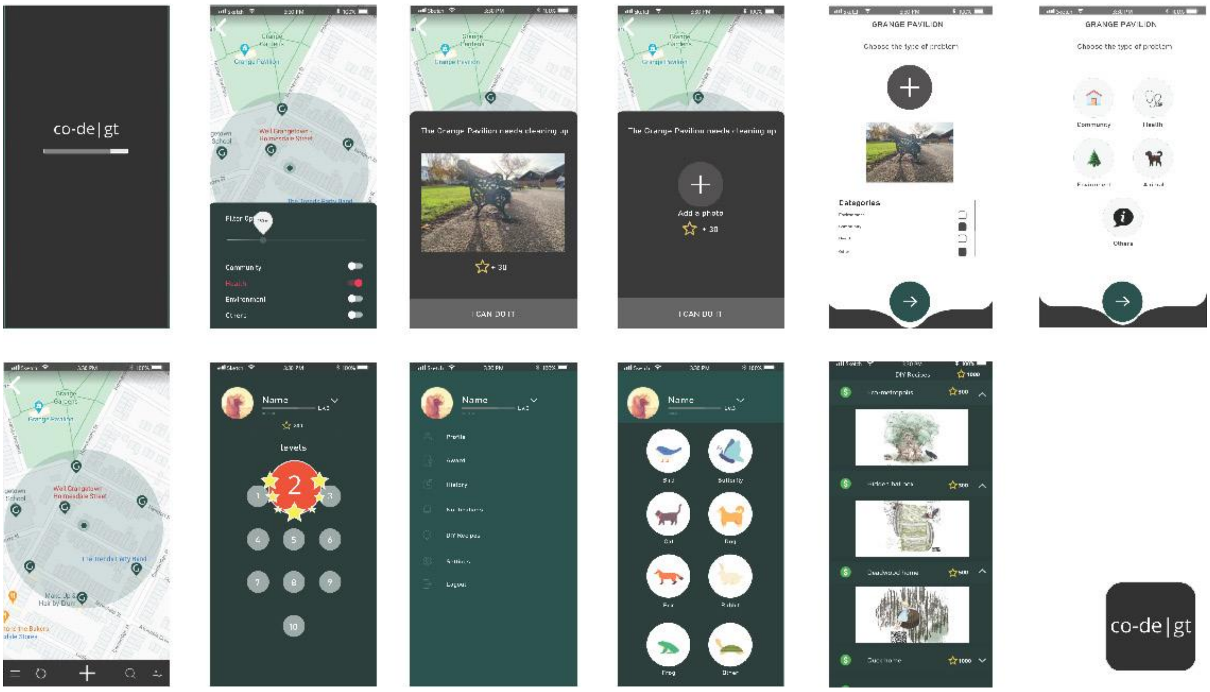

Figure 7: CO-DE|GT mobile application interface design (Synergetic Landscapes Unit, 2021)

This unit mainly developed within the COVID 19 pandemic, when direct analogue social interaction was very limited. Therefore, more attention was paid to online interaction through social media, video channel, blogging, etc. The app has been tested through two online events, the Cardiff University Sustainability Week (Raye & Davidová, 2021) and the UN World Creativity and Innovation Day (Davidová, 2021). At this moment, the application has been and is being tested on the Grangetown community. We have been organising public picnics using QR codes to introduce the public to the mobile phone application, as most of Wales is being soon vaccinated. A poster with the app's QR code is presented in Grangetown Pavilion that has been opened to public as part of the Community Gateway project.

The app should in the future differentiate several species (see Figure 7). For being the initial stage, we selected only the categories of land, water, sky and underground creatures and the types of tasks in the categories of community, health, environment, animal and other. The users can upload their tasks to the map location with these categories, assigning tokens for completing the task and assigning tokens to other species that relate to the task. This covers a timeframe for completing the task. The application is starting with the DIY edible and habitable prototypes recipes that are located on the first authors blog (Davidová, 2020d). In future, anyone would be able to upload their recipes for their tasks. The application should be able to place DIY videos from YouTube and other video channels and blogs. Different community members will be able to act on behalf of other creatures and extend their habitats and edible landscapes for their tokens by assigning tasks to community members.

From a technical perspective, the app is being developed using an HTML base progressive web application (PWA) approach in order to allow for operating system agnostic capabilities and adaptive design approach. This allows the solution to be accessed via a web browser, but once saved to the home screen of a mobile device (Phone orTablet/iOS or Android) and accessed via this link, all browser-based UI elements are hidden and the application behaves as if a native mobile application. Simply access the website once, save to the home screen. We utilise HTML, HTML5, JavaScript C# and the Google Maps API (embedded in a .Net container. The database subsystem is utilising Microsoft SQL Server Express.

Discussion and Conclusions

The potential for blockchain to impact the built environment has been explored elsewhere (McMeel & Sims, 2020). Including specifically potential for a radical reconfiguration of the relationship between people and other agents with which we share the environment, such as animals, buildings and plants (Davidová & McMeel, 2020). The World Economic Forum has recognised that blockchain, crypto-currency and the 'token economy' provide a means for 21st century communities and distributed organisation to reclaim power and enact their values in a way not possible through 20th century centralised banking, industrial and commerce models (World Economic Forum, 2018). This project is expanding further on this work in two areas: (1) In relation to community or 'complimentary' currencies (Amato & Fantacci, 2020). (2) Potential for a crypto-currency to circulate only within a limited community.

A complimentary currency is an unofficial currency that circulates in parallel with a national currency. It is usually set up by private citizens or advocacy groups and used only within a limited geographic area. The Bangla-Peso from Kenya and the Fureai Kippu from Japan are well established examples (Hayashi, 2012; Kimenyi & David Muthaka, 2013). Blockchain offers the potential to take these concepts into the digital age. Digital currencies also offer the potential to circulate only within specific limits. Unlike existing complimentary currencies, this research has shown the potential for a new type of community currency that has no geographical limits but is limited by people's value. For example, the Plastic Bank uses these technologies to stimulate a specific economy limited to monetizing waste plastics and redirecting them into a recycling system (Katz, 2019).

We argue this can apply across the species, things, and whatever intelligent systems (including AI) within such communities. The work here explores how *other than human* agents can be integrated in our economic models, strengthening clear dependences and coperforming better through interactions. To expand on such coperformance, we need to adapt our cities for coliving with others (Davidová & Zímová, 2018). This project is trying to achieve this through free DIY recipes, approaching communities of makers that are recently questioning the building market (Aravena, 2016) and hopefully soon the building industry. Boeva and Troxler point out at the making needs to abandon the market/state duopoly of the first and second industrial revolution, the market economy based on the assumption of unlimited growth, and the fair functioning of the free market (Boeva & Troxler, 2020). This project is testing how making could be integrated in the community based Post-Anthropocene economy and industry for 21st century that may hopefully become fully Non-Anthropocentric in the future.

This research explores how the features of contemporary digital currency can be combined with concepts of complimentary currencies to stimulate an economy of value; an economy of products and services that re-populate the urban environment with wild-life habitats that will result into a more balanced ecosystem.

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Moving toward paradigms and patterns of transformative innovation in public sector labs

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This paper shares work in progress from action research focused on the transformative potential of public sector innovation labs (PSI labs). Much of the research about PSI labs remains within current paradigms of Western and European governance. If public sector innovators hold an ambitious and systemic innovation intent, then there is a need to stretch beyond these dominant paradigms. Westley et al. (2011) capture the need for this ambition: "to support 9 billion people without transgressing critical planetary boundaries, efforts to diffuse and scale the most promising innovations must be accelerated. This requires the transformation of the institutions that shape our cultural, political, and economic transactions" (p. 775).

Given this urgency, I argue that PSI labs that hold an ambitious, systemic intent must take an approach to their work that does not (inadvertently) reinforce the problematic dimensions of dominant paradigms. Action research data is used to construct a conceptual framework that proposes aspects of transformative/emergent/resurgent paradigms of governance for innovation. The tensions inherent in moving away from what is, and toward what must/may be are explored. Potential roles and responsibilities of design/ers in skillfully navigating the spaces that these tensions create conclude the paper.

Keywords: public sector innovation, social innovation lab, systems thinking

Introduction

Much of the literature about public sector innovation (PSI), and public sector innovation labs (PSI labs), takes the current paradigm of governance as relatively fixed. In the context of public sector organizations in North America and Europe, these dominant paradigms of governance are fundamentally shaped by settler colonialism and New Public Management (NPM) and by the systems, structures, and behaviours that arise from these paradigms. There is some PSI and PSI labs literature that explores ideas of ambidextrous, collaborative, networked, citizen-engaged, adaptive, design-oriented, and open governance that may be pointing toward emerging ideas about an evolving governance paradigm (Bason, 2017; Blomkamp et al., 2018; Blomkamp, 2021; Boukamel & Emery, 2017; de Vries et al., 2016; Hartley et al., 2013; Lewis et al., 2017; Lewis, 2020; McGann et al., 2018; Sørensen & Torfing, 2011). Literature that explores the tensions between enabling conditions and barriers to PSI tends to be framed within these dominant paradigms as well (for example: Bekkers & Tummers, 2018; Demircioglu & Audretsch, 2017; Gryszkiewicz et al., 2016; Munro, 2015; Tõnurist et al., 2017; Torugsa & Arundel, 2016). Enabling conditions and barriers related to context, conceptions of leadership, institutional and organizational culture, collaboration, identity/purpose, and impact measurement also remain largely within the frames of settler colonial and NPM frames (for example: Brown & Osborne, 2013; Carstensen & Bason, 2012; Considine & Lewis, 2007; Gieske et al., 2016; Hartley et al., 2013; Kronsell & Mukhtar-Landgren, 2018; Lewis et al., 2017; Mulgan, 2009; Ricard et al., 2017; Timeus & Gascó, 2018; Tõnurist et al., 2015).

Innovations that aim to work at the root causes of complex civic challenges must necessarily look beyond the dominant paradigms, systems, and structures that created them, particularly when the intent is to move beyond interventions that make the existing system more efficient or user-friendly. Arguably, efficiency and user-oriented innovations may actually work to uphold the problematic systems and structures of the dominant system, and distract from or prevent more radical shifts from occurring (Wheatley & Frieze, no date; Sharpe et al., 2016). An example can be drawn from many 'innovations' in public engagement that do not shift power, agency, or decision-making and tend to keep those who already have positional power and authority in place. There are decades of evidence that working on complex challenges like systemic oppression and climate change from within these dominant paradigms is not leading to change at the scale or speed required. How then might structures like PSI labs think differently about systemically intervening in complex challenges in order to create the conditions necessary for innovation that is not bound by the current governance paradigm?

I argue that this is the space of transformative, emergent, and resurgent innovation, and not the space for incremental, efficiency-oriented, or user-centered change. By attending to paradigms, Meadows (2008) tells us that the impacts of systems change efforts are likely to be much more significant than other types of interventions, and that we need to "keep speaking and acting, loudly and with assurance, from the new [paradigm]" (p. 164). What is this new/resurgent paradigm that we might begin to imagine and enact in order to work in/with/on complex, systemic civic challenges? And how might this create a generative tension with what we may need to move away from, or hospice? This short paper describes potential elements of paradigms of transformative, emergent, and resurgent innovation in the public sector. Patterns of tensions created by what we may need to move away from and move toward are explored. The conceptual framework is a result of participatory action research and constructivist grounded theory building with 85 public sector innovation lab practitioners from 25 organizations in 7 countries (Canada, Europe, Australia) conducted from 2017 – 2020, and continues to be a work in progress. The paper closes with some questions about the potential roles and responsibilities of systemic design/ers in working with these tensions.

Change, Transformation, Emergence, Resurgence

Before discussing the conceptual framework, working definitions for the ways in which the terms change, transformation, emergence, and resurgence are used here are provided. Most of these terms are used quite regularly in innovation discourse, although they often mean different things. This section draws from a collection of thinkers that are exploring these processes (Corntassel, DATE; Juarrero, 2015; Kimmerer, 2013; Lichtenstein, 2014; Meadows, 2008; Scharmer, 2016; Sharpe et al., 2016; Simpson, 2017; Snowden & Boone, 2007; Wheatley & Frieze, no date).

Change happens through incremental adaptations. The foundations of the current system remain unquestioned and unchanged, and the focus is on making things work better through small improvements.

Transformation is a more significant shift in people, structures, processes and systems. It is often triggered by a growing problem, challenge, or crisis, and this pressure is what is required in order to shift or dislodge a stable or stuck approach into a different state.

Both change and transformation modify, respond to, and/or adapt existing elements, processes, structures, behaviours and routines.

Emergence is a dissimilarity (rather than a difference), where the parameters themselves change, rather than the variation of existing parameters that happens with change or transformation. Emergence is creation sparked by aspiration, the 'becoming' of a vision for a new opportunity that was not there before. Emergence tends to vastly expand the potential, capacity, and capability of people, organizations, and systems to work on the challenges that they face.

Resurgence is focused on work to recover, revitalize, and renew possibilities of being and relationship that have been suppressed and marginalized by the dominant system. Resurgence is most often associated with Indigenous cultures, and reflects integrated spiritual, cultural, economic, social, and political dimensions of these processes.

Noting that there are fundamental and critically important distinctions and differences between transformation, emergence, and resurgence, these three ideas are taken together when playing with paradigms in the conceptual framework that follows. The framework aims to begin to name how transformation, emergence, and resurgence (together) are different than the change orientation most often used by PSI and PSI labs.

Working with Paradigms to Create and Explore Tensions

Figure 1 describes aspects of what holding paradigms of transformative, emergent, or resurgent innovation might involve. In the centre column are aspects of paradigm, along with the patterns to move away from (on the left), and patterns to move toward (on the right). This conceptual framework was generalized from literature and rich action research data generated by/with 85 action co-researchers when prompted to consider and practice ideas about leadership, enabling conditions, barriers, and agency/accountability for transformative public sector innovation. Further nuance to the moving away and moving toward patterns is provided as an appendix (Table 1), where descriptive fragments of data from action co-researchers is shared. These moving away/toward patterns are intentionally shown as spectra rather than binaries so as to invite consideration of many different ways to stay in motion with the patterns, engage with the tensions that they create, and to avoid an overly simplistic 'this is better than that' interpretation.

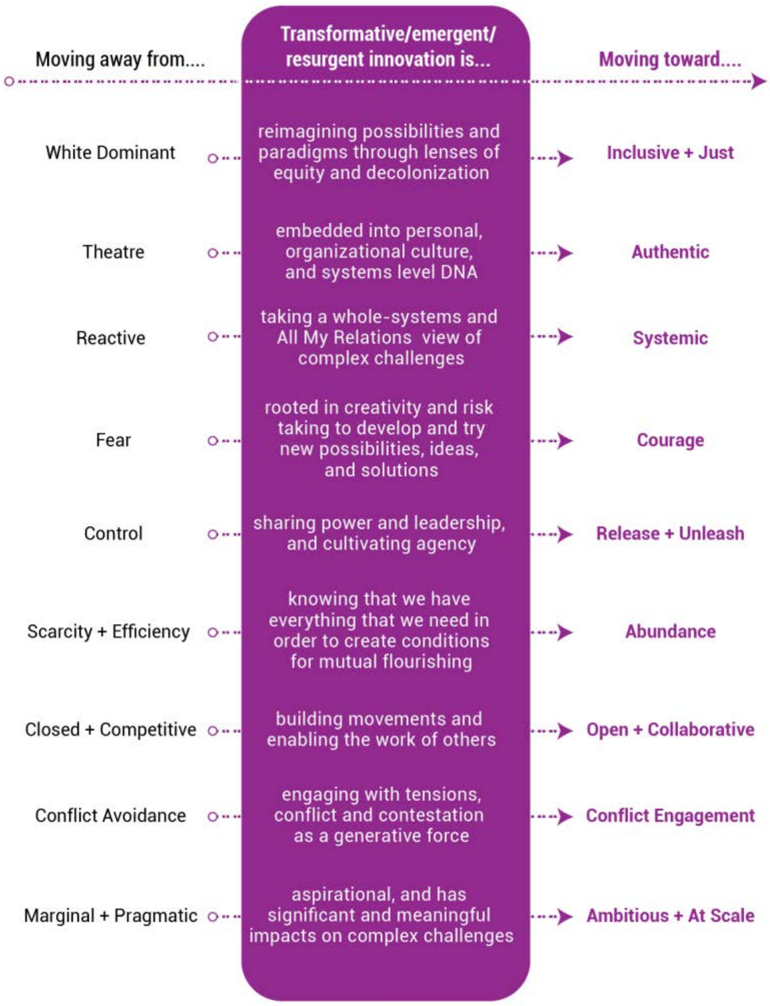

Figure 1. Paradigm and patterns of transformative, emergent, resurgent innovation.

Questions for Discussion

Are there systemic design interventions that might support hospicing/letting go of the systems, structures, and paradigms that no longer serve? Are there systemic design interventions to support the imagining/letting come of systems, structures, and paradigms that enable transformative, emergent, and/or resurgent innovation?

What are the potential and unique roles or responsibilities of an innovation lab to articulate the paradigms within which they are operating? To move toward paradigms that might enable systemic transformation on complex civic challenges? To identify and experiment with systemic intervention points that might help to shift these stuck paradigms and patterns into something more generative?

Working on transformation, emergence, and resurgence is often slippery and hard to describe, and has poor measures to tell us when we are 'there.' Might this framework give us some clues or signals about how to understand impact?

When we work on systemic interventions that challenge the dominant systems, structures, and narratives there will be push back. How might practitioners ready them/ourselves to navigate this? How might researchers support and enable this?

While it is important to hold this conceptual framework lightly and consider it as offering some provocative food for thought, it also surfaces how 'innovation' can become a way to mask or hide hard-to-face truths about how current systems are failing us in many ways. How might our personal and collective work be inadvertently contributing to keeping problematic systems, structures, and behaviours in place?

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Appendix

Table 1. Data fragments from participatory action research identifying leverage points for systemic interventions for transformative, emergent, resurgent innovation

Paradigms: transformative/ emergent/ resurgent innovation is…	Leverage points to move away from…	Leverage points to move toward…
Reimagining organizational possibilities and paradigms through lenses of equity and decolonization	White Dominant • Current paradigm of colonization and white dominance resulting in ongoing systemic and structural inequities, oppression, and injustice • Limited opportunities for innovation to happen within oppressive organizational systems, structures and paradigms • Those who benefit most from the system tend to be in power, and to keep the current system in place, "cling to the dominant system"	Inclusive + Just • Based in Indigenous, anti-oppressive, feminist, and queer ways of knowing and being • Letting go of/unlearning white dominance • Come together, and practice being human • Examine values attached to quality of work, formulate problems differently, and include a diversity of perspectives • Unlock new (old) ways of knowing, doing and being that then inform a renewed construct of 'public sector'
Embedded into personal, organizational culture, and systems level DNA	Theatre • Innovation as performance; a façade of social innovation • Lot of talk, not a lot of commitment or follow-through • Word innovation regularly used, but not defined, and not integrated into organizational strategy, processes, budgets, performance objectives, or measures • Innovation is strongly attached to brand, identity and narrative without much substance	Authentic • Innovation-related values, purpose, goals, strategic approach and activities are clear and strongly theorized • Processes, structures, systems and communication infrastructures in strategic alignment, while leaving room for the non-linear and emergent nature of innovation work • Adequate resources, time, social and political capital invested and commensurate with the scope of the challenge • Strategic learning and adaptive leadership systems and processes in place
Taking a whole-systems and All My Relations view of complex challenges	Reactive • 90% of what we do is reactive because we're desperate; always operate like it's an emergency • Reductionist approaches; "working at the end of the pipe, cleaning up the garbage" • Quick fixes are rewarded, incentivized, encouraged and/or required • Case-by-case, one-off and short-term reactions are the norm	Systemic • Strong, systemic analysis to surface interconnections, relationships, and dependencies and work from this place to identify potential response • Slow down and ask deeper questions of self, organization, and system to reveal assumptions, biases, blind spots, privilege, and paradigms • Strategic clarity about what is the real problem that we are trying to solve? • Catalyse change from deeper leverage points; change the unchangeable
Rooted in creativity and risk taking to develop and try new possibilities, ideas, and solutions	Fear • Blame, shame, and punish when there are failures • Fear of screwing up • Stay the course; status quo as the easy way because it is known, even if it underperforms • Fail to avoid negative consequences of current trajectory	Courage • Let's try it, let's do it; how amazing would it be if… • No one is going to yell at you for having an interesting idea; create comfort and take away fear when someone goes first • Step into ambitious goals and idea, even if you know you might not get where you are trying to go
Sharing power and leadership, and cultivating agency	Control • Top-down leadership structure and approach to managing innovation • Ego-driven; innovation is for people with special skills, access, or power • Internalized hierarchy; wait for someone else to lead • Innovation is not my job; innovation is stifled	Release + Unleash • Innovation leadership lives in many people, and they need opportunities and agency to realize this • People showing up to lead innovation often are not the senior leaders; who is stepping into what is the hardest? • Co-create culture of supporting people; we should be getting people excited, not holding them down
Knowing that we have everything that we need in order to create conditions for mutual flourishing	Scarcity + Efficiency • Public sector system is being starved, leading to narrative that it is inefficient and underperforming • Missing basic tools to enable great work • Keep squeezing more and more out of people	Abundance • We have the people, skills, talent, knowledge and commitment if we develop, enable and support this • We have the necessary resources if we work

	• Tolerate operating with deficiencies, 'I can't believe what we do with so little' internalized as source of pride	collectively and direct them where they need to go • We have the time that we need to think, act, reflect, and learn in deep relationship with others; these things take time
Building movements and enabling the work of others	Closed + Competitive • Organizational systems and structures discourage and inhibit collaboration • Consistently de-prioritize building and strengthening relationships • Work with those we already know, stay in echo-chambers • Activities, plans, strategies, resources, information are withheld or siloed within- and between people and organizations • Low trust; competition for attention, resources and access	Open + Collaborative • Create pathways and incentives for cross-pollination, connection, openness and sharing • Look outwards for ideas, collaborators, expertise, and experiences • Enable innovation ecosystems that support interconnections, reciprocity, collective impact, shared leadership, and trust
Engaging with tensions, conflict and contestation as a generative force	Conflict Avoidance • Disruptors and disruption considered problems that need to repressed and managed • Avoid working with conflict around big issues because they scare people • Important issues are stuck, without building shared understanding of different points of view even when there is disagreement • Difficult issues are avoided, delayed, worked around, and get progressively worse	Conflict Engagement • Disruptors invited as catalysts, disruption provokes curiousity, loving contestation welcomed • Skillfully hold space for brave, honest conversations, create opportunities to engage with difference (internally and publicly) • Learn to work with discomfort as a place for learning and movement, to reveal promising possibilities
Aspirational, and has significant and meaningful impacts on complex challenges	Marginal + Pragmatic • Low organizational readiness and willingness to make investments required to get to different outcomes • Look for prescriptive, formulaic ways to do innovation • Innovation often one-off's, at a micro level, without scaling or significant impact • You have to be realistic in what you deliver	Ambitious + At Scale • Challenges are high stakes and urgent, and there isn't time to waste • Cultivate readiness to take the big leaps and to make systemic, durable change • Efforts have a profound impact on a lot of people, and in the world

Tensions of infrastructure space

Revealing disconnections in an Eastern European special economic zone

Ina Valkanova

This short paper presents the work-in-progress of research aimed at a meaningful transformation of a large-scale infrastructure space in Bulgaria. As part of an action research doctoral project, the paper explores the possibilities for the transformation of Trakia economic zone TEZ from an extractive operation into space with local value. Starting from the ideological position that change is always possible, the research test how we can counteract the dominant global narrative of contemporary production from a local perspective.

The paper describes the historical development of the industrial zone, highlights how the complex-mix of actors design use and transform the spatial reality of TEZ, and presents three tensions that occur in the actual reality of TEZ. Those tensions are not isolated processes but are instead part of an ecosystem of ambitions, perceptions, and activities. Therefore, we need to employ a systemic understanding of tensions to produce long-lasting change. The presented questions in the paper seek to raise a debate about the nature of tensions, their conceptual frameworks, and possible action strategies for activating tensions thoughtfully.

Keywords: capital-led development, infrastructure space, soft-system methodology, transformation, action research

Introduction

The short paper presents some questions, emerged from a research trajectory designed to improve the socio-spatial aspects of a large- scale, capital-led, infrastructure project. Focusing on the case of a Trakia Economic Zone in the region of Plovdiv, Bulgaria, the study aims to explore the potential of infrastructural transformation for the benefit of local dynamics and people.

Introduction to the case

TEZ can be characterized as a special economic zone (SEZ) - "geographically delimited areas within which governments facilitate industrial activity through fiscal and regulatory incentives and infrastructure support"[1] Historically, the typology of SEZ descended from the historic free ports that have initiated global trade.[2] However, as container shipping became the international standard, new inland centers of global trade could develop. Subsequently, modern free zones adjacent to seaports or airports or along border corridors appeared in the 1960s[3]. Endorsed by the United Nations Industrial Development Organization (UNIDO), zones began to multiply around the 1960s due to the increasing reliance of global manufacturers on offshore production. While emerging economies such as Asia or Africa are currently committed to attracting export production with an

[1] (United Nations Conference on Trade and Development, 2019, p. 128)

[2] (Easterling, 2016, p. 41)

[3] (United Nations Conference on Trade and Development, 2019, p. 128)

abundance of cheap labor, the former Eastern Bloc countries rely mostly on their proximity to European markets to draw foreign direct investment.[4]

The choice of TEZ as a case study derives from the inductive nature of the research. Although concerned with a transnational topic, my initial interest was not in understanding the global dynamics of production but in making sense of the specific environment of TEZ, which I first encountered in TEZ in 2016.[5] Trained as an architect, I struggled to make sense of the spatial reality of the zone. It seemed that the large factories in the form of big boxes, scattered around the periphery of Plovdiv, landed in the landscape almost accidentally. Observing the foreign trucks going in and out of the factories, I sensed that the project was a clear articulation of transnational exchange and distribution of products and people. While TEZ is locally disembedded, it is globally connected. This assumption became validated through my first inquiry of the zone management, which was surprisingly easy to initiate. Often such “back door” spaces are perceived as closed enclaves, hostile to outsiders. However, I was quickly able to get almost unlimited access to managers, workers, documents, maps, and processes that helped me reconstruct the creation timeline of TEZ.

The **fragmented way in which TEZ was conceived and developed** contributed to a certain chaotic aspect of the planning processes of the TEZ. This disintegration led to situations where production facilities were built on locations without sufficient infrastructure. Even today, global companies are forced to stop production occasionally due to electricity supply failure. Another critical aspect of the current state of the zone is the lack of available human labor. In the 2000s, the abundance of cheap labor force drove many international companies to move to Bulgaria and, until today, remains an essential factor in the decision of a global company to outsource production to Bulgaria.

Influenced by the European environmental agenda, the zone is in **an important moment of transformation.**[6] Since there is no straightforward recipe for how such adaptation should occur, the different parties are forced to learn and experiment. This course of change is indeed people-centered - the zone is influenced by individual ambitions of people in power and experiences and desires of the thousands of factory workers that each company is fighting hard to keep. This moment of tension between people's desires and politicians' ambitions, coupled with the overall EU urge to re-think the ecological and social aspects of industrial development, provides a productive opportunity for changing the individual perspectives towards more locally valuable and embedded conditions of the zone.

Playing with tensions through revelation and activation

My research hypothesis starts from the assumption that the disconnections between the various TEZ actors produce tensions that influence each actors’ practice, decisions, and operation mode. The actors are, however, firstly often not aware of those tensions and secondly do not comprehend the systemic nature and relation of those tensions. The research focuses precisely on revealing those tensions, with the hope to activate them through a collaborative effort to produce meaningful change. For the purpose of the study, tension is framed as a situation in which there are different needs or interests that cause difficulties. The role of tensions as a trigger for transformation has been adopted in various fields of study and practice. Notably, activity theorists have positioned tensions, contradictions, and gaps as “dynamic resources and engines for change.”[7] Steven J. Jackson uses the notion of breakdowns and repair towards developing a hopeful collective approach to technology, similar to the ambitions of my study. Although TEZ may not be at a moment of visible breakdown, the zone is a space of deep tensions between different aspirations and needs of both its creators and users. To paraphrase Jackson’s quote, “It is precisely in the moments of tension that we learn to see and engage our infrastructure space in new and sometimes surprising ways.”[8] Starting from this position, the research aims to grasp and reveal the tensions

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[4] (Pop, 2018)

[5] As a director of the international festival One Architecture Week I planned an exhibition project on contemporary production, TEZ being of the cases.

[6] The new funding possibilities of EU Green deal are perceived as the key future resource for funding industrial parks. The management of TEZ and many municipalities in Bulgaria are currently working on a strategy that responds to the requirements of EU Green deal objectives.

[7] (Engeström & Sannino, 2010)

[8] (Jackson, 2014, p. 230)

of TEZ. The effort is focused not merely on an accurate description of the tensions but on building knowledge of how they can be used in a productive way to re-imagine large-scale infrastructure.

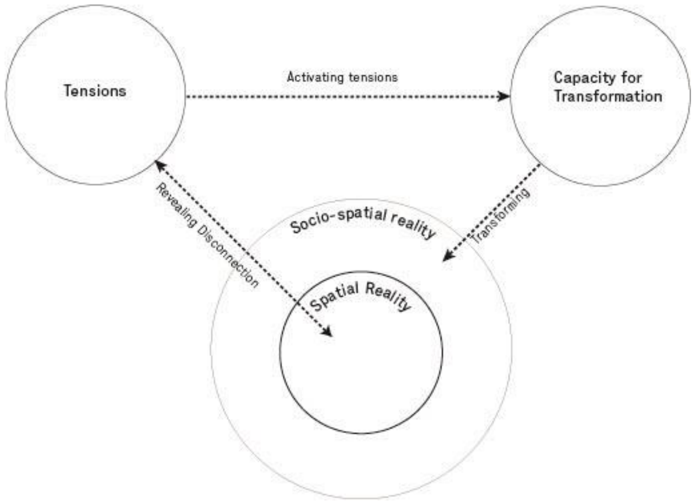

Figure 1. Research framework

To tackle the research problematic, to reveal disconnections and tensions, and possibilities for the transformation of TEZ, I adopt a "situated[9]" perspective through an action research approach.[10] This methodology's choice is motivated by the need to develop an ongoing engagement with the actor-network of TEZ. This means I situate myself within the practices of TEZ - municipality, private investors, workers, developers. In the study, I employ Soft-system methodology (SSM) - a particular research trajectory of the action research family. Soft system methodology is a process that aims to find ways of "understanding and coping with the perplexing difficulties of taking action, both individually and in groups, to improve the situations which day-to-day life continuously creates and continually changes[11]." Although SSM requires elaborate explanation in my academic field - urban studies - I will not provide a detailed research design in this paper. I believe that SSM is well known and recognized approach in the system thinking field, and the audience is knowledgeable about the methodology. I will, however, mention the tools and actions I have employed to engage the four selected groups in a long-term collaborative trajectory.

I have chosen to focus on Industrial Park Kuklen (one of the six parks of TEZ) and engage with the following practices in a shared goal-oriented research process.

- TEZ Management and Developers

- Municipality of Kuklen

- Companies of Kuklen Industrial Park

- Factory Workers in Kuklen

[9] (Haraway, 1988)
[10] (Kemmis, 2014)
[11] (Checkland, 2000)

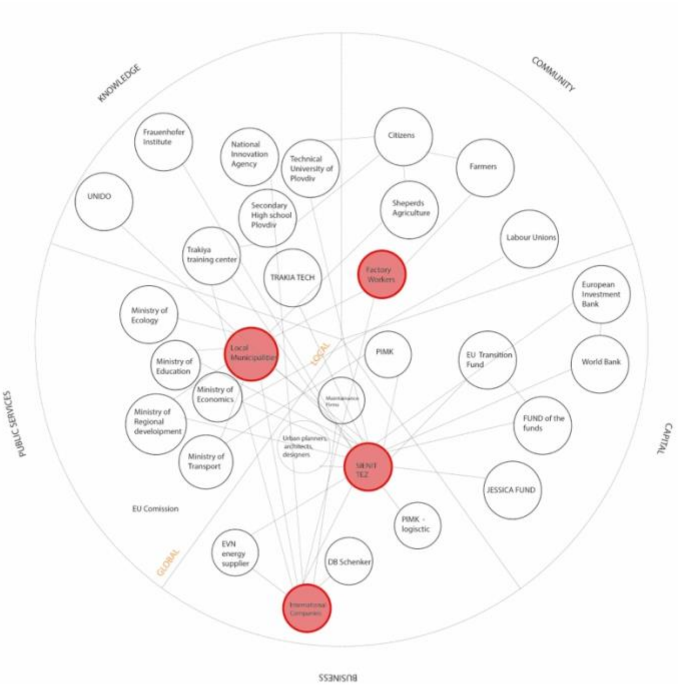

Figure 2. Stakeholder map based on the "penta-helix" model, Source: Cities of Making

The selection of actor groups includes the most relevant actors and users of TEZ and is based on the level of influence on the transformation of TEZ, on their distinct positions and (dis)connections. Except for TEZ management, which works closely with most actors, the other groups operate in their particular area and rarely interact. The worker's group, for example, even though crucial for the future of TEZ, is never included in decision-making processes and, therefore, highly disconnected from the spatial production of TEZ.

I **first** approached the case of TEZ through my own personal perspective - observation and semi-structured interviews. In the **second stage**, I spent two weeks working within each group on the related task. In the third stage, I am currently in; I conduct workshops with each group to collectively explore and define the problem situation and sketch purposeful activity models. The key here is not to start from a concrete problem but to make sense of a complex situation and reveal underlying issues, tension, and challenges. Through this stage, tensions between individuals' desires, ambitions, and goals naturally emerged. Currently, I am in the process of revealing the emerged tensions through diagrams and visual methods (photo and video), with the intent to position them as a starting point of debate with all actor groups in the **third stage of research**. **The final fourth stage** will be focused on a concrete intervention, which emerges as a direct response to the explorations of the tension in the previous steps.

I will briefly present three tensions that emerged out of this engaged research process.

The first tension is related to the nature of the development of TEZ. As already described in the introduction, the zone is conceived out of the private endeavor. Sienit has acquired a portfolio of lots to sell to foreign investors, and their main business logic lies in turning profit out of the real estate. Logically, there should be no doubt about the private nature of TEZ. However, both the company and the international production facilities positioned TEZ as a public project in the workshop we conducted together. The reason for defining their status as public is the high number of workspaces the zone produces.

Additionally, TEZ is expected to contribute to a long-term innovation landscape of the region through the education of skilled engineers. Therefore, they would aim to acquire public funds to develop the projects. How do we define shared public-private interests? How should we ensure a private commitment to a common good?

The second tension lies in the relationship between labor and automatization. While the companies expect governmental support for their private activities, in the collective workshop they sketched an activity model focused on automating the production processes. Automatization is an understandable desire since Bulgaria is the fastest shrinking country globally, and the labor force is becoming immensely scarce. However, this raises the question, why would the government fund this process and support the complete automatization of the manufacturing activities? What type of infrastructure of care is needed for the transition of people in an automatized economy?

The third tension I would like to present is the disconnection between promise and reality in the education sector. Pressed by the shrinking demographic of Bulgaria and the persistent need for skilled labor of the factories, education is an integral part of the strategy of all actors of TEZ to attract and sustain investors. Raising the quality of technical education is often mentioned as one of the key reasons why the government should support the creation of industrial zones. In 2021 the first dual course opened up in TEZ in the technical school of Kuklen. However, there was no interest by the local students, which are predominantly from a minority background. This lack of willingness to study in the course was blamed on the general passive attitude of the school children.[12] However, after engaging with the students of the school of Kuklen, I realized most of those kids were not disinterested, but they were unaware that the industrial zone even exists. This process shows an extreme disconnection between intentions, perceptions, and reality in one of the most pressing issues of TEZ.

Except for these presented examples, there are many other tensions of the practice of TEZ. What is a common thread between all of them is that they are related to each other. None of those cases is a product of an isolated process, but they are all part of an **ecosystem of activities and attitudes towards contemporary global production development.**

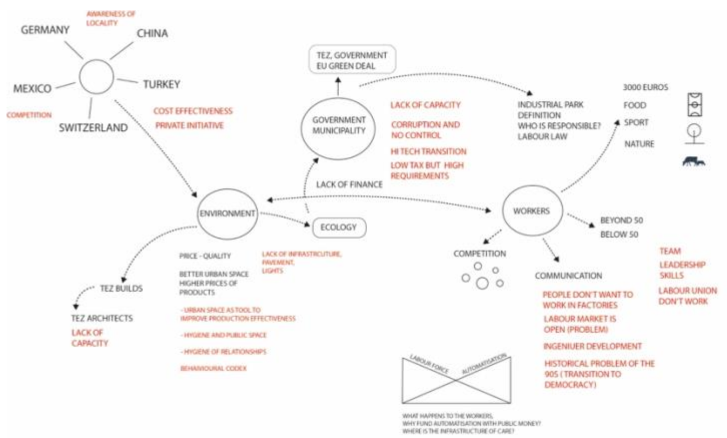

Figure 3. Rich picture of three international production companies

Therefore, I would like to raise the following questions for discussion and input:

1. How do we theoretically define tensions are triggers for change? What is the difference between contradictions, inconsistencies, and tensions, and they all result from the same system or somewhat interdependent of each other? What frameworks can we use to conceptualize the understanding of tensions are parts of systemic thinking?

2. How can we design action trajectories that create awareness and activate tensions to produce desired changes in a systemic environment, such as a global production network in local settings?

[12] The general sentiment in explanations of various parties, regarding the failure to engage students in the dual technical degree was that students are not interesting in studying these subjects. However, many of the teenagers were highly interested in automobiles. The question should be rather what type of engagement methods are employed in the school practice and why are those methods failing.

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Track 12:

Providing New Lenses For Systemic Design

Chair: Prof.dr. Kees Dorst

Triggering spontaneous self-regeneration in cities. Towards a systemic approach to spatial design

Elena Porqueddu

The recent theory of planning and urban design highlights how healthy vibrant cities behave as complex adaptive systems that are subject to spontaneous cycles of regeneration and decline. Although such systems cannot be designed entirely top-down or controlled, they can be influenced. In this perspective, the present paper investigates the potential of spatial design to intervene in site-specific adaptive cycles, in order to foster processes of spontaneous self-regeneration and prevent or invert emergent decline. Such a systemic approach to spatial design endeavours to frame the most appropriate type, position and scale of minimum interventions which can maintain the system between the extremes of uniformity and diversity, stability and dynamism, thus preserving its adaptive capacity. This approach is illustrated and tested here by presenting two projects which succeed in (1) increasing the system's ability to keep self-organizing in new better social-spatial configurations (which can neither be predicted, nor predetermined), (2) triggering cross-scale incremental positive effects which extend in time far beyond the scale of the project site, and (3) minimizing social and economic costs, an aspect which is particularly relevant at a time when economic resources are extremely limited.

Keywords: spatial design, complex adaptive systems, urban regeneration, self-organization, multi-scale thinking

The city as a complex adaptive system: challenges for spatial design

The recent theory of planning and urban design highlights how healthy vibrant cities or neighbourhoods behave as complex living systems: open, non-linear, emergent, self-organizing (Allen and Sanglier, 1981; Portugali, 1999; Johnson, 2001; Dovey, 2012; De Roo, 2016, 2017; Porqueddu, 2018a). The main characteristic of such complex urban environments is that their evolution cannot be predicted in advance because it arises from unexpected interactions between physical creation and social behaviour (Sennett, 2013). Furthermore, their overall shape at the macro-scale cannot be predefined or controlled because it emerges from unforeseen (social-spatial) local interactions rather than being predetermined by an *a priori* intention (Porqueddu, 2018b, Moroni and Cozzolino, 2019).

The emergent nature of complex self-organizing systems is incompatible with forms of overdetermined top-down design which materialize into overall projects where everything is predefined from the micro- to macro-scale (Porqueddu, 2018, 2020). Nonetheless, such systems need some form of direction. In fact, they can also spontaneously veer towards their decline. In this respect, Jacobs (1961) foresaw how the same forces which nourish city diversity can also contribute to its self-destruction. The recent theories of Complex Adaptive Systems and Panarchy have validated Jacobs' insights by demonstrating how complex systems spontaneously follow cycles of self-regeneration and decline (Miller and Page, 2007; Gunderson and Holling, 2002).

After Jacobs' pioneering work, planning scholars have adopted CAS theories in analysing the development of neighbourhoods, cities and regions, and to explain the emergence of urban socio-spatial patterns (Thrift, 1999; Portugali, 1999; Hillier, 2012; Batty, 2013). This ability to detect emergent patterns makes it possible to intervene when self-organizing processes head in an undesired direction (Rauws, 2015).

While strategies aimed at influencing Complex Adaptive Cycles and related Self-Organizing processes in cities have been explored in Planning Theory (De Roo and Rauws, 2016; Moroni and Cozzolino, 2019), they have been under-investigated in the spatial design disciplines. In this respect, the present paper aims at exploring the role of spatial design in triggering (or accelerating) processes of spontaneous self-regeneration in cities and in preventing or inverting emergent cycles of decline.

The first section of the paper focuses on the main aspects of CAS and Panarchy theories which are relevant to understanding and managing adaptive cycles in cities. The second section highlights the main conditions for preserving the adaptive capacity of complex urban systems. The third section identifies two possible approaches through which spatial designers can proactively interact with complex adaptive cycles of self-regeneration in cities and presents two projects which are useful for exemplifying and testing the proposed approaches. The fourth section traces some final remarks concerning the implication of the aforementioned theories for spatial design disciplines and the advantages in applying a systemic approach to spatial design.

Understanding Complex Adaptive Cycles across Scales

The present section briefly illustrates the main aspects of CAS and Panarchy Theory which can be relevant for spatial design theory and highlights their resonance with Transition Theory. It then traces some connections with the pioneering work of Jane Jacobs, who observed spontaneous cycles of self-regeneration and decline in cities long before CAS and Panarchy Theory were conceived and subsequently applied to urban studies and planning theory.

Complex Adaptive Systems (CAS) theory shows how complex systems evolve through adaptive cycles and how it is necessary to recognize these cycles in order to prevent their decline and foster their ability to self-regenerate. These recurring cycles consist of four phases: rapid growth, conservation, release, and reorganization (Gunderson and Holling, 2002; Miller and Page, 2007). During Rapid Growth, the system's components are weakly interconnected, and its internal state is weakly regulated. This is the time for innovation and growth. The transition to the conservation phase occurs because the system becomes more strongly interconnected and regulated: different ways of performing the same function (redundancy), are eliminated in favour of performing the function in the most efficient way (efficiency). The cost of efficiency is a loss of flexibility: such a system is increasingly stable, but over a decreasing range of conditions. In other words, its resilience declines. Under a small shock, the system's web breaks apart and suddenly comes undone. The release phase is brief and chaotic, but the destruction that ensues has a creative element: tightly bound capital is released, and all options are open. This quickly leads to a phase of reorganization and renewal. Novelty arises in the form of new inventions, creative ideas and people.

The point in managing adaptive cycles then becomes how to prevent a large collapse in the late conservation phase or to accelerate a reorganization phase, if the collapse has already happened. In the first case, the strategies elaborated by intelligent managers usually consist of undoing some of the constraints of the conservation phase, in order to navigate a graceful passage through the growth phase, without falling into a release phase (which is costly and unpleasant and involves the loss of capital) (Gunderson and Holling, 2002; Walker and Salt, 2006). In the second case, some actions can be undertaken to foster the emergence of the new inventions and connections which can accelerate the transition from the chaotic release phase towards the growth phase.

Panarchy (Gunderson and Holling, 2002) theory is also crucial as it stresses how complex adaptive cycles and feedback loops develop across scales. A crucial point in this theory is to consider that the scale in which we are interested is connected to and affected by what is happening at the scales above and below, and that the linkages across scales play a major role in determining how the system is behaving on another scale. In this respect, if we fully consider the city as a complex living system, we cannot successfully interact with it by focusing on only one scale. In this sense, CAS and Panarchy Theory also resonate with Transition Theory, which explores how patterns in system innovation emerge from the interplay between dynamics at multiple levels (MLP) (Geels, 2004; Öztekin and Gaziulusoy, 2019).

In cities, self-organizing processes of regeneration and decline were observed by Jacobs (1961) long before CAS and Panarchy Theories were developed and applied to urban studies. Jacobs foresaw the tendency for outstandingly successful diversity in cities to destroy itself across time cycles, which she described in six famous steps: (1) in some places a diversified mixture of uses becomes a popular and successful assemblage, (2) this success fosters an ardent competition for space, and the locality develops, (3) only a few dominant uses emerge: the winners of the competition represent only a narrow segment of the many uses which together generated success, (4) visually and functionally, the place becomes monotonous and loses its appeal, (5) the locality's suitability, even for predominant use, declines, (6) the place becomes marginal. With regard to Self-Destruction Theory, Jacobs's observations also revealed how linkages across scales are a key aspect in understanding diversity and resilience cycles in cities. Indeed, she argued that streets which experienced the self-destruction of diversity after a successful period (late conservation phase), could quickly regenerate their diversity (from release to rapid growth), only if they were surrounded by other streets that were in a phase of flourishing diversity (rapid growth). That is to say that in this case a micro-cycle can be positively affected by wider scale processes and vice versa. Managers who understand adaptive cycles across scales often avoid a release phase at the scale of concern by triggering release and reorganization phases at lower scales, thereby preventing the development of a late conservation phase at the scale of concern (Gunderson and Holling, 2002; Walker and Salt, 2006).

The following sections illustrate how these theories make it possible to frame the physical space as a component of a complex system which includes human actions (Portugali,2013; Moroni and Cozzolino,2019; Porqueddu, 2020) and which evolves in time following non-linear trajectories and adaptive cycles.

Enhancing the system's adaptive capacity

CAS theory shows how the maximum adaptive capacity emerges when the system remains "on the edges of order and chaos" (Waldrop, 1992), when it keeps flowing between two extreme points: uniformity, a position close to equilibrium which renders the system inert, and diversity, a position so far from equilibrium that the system could collapse. Between the two extremes of uniformity and diversity, efficiency and redundancy, stability and dynamism, a complex system is able to adapt and to self-organize, to change by means of internal dynamics while building on layers of robustness, through which it will be able to survive. In other words, Complex Adaptive Systems are at the same time robust and dynamic, uniform and diverse, efficient and redundant. Their dynamism is fostered by a robust layer that is able to support change. When some external forces exert pressure for internal adjustment, a set of cohesive conditions is crucial, allowing the system to adjust while keeping it functionally together (De Roo and Yamu, 2015).

In CAS Theory, Self-Organization processes, which concern the spontaneous emergence of order out of disorder (Prigogine and Stengers, 1984), have a prominent role in maintaining the system's adaptive capacity (Boonstra and Raws, 2016). In this respect, the literature on complex systems and self-organization distinguishes between Autopoietic and Dissipative system behaviour (Van Meerkerk et all., 2013). Autopoietic Self-Organization refers to the self-maintenance and reproduction of the system (Jantsch, 1980; Luhman, 1995) and is aimed at stabilizing it. Dissipative Self-organization (Prigogine and Stengers, 1984) is boundary breaking, leading to the evolution of systems. Dissipative self-organization refers to the increasing connection of various subsystems leading to a far-from-equilibrium situation in which small changes in the components of a system might lead to large scale change (Morçöl, 2005:11).

Complex systems (both physical and social) that show both types of self-organization are in a condition of 'bounded instability' (Merry, 1999) in which they can find 'the mix of confirmation and novelty' that maximizes their adaptive capacity. In a situation of equilibrium, the system is too static to be fully adaptive to new, unexpected situations. It can grow isolated and thus become irrelevant to its environment, and unable to learn, evolve and renew. On the other hand, when the system is totally unstable, it is incapable of responding in a coherent way to new challenges and could easily fall into chaos and decline (Van Meerkerk et all., 2013).

In cities, the enabling and constraining conditions which might nourish or threaten the adaptive capacity of a certain social-spatial network can be very heterogeneous: they can concern the set of rules (Moroni, 2015; Moroni and Cozzolino, 2019), certain kinds of policies (De Roo and Yamu, 2015; Rauws and De Roo, 2016;), the taxation system, the distribution of property or land prices (Dovey, 2012; Dovey and Symons, 2013, Moroni and Cozzolino, 2021). In the following section, I will highlight how spatial conditions can also be crucial in fostering the adaptive capacity of specific socio-spatial systems and how designers can improve their ability to shape such conditions or intervene in their evolution.

Influencing complex adaptive cycles: two spatial design approaches

This section identifies two possible ways in which spatial design can contribute to maximizing the adaptive capacity of place-specific socio-spatial systems, thereby triggering or influencing self-organizing cycles of regeneration.

The two approaches are illustrated and tested by presenting two spatial design strategies which have a crucial role in fostering a condition of 'bounded instability' in their area of influence. Although the designers of these interventions do not mention the theories presented in this paper, I will highlight how these projects represent significant examples of how spatial designers can proactively cooperate with complex adaptive cycles and self-organizing processes in cities. The subsequent paragraphs start with a description of each approach, which is then followed by a concise illustration of the case-study aspects that are relevant in supporting it.

Designing incremental adaptive structures

The first approach to spatial design consists of setting the essential initial "cohesive conditions" which can structure dynamic, open evolution. Designers can shape the robust physical structures which can foster and support the maximum dynamism and diversity, thereby preventing the system from developing extreme rigidity and efficiency or falling into chaos. This robust layer enables an open relationship between physical form and its social function, thus increasing the site-specific capacity of certain socio-spatial networks to co-evolve across time, to adapt to unpredictable activities, uses and needs of specific dwellers or to social, environmental, technological emergent transformations. In this respect, these cohesive spatial conditions render the socio-physical system responsive and able to adapt to unpredictable disturbances and unexpected situations, thus contributing to keeping the socio-spatial system robust, even though not pre-determined and in a constant state of becoming.

An example of such an adaptive structure concerns the incremental housing project built by Studio Elemental in Iquique (Chile) (Aravena and Jacobelli, 2012). The project is an innovative response to the challenges presented by a new policy from the Ministry of Housing and Urban Development, operating through the Housing Solidarity Fund. The beneficiaries of this social housing project were living in a central area of the city (where they had previously squatted) which was close to many job and education opportunities. The priority for the designers was to create a solution that allowed them to remain in this area, where they were already integrated in a good network of relationships. Since the site cost three times more than the amount that social housing could afford, the budget available for construction decreased dramatically. In order to avoid a reduction in the size of every single unit and in the quality of construction, Studio Elemental designed the new buildings as basic unfinished structures that could gradually be transformed by the residents, according to their individual needs. The structure alternates built segments with equally sized voids, the dimensions of which are designed to fit simple, low-tech construction (Fig. 1).

This building was designed so that the expansions occurred within the initial volume, thereby limiting the possibility for chaos without the need to control every single addition. The void could be filled by each family in a different way, also by re-using the elements saved during the demolition of the former informal settlement (doors, windows, fences, etc.). Studio Elemental (2012) defines this building as a 'diversity organizer': an incremental structure that encourages each dweller to play with heterogeneous spaces, surfaces, personal colours, textures and uses, according to ever-changing needs and possibilities (Fig. 2). From this perspective, the Elemental project can be considered as a robust structure capable of containing and rationalizing informal, diverse, unpredictable expansions without pre-defining the formal outcome of the transformation. In this case, a top-down design intervention triggers an incremental transformation which emerges from the individual actions and interactions of the dwellers. The uniformity of the initial structure fosters the diversity of the additions: here a traditional standardized building technique, usually associated with the monotonous landscape of social housing neighbourhoods, fostered the development of diverse expansions. The stability of the initial form supports the dynamism of the addition in time.

This design strategy gives great importance to coordination as it recognizes that the sum of individual performances, even though each of them is of a certain quality, does not necessarily guarantee the collective quality of the common good. The main role of the architects in Quinta Monroy was to provide those things that the individual interventions could hardly guarantee, such as safe structural frames, well-lit and properly ventilated rooms, and high-quality common spaces. The designers did what the inhabitants had been unable to do spontaneously: take care of the quality of the whole and coordinate the operations that required a collective sense (Aravena and Jacobelli, 2012). That is to say that designers were able to guarantee architecture of high quality, without over-controlling its spontaneous process of growth. In Quinta Monroy, the initial fixed structure is the collective cohesive layer which expands rather than limits the possibility for individual actions and channels them towards the collective interest.

Furthermore, not only did the Elemental team work with space and architectural elements, but it also included the action of the inhabitants in the design brief. In other words, the designers and the residents were seen as integral parts of the spatial transformation, rather than as external subjects. The fact that the inhabitants became the owners of the houses and were directly involved into the construction process of their individual expansions had many relevant implications. Firstly, the owners increased their motivation to maximize the quality of the expansion; secondly, this process fostered a sense of belonging: all of the inhabitants preferred to stay and continue improving their homes instead of selling them, although the value of the houses doubled after their additions (Aravena and Jacobelli, 2012).

Finally, the experience in self-construction by the inhabitants was one of the main ingredients in the project, and this was crucial in reducing the building costs considerably. In this respect, the Elemental project succeeded in maximizing the use of public resources to create a value (economic and social) far greater than the sum of its parts: the equation $7,500 (public investment) + $750 (family investment) = $20,000 was firmly based on the location within the city (Aravena and Jacobelli, 2012).

Figure 1. Elemental: Quinta Monroy: basic structure. Courtesy Elemental

Figure 2. Elemental: Quinta Monroy: incremental transformation. Courtesy Elemental

Design as a good perturbation

The second possible approach to spatial design consists of intervening in current adaptive cycles in order to restore the balance between uniformity and diversity whenever a social-spatial network risks becoming too rigid and efficient and losing its diversity and redundancy (late conservation phase), or when it misses the minimum cohesive conditions necessary to avoid falling into chaos. In spatial terms, these interventions can materialize in a myriad of ways which aim to increase the cohesive conditions or to reduce some constraints across site specific social-spatial networks. For example, a design action might strengthen or insert a robust spatial structure when the system lacks a cohesive layer, or rather it could undo some constraints, for example by adding new, *a posteriori* undetermined spaces (open structures) to an overdetermined rigid structure. In both cases, designers intentionally influence an adaptive cycle, in order to prevent a late conservation phase or a release phase or, in other words, in order to restore the balance between uniformity and diversity, if the system had already fallen into one of these phases. Such an approach is based on a place-specific understanding of complex adaptive cycles across scales. This understanding makes it possible to identify the most appropriate type and scale of (minimum) intervention which can foster or restore the system's adaptive capacity, and thus its power to self-regenerate and self-produce the solution to emergent problems.

An example of this design approach is the famous Integrated Urban Plan (PUI), a complex program of city transformation promoted by Medellin municipal government and coordinated by Alejandro Echeverri (Echeverri and Orsini, 2010), where a series of punctual interventions triggered an incremental cycle of self-regeneration across the informal settlements which were involved in a dramatic process of decline. In Medellin, an understanding of social-spatial dynamics across scales revealed that, besides all the well-known problems related to extreme poverty, crime and violence, the informal settlements also own a peculiar and vital network of micro-connectivity that creatively supports social and economic exchanges on a local scale (Davila, 2013; Porqueddu, 2018). Nonetheless this intricate informal network grew excessively across the steep terrain of the mountains, thus preventing efficient connections with the rest of the city on a macro-scale. In this respect, the Metrocable project is the creative solution that makes it possible to reconnect and reintegrate the poorer areas of Medellin with the rest of the city through selective intrusion into their social systems, and thus with minimal damage to their existing labyrinthine structures. Building new streets to accommodate buses would have meant demolishing a large number of dwellings, thereby harming the vital intricate network. Furthermore, the Metrocable required little in terms of land acquisition and could be built over a relatively short period of time, thus considerably reducing economic costs (Brand and Davila 2011). Not only that, a bus network would not have been the most suitable solution for these settlements, as they are spread across the steep terrain of the mountains.

Furthermore, in Medellin, a social-spatial understanding led the design team to identify the strategic position for the Metrocable stations, which became focal points for the areas towards which the majority of residents move. By improving the spatial connectivity, the Metrocable affects local movement patterns, which consequently affect commercial patterns. These new focal points have also become reliable locations for positioning commerce, both formal and informal (Goodship, 2015), thus fostering an incremental upgrade of these areas, which used to be centres of extreme violence and crime. In this respect, the construction of the Metrocable network brought a new energy to the urban economies in its area of influence (Coupé and Cardona, 2013).

A new macro-scale connection traced from the top down triggered an incremental process of regeneration at the micro-scale of the intricate lanes of the informal settlements. In this perspective, the Metrocable project shows how social-spatial analysis enables designers to frame the most appropriate type of (minimum) intervention that can influence rather than determine individual movements and actions across urban space, thus activating a process of incremental change and self-regeneration.

On the one hand, the Metrocable enables the inhabitants of these settlements to easily reach the metro system and go to work downtown. On the other, the Metrocable offers a kinaesthetic experience across the stunning panoramic view of the whole city, thus turning the image of these settlements as places that are dangerous and segregated, into that of ones that are attractive and interconnected (Fig. 3). In this respect, the Metrocable also nourishes awareness of the potential beauty of these districts, thus stimulating trust in the communities inhabiting them and attracting new visitors who can also contribute to fostering the local economy and increasing diversity. Because of its strong visual impact, the Metrocable also became a symbol of inclusion. Conventional road and bus systems may have the capacity to move a higher volume of passengers, but they do not have the visual and aesthetic appeal and symbolic power of the aerial cable cars (Brand, 2013).

The Metrocable was just one of the components of the incremental process of urban improvement. This process was also triggered by complementary projects. A variety of new cultural spaces and sports facilities were clustered in the areas around the stations, which became hubs that could partially compensate for the notable lack of such services in these settlements. The new supralocal attractions were scattered across the local urban fabric, thus stimulating the emergence of a new distributed network of exchanges with the rest of the city. Moreover, the PUI developed a series of micro interventions, such as the construction of small plazas along the existing informal lanes, designed to upgrade the local informal micro-network of connections (Fig. 4).

The PUI in Medellin did not consist of a big redevelopment project where everything was redesigned from micro to macro scale. Instead, it produced a series of heterogeneous projects at different scales, scattered across and interwoven with the informal urban fabric, rather than being concentrated in a predefined area (Fig. 5). High-quality infrastructures, stunning examples of architecture, and local micro-interventions were distributed at discontinuous strategic points and treated as components of a complex integrated urban strategy, rather than as separate projects. This ability to go beyond individual interventions without producing overall plans created the conditions for an incremental spontaneous area improvement. These punctual projects stimulated and influenced cross-scale effects, thereby inverting a cycle of decline. In this respect, the Metrocable project enhances the slow micro-connectivity by building new, wide-scale fast connections. Vice versa, the coordinated assemblage of punctual micro-interventions across the intricate lanes triggers an incremental process of self-regeneration which extends on a macro-scale, far beyond the scale of every specific project site.

Finally, in Medellin designers and planners do not replace large parts of the existing informal urban fabric with a new formal overall order designed from the top down. Instead, their formal top-down actions trigger spontaneous processes of bottom-up self-regeneration across the existing urban fabric. In this respect, the PUI can be framed as a minimum new robust structure capable of fostering the vitality and dynamism of the informal settlement while preventing it from falling into chaos: the new structured macro-network of public spaces and oriented fast connections increased the efficiency of the system without reducing its micro-scale redundancy, which is crucial to its vitality and resilience.

Figure 3. Medellin Metrocable: Panoramic view from a cabin. Photo © Camilo Montes Gutierrez.

Figure 4. Medellin. PUI Northwest Area: improvement of informal lanes. (Materials from EDU re-assembled by the author). Source: EDU, 2004 (graphic team EDU – urbam EAFIT). Courtesy Juan David Hernandez.

Figure 5. Medellin. Projects around Santo Domingo Metrocable station (PUI Northwest Area). Photo © Carlos Tobòn. Numbers and captions inserted by the author.

Towards a systemic approach to spatial design

The present paper highlights how, by understanding complex adaptive cycles across scales, designers can acquire the ability to identify the minimum top-down actions which can contribute to triggering a spontaneous process of self-regeneration that emerges from the bottom up. By recognizing that they do not have the power of control over emergent self-organizing orders, designers can acquire the 'Butterfly' power of subtle influence (Irwin, 2014).

In this respect, the design action can be framed as a good perturbation: designers modify or insert the minimum physical elements which can repair or increase the system's ability to self-regulate, self-adjust, self-organize in new better social-spatial fits (which can neither be predicted nor predetermined). In this perspective, designers become capable of shaping the minimal spatial interventions which can guarantee that the system preserves or recovers its adaptive capacity and remains in a state of becoming (vital, learning, in evolution). CAS theory shows that the adaptive capacity and responsiveness of a complex socio-spatial system, such as a city, decreases when there is either an excess or a complete luck of uniformity or structure. For this reason, the main role of spatial designers becomes either that of strengthening or inserting a robust spatial structure when the system lacks a cohesive layer, or that of undoing some constraints in overdetermined rigid structures.

The theories presented lead to developing a spatial design approach which shifts the focus from the final shape of the artifacts toward the non-linear (and cross-scale) effects triggered by their insertion in site-specific adaptive cycles. In this perspective, designers keep acting on physical form, although form it is not the goal, but rather it becomes a means to (re)activate the connections which foster/restore the capacity of a certain spatial network to learn, adapt, evolve, and renew. For example, the social housing settlement in Iquique is undetermined and unfinished, but it does not lack form: its shape is defined from the top down, even though it is conceived to be constantly transformed, adjusted, and incremented, from the bottom up. The stunning architecture in Medellin consists of very iconic buildings whose form and position are top-down defined, even though they were conceived in order to upgrade the existing informal lanes, in which they are immersed.

In this respect, both presented projects highlight how aesthetic quality can also be crucial in enhancing the process of self-regeneration, as it works on an emotional symbolic level. In Iquique the interesting and colourful landscape that emerged from the self-construction process nourished a sense of belonging among the inhabitants and increased their motivation to keep upgrading their house. In Medellin, the beautiful panoramic experience of the Metrocable and the new stunning architecture contribute to shaping a new positive perception of the informal settlements, thereby accelerating their process of self-regeneration.

The design strategies presented show how, by truly understanding cities as complex adaptive systems, designers can stop designing overall projects where everything is predetermined from the top-down from micro to macro scale. Instead, they can acquire the ability to:

1. play with cross-scale effects; they can stimulate incremental change through progressive site-specific micro-interventions placed at strategic points and at the right time in cycles of regeneration/decline.

2. design the site-specific essential robust physical conditions which can structure an open non-linear evolution over time without predetermining its outcome.

As illustrated by the projects presented, such a systemic approach to spatial design succeeds in minimizing social and economic costs, an aspect which is particularly relevant in a period characterized by extremely limited economic resources.

Finally, the present paper highlights the urgency for spatial designers to explore the complexity that lies between order and chaos, uniformity and diversity, stability and dynamism, and between individual expression and collective interest. Such understanding can inform a systemic approach to spatial design theory and practice, enabling designers to proactively cooperate with complex adaptive cycles of self-regeneration and decline in cities thus opening up new unforeseen possibilities for the heterogeneous landscapes of our everyday life and their emergent state of becoming.

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Infrastructuring for social innovation inspired by social insects

A research through design method for understanding the nature of social biomimicry

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Infrastructuring has been valued in social innovation sector since it can support collaborations by connecting diverse actors and arranging resources. Setting collaboration as the goal of infrastructuring, we expect the collaborations of animals to be an inspiration for infrastructuring. Such attempts to apply natural principles to human societies are termed social biomimicry, but its practice and methodologies have rarely been studied. This research aims at understanding social biomimicry practice in the context of infrastructuring. To investigate the empirical social biomimicry process from a first person perspective, we employed a research through design (RtD) method. By designing and operating an open collaboration platform inspired by the self-organisation of social insects, we found that social biomimicry has limitations in address the relational and evolutionary aspects of infrastructuring properly. Discussing how such constraints of social biomimicry leads to challenges for designers, we suggest the necessity of methodologies to support designers.

Keywords: Social biomimicry, Infrastructuring, Research through design (RtD), Socio-technical system (STS)

Introduction

The social innovation domain emphasises the significance of infrastructure because they facilitate collaborations by connecting diverse stakeholders and arranging time and resources for group work (Hillgren, Seravalli, & Emilson, 2011). Being perceived to reflect the relationship between people's activities and the technologies supporting those activities (Karasti, 2014), we can consider information infrastructure as a socio-technical system. An STS perspective describes a process that includes technical systems, designed for specific purposes, and social systems, which evolve depending on the external environment and technical systems (Fisher and Herrmann, 2011). Although designers cannot manipulate a social system, they can design a technical system to influence the social one (Baek et al., 2018). From an STS perspective, we redefine infrastructuring for social innovation as designing technical systems to induce collaborative behaviors for social innovation in social system. Setting collaboration as the aim of the social system, this research was motivated by the potential that collaborative animals in nature can provide inspirations for infrastructuring.

Such attempts to apply natural principles to human societies are termed social biomimicry (Holbrook, 2010; Ausubel, 2012; Werntz, 2014; Hunter, 2015; Schieffer and Lessem, 2016). Both social and conventional biomimicry use technical systems as their design objects. They are distinguished in that conventional biomimicry directly applies natural principles to technical systems, whereas social biomimicry indirectly achieves its design purposes by manipulating technical systems, which in turn affect social systems. Studies show the potential of social biomimicry by suggesting that diverse natural principles apply to human organisations (Mars et al., 2012; Baumeister and Herzlich, 2015; Paulraj, 2011; Agarwal and Vrat, 2014; Fewell, 2015). In particular, biomimicry communities for social innovation have focused on how natural systems adapt, communicate, cooperate, self-organise, and build effective networks. They argue that we can learn from natural strategies to transform our culture, drive business growth, and lead an organisation (Biomimicry for Social Innovation, n.d.-a). However, to the best of our knowledge, little research exists on social biomimicry practice and methodologies (Mead, 2014), which raises the need for the investigation of empirical studies on social biomimicry. Thus, as a complement for the studies in social biomimicry practice, this research addresses the following research questions:

• Question 1: How does the characteristics of design object (infrastructure for social innovation) influence the practical application of social biomimicry?

• Question 2: What are the designers' challenges in social biomimicry practice?

Here, we use a research through design (RtD) method to explore a social biomimicry practice where the self-organisation of social insects is applied to the design of an online platform for crowdsourcing social innovation ideas. RtD helps researchers be more aware of their design activities and obtain the unobservable tacit knowledge and decision-making processes (Pedgley, 2007). To understand the designers' cognitive process and challenges involved in social biomimicry practice from a first person perspective, we designed and operated an open collaboration platform for social problem solving inspired by the self-organization of social insects.

Literature review

Biomimicry for social innovation

Social innovation is 'new ideas (products, services, and models) that simultaneously meet social needs and create new social relationships or collaborations' (Murray et al., 2010, pp. 3). That is, the aim of social innovation is to achieve behavioural changes and social wellbeing, in addition to resolving social problems such as the unavailability of safe drinking water and poverty (Ceschin and Gaziulusoy, 2016). To achieve these aims, social innovation addresses diverse design objects: principles and ideas, services and products, social movements and programmes, organisations and processes, and legislation and policy (Phills, Deiglmeier, and Miller, 2008; Sørensen and Torfing, 2014). Social innovation requires the involvement of diverse stakeholders, including research centres, industrial associations, non-governmental organisations, local administrations, end-users, and policymakers (Ceschin and Gaziulusoy, 2016). Since collaboration has great significance in the social innovation process, new leadership and management is needed to support the collaboration of diverse actors in social innovation (Sørensen and Torfing, 2014). Further, Murray et al. (2010) argued that expanding networks and inviting new participants will augment the drivers of social innovation and overcome organisational constraints and pursue an open and social approach.

The biomimicry community argues that nature, with a 3.8-billion-year history, can inspire the design for social innovation (Phills, Deiglmeier, and Miller, 2008) with features such as sustainability, adaptability, collaboration, mutualism, and networking. There are a few biomimicry tools and methods for social innovators. For example, Life's Principal Leadership Cards, a deck of 52 cards, introduce natural phenomena and inspirational principles for improving leadership (Biomimicry 3.8, n.d.-a). Furthermore, the biomimicry community holds workshops where participants can observe nature and learn about biological cases and biomimicry tools and about how they can apply biological inspirations for improving leadership, management, and organisational capacity (Biomimicry for Social Innovation, n.d.-b). Designers can also find natural cases from Life's Principal Cards (Biomimicry 3.8, n.d.-b) and Asknature (Biomimicry Institute, 2018), which nevertheless were not specifically designed for social innovation. Both include physical, chemical, and technical insights; nevertheless, the cases and principles related to adaption, cooperation, and coordination are applicable to enhancing social capacities. The review of extant biomimicry methodology for social innovation suggests that it introduces inspirational phenomena and natural principles without validation. This is contrasted by biomimicry in the engineering domain where diverse tools and methods have been developed and assessed on academic and systematic approaches (Fayemi et al., 2017).

Infrastructuring for social innovation

Infrastructuring is defined as a 'continuous process of building relations with diverse actors and by a flexible allotment of time and resources' (Hillgren et al., 2011, pp. 180) or 'social constructs with open, dynamic, and heterogeneous structures for participation' (Karasti, 2014, pp. 143). Due to the characteristics of infrastructuring that support engender a long-term trustful collaborative relationship (Hillgren et al., 2011), we argue that collaborative principles in nature can be applied to infrastructuring for social innovation.

Infrastructure has some traits to be considered for designing them. The first trait is the relational aspect. As aforementioned, infrastructure facilitates the relationships among actors, but its development involves intricate relationships as well (Simonsen, 2020). As an object is defined as a tool when it is used for an activity, infrastructure emerges depending on the structures and activities of human practice (Star and Ruhleder, 1996). Accordingly, it reflects the relationships between human organisational methods and the technologies enabling and supporting such practices (Simonsen, 2020). Furthermore, infrastructure has outward connective capacities to plug into external tools and other infrastructure (Simonsen, 2020). Because of these complex relationships, infrastructure is relative rather than absolute to designers' perspectives (Star and Bowker, 2002). One person's infrastructure can be another's design object (Star, 1999; Karasti, 2014); for instance, a crowdsourcing platform may be infrastructure for participants but a product to create and maintain for software developers.

The second trait is the emergent and evolutionary aspect. Infrastructuring is defined as 'the work of creating socio-technical resources that intentionally enable adoption and appropriation beyond the initial scope of the design, a process that might include participants not present during the initial design' (Dantec and DiSalvo, 2013, pp. 247). This implies that infrastructure design should consider dynamic factors – including the number of participants – and respond accordingly. Star and Bowker (2002) claimed that infrastructure can be modifiable at both the individual and social levels; it should allow users to adapt it to their purpose and adjust to changing social needs. However, designing a modifiable infrastructure is difficult because the required flexibilities are usually emergent (Star and Bowker, 2002). Thus, Star and Bowker (2002) stated that infrastructure should be designed through an evolutionary, distributed process rather than a single great design plan or master blueprint. Nevertheless, infrastructure evolution remains a demanding process and requires time and negotiations (Simonsen, 2020).

Research through design

RtD is 'a research approach that employs methods and processes from design practice as a legitimate method of inquiry' (Zimmerman et al., 2010, pp. 310). In this approach, researchers conduct design practice and observe the challenges and processes firsthand (Yang et al., 2019). We could not identify a standardised RtD methodology (Zimmerman et al., 2010), but Bayazit (1993) suggests how to acquire knowledge from design practices as follows:

Knowledge elicitation. This stage involves observing the design domain and data collection, which are then refined or rejected until a satisfactory position is reached following an empirical approach. To acquire expert knowledge, researchers use diverse methods, for instance: (1) examining documentary evidence, (2) obtaining direct information from users and designers, (3) conducting observations while using and creating the design, (4) experimenting with the design and the developed method (prototype), and (5) conducting knowledge and conceptual analysis through calculation techniques using physical and abstract models.

Interpretation of knowledge. The collected data are analysed and interpreted. Diverse types of sensory information including visual, auditory and tactile information is verbalised for analysis. Designers' cognitive processes are often verbalised through reporting methods such as talk aloud or think aloud.

Structuring of knowledge. The knowledge of design activities are structured as a model accurately representing the design process and the concepts relevant to design. While design processes are structured as sequential schema, the structures of other concepts can be described by links, boundaries or part-whole relationship.

Method

In this study, we applied an RtD approach to a social biomimicry project to examine how the traits of infrastructuring influence the social biomimicry practice and what the designers' challenges are. We followed the RtD process proposed by Bayazit (1993) as described in Table 1.

Table 1. Outline of the Research through Design Process

	Knowledge elicitation (Data collection)	Knowledge interpretation (Data analysis)	Structuring of knowledge (Modelling)
Platform design	• Documentation on framework development and platform design • Platform design result	Thematic analysis - Codes and themes - Thematic map	The model describing social biomimicry's scope
Platform implementation	• Documentation on platform operation • Posts and logs made by participants • Interviews with participants		

Outline of social biomimicry project

We designed and ran an open collaboration platform. The platform, titled UVENGERS meaning the avengers in Ulsan, supports crowdsourcing solutions to social problems through collaboration among community members – primarily university students and young adults. We created the online platform inspired by the self-organisation of social insects for open collaboration in the Ulsan province of South Korea, developing a design framework and platform and conducting three social problem-solving projects through it. Figure 1 shows how the project progressed over three years.

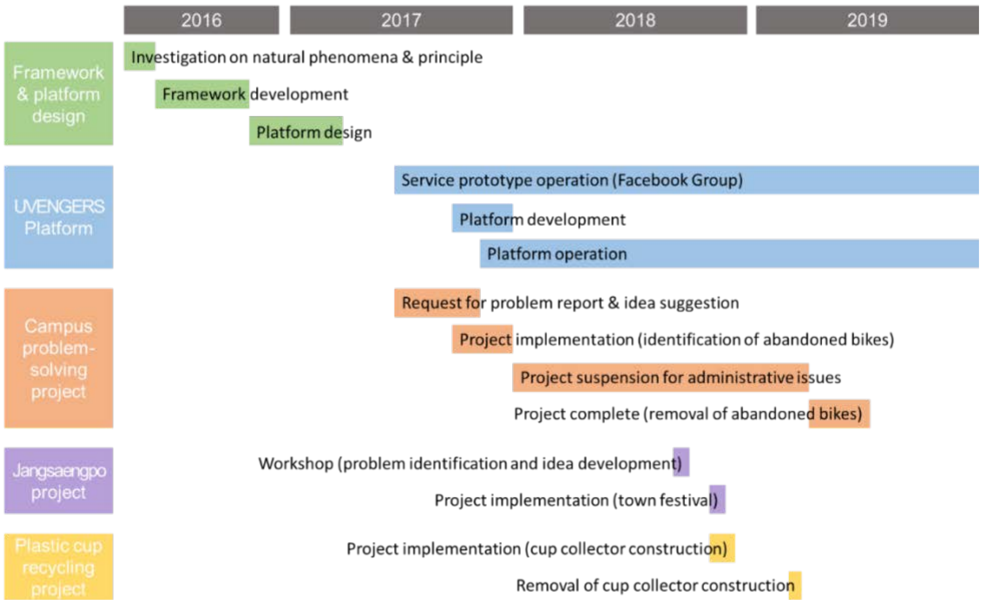

Figure 1. Timeline of the Project

First, we investigated the self-organisation mechanisms of social insects and extracted an underlying principle. This principle explains the reinforcing or balancing feedbacks found in the species' interaction with one another and reaction to the external stimuli. It is through these feedbacks that they can behave as a complex and large system. We used this principle to design a framework for the open collaboration platform (Kim and Baek, 2017). The platform had three menus: problems and ideas, projects, and portfolios (Figure 2). In the problem and ideas menu, users reported social problems that they encountered and shared corresponding solutions. Further, they could support and follow the problems that they were interested in by pushing the 'empathy' buttons. When there were sufficient solutions to a problem, users chose the best solution by voting. Then, the problem was moved to the project menu, where users volunteered to be managers and participants to realise the solution. Next, they executed the project and uploaded their project process on the platform. If they found a project sponsor, the sponsor was acknowledged on the project page. Once a project was complete, it was moved to the portfolio menu. The project pages in this menu could evidence participants' contributions and act as references for future projects.

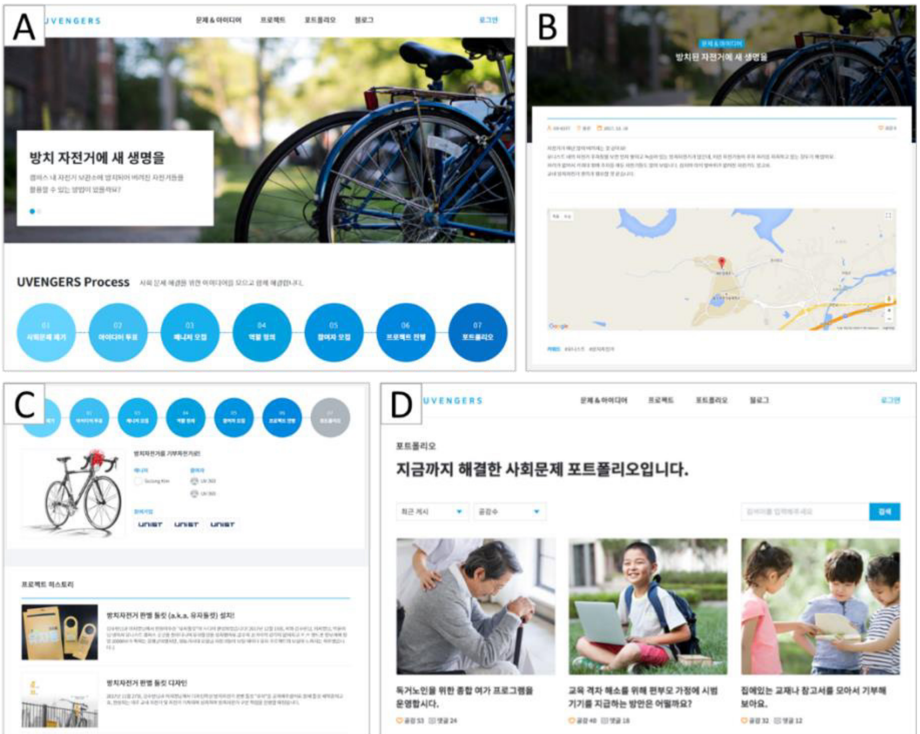

Figure 2. Screenshots of UVENGERS Platform (A: landing page, B: problems & ideas, C; projects, D: portfolios)

While developing the online platform, we began our first project for solving campus problems using Facebook. We collected reports and solution ideas on campus problems from university students and posted the project's progress on the Facebook group. From these reported problems, we ran a project to solve the problem of an abandoned bike (Figure 3, A). After the platform was completed, we transferred the project data from Facebook to the platform and undertook two more projects: revitalising Jangsaengpo village in Ulsan (Figure 3, B) and encouraging plastic cup recycling on campus (Figure 3, C).

Figure 3. The Social Problem-Solving Projects Using the Platform

Data collection

We employed diverse data types. First, we collected documents recorded by us, including the investigation of the self-organisation phenomenon, the descriptions of platform design frameworks, and the UVENGERS platform design as well as our project logs. Second, we collected the Facebook group posts, posts from the UVENGERS platform and other social media, and the communication logs and project-related documents posted by platform users. Finally, we conducted one-on-one and focus group interviews with platform users (Table 2) regarding their experiences and opinions on how the platform could be improved.

Table 2. Interviewee Information

Project	One-on-one interview	Focus group
Campus problem-solving project	1 project manager	-
Jangsaengpo project	2 project managers	6 participants
Plastic cup recycling project	-	1 project manager 2 participants

Data analysis

The research data were analysed using thematic analysis, following Braun and Clarke (2006). First, we organised all documents and interview transcriptions into a data corpus and read it with a colleague. Here, two researchers obtained initial insights from the data and discussed them to reach an agreement on the potential codes, while the main researcher developed a coding scheme with 28 codes. Then, two researchers performed coding according to the coding scheme using the qualitative analysis software NVivo, shared their results, and modified them through further discussion. By doing this, we excluded one code and added two; that is, we obtained 29 codes in total (Table 3). Depending on this final code set, we searched for and named the themes and organised them into a thematic map, including 4 themes and 21 codes.

Table 3. Code List

No.	Code	Description	Final code list	Thematic map
1	Application of natural phenomena	Inspiration from natural phenomena was applied to the framework and platform design.	O	O
2	Application of knowledge of human behaviour and organisation	Knowledge of human behaviour and organisation was applied to the framework and platform design.	O	O
3	Expectations and needs on the platform	The platform was expected to effectively support social problem-solving projects or provide subsidiary benefits.	O	O
4	Platform accessibility	Instead of using a new platform, participants tended to use other familiar social media.	O	O
5	Burden on using the platform	The participants felt it a burden to post on the platform.	O	O
6	Problems in platform usability	Using the platform is complicated and inconvenient.	O	O
7	Platform constraints	Some realistic and environmental conditions restrict the platform's optimum operation.	O	O
8	Project constraints	Some realistic and environmental conditions restrict project progress.	O	O
9	Project participants	Issues exist related to participant groups, e.g., significance of a common understanding and project purpose.	O	
10	Managers	The manager's role involves a high level of participation and burden of responsibility.	O	
11	Stakeholders	Issues exist related to external stakeholders; e.g., differences in position, diverse stakeholders' criteria, and value perception were obstacles to project agreement and decision-making.	O	O
12	Initial inducement of users	Initially, participants were invited via personal contact and on/offline advertisements.	O	
13	Difficulties in inducing participation	Inducing problem reporting and suggesting solutions is difficult; however, inducing participation in practical activities is more difficult.	O	O
14	Specific scope encourages participation	Specified themes or problems increase motivation for participation. Broad topics and ambiguous issues make participants hesitant.	O	
15	Project activities result in positive feedback	Participants' project activities induce the participation of new members.	O	O
16	Impact of projects on communities	The projects were effective in publicising the problems and expanding links to other stakeholders, even though the project output was unsuccessful.	O	O

17	Poor communication	The platform rules and policies, such as managers' duty and the rewards, were not clearly informed.	O	
18	Problems found in platform operation	The problems and requirements found while operating the platform.	O	
19	Necessity of support for the project	The participants faced difficulty in considering diverse stakeholders and anticipating the subsequent effects of the projects.	O	O
20	Necessity of the workshop	Workshops were needed to guide participants in how to effectively use the platform for their projects.	O	O
21	The gap between online platform and offline activities	The use of the online platform was not very active because most project activities were conducted offline.	O	O
22	The gap between platform output and intended purpose	The project portfolio was insufficient as evidence to persuade sponsors.	O	O
23	Limitations of conventional problem-solving methods	The realisation of ideas depends upon the decision-makers of centralised systems and the solutions are usually temporary.	O	O
24	Natural model and open collaboration practice	In reality, the project process was different from the planned linear project process based on a natural model.	O	O
25	Difficulties in open collaboration	Although the platform was designed for open collaboration, the projects were performed in a top-down manner.	O	O
26	Similarity-focused approach	Natural inspiration was adopted as it is similar to open collaboration behaviours, instead of its potential, to overcome the limitations of open collaboration in human societies.	O	
27	Operational strategy according to the life cycle	The platform required running the projects with specified groups in the initial state without abundant users. The projects must be conducted with unspecified individuals once the platform grows and involves enough users.	O	O
28	Importance of realisation	The realisation of ideas is essential to satisfy the needs of participants and reveal the platform's efficacy.	O	
29	Improved cooperation	The participants stated that the platform was helpful for their cooperation.	O	O

Results

Figure 4 shows the thematic map.

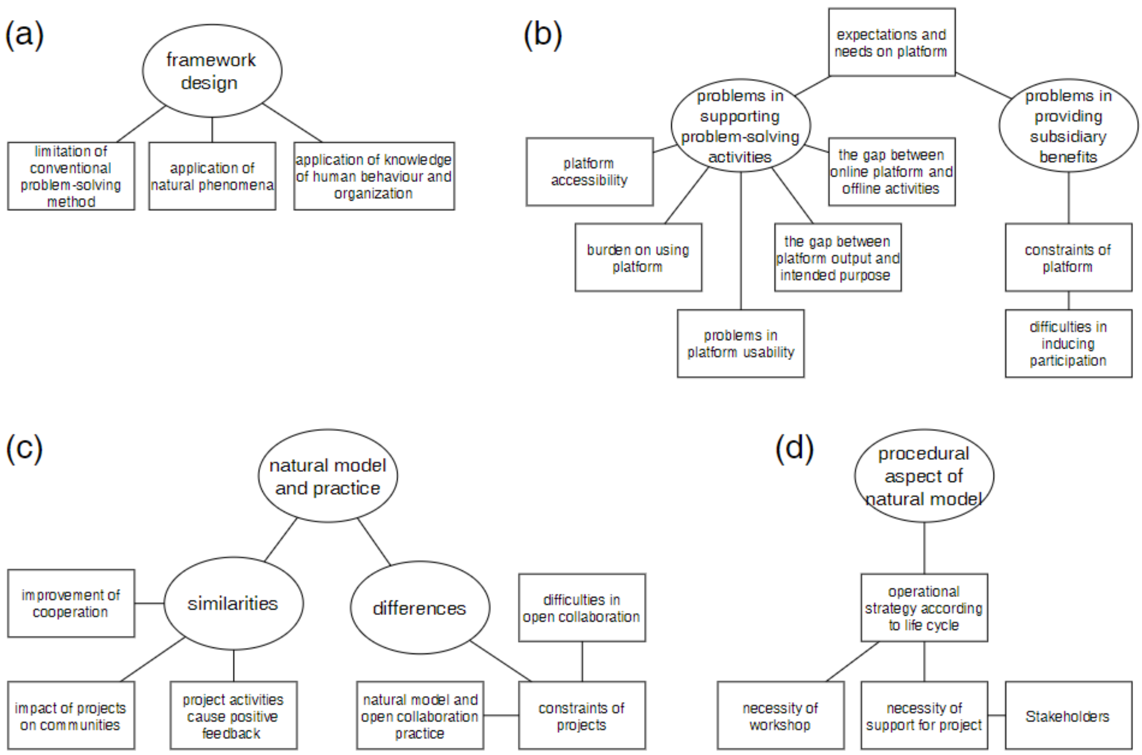

Figure 4. Thematic Map

Theme A: Framework design

The design goal of this project was to facilitate open collaboration for all the stages of the problem-solving process from identifying problems to implementing solution. Designers took the social biomimicry approach, identifying the similarities between the patterns of open collaboration and self-organising behaviour amongst social insects. Generally, inspiration from natural phenomena is translated into a platform design framework's schema. Here, we extracted a natural principle from the self-organising behaviour of social insects: self-organisation enables communities to collaborate and achieve complex, large-scale outcomes through local communication, decision making, and individual actions based on simple rules and the environment. This principle formed a framework with five elements: (a) organisational goals or required tasks and resources, (b) actors, (c) commons, (d) task design, and (e) information communication. Further, we undertook literature reviews on organisational design for open collaboration to identify how each element should be set (Kim and Baek, 2017).

Theme B: Problems in providing values

The participants had two main motivations: interest in the problems and subsidiary benefits (such as proof of extracurricular activities and economic profit). Participants interested in the problems expected the online platform to support their problem-solving activities; specifically, they wanted to share their projects through the platform and get stakeholders' feedback on their solutions. They also wanted the platform to help them acquire human and financial resources by matching them with new colleagues and sponsors. Additionally, they expected the platform to be a more effective tool for the tasks that, up to that point, had been conducted offline. However, the platform could not fulfil those needs because of several limitations. The platform's accessibility was low; therefore, the number of platform users hardly increased, and its impact as a communication media was poor. Participants, therefore, used popular social media services instead to advertise their projects or listen to stakeholders' feedback. They also preferred other familiar social media sites because they felt burden about learning how to use the new platform. Since most project activities were offline, they felt that posting on the platform was an additional task. Platform users noted some usability problems as well. The transition from 'problems and ideas' to 'projects and portfolios' and the process of applying for managers were complicated. Moreover, the text editor was inconvenient to use on mobile phones; thus, participants perceived the platform to be ineffective for its original purpose of raising project funds and participation.

Furthermore, the platform could not satisfy the participants' needs for subsidiary benefits because of operational constraints. From the user research, we found that university students have a strong desire for a certificate of voluntary activity as it is a graduation requirement. However, since we were running this platform as a start-up, we could not issue a certificate. In terms of economic profit, we could not monetarily reward participants since the start-up did not generate revenue. Without these motivating factors, it was difficult to ensure project participation. Some community members reported problems and inconveniences and criticised the project outcomes but hardly suggested any solutions. Recruiting volunteers for projects was even more difficult. For instance, when we held a workshop for the campus problem-solving project, some students shared their ideas and opinions; however, none of the volunteers wanted to participate and take charge of the project tasks.

Theme C: Similarities and differences between the natural model and practice

Implementing the open collaboration platform resulted in user behaviours that were similar to or different from the natural model of self-organisation. Despite the platform's limitations and the difficulties in inviting participants, they responded that the platform helped facilitate collaboration. In the plastic cup recycling project, for instance, the manager reported that after initially designing the cup collector, they revised the design based on feedback from other participants. Moreover, the platform-based activities triggered positive feedback for the self-organisation of community members by drawing their attention to social problems and encouraging their participation. At the beginning of the campus problem-solving project, we held a two-week event on social media to collect campus problem reports. Some student kept posting the problem reports even after the event. The projects' outcomes also involved positive feedback: by experiencing these outcomes, non-participating community members perceived the social problems and supported the projects. Even though some outcomes could not successfully solve the problems, they publicised them and invited potential collaborators. In the plastic cup recycling project, the cup collector could not solve the problem of poor segregation. Nonetheless, the project participants publicised this issue on social media by reporting that students tended to throw the cups without separating the lids, straws and liquid. Thus, students perceived this problem, and some even criticised others who did not correctly recycle their cups. Furthermore, a student club suggested that the project participants should conduct a campaign to encourage recycling together.

In some ways, the project practices displayed different behaviours from the self-organisation found in nature. The first reason was operational constraints. To complete the projects in a limited time, participants had to take a centralised decision-making approach instead of collective intelligence, which takes more time; moreover, the problems often required the contribution of experts or organisational authority. Accordingly, even though the solutions were derived through collective intelligence, they were implemented depending on a few people with expertise or decision-making power. Consequently, in contrast to the collaboration of unspecified individuals in the natural model, the projects were conducted in a top-down way by the specified participants. Specifically, most participants were managers' acquaintances, and managers tended to dictate the projects' direction rather than facilitate members' participation and collaboration. The plastic cup recycling project had to be completed in a month because of the time limit of the project fund. Hence, the manager omitted communication about the target problem with the stakeholders on campus and conducted the project with predetermined team members and solutions.

Theme D: Procedural aspects of the natural model

Being unfamiliar with the platform and the process of social problem-solving projects, participants claimed that they needed further assistance in using the platform and in conducting projects. Regarding platform usage, participants often misunderstood how to use it as well as their roles and authority while using it. For instance, the manager of a campus problem-solving project did not understand that they could post on the project page, even though we had notified them as soon as they had become managers.

In the Jangsaengpo project, participants did get used to the platform because we taught them how to use it and asked them to post their ideas while using it in the workshop. However, the workshop's scope ranged from problem definition to project planning; therefore, participants were still unfamiliar with the project menu. Furthermore, participants needed additional support for running the projects. They had difficulties in terms of problem-solving methodologies, such as understanding stakeholders, resolving conflicts among them, and facilitating their collaboration. In the plastic cup recycling project, the participants implemented the cup collector without exploring the diverse stakeholders involved in the problem. Consequently, they faced unexpected opposition from the cleaning staff because the cup collector was inconvenient to empty and clean. The Jangsaengpo project's participants also encountered a problem in their project outcomes due to the lack of a collaborative attitude. They designed and produced some local goods to activate a community economy; however, since the designers worked independently without discussion on the products' concepts, their outcomes lost any consistency as a product family.

The Jangsaengpo project's manager claimed that we needed to operate the platform and projects according to the platform's lifecycle: as there were few platform users in the initial phase, we needed to conduct the projects within groups or communities rather than targeting many unspecified people from the beginning. Since the platform was new to them, we needed to guide them on using the platform across the project lifecycle via platform-based workshops, covering the entire process. Then, the users would be able to understand the platform's functions and its effectiveness. After the platform had built a loyal user base and accumulated some successful project cases, we could have invited the participation of sponsor organisations and the public. As the platform's impact increased, the public would be able to report social problems, suggest ideas, and conduct projects in a self-organised manner. This strategy could be effective for resolving the current challenges – lack of users, platform unfamiliarity, and top-down operation of projects – in the platform and achieving open collaboration in the long run.

Discussion

The traits of infrastructuring and social biomimicry practice

In this study, we applied social insects' self-organisation mechanisms to designing an open collaboration platform. This is equivalent to infrastructure for social innovation. We found that the scope of our social biomimicry approach could not address the relational and evolutionary aspects of infrastructuring properly.

The first limitation in scope was to disregard the organisation's external environment, which refers to 'everything outside an organisation's boundaries that might affect it' (Griffin, 2016, pp. 67). It comprises the task environment, including aspects such as the regulators, customers, suppliers, competitors, and strategic partners, apart from the general environment, comprising technological, economic, politico-legal, sociocultural, and international dimensions (Griffin, 2016). Such aspects influenced the operation of UVENGERS and the projects; for example, for-profit organisations, including start-ups, are regulated, and they cannot apply for the authority to issue certificates for voluntary activities (Theme B). This factor in the political-legal environment influenced our strategy to encourage user participation. Furthermore, the project period was influenced by the project sponsor, equivalent to a supplier, that resulted in a top-down approach to rapidly complete the project (Theme C). Although these external organisational environmental factors are important for the platform's operation and the projects, they were not significantly addressed in the platform design framework. Consequently, insufficiently considering the external environment presents an obstacle to self-organisation and open collaboration.

Another issue was the failure to consider the procedural aspects of infrastructure development. We developed the platform design framework by gaining inspiration from social insects, which demonstrate innate habits or motivated behaviours such as pheromone emission or bee-dancing (Theme A). Thus, the framework modelled a platform mechanism in a mature state, whereby users were already motivated to post on the platform and press the 'like' buttons. The platform design's developmental process was not covered by the framework; however, in reality, platform value depends on the number of users since they are unwilling to use a platform without a critical mass (Salminen, 2014). Because the UVENGERS platform did not achieve critical mass, participants did not use it to communicate with members or promote their projects (Theme B). To achieve success, apart from having a critical mass, a platform must establish the correct strategy at every stage of the growth process (Kim and Yoo, 2019). Procedural aspects also needed to be addressed as one project manager observed the need to adjust the platform's operational strategies according to its lifecycle (Theme D).

Challenges in social biomimicry

The case study demonstrated that the scope of social biomimicry for infrastructure design is missing details regarding the organisation's external environment and developmental procedure. However, nature's ecological hierarchy and evolutionary processes imply that these gaps originate from the constraints of the social biomimicry approach instead of the natural ecosystem's characteristics.

Social biomimicry for infrastructure design attempts to establish conditions or environments where actors can build relations and collaborate. As each individual's behaviour, groups, organisations, and the environment are interrelated (Mullins, 2010), these dimensions must be considered to facilitate actor collaboration while designing infrastructure. As a human organisation has hierarchical dimensions, a biological organisation also involves several interconnected levels of scale: individual living organisms, populations, communities, ecosystems, and the biosphere (Van As, 2012). We can intervene, to some degree, in both biological and human organisations by, for example, farming or developing platforms. However, both organisational types include factors that are difficult to manipulate, such as the regional climate and cultural tendencies. Because of such uncontrollable environmental factors and the interactions amongst different organisational levels, we often fail to implement the intended interventions or cause an unintended effect.

Developmental processes are observable in both human and biological organisations; as human organisations undergo developmental processes (Greiner, 1998; Kim and Yoo, 2019), biological organisations also evolve. Evolution in nature operates at the genetic, organismal, and population levels, and it involves natural selection, which happens as a specific feature of entities and affects their survivability (Hall and Hallgrímsson, 2011). Particularly, living creatures' behaviours evolve through complex interactions amongst genetic information, physiological processes, and environmental factors (Papini, 2010). For instance, in the evolution of social behaviours, the social context and/or the environment affects organisms' behaviours and their genetic information. Conversely, genetic traits can also modify the social environment by making organisms prefer specific social conditions (Sokolowski and Levine, 2010). This theoretical knowledge of evolution demonstrates that social insects' self-organisation emerged from changes at the genetic, organismal, and population levels rather than merely from interactions among the features of individual entities and environments. As the biological organisation demonstrates, we infer that human self-organisation requires the developmental process to include changes and interactions amongst different organisational levels.

Although both human and biological organisations are hierarchical and go through an evolutionary process, social biomimicry has limitations on the scope of observation and application. For example, we can only observe the mature state of the self-organisation phenomena in a social insect population and apply this principle to platform design in a mature open organisation (Figure 5).

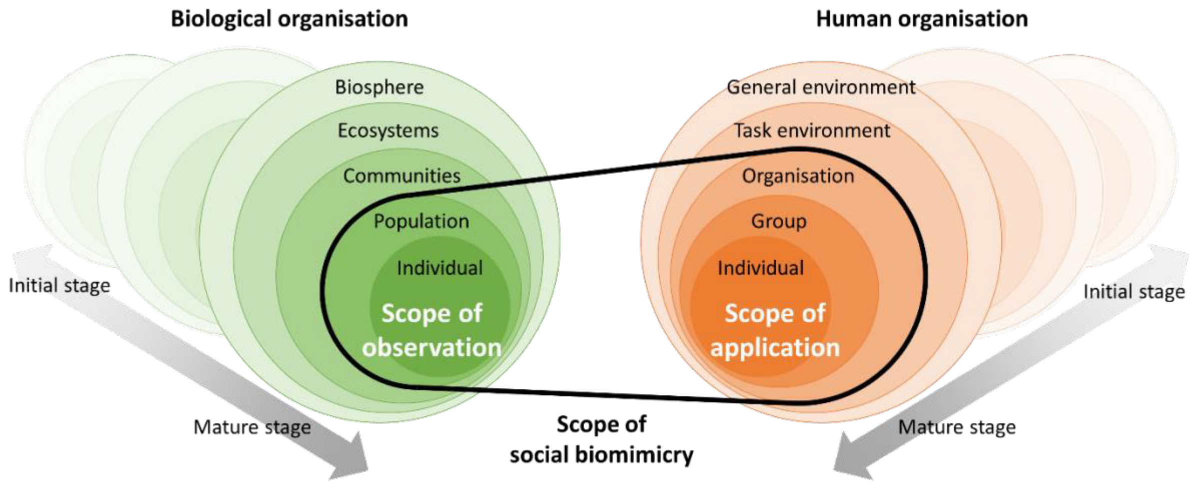

Figure 5. The Model Describing the Scope of Social Biomimicry

It is impossible to overcome the constraints in the social biomimicry approach completely as all factors cannot be considered in all hierarchical dimensions of both biological and human organisations. Furthermore, we have limited understanding of how social behaviours evolve in non-human animals. Under these constraints, we must examine whether social biomimicry approaches are still acceptable if the aim is not to closely imitate natural phenomena but only to gain inspiration from them. Buraczynski (2013) states that biomimicry for architecture does not perfectly reproduce natural phenomena, and due to ecosystem interactions, its effects can differ from the design intention. The issue is that biomimetic architecture is usually directly applied to the real-life environment without thorough testing; even if tests are conducted, long-term effects on human health, society, and the ecosystem may occur, that are yet to be identified. Regarding the long-term influences of design outcomes complex interactions with actors and external environments, social biomimicry adopts a similar position to biomimicry for architecture. This considers designers' 'responsibility to filter nature knowledge and adjust it' to the design space (Cohen and Reich, 2016, pp. 16) and the impact of design outcomes on human societies. Social biomimicry should adopt a more cautious approach instead of recommending natural phenomena as inspirational sources. We propose that social biomimicry methodologies support designers in being aware of the limitations in the scope of social biomimicry and guide them to overcome such limitations using their expertise related to design objects.

Conclusion

This study investigated social biomimicry practice in the context of infrastructuring using an RtD approach. The findings showed that the social biomimicry lens is limited in considering the external environment and the developmental procedure of organisations. In reality, it is not possible to consider all hierarchical and procedural factors. Nevertheless, the potential impact of its outcomes implies that limiting social biomimicry to gaining inspiration from nature cannot justify those limitations; accordingly, we suggest that these methodologies must support designers in addressing the limitations of the scope of social biomimicry itself.

As this study is based on a single case and an RtD approach, one must be cautious in generalising our results. However, this study is meaningful as a pioneering attempt to gain insight into social biomimicry traits through empirical research. We call for further studies on social biomimicry practice to improve our understanding of social biomimicry traits and accumulate empirical evidence regarding its efficiency. In addition, the empirical evidence should lead to further research on developing the methodology.

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Allopoietic design – Designing of the not-thing

Tore Gulden

In this article, I explore allopoietic systemic design as a perspective and process.

Allopoietic systems are understood as systems that produce something other than the systems themselves. Hence, an orientation of allopoietic design is then not on the making of the thing but on what the thing produces. The produced systems could be quarrels, engagement, teaming up, deceptive behaviour, cooperation, and, hence, activation in general and the history of these praxes. The emphasis of the allopoietic design perspective is thus on the elicitation of praxes (behaviour and thinking) and the subsequent feelings elicited.

The allopoietic view involves parting with the "meaninglessness of physical properties" (Krippendorff, 2007) and products and services, and instead studying them as *interfaces* (Krippendorff, 2007) and thus platforms for communication dynamics. By extension also proceeds the understanding of *the user* or *the users* (Krippendorff, 2007) that has inspired the development of misleading emphatic design methods inspired from algorithms, such as a *persona.*

Service design functioning is analysed in relation to play and game dynamics and progression (control) and emergence (autonomous) structure platforms, and I discuss how the notion of service design should be replaced with the notion of the *framing of progression and emergence interfaces*.

Keywords: systemic design, service design, game dynamics, play, allopoietic design, progression interfaces, emergence interfaces, and framing

Design in light of game and play theory and systems of play

Bateson described play not as "the name of an act or action; [rather] it is the name of a frame for action" (cited in: Nachmanovitch, 2009, p. 1). Hence, he emphasised the practice of seeking an understanding of the phenomenon of play as process, behaviour, and communication. That is, the term play itself does not give insight. Bateson's phrasing of *what play is not* exemplifies the method of cybernetic explanation, which implies looking to the other end of a phenomenon to understand the phenomenon itself (Bateson, 2000/1972). As an example, Bateson (2000/1972) studied *play* by exploring *not-play* and further examined these dimensions from the perspective of *playfight* and *fight*. By this study he found that these two ends of *playfight* and *fight,* produce almost identical behaviour, thus the difference in play and not-play lies in the communication.

Bateson's (2000/1972) notion of the frame describes an emerging factor or context for play to happen. Goffman, later building on this idea, described games as "framing" (1986) that serves as a boundary or membrane that allows or elicits "world building activities" (Goffman, 1961, p. 21) and uplifts these activities from daily life situations. Hence, a frame may be described as a specific context by the rules and/or by the physical and augmented environments that elicit play. For example, in basketball, a player must conform to the rules about not kicking the ball, the position of the basket, the bounce of the ball, which is limited by material characteristics and air pressure, and the organisation of the players, which limits passing opportunities. All restraints "make clues, i.e., and thus sources of information" (Bateson, 1972/2000, p. 400) or "a difference which makes a difference" (1972/2000, p. 318), "which will guide [the player´s] selection" (Bateson, 1972/2000, p. 400). Framing then serves to activate by *enabling constraints* (Bunnell, 2015).

The concept of framing and enabling constraints that a game consists of is equivalent to what the design of a service or product (*interfaces)* comprise. A service for example functions as a frame that will continuously inspire and demand specific behaviours by enabling constraints. A frame exists as a temporary shared environment for the participants (Linderoth, 2012); hence, when the play or other behaviour elicited by the frame ends, the frame ceases to exist. That is, designed frames, such as services and interfaces, only exist when they activate. The systems perspective explains how services and *interfaces* are not fixed or stable, but temporary. Matter then, is no longer the massive element of understanding of design. Rather the emphasis is on the elicitation of behaviour, or how matter serves as framing. In this research, design is therefore understood as framing. The sub-functioning's of a frame are defined as enabling constraints.

Praxis

Bateson (1972/2000) argued that there is much to learn from studying the details of recursive systems by examining the network of sequences or circuits of which they consist. Sequences or recursive "networks of closed circuits" of communications that are connected with cognition and behaviour are referred to by Bateson as *praxis* (1972/2000, p. 318). Bateson exemplified such praxis by describing the network of closed circuits in the action of cutting down a tree as follows: difference in tree, difference in retina, difference in brain, difference in muscles, difference in movement of axe, and difference in tree (1972/2000, p. 318). The continuance of these circuits is praxis, which influences the structure, and the structure influences the praxis. In playing a computer game, praxis may be exemplified as follows: difference in picture, difference in retina, difference in brain, difference in muscles/fingers, and difference in picture. In this example, the functioning of the system can partly be described through the players' drive to create a difference in the picture produced by game mechanics, which, combined with praxis, produces feelings. Praxis therefore consists of the systems of communication and their continuance or change due to the behaviour and cognition connected to or associated with the communication system.

Allopoietic processes and systemic design

The behaviour and activation generated by the frame and its enabling constraints are described as allopoietic functioning; that is, the design produces something more or other than itself (Ashby, 1956/1963).

The relations, behaviour, circuits of praxes, cognition, and feelings that are produced by the frame are understood as systems. Systems can be seen as communications or relations that happen between things that influence both behaviour and structures (Meadows, 1999; Meadows & Wright, 2015). Systems theory recognises contexts for design and interventions as exceedingly complex and emphasises that systems dynamics progress by or are dependent on structures.

Both complexity and systems are difficult to describe and understand because they have the "disturbing traits of a mess, of the inextricable, or disorder, of ambiguity of uncertainty" (Morin, 2008, p. 5). The difficulty in understanding these disturbing traits may have to do with the typical characteristics of systems: they are

Figure 1. The players, field, ball, goal, spectators, rules, materialization of rules as lines, referees, and weather comprise the structure in football.

Picture 1. Lofotmuseet

intangible, and they are always intertwined with the structure from which they emerge. To understand complex networks, systems theorists have suggested diverse approaches to studying systems, some of which will be described in this article. One such approach is the separate study of systems and structures to identify systems and their functions (See e.g., Luhmann & Gilgen, 2012; Maturana & Guiloff, 1980; Varela et al., 1974). The structure is then considered the context or frame that makes a functioning system possible, and everything that the system utilises is what defines the structure (Luhmann, 2012, p. 70). An example is play in football. Analysing football by Luhmann's description of systems and structures, the players, field, goal, and ball are parts of the active existing structure (Figure 1). Thus, everything in the field that the systems do not utilise (e.g., earthworms, billboards, and power poles) is not part of the structure. Because they do not provide information that influences the systems' functioning or behaviour, they do not exist in relation to the system's influence.

In game research, a game is often understood as a system in that it consists of elements that depend on each other to function (Salen & Zimmerman, 2004). In this research, however, a game and any other structure that elicits behaviour are understood as frames, and what it produces is understood as systems. The designed structure is the game, and, together with the rules, makes the enabling constraints. Accordingly, the play and communications, and thus relations (Bateson, 2010) within a team's praxes, are understood as systems (Figure 2a., orange, turquoise, and green area). The orange area (see Figure 2a) illustrates one team's social interaction systems. These systems consist of communications and relations and are based on the existence and history of communication, the organisation of the structure (placing of the ball, players, speed, etc.), and the existence and history of praxes (behaviour and thinking). The experience and recurrent communication systems based on the history of praxes may explain the playing style or culture. The opposing team produces a similar communication system with similar mechanics; however, its function differs (Figure 2a, turquoise area). When the two systems interact during a match, a new, common system is produced (Figure 2a, green area); the character and complexity of this system differ from the history of the praxes and play systems of each team and the several subsystems that emerge during the game. Communications, interactions, and praxes (i.e., behaviours, systems, and closed networks of circuits), which I call *systems of play,* emerge from the frame of the football game. All communications during play serve to produce information simultaneously in the common system. These interactions may involve moves, behaviour, interactions, observations, multiple layers of expectations, exchanges, expectations, double expectations (i.e., I expect that you expect of me) (Gulden, 2018, p. 109), and so forth, all of which produce information that makes a difference; that is, it becomes information because it is observed, considered, and acted upon.

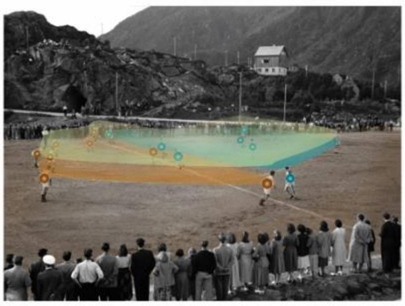

Figure 2a. All systems function simultaneously. Communications by passing, trickery, running, and reading facial expressions or body movements are all part of all the systems enabled by the constraints of the structure.

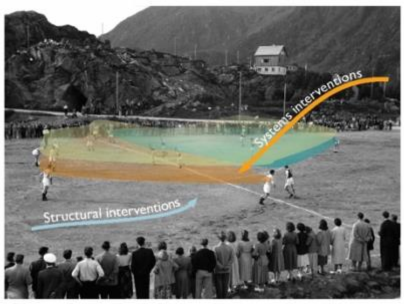

Figure 2b. Interventions on structural and systemic levels

The above analysis illustrates how a structure can function as a frame with enabling constraints that elicit systems. The division between structure and systems also shows the very different types of interventions possible in football (Figure 2b). The analysis also shows how one can approach a context or situation through structural and/or systemic interventions in design.

Allopoietic design

Structural and/or systemic interventions involve considering the allopoietic functioning of a game, service, or product, and thus the systems in which the elicited system of play is generated by the design and how they operate, create, or influence. For example, by analysing the game Monopoly to determine the allopoietic facet of the design process, the dimensions of designing the board, pieces, aesthetics, or framing are considered. However, the emphasis would be oriented towards the consideration of the creation of potentials for quarrels, deception, competition, teaming up, circularity of praxis, and autopoietic functioning—that is, systems that create their own systems (Maturana, 1991), feedback loops, self-strengthening feedback loops, and so forth. Each of these factors is elicited by framing and game dynamic functions that serve as enabling constraints, such as rules, alterations by chance, and special abilities.

Structural and systemic interventions are natural to perform from both systemic and game dynamics perspective. A problem in design, however, is that the history of praxes within the practice have emphasised on structural interventions. The systems based on communication, flow, behaviour, thinking, feelings, etc., are either not considered in the design process or handled as things. When these systems are handled as things in the design process, they are utilised with the trust that the term itself offers insight. As Bateson noted (1972/2000, p. 275), psychologists commonly speak as if the abstractions of relationships ("dependency," "hostility," "love," etc.) are real things that are to be described or "expressed" by messages. This is epistemology backwards: in truth, the messages constitute the relationship, and words like "dependency" are verbally coded descriptions of patterns immanent in the combination of exchanged messages. As has already been mentioned, there are no "things" in the mind-not even "dependency." (Bateson, 1972/2000, p. 275)

Summative and systemic analysis

A structural perspective in design can be exemplified by a summative evaluation of the 11 players on a football team and their different abilities; that is, the players are viewed as entities, and the sum of these entities is viewed as team characteristics (Figure 3a). The systemic analysis of the same players would underline the evaluation of how the players understand and act within the communication dynamics at play (Figure 3b) but would also include the individual qualities. Understanding players as *networks of praxes and dynamics*, and not things, represents a perspective that is well known by, for example, football coaches in their efforts to build a culture or team. Most coaches recognise that it is not the quality of the entities, or players, that makes a good team. Having the best players with reference to physical abilities does not ensure the players' quality as team contributors; however, additional understanding and communication abilities within the dynamics of a game do. That is, to understand, change, or design for quality in football, it is of some help to address the individual skills apart (structure) but more important to understand individual skills as part of play (structure and systems), and even more central to understanding the collective functioning and intervening in these dynamics elicited during play (systems).

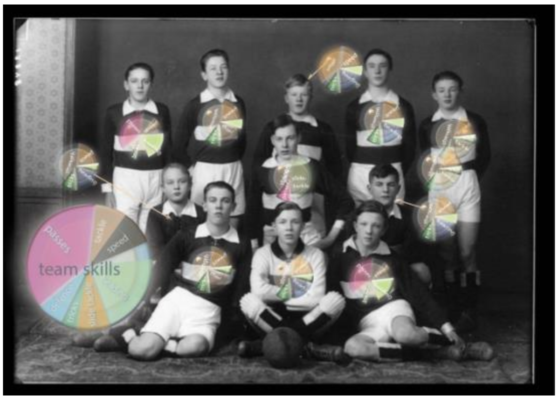

Figure 3a. Example of a positivistic understanding of team skills by evaluating the individual skills in a team. The sum of these are understood as the team skill.

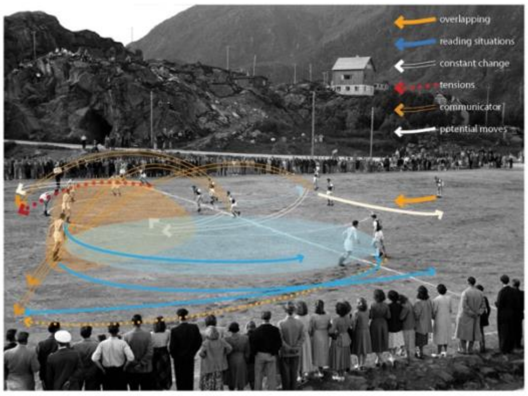

Figure 3b. The cybernetic understanding of team skills builds om two principles. First, one cannot understand dynamics apart from a functioning system, that is, the individual and collective skills are observable when the actual play happens. Secondly, it is the relations and praxes and dynamics between the players and the emergent allopoietic and autopoietic systems functioning that describes team qualities or skills, not the qualities of the entities alone.

Team performance is thus influenced by the dynamics and individual skills, and the dynamics describe how systems make "more than the sum of parts" (Bertalanffy et al., 2015, p. 57) by communication, which suggests that dynamics produces something that the entities alone cannot.

Personas

Personas is a method developed to understand users as part of a design process. The method represents the "paradigm of simplification" (Morin, 2008, p. 3) and can generally be described as a summative reductionist structure-oriented method of describing many people as one entity. Cooper (2012) stated that a "typical persona description should be a synthesis of the most important details observed during research, relevant to this persona" (Cooper et al., 2012, p. 102), and that "the goal is to find a single persona from the set whose needs and goals can be completely and happily satisfied by a single" (Cooper et al., 2012, p. 104) design. The descriptions of personas referred to as narratives in the literature are based on observation, interviews, and research and are used as origins for design processes and interventions. Hence, humans are translated into something that is part of a structure. From systems perspectives, knowledge in understanding behaviour and thinking and, for example, communication dynamics and double bind (paradoxical communication), praxis, feelings, flow, motivation, feedback loops, and engagement as insights for design demonstrate the shortcomings of the persona method in design. The process of writing a persona produces descriptions of often limited, existing, and non-existing social structures by categories, such as income, personality, age, and social standing, without attempting to understand the complexity they consist of and the context in which they exist. These analyses and targeting classifications created by the persona method made to design for specific needs and marketing segments function as fixed descriptions and insights. This is in contrast to the meaning of a persona described by Carl Jung (as cited in: Shelburne, 1988, p. 32) which is possibly the origin of the use of notion in design theory. Carl Jung used the notion of *persona* to describe the "relationship of the individual to society" (Horneland, 2021; Shelburne, 1988, p. 32). He further emphasised how "attempting to adapt to the demands of society we tend to identify ourselves with the consequent roles that we must play to fit smoothly into the social order" (Shelburne, 1988, p. 32). It is this group praxis that Jung called persona. The word persona means mask and describes the person that we pretend to be to adapt to specific systems or societal collective psyches (Cited in: Shelburne, 1988, p. 32). Jung's description is thus counter to Cooper's, as Jung discussed what people pretend to be, whereas Cooper highlighted what people are. In contrast to how design theory understands personas, Jung suggested that by describing a persona, one learns about the collective psyche and the collective unconscious in contrast to the individual psyche. He emphasised personas as a phenomenon, which in this article is understood as systems—the relations and dynamics in the now—rather than considering personas as stable social constructions. Understanding personas as Jung did could potentially produce interesting insight for designers in that it would contain processes of understanding and designing for how people pretend to be, and of the collective psyche, they desire to be part of, and hence descriptions of, the dynamics that elicit such pretending. However, the method aims at describing existent phenomena without methods to do so and conveys the hazard of establishing stable social predigest and xenophobic understandings, for which Jung has also been criticized (Shelburne, 1988). Similarly, personas in design methodology are created with the confidence that terms or words (the personas)—or what Bateson calls abstractions, such as *young* or *active*—are fixed constructions and that they also contain and convey embedded insights about the phenomenon itself and about being in the now within such categories, as if the words exist as real things. The data derived from the persona analysis are often understood as systems, although they are not, because of the lack of attempts or methods to understand dynamics such as relations and communication, and changes in dynamics do not yield learning about systems. Interesting insights are produced from the comparison of the persona approach to Krippendorf's reformulation of THE user as *stakeholder networks,* which is further developed in this research and described as *networks of praxes and dynamics*. The function of *networks of praxes and dynamics* suggests seeking understanding about the systems, their influence, communication dynamics, relations, etc. as descriptions of thinking, acting, and functioning in and with contexts. Accordingly, the designers seek to describe humans as entities with *personas* (such as the summative description of eleven individual skills on a football team as a team quality), while seeking to understand and describe *networks of praxes and dynamics* leads to the documentation of the dynamics that constitute human praxes, thinking, communications, and reactions (like descriptions of interaction systems of play in football).

The perspective of THE product and personas thus represents an epistemology that can be described as a mechanistic or first-order cybernetic because the focus is on understanding dynamics as structures and systems as closed systems, such as a thermostat and an oven that act on one constant, which is room temperature. This is opposed to open systems or second-order cybernetics, such as systems of play in football, which involve systems that sustain and create systems, and short-lived complex systems that change and observe other systems of play, all of which alter the organisation of the structure, consequently influencing the systems. A mechanistic understanding of the game*play* of Monopoly can be exemplified by a player who arrives at a position on the board; a certain amount has to be paid, and whether it is paid or not paid, as if nothing happens, no interaction systems are elicited. The mechanistic system, such as a persona, can thus be described without what it produces.

Hence, it is essential, when describing open complex systems, often short lived, to examine the dynamics, such as communication and engagement (McWhinney, 2005, p. 24), and the frame that elicits them. For example, describing a football team as an individual skill does not inform us about what they can do in collective praxes, and to understand praxes, it is not sufficient to describe them without the context in which they emerge. Identical movements of waiving of an arm, for example, can mean hello or help, depending on the context. Hence, to understand behaviour, it is beneficial to examine the frame and dynamics.

Describing the frame and the elicited dynamics will thus produce insights into how the dynamics function and why they emerge. For example, regardless of background or education (e.g., a classified group), a person exposed to paradoxical communication or double bind situations (Bateson, 1972/2000), such as in physical education when the teacher divides the class into teams (e.g., the classmates welcome you with words but communicate disappointment in other types of messages), will experience the situation hurtful. Approaching this situation with traditional classification methods for design, such as personas, one would establish groups of the prioritized as one persona and non-favoured children as another and subsequently design for each group or their combination. From a systems perspective and allopoietic design perspective, however, the logical action would be to seek understanding about the dynamics and alter the system that creates such groups. Accordingly, by understanding and aiming at changing the functioning and dynamics of systems and structures and their organisation, the designer is freed from creating and targeting unnecessary, superficial, or non-existent groups in society. Instead, it is of interest to leverage or intervene in the functioning of systems and praxes (Meadows, 1999).

Hence, even though the functionality of dividing structures and systems is presented to understand systems and their intertwined functioning with structures as a praxis in design processes, one cannot understand systems without recognising their intertwined functioning and dependence on structures or frames. That is, one cannot intervene in either of the two and harvest the expected results because they coexist. The problem of exploring the dynamics of such coexistence is analogous to Bateson's problem of dividing nature and mind. He stated that his study of the Atmel people in New Guinea was "an attempt at synthesis, a study of the ways in which data can be fitted together, and the fitting together of data is what I mean by 'explanation'" (Bateson, 1958/1936, p. 281).

Personas and systems goals

Cooper et al. suggested (2012, p. 104) that when working with personas, one should seek to describe the goals of the persona. Systems theory suggests looking into different phenomena, such as feedback loops, flow, and information, to understand a systems goal. This implies that a system goal is different from the sum of individual goals. When designing to, for example, change systems or comply to systems and phenomena, it is useful to understand the goals of the systems. However, this is not an easy task. The technique of negative explanation from cybernetics and Bateson may be useful to detect and describe systems goals. This would involve describing the malfunction of the system studied to define its goal. For example, in a football series, the individual goal of children might be to get friends, become famous, or feel the team spirit and happiness by mastery. However, a malfunction in the children's football series might be that the system damages the very structure on which it depends to exist when children are injured during play, so that the scheme cannot continue. The negative explanation then exemplifies how the system goal could be phrased as *assisting* or *recovering*—that is, being able to have enough players and teams meeting up so that the series can continue. The point is that the examination of the system goal suggests very different functioning than the sum of individual. Therefore, considering systems goals contributes to a deeper understanding of the frame examined, the design process, and how the design will perform.

Services

Service designers devote quite some effort to understanding people's needs and goals and apply user-oriented methodology, such as co-design, to understanding contexts in which a sum of individual goals, functioning, or personas are intended to function. Service design is therefore typically described as what is between a provider and user and the interaction (Penin, 2018), act, activity, a continuous result or state[1], such as in product service systems (PSS) (Morelli, 2006), an experience, or offerings (Clatworthy et al., 2014), or a perspective on business with different offerings than goods (Yu & Sangiorgi, 2018). However, the user is considered a sum of entities by persona descriptions. Hence, there is potential in service design to understand users as *networks of praxes and dynamics*, not as entities and the sum of entities. In practice and research, service design is often considered a product itself; however, the effects of design are also emphasised (see, for example, Designing the invisible: Penin, 2018). Although the research on service design describes the designs as interaction and the process as the design of the invisible (Penin, 2018), there is potential to emphasise that service designs function as framing and hence elicit praxes (behaviour and thinking).

Often, service design is understood as an interface that ensures that people do what is intended, such as a purchase or recordkeeping. The possible praxes in most services are limited and often controlled. Challenging this perspective of the service design process may contribute to the awareness of other potentials for praxis and ethics. I explored this potential by analysing the design processes and the interaction, behaviour, and thinking that services elicit in relation to play and game dynamics and the progression and emergence structure platforms offered by Juul (2011).

In progression structure games, the player is allowed to be creative and can do a lot of things; however, he/she does not perform any task that the designer has already thought of. For example, Super Mario is a progression structure game, whereas a banking service is a progression structure service. Games that allow the player to engage in ways that the designer did not think of or intend (e.g., trickery or associated games created based on basketball) are known as emergence structure games (Juul, 2011). These games allow or motivate by enabling constraints, which imply partial control and non-control, and thus creativity and the altering of structures, game, and play. In emergence structure platforms, structure elicits the emergence of many systems that, if recognised, may produce unique and unexpected contexts and situations that provide new understandings that will be acted upon. Hence, the behaviour and thinking of the player, a person, or play are somewhat free and may instigate actions outside the frame that produced the behaviour and consequently alter the frame itself. One example of such a change of frame because of emergent play is *futsal* (Berdejo-del-Fresno & Medicine, 2014) which occurred

[1] An example of such a product service system could be that one can purchase a length of grass always being within a certain range on a football. Hence all stadiums do not need all lawing equipment since a service provides this for many football fields (Penin, L. (2018). *An Introduction to Service Design: Designing the Invisible*. Bloomsbury Publishing. https://books.google.no/books?id=pqFiDwAAQBAJ ibid).

due to a lack of areas for full-size fields in Brazil and Uruguay. Hence, emergence structure platforms produce change not only for the systems elicited but also for the frame, game, or service itself.

The progression structure platform represents a philosophy of controlling the player, design, research process, or activated people or animals. The understanding and steps of action within the service originate from the previous moves and what is experienced by these moves. Progression structure is a leading concept within service design epistemology. The progression structure method implies a description of how different users will interact within the service, a situation similar to how the method of personas is described to seek understanding (see, for example, Nielsen, 2019, p. 83).

Accordingly, I suggest that the notion of service, in service design, should be substituted with the notion of *progression and emergence interfaces*. This allows for different discussions and understandings of what a service can be or how it may function. Similarly, the design of interfaces in general can be seen as a *progression and emergence framing processes*. In progression design processes, one must stick to the recipe and not change the process, while in emergence design processes, the alteration of the process itself may be one of the outcomes of the activity.

Creation of the not-thing

This study originates in systems thinking and the method of the negative explanation of design. I have introduced a way to identify systems and structures isolated and integrated and, by extension, provided a model to describe separate and intertwined systems and structures. This can provide dynamic descriptions that make analyses by negative explanation possible.

I have examined design as the making of the not-things, and the living as not-things. The designing of the not-things concerns the creation of allopoietic functioning and design understood as *framing*, which produces something other than itself that serves for systems, behaviours, praxis, thinking, feelings, etc. to emerge by *enabling constraints*. Understanding the living as not-things involves recognising that the living, and especially humans, act, and react on the basis of that they exemplify, and orient themselves within *networks of praxes and dynamics*.

Hence, within this perspective, describing and classifying people by personas of fixed things, such as young, educated, manager, or interested in coffee, as if the words represent dynamics, does not provide insight. Therefore, I suggest not using the method of personas.

A negative explanation is further suggested as a perspective to understand what a system goal is that can be performed by describing the malfunctioning of a system functioning. The other end of the contrasting understandings of these descriptions may offer insights into how one can describe a system goal. The analysis thus recommends not describing systems goals as the sum of individual goals as described in a persona. Instead, the method of understanding systems and praxis, and by extension the elicitation of praxes in combination with understanding users as *networks of praxes and dynamics,* is suggested.

Accordingly, the exploration of design as not-things and people as *networks of praxes and dynamics* yield insights for the design and research processes in it involves examining games, services, and products as not the action of creating a thing as an isolated entity or closed mechanistic system. This will yield insights into the design and research processes that lead to understanding and creating the *not-thing*, the now, and praxes, as well as the experiences and feelings elicited by praxes.

Service design is then examined in relation to progression and emergence structure platforms and play and games theory. The analysis suggests that the history of praxis within service design practice is to handle a service as a fixed thing and not a frame that elicits behaviour and thinking. Further, a malfunctioning service lacks control behaviour; thus, the system goal of services is to control. The perspective of play and game theory used to analyse this understanding suggests that a malfunctioning of services may also be the lack of the quality of people who, by the activation of the service, are able to influence and create, for example, new situations, experiences, and challenges because of the service. Hence, emergence is recommended as a quality. Therefore, I suggest that the notion of service design should be replaced with the notion of framing *progression and emergence interfaces*.

When humans encounter a design, the networks of praxes and dynamics are influenced. Hence, the design serves as an interface and thus platform and utiliser for communication in that it creates, alters, strengthens, or weakens systems, thinking and behaviours. Understanding design as an *interface* and users as *networks of praxes and dynamics* implies a new way of learning as a dimension and phase in design. These involve identifying and understanding people's praxes. Understanding praxes involves learning about circuits of action and thinking, which determines the next circuits of action, thinking, and networks of praxes; together, these comprise the system dynamics in the meeting with other systems.

Allopoietic design, then, is the framing on the basis of understanding players and users as networks of dynamics and praxes, a perspective that will yield insights into the design and research processes and understanding and creating the *not-thing* and hence the praxes and the now. The design processes then involve the consideration of the other end of things (play and not play, for example), and thus the dynamics of variable situations that can be elicited by the particular *interfaces* (context, service, game, or thing). Allopoietic design therefore contributes to the understanding of social interaction systems, relations, and experiences as facets of design, and it introduces thinking about systems, dynamics, motivation, and engagement as dimensions of design.

These findings from this study illustrate how the combination of systems, games, play theory, and design practice skills serves as a platform for research and learning. The combination of theory offers a perspective that may generate insights about possible thoughts and behaviours that designs elicit and how thoughts and behaviours influence action, the designs, and design processes themselves.

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Track 13:

Conceptual Analyses Of Systemic Design As A Field

Chair: Dr. Deger Ozkaramanli

Field Notes: Tensions Between Systemic Design and Systems Engineering

Evan Barba

As an emerging interdiscipline, systemic design remains in tension with existing disciplines that share its theories and methods. Articulating these tensions is an important step in differentiating systemic design from what has come before. Systems engineering is one such established discipline; one whose unit of analysis (the system) and purpose (designing) are similar to those of systemic design. Yet, these disciplines differ considerably in their work practices, goals, and domains. By analyzing both differences and similarities, this work aims to generate a better relational understanding between the two. Initially, I discuss some epistemological points of distinction that demonstrate how the two disciplines emphasize different aspects of systems and design to define very different types of problems and solutions. Then I will contrast how differing methods employed by these disciplines arise out of their different philosophical positions. Finally, I suggest some ways that methods from systems engineering might be adapted for use in systemic design with specific benefits for stakeholder engagement and modeling that can help advance the adoption of systemic design approaches in areas that are traditionally the purview of systems engineering and vice versa.

Keywords: Systems Engineering; methods; methodology; epistemology

Introduction

The introduction to ***Systemic Design: Theory Methods and Practice*** (Jones & Kijima, 2018) lays out the tensions between Systemic Design (SD) and Systems Engineering (SE) in the most basic terms:

> This book presents emerging work in the co-evolving fields of design-led systemics, referred to as systemic design to distinguish it from the engineering and hard science epistemologies of system design or systems engineering… Systemic design is distinguished by its scale, social complexity and integration – it is concerned with higher-order systems that that entail multiple subsystems. By integrating systems thinking and its methods, systemic design brings human-centred design to complex, multi-stakeholder service systems. (p.2)

Indeed, there is a clear distinction in terms of core philosophy and practices between the two fields, and this quote implies that systemic design is in many ways defined by its opposition to systems engineering and other hard science approaches. However, this break with the hard sciences, while clear and definite, need not be all-encompassing. As SD evolves, is it not possible for the field to actually draw on its tensions with SE as a source of productive advancement? If this is possible, we need to start by exploring the tension in more detail and articulating where the two fields share common ground, where there will never be agreement, and, most importantly, where some negotiation and better dialogue may help both fields advance and evolve in new ways. This work is intended to be a step toward these goals.

"We've Had Our Differences"

Different Kinds of Problems

As a branch of engineering, systems engineering is concerned primarily with the optimization of systems over their life-cycles to create reliable, predictable, and cost-effective outcomes (Hirshorn, et al., 2017). Core to this mission are basic methods such as requirements gathering, project management, and measurement of variables and results. SE emphasizes decomposition of systems into their constituent parts as an analytical starting point and integration of those parts to create sub-systems and a working whole (Haskins, et al., 2006). While SE employs a variety of quantitative and qualitative methods at various stages of the design process, quantitative metrics are heavily favoured. However, qualitative interviews frequently appear at various stages and qualitative judgments are often made when choosing various options. Nonetheless, SE relies heavily on assigning numerical values to options and outcomes and employing computational tools to manipulate these values.

Systemic design (SD) has a much shorter history than SE, and, while embracing many of the same systems and design theories, nonetheless presents many epistemological and practical differences. While SE approaches do appear in areas like urban planning, disaster response, and organizational management, SE was born out of, and is most suited to, the design of systems for the production of products where tight constraints, clearly specified emergent goals, and well-controlled processes are assumed. By contrast, SD uses design-led approaches that embrace the murkiness of systems without clear endpoints or boundaries, are typically larger and more interconnected than single-product systems, and are dominated by social relations rather than technical ones (although both SE and SD can be understood to operate on sociotechnical systems).

SE's roots as an engineering discipline direct its focus toward clearly defined problems. When the messy world prevents clear scope and boundaries, SE aims to clarify or draw them as its first activity. SE's tendency to be adopted in large scale engineering endeavours in aerospace, automotive, and other product manufacturing domains means the problems it choices are particularly suited to the outcomes it provides; essentially, engineered solutions to engineering problems. Complexity is embraced in SE only in its most linear form. True, the boggling number of components, sub-systems, and interfaces required to produce a modern airliner defines it as a complex system; however, the goal is simply to remove uncertainty from the process and replace it with efficiency. Non-linear interactions, which are responsible for emergent behaviours of complex natural and social systems, and make them both diverse and difficult to manage, are anathema to SE concerns. Any non-linear behaviour is a danger to the SE enterprise and its goal is to remove these entirely, or to at least minimize their impacts on the overall system by isolating them. For example, the lithium battery fires that delayed the release of the Boeing 787 Dreamliner (Ash, 2020) were an unpredicted and unwanted emergent result of its design. The solution was to control and contain the fires by retrofitting a steel battery box and venting the hot gases to the exterior of the plane. By contrast, SD tends to embrace non-linear behaviours in the systems it studies, accepting that they are necessary to the overall health and purpose of the system, and trying to leverage these dynamics in ways that allow the system to evolve through its own mechanisms rather than removing them from the system to allow for better control.

Different Roles for Humans

A second point of tension between SE and SD involves the relationship between humans and the system. SD has grown out of a human-centred design philosophy that was itself a response to the over-engineering of human interaction with products, digital technologies most notably. Here too, the same attitudes toward emergence are a dividing line. Engineering based approaches to human-machine interaction, such as human factors, engineering psychology, and usability, all treat human beings as components of the system — operators with required task outcomes to be optimized for efficiency. The human-centred design approaches that underpin SD, break from this tradition to provide for unplanned and unpredictable human-machine interactions on the one hand, and to allow end-user needs and desires to drive the design of the system rather than technical concerns. SD attempts to extend this paradigm shift to the systems level by prioritizing human needs and desired outcomes over system efficiencies and to offer humans more agency in the dynamics of the system itself. However, like SD, SE also places a premium on **stakeholder engagement**, and it is likely that its narrow perspective on the role of humans is a result of the problem domain rather than any philosophical stance on the value of human participation. Therefore, assumptions and practices around stakeholder engagement are likely to be the first place where we should try to reconcile the differences between the two fields.

Both SE and SD are interdisciplinary, they rely on and integrate knowledge and practices from many different perspectives and traditions. This is necessitated by their shared history in systems theory. Both (inter)disciplines have shared understandings of part/whole relations, multi-scale emergence and subsystems, and other fundamental assumptions from systems theory. Many clear differences exist in terms of the way both disciplines adopt design methods that are typical of engineering-led vs. design-led approaches. However, both disciplines also make heavy use of **models and modelling** in their practices, and therefore must share some core methodological beliefs about the value of models in practice. This is likely a second area where the two fields can learn from each other. In some sense, models serve the same purpose in both fields as they do more generally, they create simplified representations of some noteworthy aspects of a system in question. Models also provide an important touchstone in terms of stakeholder engagement, creating shared representations of systems that stakeholders can use in co-design, communication, and documentation. This also suggests that the two disciplines share some core beliefs about the role and value of the cognitive processes that underpin modelling methods and it may be important to unearth these in the quest for common ground.

While SE's close proximity to hard science favours different kinds of models and modelling practice than those that appear in SD, even here there is considerable overlap. For one, the models employed by SE rely quite readily on the same basic human capacities of visualization that models used in SD, like system-mapping (gigamaps, synthesis maps, etc.), do. SE does tend to attach clear numerical values to these models, but these are often far more subjective and qualitative than they appear at first blush. Examples of this can be seen in Design Structure Matrices (Browning & Eppinger, 2012) and Tradespace Exploration (Ross & Hastings, 2005), where numerical weightings can be vastly different based on their sensitivity to upstream qualitative judgments of participants. On the other side, SD has begun to employ more quantitative and computational models (Murphy & Jones, 2020), further closing the gap between these two seemingly different approaches. Modelling techniques that bridge these divides hold great promise for expanding the repertoires of both fields.

Resolving Our Differences

In this short paper I've tried to briefly outline the core philosophical similarities and differences between systemic design and systems engineering in an effort to explore the tension between these two interdisciplinary fields. I've identified systems theory as common ground between the two and located clear differences in the way the two fields approach design. I have also argued that both fields place a high value on stakeholder engagement and the use of models to create representations of the system being designed, and suggested that this intersection is rife for further exploration that may allow the two fields to overlap more usefully in practice. Borrowing some of the tools used in SE to better expand the toolbox of SD approaches may help that field find more application and support in domains commonly associated with SE, while integrating more human-centred approaches from SD in SE frameworks may better humanize that field and let it expand beyond the narrowly focused engineering problems it most often considers.

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To Slow Down or Speed Up? Uncovering the Pace Tensions in Systemic Design for Social Innovation

Suhaib Aslam

Designerly approaches have long been appropriated for systems thinking and design. This appropriation brings with it tensions regarding the pace at which design is conducted. It is crucial to unveil and reflect on these tensions, particularly within a social innovation context. This is due to social innovation's unique complexities regarding stakeholder networks, sociopolitical influences and change management. This position paper discusses how these tensions become apparent at the two ends of the pace spectrum of doing systemic design. It examines the translation of these pace tensions to tradeoffs; both at the principles level (e.g. stakeholder engagement, project scoping and long-term commitment) and at the practices level (e.g. network building, prototyping's role and room for reframing). By doing so, this paper takes an initial, exploratory step towards explicating tensions regarding the pace of conducting systemic design for social innovation. It aims to spark critical discourse around such implicit and explicit pace tensions, with the intention to enable better resolution of these tensions in practice.

Keywords: social innovation; systemic design; rapid design; slow design; pace tensions

Adapting design for systemic social innovation

Social innovation and systemic design

Social innovation involves the design and implementation of novel solutions to social problems in a way that the value generated is meant to benefit society as a whole, rather than private businesses or individuals (Bijl-Brouwer & Malcolm, 2020). Compared to other innovation paradigms, social innovation presents unique challenges. It requires an atypically extensive degree of involvement of public policy and a deep dependence on co-production by the various parties involved (Mulgan, 2006). It requires a heavy focus on approaches to enhance cooperation and communication of the involved multidisciplinary stakeholders, due to their highly complex networks with diverse viewpoints and backgrounds (Yang & Sung, 2016). Social innovation also often involves services comprising complex sociopolitical contexts with a need for focusing on effective change management (Mulgan, 2006).

Due to its unique nature, social innovation naturally requires an expansion of focus from traditional product design to designing complex service systems as a whole (Bijl-Brouwer & Malcolm, 2020). This nature fits with the intentions behind systems thinking and design. Systemic design is intended for such complex, ambiguous situations with value conflicts between extensive stakeholder networks (Ryan, 2014). It can help design long-term processes that enable incremental transformations of existing systems, and can help construct wider contexts that these systems can be a part of (Bijl-Brouwer & Malcolm, 2020; Ryan, 2014). This paper is embedded in this paradigm of systemic design for social innovation.

The need to adapt design

In practice, designerly approaches are not always able to drive social innovation due to certain tensions between them and what is required by social innovation. For instance, conventional design approaches cannot effectively deal with complex sociopolitical contexts and the associated change management (Mulgan, 2006). They might also not be suitable for driving implementation processes by enabling long-term commitment from stakeholders and might have superficiality pertaining to timeboxed projects (Mulgan, 2009).

As such, to make design thinking work for this paradigm, there needs to be a more nuanced and mindful appropriation of design to systemic social innovation: “if we want to solve big social problems, we need more than design thinking. Big social problems have many causes; involve real tradeoffs; and require solutions that can work with multiple user groups across multiple levels…” (Schulman, 2010). A similar sentiment is shared by Dorst (2015) and by Bijl-Brouwer and Malcolm (2020), who emphasize the need to not just adopt traditional designerly approaches to systemic design (for social innovation) but to *consciously adapt* them to this field.

Tensions concerning the pace of design

Adaption of design requires management of various tensions within designerly approaches, and between these approaches and systemic social innovation. This paper focuses on critically explicating and creating discourse around one specific tension: the pace of conducting design. Design has become increasingly democratized through tools and methods. Many design thinking models and their associated tools (e.g. design sprints) are known for their iterative nature and especially their rapidness. A fast-track towards innovation and a rapid way to solve problems are marketed as typical characteristics of these processes.

Whilst this rapidness has proven significantly efficient and effective in certain contexts (e.g. UX design), there is a growing movement towards slower design in other contexts. Exploring and unpacking such tension between rapid design approaches and the emerging slower ones becomes especially relevant in the context of systemic social innovation, where Ryan (2014) shows that complex sociopolitical landscapes co-exist with pushes or needs for rapid systemic transitions. As a first step towards this exploration, this paper will consider two non-mutually exclusive paces for conducting (systemic) design and will try uncovering the tension between them and systemic social innovation.

Two perspectives on the pace of conducting systemic design

Doing design rapidly

Fast-paced designerly approaches are rooted in goals and evaluation criteria of economic success (Fuad-Luke, 2002) or of high productivity and return on participation (Jones, 2018). This pace emerges, amongst other reasons, due to a strong emphasis on material products and deliverables, due to a culture of timeboxed business agreements and due to a sense of time dictated by technological innovation cycles (Fuad-Luke, 2002). In the context of systemic social innovation, Ryan’s (2014) systemic design process also focuses on a high pace to create rapid transitions between creative ideas and tangible actions.

Regarding practices that exemplify such rapid design processes, the movement of design sprints stands out. It focuses on creating propensity for rapid action by condensing the traditional design process into a five-day format of: Understand, diverge, converge, prototype and test (Banfield, Lombardo, & Wax, 2015). In practice, this rapidness can reach the extent to which the design sprints merely involve available organizational participants and typically go ahead without user research or field studies (Jones, 2018). Despite its product-oriented roots, the sprint method has been applied to systemic social innovation as well. For instance, Valentine et al.’s (2017) work includes a case study that used design sprints to facilitate co-creation of pedagogy regarding social innovation in healthcare by bringing diverse stakeholders together.

On a more traditional side, Brown and Wyatt’s (2010) work is one of the primary examples of adapting conventional design thinking to social innovation. Their design process consists of inspiration, ideation, and implementation stages. Their process also emphasizes speed. They talk about how design thinking for social innovation enables companies to “bring their products and services to market faster”. Their process strongly emphasizes continuous iterations with the primary aim of arriving more rapidly at successful solutions. For them prototyping is meant to be a rapid process geared towards turning ideas into tangible products or services to test and refine them.

Doing design slowly

Unlike the productivity and deliverables focused aims of rapid design, slow design tries to reframe the role of time, scoping, prototyping and social relationships. Hillgren et al.’s (2011) work provides a starting point for this discussion. They provide two concrete strategies to make systemic design gentler for social innovation:

“Prototyping to reveal opportunities and dilemmas” and “Design as long-term infrastructuring”. The first strategy emphasizes that prototyping should go beyond a mechanism to test potential solutions through rapid iterations, to a mechanism for creating a space to enable various stakeholders to engage with opportunities or dilemmas that can have a long-term effect on social innovation. Such bottom-up collaboration can enable stakeholders to become co-producers and co-designers of social interventions (Chon, 2020).

The second strategy, long-term “infrastructuring”, unveils a unique perspective on design’s pace and scope. Within systemic social innovation, there is a need to move beyond the conventional “project-based” approach where: the pace is fast; the project’s timespan is well-defined; and the design brief defines the scope (Hillgren et al., 2011). Hillgren et al. (2011), therefore, define “infrastructuring” as a process that focuses on long-term commitment towards a social innovation; whilst providing an open-ended structure for a design process that does not have predetermined goals or a fixed timeline. It involves continuously building relations with a diversity of actors, whilst maintaining flexible time and resource assignments (Hillgren et al., 2011). Such an approach can enable emergence of possibilities and design opportunities along the way through a long-term, continuous process of designing networks and of matchmaking (Björgvinsson, Ehn & Hillgren, 2010).

Bijl-Brouwer and Malcom’s (2020) “evolutionary design approach” to systemic social innovation is linked to Hillgren et al.’s (2011) approach and is also representative of gentler design. It is about taking small, experimental steps to nudge a system towards a desired direction by looking for traction over time (Bijl-Brouwer & Malcolm, 2020). This is done by giving prototyping a role that goes from merely testing ideas to also reframing problems; enabling coevolution of problem and solution spaces (Bijl-Brouwer & Malcolm, 2020). Like infrastructuring, this approach focuses on continuous innovation that goes beyond individual project scopes and towards continuous (re)alignments between current systemic design activities and a future vision (Bijl-Brouwer & Malcolm, 2020).

These evolutionary approaches align with Fuad-Luke’s (2002) slow design paradigm. Slow design explicitly removes time constraints imposed by economic growth, product lifecycles and technological acceleration (Fuad-Luke, 2002). It focuses on leveraging ‘slowness’ to balance human-centered, individual and cultural needs with the planet’s needs–all with the aim of creating a sustainable present and future (Fuad-Luke, 2002). Slow design explicitly de-commodifies time and its reflective practices align with Ryan’s (2014) perspective on reflection within systemic design. Ryan (2014) labels reflection as “the touchstone for all other activities within systemic design”, and the “most critical activity” to enable reframing and learning from generative actions in the field.

Bringing the two design paces together

The pace tensions in design principles and practices

Now that both fast and slow paces for conducting systemic design have been discussed, certain tensions become apparent–at the level of both their principles and their practices. Starting with principles, the faster pace aims for high productivity and return on participation to keep up with timeboxed projects and innovation cycles. The slower paces are more organic and ‘evolutionary’ in their aims, where they de-commodify time, explicitly think beyond project boundaries and flexibly manage open-ended design process structures that primarily focus on long-term commitment (and not on predetermined goals or timelines).

At the level of practices, the faster pace has a greater focus on output and the slower pace has a greater focus on building social relationships. Whilst rapidity-focused practices like sprints involve participation, the focus is on delivering output fast. In contrast, gentler practices are more focused on long-term infrastructuring by building and strengthening a diverse stakeholder network whilst continuously aligning the network’s efforts with the desired future system. There is also a clear difference between the two paces regarding prototyping’s role. The fast pace considers prototyping as a rapid, solution-validation mechanism for turning ideas tangible to be tested; whereas, the slow pace considers prototyping as a reframing mechanism to create a space to allow stakeholders to uncover dilemmas regarding long-term effects of a systemic intervention on a social innovation problem.

Resolving these tensions

The aim of unveiling these pace tensions is not to get bogged down by semantics but to pave way for flexibly managing them. It is not about choosing one pace over the other, but to have a critical and explicit look at pace and what it means in the context of social innovation and systemic design. For in this domain, such pace-related tradeoffs percolate to crucial tradeoffs regarding e.g. having enough scope for challenge reframing, building diverse stakeholder networks, preventing the push for accomplishments from enabling groupthink and constructing strong, long-term systemic interventions (Jones, 2018). It is, therefore, important to critically assess reliance on methods—and their associated paces and timelines—as they can undermine systemic design by reducing it to highly constrained procedures that do not enable true innovation (Ryan, 2014).

This paper set out to uncover the tensions and tradeoffs concerning paces of conducting systemic design. The viewpoints presented indicate that this pace can be fast or slow. They show that systemic design can happen at varying paces which mean varying: project constructions, project scopes, stakeholder involvement, ways of working etc.–all dictated by and situated in varying paces, as is the case in Jones' (2018) design model. This makes it important to manage or even acknowledge pace tensions, as each pace can have its own situations and impact requirements where it is most appropriate.

Regarding these tensions, this paper is a preliminary, exploratory step. There are several questions that are yet to be (empirically) answered: How and when are switches made between various paces, if at all? What tooling could be created to enable a flexible management of pace tensions? Can a mapping be created between systemic design paces and: project types, project needs, design phases, design tools, case studies etc.? Perhaps inspiration can be drawn from the classical Latin adage, "Festina Lente", meaning "make haste slowly" (Tranquillus, 2016). What if "Festina Lente" became a part of the way we conduct systemic design? Could that help us acknowledge and somewhat resolve this tension?

Figure 1. Depicting a classic Festina Lente symbol: The hare in a snail shell.

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Antinomies in systemic design

Dilemmas, paradoxical tensions, and Werner Ulrich

Desmond Wong and Shan Shan Tan

This short paper explores the relevance of Ulrich's (2021) boundary critique to the practice of systemic design (SD) today. The concept of '*critique*' (*disclosure*) lies at the heart of dilemmas and paradoxical tensions intrinsic to SD foundations, and is complementary to maps (*correspondence*) and design (*coherence*) as ways of knowing and acting in the world. In turn, boundary critique provides a unique account of unfolding paradoxical tensions and dilemmas: Its historical, conceptual, and pragmatic fit with SD's context and concepts could also help create, modify, and extend its learning competences and knowledge routines. On the flip side, a systematic approach may incidentally preclude the nuanced, boundary-crossing understandings that characterize SD. We suggest that scholar-practitioners consider theory synthesis approaches to embrace the diversity of perspectives and methods.

Keywords: boundary critique; reflective and reflexive practice; systemic design; social policy.

I. Old dilemmas

> "This is precisely the definition offered by Guardini of polar opposition. It is not, he said, 'a 'synthesis' of two moments into a third. Nor is it a whole, of which the two moments constitute 'parts'. Still less is it a mixture, in some sort of compromise. It is, rather an entirely distinct, original relationship of an original phenomenon. Neither pole can be deduced from the other, nor rediscovered starting from the other … Rather, both parts are contemporaneous, thinkable, and possible only thanks to each other. This is opposition: two moments are each in themselves without being able to be deduced, transposed, confused, and yet are inextricably linked to each other; … they can be thought of only one in the other … thanks to the other.'" (Borghesi, 2017)

According to the Systemic Design Association (2021), *systemic design* (*SD*) is "an integrated discipline of systems thinking and systems-oriented design" (para.1) that continues from the *Design Methods Movement/Group* (*DMG*) of 1962 to 1972, in Berkeley, United States. "Members advocated a *systems* view of *design* projects" (Rith & Dubberly, 2007, p.1), with much of the DMG pivoting on Rittel's (1972) problem structuring methods (*PSM*), then termed '*second generation design*'. Yet underlying this were Rittel and Webber's (1973) *three dilemmas* intrinsic to social policy: *Equity*, *public good*, and *wickedness*. (It is the *wickedness* dilemma that has since become canon: How to solution, when/if we cannot know the '*problem*'?)

However, a precise definition of SD is elusive and by extension, the ability to create, modify, and extend its learning competences. For a purposeful discussion, we must address the varying definitions of systems thinking (*ST*) and design thinking (*DT*) that make up SD. In this short paper, we define ST as both *PSM* and *appreciative inquiry methodologies* arising from the trajectory of operational research (*OR*) (Jackson, 2019; Checkland, 2018) – thereby excluding the '*Sengian*' alternative of ST as organizational development (*OD*) (Lane, 2016). Likewise, we define design thinking (*DT*) as the DMG's *designerly* offshoot from '*soft*' OR (Baker & Moukhliss, 2020) – thus excluding the other '*Brownian*' alternative of DT as IDEO.

One interesting observation at this point, is DT's implicit grounding in the *cybernetic* stream of ST (Jonas, 2020; 2019; Rith & Dubberly, 2007), and its move upstream from *technical* (*artefact*) to *social* complexity (*context*) (Ryan, 2014). It mirrors ST's own move from technical (*complex adaptive systems*) to social complexity (*soft systems*) and a *critical* lens. According to Jackson (2020), this is a foregrounding of ontological and cognitive complexity involving conflict, "when power comes into play on the stakeholder dimension … in the … different ways individuals and groups see and respond to the world … [And it is in this light, that] Ulrich's '*critical systems heuristics*' … take[s] seriously the existence of '*coercive complexity*'" (pp.5-6).

Regardless, ST and DT share two basic understandings. First, both recognize '*needs*' as "an imposed … faux desire, which originates outside the individual's own generative nature …. [implicitly assuming that] the desired situation is clearly understood … [,] that there is no difficulty in determining the needs … [, and that the] outcome is known from the start" (Nelson & Stolterman, 2012, p.190). Second, *dilemmas* are necessarily intrinsic to SD (*process*) as they are to social policy (*content*): Breadth and depth, intent and action, systematic and generative (Ryan, 2014; Nelson & Stolterman, 2012), so on and so forth. Like the boundary critique discussed below, it helps to be explicit about these understandings in SD practice.

Vermaas and Pesch (2020) stand out for their direct return to Rittel and Webber's (1973) three dilemmas at the intersection of the ST and (heart of) DT that make up SD. They argue and conclude that DT cannot address these dilemmas, yet provide practical recommendations that include an outline of what in ST parlance, is termed '*ongoing boundary critique*' (Gregory et al., 2020). Jonas (2020) is more historically-informed in tracing Rittel (1972) back to the *Studiegruppe für Systemforschung* (*SfS*) of 1958 to 1975 in Heidelberg, Germany. Here, ST methodologies have entrenched, extended, and stretched DT, and vice versa. In turn, the knowledge routines have allowed for a distinctly German approach to SD theory and practice.

Yet underlying Jona's (2020) framework is Churchman's (1971) initial introduction of two pivotal concepts: *Boundary critique*, and the inherent tension between appreciative inquiry (*methodologies*) and authority (*PSM*), prefiguring Checkland's (2018) 40-year reflections. Within *methodologies*, Jonas (2020) then references an inherent tension between *facts* and *values*. This is described as an "ongoing reflection of facts and values within a wider context of relevance …. [through] a design/inquiring system …. which creates the driving force for the transformation" (p.103). While implicit, Jonas (2020) sets out this way, Ulrich's (2021) triadic tension of *facts*, *values*, and *reference systems* – in other words, the eponymous '*systems*' of ST.

The SD community has yet to explore Ulrich and Reynolds's (2020) boundary critique methodology (c*ritical systems heuristics*), despite its unique fit: Historically, it has a direct line to Rittel (1972) through Churchman (1967), who interfaced with *wickedness* before teaching Ulrich (1983) at Berkeley (8 years after the DMG had dissolved into *Design Issues*). Conceptually, boundary critique aligns with Rittel and Webber's (1973) starting point in social policy and the three dilemmas (Ulrich, 1988; 1987; 1983). Pragmatically, it is a sophisticated account of working with dilemmas and paradoxical tensions best maintained as a '*question mark*'. Lastly, it provides a unique take on value conflicts and breaks in scale with(in) identity.

This short paper sets out the principles and relevance of boundary critique, as opposed to its methodology and method. This fills a longstanding gap in SD. On the one hand, leading scholars like Nelson and Stolterman (2012) cogently identify a wide range of dilemmas and tensions, but are not always specific on the process of working with these dilemmas and tensions beyond analogy; and the same may be said for Rittel and Webber (1973). On the other, those like Gregory et al. (2020) are still finding ways to '*pull*' boundary critique back from an overt *interpretivism*, so that practitioners engage with real issues of power and marginalization that affect design. Both positions are inherently paradoxical, but also *antimonious*.

While originating from Churchman (1971) and the critical lens, Midgley (2011; 2000) provides an alternate stream on boundary critique to Ulrich (2021; 1987; 1983; & Reynolds, 2020). Yet for the purposes of this paper, only a key insight is discussed: One where a system is "'*held in place*' … by virtue of the fact that it expresses … struggles between competing discourses … and [so] a boundary judgment needs to be made about which level(s) of analysis will be most appropriate for the purposes … [and] how some stakeholders and issues may be stigmatised by systemic processes, resulting in … marginalization" (pp.145-158). Interested readers are pointed to Ivanova and Elsawah's (2021) for updated discussion on boundary critique in general.

Nevertheless, there are limitations to our approach of defining SD according to the SDA, situating ST and DT, then boundary critique through the lens *historical*, *conceptual*, and *pragmatic* fit. To some degree, systematicity and precision are needed for new knowledge routines. However, this can also impose a referential enclosure that precludes nuanced, boundary-crossing understandings that have characterized SD (E.g., Jones, 2020). With this in mind, we suggest *theory synthesis* approaches for future research, where "a concept or phenomenon … [is used in] transforming previous findings and theory into a novel higher-order synthesis … and [unlike reviews, facilitate] new theoretical view[s]" (Jaakola, 2020, pp.21-23).

II. New dilemmas

White and Taket (1997) were tacit on the dangers of de-emphasizing identities in their multistakeholder approach to '*needs*' and dilemmas. Yet, Ulrich (2021) adds that the objective of boundary critique is not to resolve dilemmas, but enable *antinomy*. This is a central feature of its Kantian foundation, which recognizes that *meaning* and *process* transcend *content* (*a priori*), even where two or more sets of facts may be equally valid, yet contradictory (*a posteriori*). The three dilemmas offer examples, but a practical summary is quite simply, '*one man's freedom fighting is another man's terrorism*' (Checkland & Poulter, 2020): Where reference systems change, so do facts and values; and *purposeful* action has to account for this.

Boundary critique starts with identity through *critique*, or a reflective practice on the *claims*, *ends*, and *means* of actors (Jackson, 2019). In turn, this ensures that action is *legitimate*, *effective*, and *meaningful* to the people involved and affected in high-conflict, social complexity. In early iterations, Ulrich (1987; 1983) was more explicit on how this would operationalize the Kantian '*analytic-synthetic distinction*', which is simply a distinction between *analysis* (involving facts and observation) and *synthesis* (as they are *relative* to values or *relevant* to reference systems). However, the gem lies in how critique is an alternative to *maps* and *design* ubiquitous in ST and DT (Ulrich & Reynolds, 2020). This is discussed next.

First, there is the historical dilemma of "*the fundamental divide between systems and reality*" (Ulrich & Reynolds, 2020, p.263). This can be broken down into a triadic tension of *maps*, *designs* and *critique* that differentiated by their *ontological* proximity. Maps are close to reality; design has a "critical distance … for developing alternative futures … [in] implicit critique of the present" (p.264); while critique is furthest away. Indeed, a critique is an affective and embodied abstraction behind maps and design (*Figure 1*). In philosophical terms, this is to explore meaning as *correspondence* (*maps*), *coherence* (*design*), and as '*dis*'-*closure* (*critique*): It is a singular point that should enable SD to create, modify, and extend its own competences.

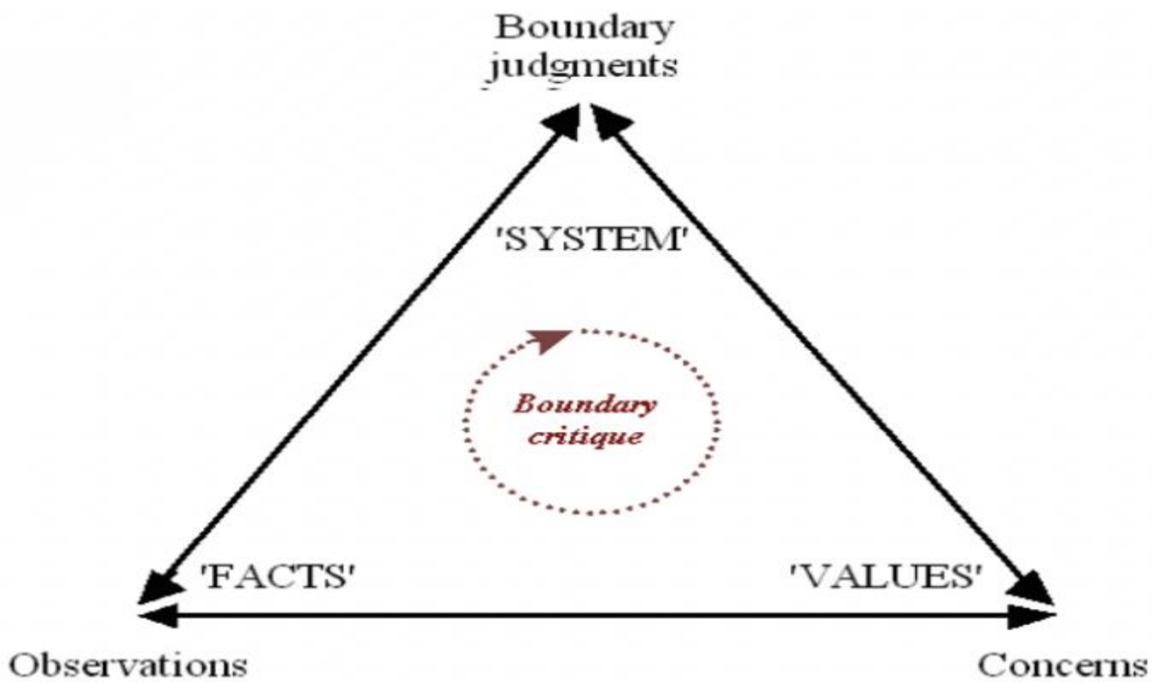

Figure 1. Boundary critique, from Ulrich (2021).

To those familiar, this may well be the answer to Archer et al.'s (2005) claim in DT for a third area in general education (*design*), contra science (*facts*) and humanities (*values*). "The simple answer must be that we do not know what literacy in design might mean because we have not yet experienced it in … society" (p.49). We suggest that boundary critique may be the answer today.

Second, there is the deeper, conceptual dilemma and paradoxical tension between *positive* and *negative* heuristics of sorts. This is native to theology, as an appropriated quote from von Balthasar (1991) would suggest:

"Knowledge ... can only come to itself in reflexive concepts that, as indeed valid but never sufficient, must always be criticized, relativized, submitted to the principle of analogy ... to carry through ... ever beyond the concept, ... [and mere] positivism ... (1) the strict reduction of all reduction ... to logical categories ... (2) the assignment of all negative [exploration] ... to its proper place ... *via negationis* can only be entered upon because an '*eminentia*' is already present within the '*positio*'" (para.3).

Again, *negative* critique is Kantian antinomy in complexity than polar opposition. Ulrich and Reynolds (2020) explain that "whatever we can think and say about a situation, it already contains some mapping and/or design elements ... different degrees of abstraction and conceptualization ... our notion of the situation is itself a map [and design] and likely to be conditioned by the same sort of selectivity ... we can, however, use differences ... to drive our thinking about the underlying judgments ... [and the] ways we use them" (p.264). The act of defining and structuring is itself, the *reference system* of the real "context that matters" (p.265).

Third, there is the pragmatic dilemma of the '*why*' against the '*who*' (*Figure 2*). The first set of '*why*' boundaries is broken down into a tetradic tension of purpose and value (*motivation*), resource bases and decision-making (*control*), expertise and experience (*knowledge*), and approval (*legitimacy*). In comparison, the second set of '*who*' boundaries are broken down into a triadic tension of social identities (*stakeholders*), concerns (*stakes*), and issues influencing conflict or collaboration (*stakeholdering issues*). This is a dialectical unfolding that prizes "*contexts* of application" (Ulrich, 1987, p.276) in using tension to remain sensitive to facts (*analytical*-), values (*process*-), and reference systems (*context*- competences).

2nd set of boundaries →

1st set of boundaries ↓

Sources	*Stakeholders*	*Stakes*	*Stakeholdering issues*	
Motivation	2. Beneficiary?	1. Purpose?	3. Measure of improvement?	**People involved**
Control	5. Decision maker?	4. Resources?	6. Decision environment?	
Knowledge	8. Expert?	7. Expertise?	9. Guarantor?	
Legitimacy	11. Witness?	10. Emancipation?	12. Worldview?	**People affected**

Figure 2. Boundary judgments, adapted from Ulrich and Reynolds (2020).

The numberings have been changed from the original to reflect the recommended order for dialectical unfolding for beginners. For advanced practitioners, Ulrich and Reynolds (2020) provide facilitation prompts (p.290) to enable a *future* state critique. An ongoing critique can be presented in 3 points per row, if at all. We suggest that as a heuristic, this could be distilled even further.

What boundary critique offers is to make tacit identities and the unfolding process. Often, this is done at the back of the head, which Checkland and Poulter's (2020) term a '*Mode 2*' application of ST. The idea of working with dilemmas and paradoxical tensions maintained as a '*question mark*' is recursive dialectic across the three major dilemmas, above. They also undergird Rittel and Weber's (1973) original dilemmas at the intersection of SD, as operationalized into triadic and tetradic tensions. Finally, a silent dilemma in the backdrop is that of *flexibility* (*systemic iteration*) and *structure* (*systematic triangulation*) of facts, values, and systems. This is necessarily ongoing, as actors and identities evolve (Gregory et al., 2020).

Our design case ran from February to July 2021, where we used boundary critique to set up a place-based intervention for a resident population in Singapore. Its key advantage was in providing a systematic and practical guide for conversations and iteration with over 10 organizations and groups of residents: This was then '*coded upwards*' to the multistakeholder level for further iteration, and a theory of action. Conversely, a key disadvantage were the nuances of application, not covered by Ulrich and Reynolds (2020). In practice, we found that *legitimacy* was less a sub-set of boundaries, than a prerequisite to those before (*Figure 2*). Guarantors under *knowledge* were also stakeholders to be aware of, and at various levels (E.g., '*project sponsors*').

Yet, our real challenge came through new alliances. Despite our ground rules for engaging only through facilitation as project leads, we found out that two of our team members had been covertly approaching stakeholders with new funding deals. One (*X*) would come to challenge the intervention from this: On the one hand, X refused to submit agreed-upon details for 3 months, and privately insisted that their 5 partners rescope around their choices. On the other, X also sought to impose its worldview against the interests of those involved and affected (E.g., a recurring narrative was that X was '*beyond*' services and '*knew best*', even as this went against what we had known over fieldwork with their own beneficiaries and facilitation with partners).

An important reflection from this was that pragmatic use of boundary critique must draw back to *purposefulness*; and in the real world, a purpose-based nudge and even exclusion, may be necessary. First, '*ongoing boundary critique*' must be tacit about finding congruence between the people involved and affected (whether or not *legitimacy* is seen as a sub-set of boundaries or a prerequisite, above). Second, between what stakeholders say and actually do. Closer to the alternate stream of boundary critique, our team members' and X's behaviors were constantly "expressed in '*asides*' … defending their own boundaries of interest whilst disregarding the views of others … [while] unsure about … commitment to the Project" (Midgley, 2000, p.342).

III. Conclusion

Boundary critique is complementary to SD, and has much to offer even to composite ST and DT. As Nelson and Stolterman (2012) explain, "the *process* of design is always the most effective and efficient means of getting … to new places … it calls for *good* compositions – not *true* solutions … based on notions of *reflections* and *substance* … [and to take away from] the focus on *problems*, whether wicked or tame, as the … trigger [that] … has limited our ability to frame change as an outcome of intention and purpose … [to] focusing on intentional actions that lead to states of reality … desirable and appropriate … the reconstitution of *sophia* … [and] reflective practice, intellectual apperception and intentional choice" (pp.5-20).

In turn, "institutionalizing systematic processes of reflection and discourse on the boundary judgments that condition people's facts and values, [maps and design] … [will help us] talk about and question the same facts at a time; rather than being at cross-purposes" (Ulrich, 2021, p.7). Over time, boundary critique has deepened its focus on *process*, which adds to its universal complementarity. It has also extended beyond its Kantian foundation (Ulrich and Reynolds, 2020; Ulrich, 1988), acknowledging the equal influence of *pragmatism* drawn on by German SD (Jonas, 2020) and Churchman (1971) through dialogue with scholars like Ormerod (2020; 2007). It is a unique alternative to expert-led maps and design, and the original dilemmas.

Notably, disclosure from critique is not mutually exclusive to maps and design, and Ulrich (1987) himself advocated for analytical competences, alongside context and process ones. The different ontological proximities in critique, maps, and design imply different degrees of reflexive/reflective and instrumental thought that cannot contained within the other. As such, the proper place of boundary critique is to help SD practitioners become more tacit about different dimensions of purpose and reference systems. It may also have an adjacent contribution to boundary specification problems that remain in '*hard systems*' modelling today (Laumann et al., 1983). Interested readers are pointed to Wong and Tan (2021) for a preliminary synthesis of the two.

Aside from the issues with referential enclosure (para.10), we would point out to scholar-practitioners a fourth, unspoken dilemma that surfaced through our design case: When is a purpose-based nudge, and even exclusion, necessary and legitimate? To take this question a step further, how does this change when the people affected are wholly irrational actors (E.g., lung cancer patients who insist on smoking, traders who choose to invest via '*dark pools*')? And then, what should governance look like, and how can we realistically track '*ongoing boundary critique*'? These are questions that have not been answered in the literature, other than '*matrices*' for multi-methodology (Jackson, 2019). In turn, Wong (2022) is a preliminary response.

Thinking again on fit and new dilemmas through *historical*, *conceptual*, *pragmatic* fit is rarely explored in SD literature, but can be useful to future scholars if appropriated carefully. Conversely, a more precise definition of SD could preclude new knowledge routines, or confines ST and DT to the '*Sengian*' and '*Brownian*' – which have limited application, and as is the unfortunate case in Singapore. While Ulrich's (2021) boundary critique is one of two streams, it is a means to antinomy in SD and new learning competences for a transdisciplinary community. In short, "it is becoming more obvious that we need to think more carefully about what we choose to create or change ... in guiding the evolution of human systems – the *praxis* of a wise hand" (Nelson, 2021, p.5).

> "*To return to the things themselves is to return to this world prior to knowledge, ... of which knowledge ... speaks, and ... with regard to which every scientific determination is abstract, signitive, and dependent, just like geography with regard to the landscape where we first learned what a forest, a meadow, or a river is. This movement is ... distinct from the idealist return to consciousness, and the demand for a pure description excludes the process of reflective analysis just as much as it excludes the process of scientific explanation ... The world is there prior to every analysis ... it does not wait for our judgments ... or deliberate taking of a stand ... [Rather,] it is the natural milieu and the field of all my thoughts and ... explicit perceptions.*" (Merleau-Ponty, 2012, pp.xxii-xxiv)

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Track 14:

Crises As Context For Studying Systemic Design

Chair: Dr. Remko van der Lugt

COVID-19 immunity certificates as complex systems

Applying systems approaches to explore needs, risks, and unintended consequences.

Cecilia Landa-Avila, Gyuchan Thomas Jun, Isabel Sassoon, Ozlem Colak, Corina-Elena Niculaescu, Tina Harvey and Panagiotis Balatsoukas.

Implementing COVID-19 immunity certificates without careful consideration of user needs and human factors could put public health at risk, infringe privacy and lead to societal inequalities. There are polarised and complex views among different stakeholders (including academic researchers, service providers and the public) about the feasibility and the ethical, safe, trusted and fair use of immunity certificates. Therefore, there is a clear need to understand the needs, unintended consequences, and risk of implementing immunity certificates before designing services around them. This understanding will prevent compromising human rights and civil liberties, and at the same time, help protect public health and return to normality. This paper presents the application of systems/service approaches as part of the IMMUNE project, a research project funded by the UK Arts and Humanities Research Council (AHRC). IMMUNE has investigated the design of services for immunity certificates in the UK. This research has generated recommendations meaningful to the post-pandemic systems/service design, emphasising the tensions and intertwinement of public health with everyday life.

Keywords: public health; immunity certificates; synthesis map; COVID-19

Introduction

Since the declaration of COVID-19 as a global pandemic by the World Health Organisation (WHO), multiple preventive public health strategies and interventions have been deployed to control the spread of the virus and its pressure on the national health systems. Initially, these strategies were focused on personal hygiene (like guidance for careful hand washing and thorough cleaning of surfaces) and social distancing measures before moving to nationwide lockdowns. Subsequently, test and trace services and several symptom monitoring apps were launched to help monitor and constrain the virus. Recently, the rollout of viral vector and mRNA vaccines has offered new effective alternatives to slowing the spread of the virus and reaching herd immunity. The interventions mentioned above have made possible the gradual exit from national lockdowns and the re-opening of the economy. As part of their plans for a safe return to normal activities, several governments have proposed the use of immunity certificates. These immunity certificates (also referred in the literature as immunity passports or vaccination certificates) would allow individuals who have antibodies of the SARS-COV-2 or who are not carriers of the virus to return to work, travel or socialise without restrictions (Eichenberger et al., 2020).

Although some evidence in the United Kingdom suggests positive attitudes towards immunity certificates among the population (Lewandowsky et al., 2021), immunity certificates face questioning as more uncertainties and concerns have arisen (Brown et al., 2020). The most common concerns include: the lack of clear evidence about how long does immunity last and what are the differences in the presence of antibodies between people who have had the vaccine or recovered after contracting the virus (Chen et al., 2020); fair access to safely acquire immunity (Brown et al., 2021); uncertainty about how effective are the existing vaccines against the new variants of the virus (Karim, 2021); availability of reliable serological tests to prove immunity status; growing public disbelief about the effectiveness of existing technology to guarantee the confidential and trustworthy sharing of information about the immunity status of an individual, or the falsification of this information (Bansal et al., 2020); and finally, challenges related to the implementation of immunity certificates within the existing business models or various service providers across the travel, cultural, sports and other event management sectors (Makarona & Kavoura, 2021). Failing to address these concerns will inevitably result not only in the low uptake of immunity certificates but could trigger adverse and unintended consequences for public health, leading to inequalities in society and stigmatisation (Voo et al., 2021).

The inconsistent arguments, concerns, and mixed evidence around immunity certificates have made evident the need to understand this phenomenon within a complex systems lens. By doing this, a holistic understanding of conflicting perspectives and elements can be exhibited. Still, most importantly, a complex systems approach may uncover tacit knowledge, identify evidence gaps, and unveil unvoiced concerns and risks that should guide the design of services around immunity certificates. Specifically, to investigate immunity certificates as a complex system, we will address the following two questions:

1. First, what are the possible risks and unintended consequences of immunity certificates?
2. Second, what are the key requirements, resources, technologies, and processes needed from different stakeholders to design services around immunity certificates to mitigate any unintended consequences and risks?

First, this paper presents the methodology followed to address the research questions, listing the methods that facilitate the investigation with a complex systems approach. Then, one example of the synthesis map is presented (concept of immunity). Finally, the research outputs are described, and preliminary benefits and implications are discussed.

Methodology

The methodology reported in the present paper was conducted between February-November 2021 in the United Kingdom as part of the IMMUNE (Immunity Passport Service Design) project. This project was funded by the UK'S Arts and Humanities Research Council (AHRC).

A series of studies engaging with multiple stakeholders were conducted as part of this research (Figure 1). The stakeholders were members of the public (including patient groups), service providers (focus on tourism, cultural, sports, travel, hospitality sectors), and experts in virology, public health, policymaking, bioethics, law, data science and artificial intelligence. Working with such heterogeneous groups required applying methods that provide adaptability to overcome the lack of a shared knowledge base and facilitate balance participation and knowledge translation. Thus, the research design combines interviews, nationwide, large-scale online questionnaire surveys, focus groups, and participatory design workshops. Due to the COVID-19 restrictions in place in the UK, all the studies were conducted online.

Figure 1 summarises the research process. The remainder of this paper focuses on explaining the methods of focus groups and participatory workshops, as these methods required a higher level of preparation, adaptation and planning to study the complex and conflicting needs of different groups of stakeholders. Nonetheless, the other methods used, interviews and online questionnaire survey, also informed the outputs of the research, but their description is out of the scope of this paper.

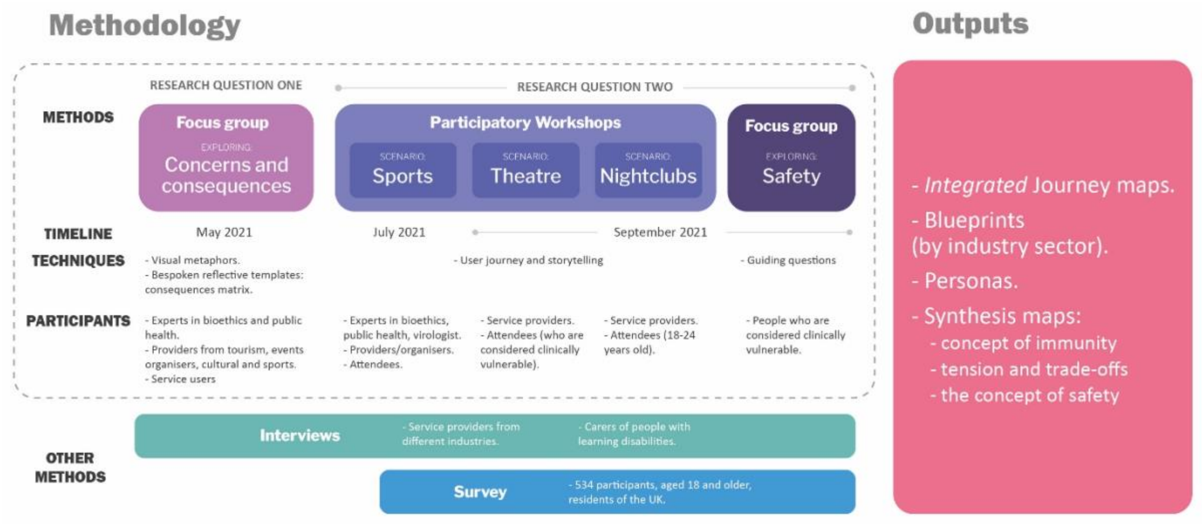

Figure 1. Overview of the research design.

The first method of data collection used was a focus group. The aim was to collect data about the first research question (i.e. what were the risks, concerns and unintended consequences of immunity certificates). The focus group was split into two sessions that took place one week apart. A total of 23 individuals participated attended both sessions: eight service users, ten service providers (three from the tourism sector, three from the cultural and creative industries, one from the local council who represented businesses, one from the aviation industry, two from sports and events management representatives), three experts (in public health, bioethics and secondary care) and two representatives of patient groups. In each session, participants were split into two groups of 4-6 participants each. The decision to split participants into smaller groups was made in order to allow more chances for them to contribute to the discussion and articulate their thoughts. The focus group took place remotely via the MS Teams platform. To stimulate the activities of the focus groups, it was important for all participants to share a consistent internal representation of the phenomenon under investigation. This was achieved using a synthesis map (explained in the next section of the present paper). An online collaboration tool (Miro) was used to facilitate brainstorming and sharing of knowledge and ideas. Specifically, the online collaboration tool contained a series of templates created to collect data about participants' perceptions about the risks, concerns, and unintended consequences of using immunity certificates. Examples of such templates included visual metaphors (icebergs), used to motivate the expression of unintended consequences, and matrices, used to facilitate group decision-making about which concerns were perceived to be riskier and likely to happen.

Following the focus group sessions, three online participatory workshops were conducted, each focused on examining the use of immunity certificates in a different industry. It was decided to start with the sports context since this sector was the first to pilot the immunity certificates in the UK (e.g., EURO2020 and Wimbledon 2021). A total of seven people participated in this first workshop, including three attendees, three experts (one expert in bioethics, one in public health, one virologist) and one sports event organiser. At the beginning of the workshop, a speculative journey map was presented in the form of a video (https://youtu.be/nvmJOYls6Z8). The video illustrated how immunity certificates could be used, emphasising critical moments when decisions and dilemmas were faced. Then, participants discussed the journey, codesigned alternatives and raised more concerns using the same online collaboration platform used for the focus groups. The subsequent two workshops followed the same procedure. The second workshop examined the use of immunity certificates in indoor events, using as an example the visit to a theatre, while the third workshop was focused on the design of immunity certificates for nightclubs.

In the aforementioned data collection activities, an effort was made to recruit participants that were typical of the following three types of personas: 1. healthy individuals of all ages who have been double vaccinated or acquired immunity through natural infection; 2. clinically vulnerable groups of patients; and 3. healthy individuals aged between 18-24 years old who have an active night social life, attending nightclubs and other similar events frequently. These personas emerged from the findings of the initial focus group, the literature and content analysis of recent news items that appeared in the press during the period between April – July 2021.

Finally, following the results of the initial focus groups and the workshops, it became clear the need to run another focus group with people considered clinically vulnerable (to be high risk for hospitalisation or even death if contracting the virus). Specifically, the aim of this focus group was to understand their concerns around the use of immunity certificates and how they might be designed to increase the sense of safety among this group of people. The focus group took place remotely using MS Teams with six participants. The discussion followed a series of questions and voting of preferred options.

Data was analysed using a combination of internal (research team members) open sense-making techniques, such as affinity diagramming, open mapping, and synthesis maps (Jones & Bowes, 2017). Data collected was translated/adapted into user journey maps and service blueprints .

A synthesis map of the concept of immunity

As explained in the previous section, in the case of the focus group, a synthesis map was used to help participants situate immunity certificates in the wider context of COVID-19 immunity. The map included the concept of immunity, the social determinants that can influence immunity, the different threats to immunity, the strategies in place to retain immunity, and the impacts on the healthcare system. Following the results of a narrative review, we mapped the concept of immunity as a complex system in the form of a synthesis map (Figure 2) (available also at: https://doi.org/10.17028/rd.lboro.14572545.v1). The map was shared with participants in the focus groups, accompanied by a video (https://youtu.be/6nFhz9KXqUU).

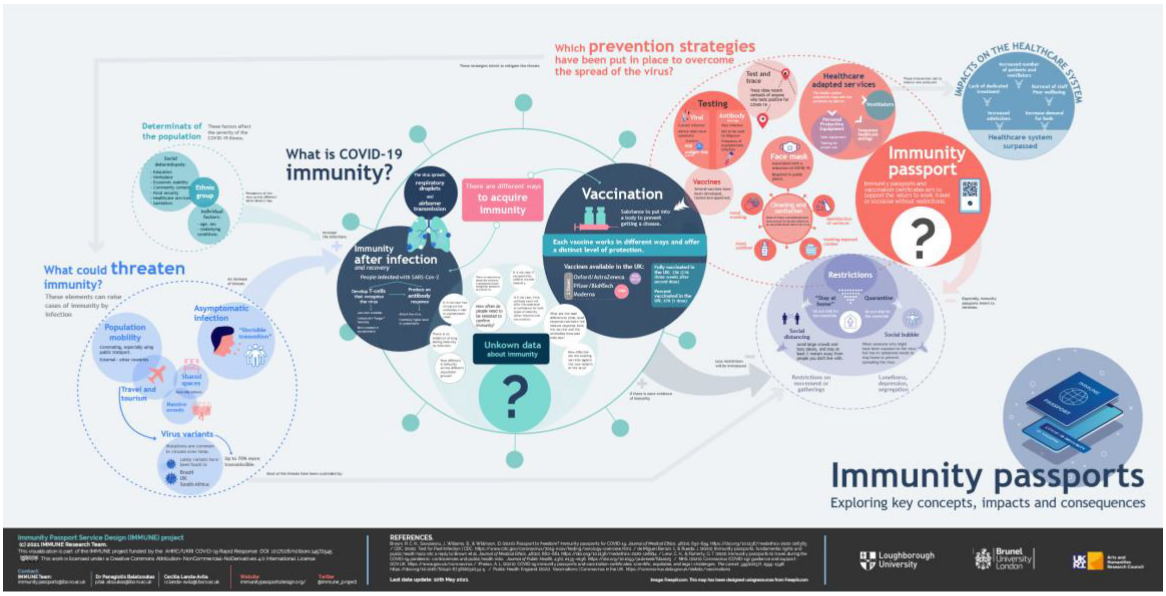

Figure 2. Synthesis map of immunity certificates (first version).

During the different stages of the data collection process described above, this synthesis map evolved and acted as a dialogical device for the research team to reflect as part of the data collection and analysis process. The latest version of the map now presents more details. Specifically, the map helps visualise the complex relationships of the key requirements, resources, processes, and technologies needed to design immunity certificates. Also, the map defines requirements for systems/service design across the different sectors (including sports, culture, and nightclubs).

Expected outputs and way forward.

This research project explored immunity certificates as a complex system to understand possible unintended consequences and risks and how we might design systems/services around them to mitigate these risks and consequences. Throughout this research project, the involvement of a variety of stakeholders with ill-defined and conflicting needs have required for systems-oriented methods that not only help to make sense of the complex situation but to assist a balanced power dynamics of the different participants, invite the discussion of conflicting views, deal with the uncertainty, and envision unexpected consequences.

The outputs of this research primarily contribute to the understanding of immunity certificates from a systems/service design point of view. Secondly, the research documented a "complex systems" oriented research process, developed bespoken sense-making visual tools, and generated recommendations on facilitating participatory sessions with heterogeneous groups. These recommendations are specifically meaningful to the post-pandemic systems/services design, which will emphasise the tensions and intertwinement of public health protection with human rights and civil liberties.

In addition, the research also identified the limitation of tools such as user journey maps. Journey maps fall short in communicating the diversity of paths that people should face, and there is a tendency to perceive that the journeys occur in a linear way. To address this problem, a new type of 'integrated journey maps' is proposed as a novel way to document the complexity of immunity certificates. These integrated user journey maps allow the mapping of multiple personas at once, contrasting points of conflict between different personas and across the stages of the journey. In addition, the integrated user journey maps compare similarities and differences, bringing personas with similar journeys together and distancing those with the most differences.

The authors of this contribution propose to focus the panel discussion at RSD10 around the following questions:

- How could systems/service methods facilitate the discussion of tensions and conflicting opinions for health systems design?

- How do the research outputs (e.g., integrated journey maps and video storytelling) help to communicate the complexity of immunity certificates, and how these outputs could be improved?

- What are the future research directions in the phenomena of immunity certificates as a strategy to advance the development of more resilient health systems?

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Design-driven industrial conversion during COVID-19 global outbreak

A systemic business strategy and design approaches to face complex market crisis.

Eva Vanessa Bruno, Beatrice Lerma

This paper highlights the evolution of designers' responsibility during an unexpected emergency period like the COVID-19 outbreak. This process will be described through a set of case studies showing that the design discipline is resilient and capable of gathering the proper needs at the right time and relieve market tensions. Indeed, designers can help companies in the process of industrial conversion, an ambidextrous strategy that allows producing what is missing but extremely urgent during an emergency. The paper describes via case studies the way firms converted to produce necessary goods such as clean hand sanitiser, lung ventilators and the personal protective equipment needed by citizens and medical personnel. During the COVID-19 emergency period, what are, and have been, the challenges for designers? What new expertise, skills, activities will the designer have to gain? How designers give innovative answers with new activities to support companies during emergencies? The answer was found in the designers' ability to examine the problem holistically and choose the most innovative and contextually appropriate solutions. Together with management ingenuity, they also fit in with ambidextrous strategies that direct the company towards new opportunities by exploiting the resources already belonging to the firm, untangling the economic complexity.

Keywords: Design for Emergency; Industrial conversion; Ambidexterity; Innovation management; Market tension

Introduction and background

In the modern global economy, pioneering and disruptive business strategies has become a central topic for dealing with complex market crises. Strategic, systemic designers and innovation managers can play an essential role in addressing the challenge of new business models and mitigate market tensions.

Design for emergencies is not currently widespread in the mosaic of the disciplinary areas of design research in Italy, according to the Design Research Map (Bertola et al., 2018) by SID (Italian Design Society). However, the role of designers becomes relevant in all those situations where time is a crucial factor because designers suggest long-lasting practices and processes, not temporary solutions (Traldi, 2020).

The "emergency" is defined as a permanent and implicit condition of contemporary society (Piscitelli, 2019) because of the presence of prolonged crises, such as the climate change that the whole world is facing. However, this condition of permanent emergency has been strengthened with the COVID-19 outbreak because it awakened society from the habituation to the state of emergency. Indeed, the COVID-19 global pandemic was an unforeseeable event that had overturned political, economic and social structures since 13th January 2020, when the Chinese government announced the first case of a novel coronavirus recorded in November 2019.

This study provides new insights into the designer's role during the COVID-19 outbreak: designers from all over the world have proved to react to the emergency based on their attention on human needs, especially needs that do not yet exist are still unknown. According to Donald Norman, designers answer the question: "how do you discover a need that nobody yet knows about?" (Norman, 2004, p. 70). How to respond to those needs before the system collapses? In this paper, the authors aim to show the design contribution for the COVID-19 global emergency in Italy and abroad through a selection of case studies with immediate and short-term effects of industrial conversion. Firms switched a part or all of their production to manufacture much-needed personal protective equipment (PPE) and medical devices. Industrial conversion has been a winning strategy not to close firms, continue producing goods, respect safety measures, and help countries supply medical equipment. It was essential in Italy due to the lack of medical devices and PPE like masks, ventilators, scrubs, gloves. Indeed, Italy was not autonomous in terms of their production, and some medical supplies purchased abroad have been blocked at the border by the producing countries. The fear of running out of these precious pieces of equipment has reduced or suspended exports, causing inconvenience to countries that needed them.

The paper argues that designers who collaborate with risk managers can work to forecast emergency needs that do not exist yet, get the market ready for upsetting events with design-driven innovative projects (Verganti, 2019) and new methods of using services and products.

Industrial Conversion to re-open closed firms

The industrial conversion is an ambidextrous strategy (Duncan, 1976) that allowed companies to enter higher-demand production sectors through new plants or the transformation of existing ones, maintaining high manufacturing know-how. Below are some examples of industrial conversion in the COVID-19 pandemic, proof of the desire of companies to find new opportunities achieving the demand for equipment avoiding plants closure.

Textile firms: masks and scrubs

The need for surgical masks has been met by fashion companies, which have used their implants to produce non-woven fabrics (TNT) and so-called community masks. Companies like Armani, Bulgari, Prada, Miroglio, Calzedonia, H&M started running their plants to produce scrubs and masks with TNT supplied by other companies. Companies that produce sportswear, like Santini, have used their technical fabric to produce washable and reusable masks. Even when the plant could not open, the seamstresses of Scervino, from Florence, sewed masks and scrubs from home with the fabrics that the company had bought on purpose.

Figure 1: A Worker Irons Masks in the Atelier Miroglio Headquarters in Cuneo, Italy. Source: Bertorello 2020

Fabric and filter material suppliers have made their contribution too. The company Ahlstrom Munksjo is a helpful example. Its plant in Turin produces non-woven fabric to filter diesel fuel. Due to the emergency, they have identified this production line as filter materials suitable for the virus.

Alcohol and perfume firms: sanitizer

Sanitising gel was another good missing immediately from supermarkets and pharmacies at the beginning of the pandemic. Firms that produced alcohol converted their plants to produce denatured alcohol (tax-free), made with a chemical process that makes undrinkable edible alcohol (not tax-free, which is more expensive than the previous one). It has classic pink colouring. For example, Bacardi partially converted the Martini plant in Pessione (Turin, Italy), supplying denatured alcohol to the local community and the Red Cross. This new production was not affecting the production chain of the products in the company's portfolio, but it expanded it. Big companies such as Campari (Milan, Italy), Amaro Ramazzotti (Milan, Italy) and brewery BrewDog (Ellon, Great Britain) and also small local distilleries did the same. In these cases, part of the production has been devolved free of charge to the Civil Protection, partly for sale, in small quantities, to make up for supply difficulties in supermarkets.

Figure 2: BrewDog's beer bottle hand sanitiser packaging. Source: insider.com.uk 2020

Luxury cosmetic and perfume companies like Christian Dior, Guerlain, Givenchy, Bulgari switched the production lines from perfume to hand sanitiser, exploiting the pre-existing ethyl alcohol supply chain.

Mechanical firms: ventilators

The final analysed product is slightly different from the two previous ones, as it is not a common good. However, it is intended for hospitals and first aid: mechanical lung ventilator. It is a mechanical ventilation machine to help patients with respiratory failure, one of the most severe COVID-19 symptoms. The ever-increasing demand for lung mechanical ventilators due to the high number of patients with respiratory failure has led to the use of a single ventilator for multiple patients (multiplex ventilation). However, studies have confirmed several risks (Chatburn et al., 2020). Therefore, firms with high technological content, especially in the automotive sector, converted their plants to produce lunge mechanical ventilators. Big companies like Lamborghini, FCA, Mercedes, Ferrari, General Motors, Ford, Tesla started to produce ventilators, like Ferrari's FI5 fan, which can be mass-produced using materials that are easy to find. Manufactured ventilators have a much lower cost than ventilators currently available on the market. Other non-automotive companies contributed, too, like NASA, Belkin, Fitbit.

Figure 3: FI Ventilator by Ferrari. Source: Ansa 2020

Designers, universities and local SMEs: pre and post COVID-19 approaches

In this section we describe the relationship between designers, companies and industries from the 1990s to the present. The authors proposed a categorisation according to Germak (2014) and expanded it with different approaches due to the COVID-19 outbreak.

In the 90s, companies proposed collaborations with designers within universities to define a new product or a new collection. The answer from universities was not simply applied creativity but a breakdown of the problem that offers a meta-design project as output. In the 2000s, the companies' demands changed radically: designers did not answer: "What to do?" but "Where to do?". (Germak & De Giorgi 2008). As explorers, they aimed to find new markets, new products, or to produce innovation discovering potential or hidden design opportunities. In the second decade of 2000, the role of the designer within the company changed once again. They became those figures able to connect different knowledge and coordinate it, creating interaction between team-members, key figures within cross-functional teams. In the last ten years, companies have been looking for more specialized figures, such as product designers, graphic designers, service designers, and system designers. Besides, designers in the companies also deal with research and development and with the team and process managing (Cooper et al., 2009). Designers can merge, thanks to the collaboration with other experts, skills related to project management and organization, communication, marketing research and business management (Eroglu & Esen, 2016). In addition, in recent years, there has been an evolution in the target market of projects. The consumer was the real object of the brands' campaigns, but now they want to communicate to the prosumer as an active user and producer of information simultaneously. The designer now designs objects and advertising campaigns for these new consumers through a careful analysis of the environmental market (Tapscott & Williams, 2010).

During the COVID-19 health emergency, the relationship between designers, companies and universities strengthened. In fact, with the forced closure of the spaces of the university and the facilities, they have brought into play what they could: intellectual resources on the one hand and technical expertise on the other. This synergy has allowed designers and researchers to respond to the health emergency, designing community masks, applications to manage queues, and delivering goods, no-touch tools to interact with objects safely, advertisements, and infographics. How can universities or design-oriented research centres and designers help companies during the COVID-19 outbreak? Design can be helpful in three main aspects: environment sanitising, respect for social distancing, and products' dematerialisation. As far as the sanitisation of spaces is concerned, designers could orient their project to sanitising products, such as UV lamps, automatic gel dispensers, portable ozone generators, and surfaces with antibacterial treatments.

Figure 4: Hand Sanitizer Loop. Source: JPA Design 2020

Concerning social distancing, designers could realise products such as totems, dividers, protective devices, and stickers, infographics, and advertising from a graphic point of view.

Figure 5: Wave Social Distance Signage. Source: studio 5-5 2020

Finally, the services designer and UX UI designers could be the protagonist of the digitisation of actions or enhancement of all the services used to contact people. That now cannot be done to avoid the spread of the virus. There are many examples, such as new queue-jumping applications for supermarkets and post offices, QR-readable menus, online shopping or virtual dressing rooms, panels to entertain during the queue.

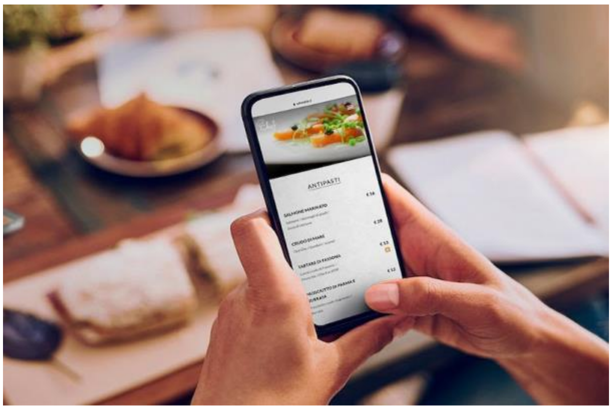

Figure 5: Safetable, QR Code Reader for Digital Menù. Source: barro 5-5 2020

Final Considerations

Design expresses its full potential when people chase away the idea that design is only about something beautiful. As Vignelli (2011) said, "the function of design is to design things that always last, not ephemeral. When something is ephemeral, it is worth what it is worth: nothing". Designers look from other points of view at the products and spaces to be used after the emergency. People will probably have to get used to spaces that were previously considered closed, open, inspired by biophilic design (Söderlund, 2019), to be in public space where products or graphics remind us to be careful and not to be too close, to talk through a mask, and to eat in a restaurant with plastic barriers.

Designers, universities and companies have shown that they can work together to manage market tensions. For this reason, the authors believe that the industrial conversions analysed in this paper will be carried on, in parallel with the previous production, in a reduced size to add products to the portfolio. Industrial conversion during the health emergency has shown how it is a helpful tool to answer new questions and find new technological challenges.

Will the state of permanent emergency ever end? What should we be ready for in the future? There are many questions about what will happen in the coming years and how designers will deal with future problems. How might designers rethink homes to better support the remote working and workplaces and school and universities during social distancing? How might care of sick or weak people when visitation or is not safe? How might designers rethink place-based and presence-based activities to be successful virtually? More generally: how will designers plan in the future? For short, medium- or long-term emergencies?

The figures who will find new design proposals to respond to new emergencies (related to the environment, health, social and war) will be the systemic designers, the strategic designers and the designers for the emergency in collaboration with a risk manager. Together they can bring design-driven innovation (Verganti, 2019). Universities should, therefore, work to educate and train these professionals, who will be the designers of tomorrow.

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Value Metamorphosis: Investigating the Impact of COVID-19 on Indian Weddings as a System

Hemul Goel, Aditya Sharma and Sanika Harshe

Indian weddings are an extensive affair. Multiple *performers* come together to witness the union of two families displayed amid various elements that become markers of their social status. The entry of the pandemic has acted as a force upon the pandemic, changing the values associated with Indian weddings. Looking at the wedding as a system we discuss the pandemic's transformative impact that has catalysed a shift away from a culture of conspicuous consumption. It is imperative to study this phenomenon as it affects consumption patterns and design trends. We begin by mapping the system and recognising key stakeholders who are subject to face the challenges posed on social gatherings due to the pandemic. Qualitative research methods were used to collect data from these stakeholders who showed how values had evolved. These findings form the premise of further inquiry into designing a system that would help retain these values once these restrictions are removed.

Keywords: Conspicuous consumption, Indian wedding, COVID-19, pandemic, values

Reflection question: How is COVID-19 leading to the emergence of emotional and experiential value conflicts amongst Indian weddings?

Introduction

In contemporary times, Indian weddings seem glittering and performative, however, this wasn't always the case. They were a communal event, wherein two families would come together to celebrate the union of the couple with home- cooked food in communal spaces decked up with eco-friendly elements of decor created by local craftspeople. The estimated worth of the Indian wedding industry is USD 50 billion[1], second only to the United States.

What brought about this transition? (Kapur, 2009) discusses the impact of Bollywood in cementing the idea of the big fat Indian wedding from a simplistic homely affair to a "Bollywoodized" one where "rituals mediated by the media are enacted." Weddings are multi-day affairs with various rituals spread across venues that come with extensive guest lists featuring the extended family, distant relatives, colleagues and friends.

Going by current standards, an average Indian spends about one-fifth of their lifetime earnings on the wedding of their children.[2]

The wedding industry in India has been touted as recession-proof, yet the unthinkable happened in 2020[3], when for the first time in decades, the industry - along with its allies - was hit by high rates of unemployment and losses. The pandemic came as an external force, challenging the existing structures and creating tensions between the various stakeholders and the values they uphold.

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[1] **Digital Classifieds In India 2020,** 21 September 2016, A study by KPMG in India & Google

[2] **Digital Classifieds In India 2020,** 21 September 2016, A study by KPMG in India & Google

[3] The global economy plunged into its deepest contraction in living memory in April-June 2020 as COVID-19 took its toll. In India, real GDP fell by a record low. Gold prices remained elevated as heightened uncertainty continues to boost its safe haven appeal.- **Monetary Policy Report – October 2020, Reserve Bank Of India**

Figure 1. India is the largest market of gold in the world. A graph depicting the change in gold prices over the years, in the Indian market (Source: Reserve Bank of India)

The study aims to understand the transformative impact of the pandemic on Indian weddings and its implications for future events. In the following sections, we will look at the Indian weddings as a system, wherein we (i) offer a brief review of the literature associated with the wedding as a site of values (ii) describe an ongoing study understanding the value conflicts in weddings before and during the pandemic (iii) discuss initial findings from primary investigations and (iv) describe the future direction of research.

Background

Values are socially approved desires and goals that are internalised through the process of conditioning, learning or socialisation and that become subjective preferences, standards and aspirations (Mukherjee, 1949). The work described in this paper, based on Veblen's definition, of conspicuous consumption[4] considers it to be a notable value of Indian weddings. Indian weddings have developed into a socially acceptable site for signalling wealth and status through conspicuous consumption. Renowned sociologist Patricia Uberoi remarked that Indian weddings are, "the most visible site of conspicuous consumption and conspicuous waste." This emphasis on conspicuous consumption as a value is internalised through vehicles like popular culture, mass media or even social media that attaches an aspirational value to it. This form of consumption comes at various price points across the income spectrum - while the expenditure for the nuptials of Asia's richest person's daughter stood at USD 100 million[5], people in rural India with humble roots spend at least, an average of four months of household income (Bloch, Rao & Desai, 2004).

In Indian weddings, conspicuous consumption as a value is expressed by the *performance* of the wedding as a spectacle. Different *performers* come together to render a *performance* of the events, rituals and even that of the self. Schechner (2017) defines performances as actions, interactions and relationships between the performers and the audience. Schechner (2017) further discusses the concept of props, denoting the different elements used to display wealth. In an Indian wedding these props include both macro and micro details beginning from the invites, venue, food, gifts exchanged to more humane elements like the bridal entry, and the guests themselves. Bhardwaj (2020) takes it a step further, stating, "The prop used in this performance becomes a yardstick for measuring the standard of performance itself." It is the scale of display that is used by the audience to ascertain

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[4] In order to gain and to hold the esteem of men, wealth must be put in evidence, for esteem is awarded only on evidence" (p. 24). By social custom, the evidence consists of unduly costly goods that fall into" accredited canons of conspicuous consumption, the effect of which is to hold the consumer up to a standard of expensiveness and wastefulness in his consumption of goods and his employment of time and effort" (p. 71).Veblen, Thorstein. The theory of the leisure class: An economic study of institutions. London: Unwin Books, 1899; reprinted New York: Dover Publications, 1994

[5] This $100 Million Indian Wedding Will Put *Crazy Rich Asians* to Shame, Time, 2018, P R Sanjai and Anto Antony, Retrieved May 10 2021

the social status of the hosts. The success of any performance is based on the interactions and dialogues between different elements. In his work on performance, Deighton (1992) expounds upon performance as an act undertaken not just for the consumer but for their audience as well. Though not a part of the roles, the multi- day event becomes the *stage* for these interactions to play out. We demarcate the *performers* based of the *roles* they undertake in a wedding.

- **The Actor**: The active *performers* around whom the event is oriented including the bride, groom, families and close friends.

- **The Audience**: The passive *performers* that *consume* the affair including extended families, friends, colleagues and guests invited for this display. Bloch, Rao & Desai (2004) discuss the difference between the notion of individuality in India, stating, "An Indian is defined not just by his or her accomplishments and character, but also by their circle of acquaintances and friends." It's this peculiarity about the Indian idea of individuality that creates extensive guest lists as people use the wedding as a site to illustrate their social prowess by displaying their connections.

- **The Facilitator**: Wedding planner, designer, entertainers, photographers and the wedding industry that banks on the display of wealth that makes the Indian wedding market the second largest in the world.

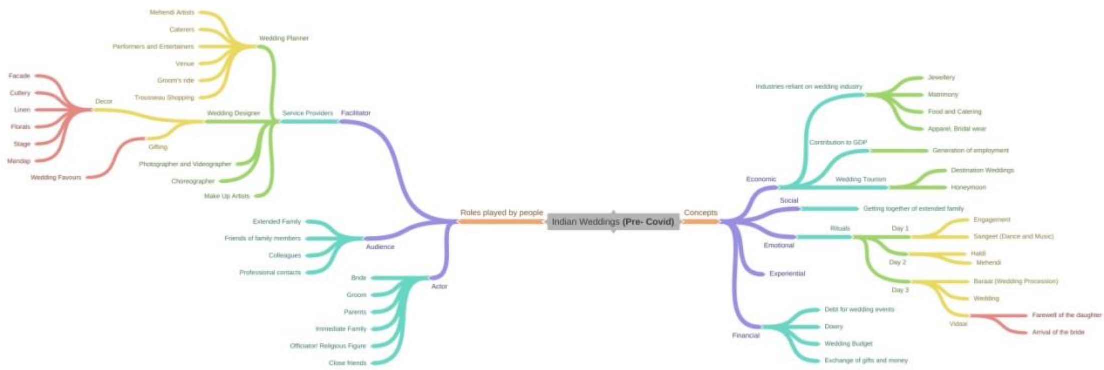

Figure 2. A map portraying the system of Indian weddings before the COVID-19 Era

Against this canvas, the pandemic came about as a force that challenged the pre-existing system of the Indian wedding. Restrictions included shutting wedding venues, banning gatherings, closing markets and limiting wedding guests. These conditions forced the *performers* to seek out conscious consumption as a possible solution for pandemic weddings. Willis and Schor (2012) have stated conscious consumption includes choices that consider "the larger context of production, distribution, or impacts of goods and services." They further add, "Conscious consumption choices may include forgoing or reducing consumption or choosing products that are organic, eco-friendly, fair trade, local, or cruelty-free." In the weddings held during the pandemic, the restrictions on vendor availability along with those mentioned above, left *performers* with no choice but to manage with locally available or self-created (Do It Yourself (DIY)) resources. Adhering to this perspective, we wish to understand the impact of the pandemic on its ability to displace the value attached to conspicuous consumption with that of conscious consumption by investigating (i) the qualities associated with conscious consumption, (ii) the tangible and intangible elements associated with conscious consumption, and (iii) the usage of this collective knowledge to further the trend of conscious consumption in Indian weddings.

On-going Study

Building on existing work, we have established the values attached to Indian weddings. The study deepens the understanding of these old and new values by investigating the qualities attached by different *performers* to these values. We ascertain this by observing the vocabulary used by the different *performers* in defining these events.

Additionally, a preliminary visual research was undertaken to explore the intangible and tangible elements emerging from the pandemic weddings.

During the course of the introductory qualitative study, the following *performers* belonging to the middle class income group[6] from Tier 1 and 2 cities of India were interviewed (i) 5 brides and grooms, (ii) 2 parents of the bride or groom, and (iii) 3 virtual guests. Questions asked included their idea of an ideal wedding, the emotional as well as tangible experience of the actual wedding, and memories from the event. Interviewees contributed visual material in the form of pictures and videos documenting the various artefacts they attached emotional value to from the wedding. A preliminary survey was also conducted with 8 wedding planners to understand the industry perspective regarding the emergence of conscious consumption due to the force exerted by the pandemic.

Bride 1 discussed her dreams of a destination wedding marred by the pandemic forcing her to settle for a small ceremony at home. She felt having an intimate wedding allowed her to be in the moment. “We did a Zoom link on the wedding morning, which was sent by the parents to different people. We did miss out on a couple of people and felt bad about it but in the circumstances we got married in, it didn't matter. So many people are around in a normal wedding that it gets overwhelming and (you are) obligated to respond to people, you just focus on you,” she explained.

Figure 3. A collage depicting the experience of a pandemic wedding. Clockwise from left: Bride 1 interacts with her wedding guests virtually after getting married in the living room of her house; An image of the virtual *sangeet* (an Indian wedding event) organised by the friends of Bride 1 that went viral on social media; A wedding guest’s idea of recreating the real life “experience” of the event by viewing it with a group of friends using Zoom and Instagram Live.

Bride 2 shared how it was important for her parents to have a large event but she was glad that did not happen. She said, “If there are a lot of people, it is difficult to attend to them. You want to give them good hospitality, but if you have a tighter budget, you can’t.”

Bride 3 was relieved that due to the pandemic, the parents let the couple make most of the decisions, “We got to marry in our dream church, with our close friends and family. This would have never been possible if we had, say about 2000 guests. We would have had to settle for some other church.”

[6] According to most organizations, like the World Bank and the Organization for the Economic Cooperation and Development (OECD), people living on less than US $2 a day are considered poor. For those in the middle classes, the earnings typically lie in the range of US $10 to $100 per day, as expressed in the 2015 purchasing power parities.

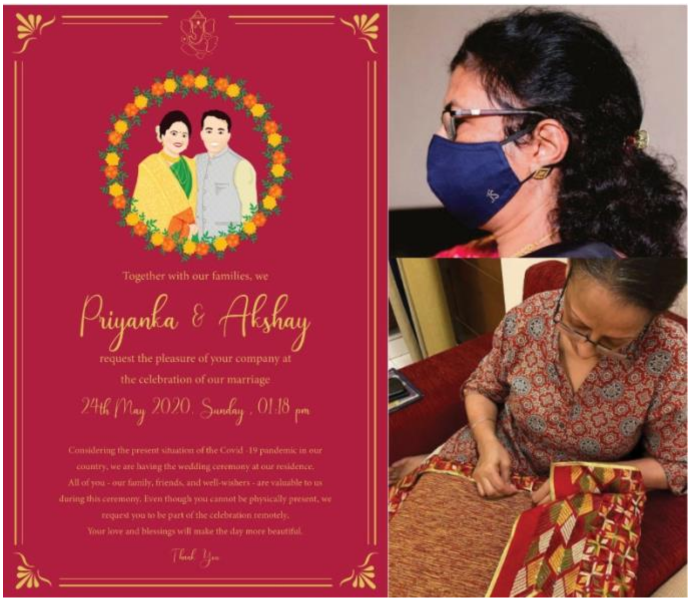

Figure 4. Clockwise from the right: Bride 3's mother hand-embroidered the masks for guests with the couple's initials, Bride 1's mother hand-stitching makeshift cushion covers for her daughter's home wedding, the invitation made by Guest 1 for her best friend's wedding

Groom 1 stated that a wedding in pre-COVID-19 times would never be as personal for him because he has a big extended family that would have to be invited.

Groom 2 mentioned that they did not give much thought to what they wore for their wedding because there was no one to "*see them in that finery*."

All the guests who attended weddings virtually said that they were very immersed despite the many technical glitches in the live streams. Some of them got misty eyed and chose to watch it together in a group in order to create an experience for themselves.

Parents of a bride mentioned how they had always wanted a big wedding for their daughter because it is a social obligation. In retrospect, they felt the wedding was a very relaxed and personal experience for them because they had the time to cherish it instead of attending to guests.

In addition to the *actors*, the *facilitators* - who are a part of the wedding industry at large - also recognised the shift created due to the pandemic. When it came to describing pre-pandemic weddings, the wedding planners used terms like "extravagant," "wasteful," "big fat," "dreamy," "lavish," "experimental," "fad based," "west inspired," "elaborate." In contrast, terms like "simple," "personalised," "intimate," "private," "local," "eco-friendly," were used to discuss weddings held during the pandemic.

While "intimate," and "personalised," were used repeatedly by different wedding planners, the same adjectives were also utilised by the actors and the audience to describe the weddings - a clear indication of the intimacy experienced by different types of performers when they were relieved of the pressure to put up a spectacle.

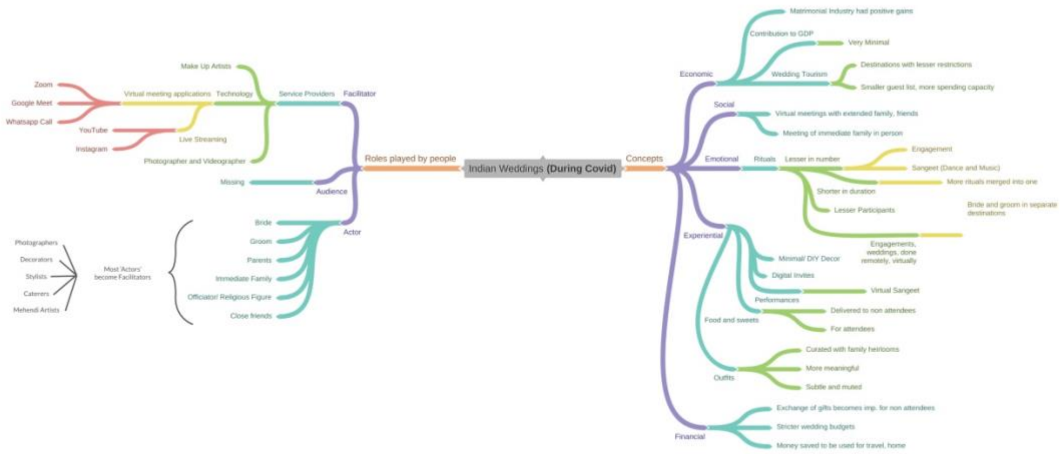

Figure 5. A map portraying the changes in the system of Indian weddings during the COVID-19 pandemic

Findings and Implications

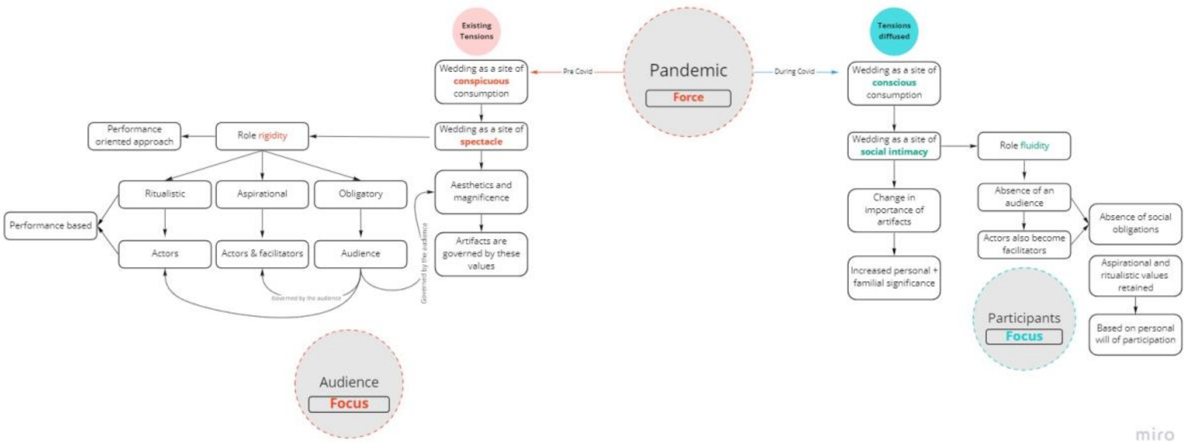

Figure 6. A flowchart depicting the COVID-19 Pandemic as the force that diffuses existing tensions in Indian weddings before and after the pandemic

This paper discusses initial findings from an on-going study. On the basis of the interactions with performers across the spectrum, values linked to a new class of weddings based on conscious consumption can be identified. These values have emerged as a common trend and are meant to inform the experience of performers and the event in a post-covid world.

- Intimacy: Post-covid, the lack of pressure to put up a spectacle and the minimal conformity to roles led to the creation of a newfound experience of intimacy at Indian weddings. Instead of catering to social obligations, couples along with their families were present in the moment, with the *marriage* taking precedence over the wedding.

- Personalisation: Family, friends and the couple DIY-ed various aspects of the wedding, leading to the development of new artefacts. While Bride 1 used her mother's old *saree* for the wedding (elevating the garment to a sentimental value), Bride 3's mother hand-embroidered masks with initials of the bride and groom for every guest. Actions like these not only deepen the experience of intimacy but also fall under the realm of emotionally durable design, developing long-term relationships between people and objects.

- Mindfulness: The experience of mindfulness for the *performers* extended beyond their ability to be in the moment towards the very choices they made regarding the wedding. Downsizing[7] the wedding also downsized the waste that comes with the event(s). Though unintentional, the reduction in scale is an environmentally and economically sustainable choice.

Conclusions and Future Directions

The on-going study aims to understand the development and retention of newfound consciousness in the Indian wedding system. In this paper we have reviewed the theoretical ideas that formed the basis of our arguments, discussed the pre-pandemic as well as during-pandemic values attached to Indian weddings and proposed the values that need to be retained in order to expand the idea of conscious consumption in the system of Indian weddings. However, what happens when an external force like covid-19 recedes - do people go back to old ways of organising these events? The on-going study will continue to (i) document the changes in the wedding as a system by studying more cross-sections of the population, (ii) examine more values attached by performers in an Indian wedding and (iii) devise a system in which these newfound values can be retained by performers in future weddings in order to facilitate conscious consumption.

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[7] On an average, an Indian wedding hosting 400-1000 people results in around 3 tonnes of waste and in some cases even more," informs Veena Balakrishnan, who planned her own wedding as a 'zero-waste' celebration after reading some startling facts on the waste that Indian weddings generate.- **Make your wedding a low waste affair, Times of India, January 2020**

Designing for Pandemic Antifragility in Multimodal Transport Hubs

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The outbreak of COVID-19 demonstrated the fragility of the transportation system and its Multimodal Transport Hubs (MTHs). Global travel reduced dramatically, leading to an existential crisis in MTHs. To cope with the pandemic, MTHs implemented multiple resilient measurements including social distancing, rapid testing regimes, and infrared cameras. Although these measurements are valuable tools, this research advocates to transcend resilient measures and move towards antifragility by applying a systems thinking approach. As Nassim Taleb (2013) defines: “Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same; the antifragile gets better.” Our goal is to contribute to a long-term future of the transportation system by transforming MTHs into a tool to effectuate antifragility during the management of health disruptions.

Keywords: Design for Antifragility, Pandemics & Systems Thinking

Introduction

In December 2019 the world was exposed to a novel coronavirus: SARS-CoV-2 or COVID-19, originating from Wuhan, China. Initially, COVID-19 was perceived as a regional epidemic, comparable to SARS-CoV-1 or MERS, but rapidly spread worldwide. Mid-February 2020, high transmission rates were found in countries worldwide including the Islamic Republic of Iran, Italy and Spain leading to the World Health Organization (2020) officially labelling it a pandemic on the 11th of March 2020. In the following weeks, the global transportation system collapsed, with air traffic hitting an all-time low in Europe on the 12th of April of 2.099 flights; a reduction of 92,8% compared to 2019 (Eurocontrol, 2021).

Although air traffic is slowly recovering, COVID-19 showcased the fragile nature of the transportation system and their Multimodal Transport Hubs (MTHs) in managing health disruptions. MTHs, such as Amsterdam Airport Schiphol, function as the backbone of modern-day transportation by facilitating the consolidation of different global (e.g. aviation), regional (e.g. train) and local (e.g. bus) modalities. Although efficient and economic from an operational point of view, the coalescence of multiple travel flows can rapidly facilitate the spread of diseases on an international scale.

MTHs have been implementing a wide array of measures to mitigate the pandemic ranging from social distancing and rapid testing regimes to infrared cameras. Although these measures offer a degree of pandemic resilience, they often are reductionist measures instead of system-level redesigns. The COVID-19 crisis forms an opportunity for a systemic reinvention of MTHs, making it a tool in managing future health disruptions rather than a spread accelerator.

This paper is part of a PhD-research collaboration between Delft University of Technology and the Royal Schiphol Group. The aim of this paper is to conceptualize the relevance of pandemic antifragility for MTHs and propose directions for future research.

The paper is structured in three sections. Section one elaborates on the pandemic fragilities of MTHs. Section two explains the spectrum of fragility. Section three explores antifragility in MTHs. Finally, the paper ends with a conclusion and proposal for future research.

Pandemic Fragilities of MTHs

Travel is a key accelerator in the spread of diseases. This can be seen throughout history; from the migration of the black plague by Medieval traders over the Silk Road, to troops movement during WW1 for the Spanish Flue and now, international air travel for COVID-19. Rapid technological advancements in global, regional and local modalities in combination with a highly networked transportation system and consolidatory MTHs facilitate quick and accessible travel. This offers great socio-economic benefits, but also significantly increases our society's pandemic fragility.

Currently, this research assumes that the pandemic fragility of MTHs consists of two dimensions: operational and systemic. The consolidation of global, regional and local modalities into MTHs allows for a non-linear spread of diseases, due to the convergence and divergence of global, regional and local travellers. Since managing the convergence and divergence processes forms the operational core of an MTH, we refer to all related issues as 'operational' fragilities. This phenomenon can be observed during the COVID-19 pandemic, where global and regional modalities significantly contributed to its spread (Sokadjo & Atchadé, 2020; Zhang et al., 2020; Coelho et al., 2020). Whether the spread of COVID-19 is mainly due to the transportation of pre-travel infected passengers, to in-travel transmissions or to in-terminal transmissions remains unclear up to now.

The 'systemic' fragilities refer to MTHs as part of a complex and layered transportation system, consisting of a wide range of actors. These actors can be traditional transportation actors, such as MTH owners, airlines, ground handlers, air traffic controllers, security services, transportation ministries and international organizations, but also relatively new actors, such as public health ministries and organizations. Creating and maintaining strong interfaces between all relevant actors during a health disruption, while avoiding misalignment and silo-mentality is a major hurdle due to the complex and niche environment. Failure to do so leads to slow and reactive governance instead of a quick and proactive one. This is undesirable, as time is of the essence when dealing with disruptions.

The Spectrum of Fragility

Since fragility is a central concept of this research, one must have a common understanding of it. Fragility, according to Nassim Taleb (Taleb, 2013), must be seen as a spectrum ranging from fragility to resilience and antifragility. Although nuances can be made between robustness and resilience (Ramezani & Camarinha-Matos, 2020), this research chooses a point of view wherein both concepts are interchangeable.

To explain the spectrum of fragility, Taleb (2013) uses three ancient Greek mythologies (figure 1): The Sword of Damocles, Phoenix and Hydra. The Sword of Damocles portrays a fragile situation wherein Damocles is invited to a royal banquet by Dionysus II while a sword hangs, with one horsehair, above his head. Any disturbance can make the horsehair snap, ending Damocles' life. To generalise this allegory, a fragile situation deteriorates when exposed to disruption. The Phoenix tells the story of a mythical creature that can be reborn, or arise from its ashes, and return to its former state. This illustrates resilience or the ability to resist disruptions and staying the same. Finally, Hydra tells the story of a multi-headed creature that can regrow and double its heads whenever one is cut-off. This is the pinnacle of antifragility, using disruptions to grow, adapt and thrive.

Figure 1. The spectrum of fragility (Taleb, 2013): Fragility & the Sword of Damocles (Westall, 1812); Resilience & the Phoenix (Bertuch, 1806); Antifragility & Hydra (Cort, 1565)

Transcending instead of returning to its former state, is a key feature of antifragility. The antifragile self-improves and transforms by having an active learning capability which is key in coping with disruptions (Taleb, 2013). Note that the distinction between resilience, fragility and antifragility is not binary but a spectrum. Achieving 100% antifragility is impossible.

Towards Antifragility in MTHs

As illustrated in the previous section, the MTHs appear operationally and systemically fragile to health disruptions with COVID-19 being its most recent manifestation. Nevertheless, MTHs are trying to overcome current pandemic fragilities by deploying a wide range of, mostly resilient, measurements, such as social distancing, rapid testing regimes and infrared cameras. These measurements often use a reductionist approach by intervening in problematic parts instead of the transportation system as a whole. Avoidance of addressing the operational and systemic paradigms can make reductionist solutions unsustainable in the long-term.

For example, social distancing is impossible to maintain when having a high throughput of passengers. Rapid testing regimes are only viable when tests are developed for a certain pandemic making them reactive and case-specific. Although currently labelled as inefficient (FDA, 2021), infrared cameras were initially seen as a resilient COVID-19 diagnostics tool. Like rapid testing regimes, infrared cameras are only viable in a reactive way. Closing MTHs during a health disruption might be the logical solution in overcoming this pandemic fragility altogether, but this is difficult to implement and maintain due to adverse social, economic and political effects. The International Health Regulations set by the World Health Organization (2016) reinforce this by stating that "*unnecessary interference with international traffic and trade*"' must be avoided when dealing with the international spread of diseases. Additionally, the closing of MTHs is again a reactive measure, thus not preventing an initial spread of diseases. Note that we are not discrediting resilient measurements but indicating that by deploying them there is a tendency to lose sight of the underlying operational and systemic issues.

Applying an antifragile approach can offer an opportunity in addressing these underlying issues. Throughout the years, antifragile methodology has gained traction and has been, explicitly or implicitly, used in several industries ranging from ICT including Netflix (Tseitlin, 2013) and BitCoin (Ramezani & Camarinha-Matos, 2020); aerospace including NASA (Jones, 2014); and risk analysis (Derbyshire & Wright, 2014). The concept even found its way, implicitly, into airport security (Ghelfi-Waechter et al., 2018). Although explicit precedents of applied antifragility remain scarce, several design principles have surfaced in the ICT industry. Tseitlin (2013) suggests the usage of active failure induction, or a form of red teaming, and combining development and operational teams. Hole (2016) emphasizes modularity, weak links, redundancy and diversity while applying a fail-fast mantra.

This research proposes designing and implementing antifragile methodology in combination with a holistic systems thinking approach applied to MTHs. This approach aims to keep a holistic vision that is broader than the transportation system and also includes for example health, government and security actors. The ambition is to develop design knowledge for transforming the transportation system in dealing with pandemic disruptions. Additionally, a strong emphasis is put on proportional measures when dealing with health disruption ranging between unrestricted travel and closure of MTHs. Other disruptions are currently out of scope, but it is anticipated that pandemic antifragility can be extrapolated.

Conclusion and next steps

MTHs are susceptible to pandemic disruptions due to their consolidatory nature. To counter their operational and systemic fragilities, this research proposes to utilise antifragile methodology and a systems thinking approach. Following the ideas of Taleb (2013) and illustrated by Ramezani & Camarinha-Matos (2020), we propose that efforts must be put into learning, improving and transforming the transportation system so that MTHs can become a tool in managing health disruptions.

This PhD research will explore how to design for pandemic antifragility in MTHs with a strong emphasis on qualitative research. A central and continuously applied methodology is action research. As defined by Greenwood & Levin (2007), action research is a research strategy and reform practice that is used in the field, consists of multiple research techniques and is aimed at creating change and generating data for scientific knowledge. The methodology is highly collaborative and focuses on mutual learning between stakeholders. By applying action research, the PhD researcher is partially embedded in the organization of a large MTH, Amsterdam Airport Schiphol of the Royal Schiphol Group, offering first-hand insights into all its challenges.

As a first study, an in-depth analysis will be made regarding the pandemic fragilities, resiliencies and antifragilities in MTHs during the COVID-19 crisis. This is done by conducting semi-structured expert interviews. During the interviews, experts are asked to talk about their experiences and lessons learned throughout the COVID-19 pandemic. The study focusses on aviation as a global modality, since this modality contributed significantly to the pandemic spread and was heavily impacted. The interviews are conducted with actors inside and outside the transportation industry. It includes experts from MTHs, airlines, ground handlers, travel clinics, public health organizations, health ministries, transportation ministries and security services. The resulting interviews will be top-down thematically analysed based upon fragility, resilience and antifragility (Braun & Clarke, 2006). To determine fragility, resilience or antifragility, criteria by for example Taleb (2013), Hole (2016) and Tseitlin (2013) are used. Additionally, classification occurs based upon experiences being operational and/or systemic, time of emergence, degree of proactiveness, etc. New classification(s) may arise throughout the thematic analysis.

Lessons learned from both interviews and action research will form the starting point for designing antifragile interventions and/or frameworks in MTHs while applying a systems thinking approach. The ideal result would be a range of operational and systemic measurements which offer a proportionate reaction in dealing with health disruptions in accordance with the IHR (WHO, 2016). It is important to highlight that those measurements can be a combination of fragile, resilient and antifragile parts rather than the antifragile being one entity.

To guarantee a degree of antifragility, evaluation of the intervention(s) and/or framework(s) must occur. This is an integral part of the design process. It is anticipated that this will dynamically take place throughout the PhD in relation to the design process. Practically verifying antifragility is difficult and is predominantly achieved by exposing interventions or frameworks to stressors. The introduction of stressors will expose fragilities, giving the opportunity to overcome them and acquire antifragility. This concept of active failure induction, or a form of red teaming, is an avenue of interest in this research. Nevertheless, practical testing is not always possible in the MTH context due to high complexity, security reasons and continuous operations. Serious gaming might offer a solution by providing a qualitative but simulated testbed.

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Track 15:

Analyses Of Language, Metaphors & Narratives

Chair: Dr. Derek Lomas

Gleaning Racial Justice Futures:

Past promises and an unequal present

Hillary Carey, Chris Costes, Mihika Bansal

Visions of the future world we want to create help align people toward change. Such concepts are present within some racial justice advocacy groups. Still, we propose that the work of attaining equity might benefit from more use of future visions as an additional tool toward creating systems change. To understand how visions of possible futures show up in current racial justice work, we analysed the communications of fifteen organizations. We used website content to discern how these organizations describe the worlds they want to build—a technique to gather information without requiring any additional effort on their part. The collect future visions were a small portion of the online material, but they provided rich depictions of systems change. From looking at how organizations described possible futures, we identified themes about future objectives. We found making freedom, health, and safety more accessible for all people to be the most common intention for these futures. This analysis helps us begin to imagine how tools of futures studies might evolve to accommodate justice-oriented world-making. We found that such tools would need to account for the complexity of imagining futures from an inequitable present day: taking account of historic structures and acknowledging the plurality of present-day experiences.

Keywords: racial justice; futures; communication; liberatory futures; design justice

Introduction

Social design movements like Transition Design emphasize collaborative, long-term visions of preferable futures as a tool for enacting complex systems change. These shared, long-term goals can align competing constituents who may find common ground in a longer time horizon and help to overcome resistance to disrupting the status quo (Irwin 2015). As designers engage in community-based, systems-change work, building out visions of the world we want to achieve through long-term social changes can be a strong leverage point for shifting systems (Meadows 1999, Irwin 2015, Tonkinwise 2015, Ramos 2017, Escobar 2018). Such visions of equity, justice, and sustainability can guide and align design interventions in the present by backcasting to identify strategic opportunities to intervene.

Racial equity work is an active and continuous practice in systems change. However, in working toward racial justice in the United States, clear and specific descriptions of what a racially just society might look like are rare. Historian and activist Robin D. G. Kelley implores, “Without new visions, we don’t know what to build, only what to knock down” (2002: xxi). Describing the outcome of such a transition is complex and nuanced. We can draw glimpses of that future from justice-centred organizations and critical race scholars. Yet, as far as a lasting image of a future world, Martin Luther King, Jr.’s iconic “I Have a Dream” speech continues to serve, sixty years later, as perhaps the most salient vision of a racially integrated and equitable world (Washington 1993).

A benefit of bringing designing into social impact spaces is the ability to imagine and explore ideas about the future: “Prototyping, prefiguring, speculative thinking, scenario-building, doing things differently, failing, and then starting all over again are all core components of design education” (White 2020:34). But design, as a field, still has much work to do in learning to work in equitable ways with communities. Being creative about learning from activists in this space indirectly, rather than asking for their time, was a way to practice equity-centred methods. Further, we can learn to adapt design tools toward liberatory engagement as we carefully practice equitable design.

Research Approach: Finding Future Visions

The research described here is part of a more extensive investigation to create methods to engage people in creating descriptions of possible futures for a racially just society. For this project, we, as design students, sought a way to learn from people already working toward change. But in heeding the recommendations of liberatory research methods (e.g., Tuck 2009, Smith 2012, Light & Akama 2014, Noel 2016, Asad 2019), we did not want to ask for efforts from community members without being able to offer a long-term commitment. So, we considered the wealth of information already available to us in the communication materials of organizations working toward change. After studying the scholarship in Critical Race Theory (e.g., Omi & Winant 2002, Bonilla-Silva 2006), antiracism activism (e.g., Kendi 2019, Cullors & bandele 2018), and decolonizing futures (Vieira de Oliveira & Martins 2018, Mitchell & Chaudhury 2020), we began our analysis.

Figure 1. A word cloud generated in the analysis software representing the most commonly occurring words in the website texts relating to the futures they are working toward.

We analysed the communication material (limited to official websites) of fifteen racial justice organizations in the United States working toward forms of anti-racism at the beginning of 2021. We began by collecting a list of fifty organizations identified through a series of incognito Google searches of terms related to racial justice (e.g., anti-racism, racial justice organization). A random number generator selected fifteen organizations from that list to analyse. This process results in a sample set of primarily national, more prominent, more established non-profits; only two of the fifteen were regional. Their missions ranged from targeting specific policies (such as gun violence and immigration) to ending racism in different forms to increasing the representation of people of colour in media.

We began our analysis by establishing a codebook to identify occurrences of future descriptions, built on themes from Critical Race Theory (e.g., structural, interpersonal) and Futures Studies (e.g., prefigurative, speculative). We reviewed the overall layout, visuals, and story of each website. We then captured text from any page of the organization's website that described long-term objectives. The future visions were a small portion of the online material, often only a sentence or two amidst rich descriptions of present-day change. Two researchers coded that text in qualitative coding software (Atlas.ti), identifying sentences that addressed what a future state of society might look or feel like when their work is accomplished. For example, "We commit to this war until racism is abolished" (New Detroit). Or goals to "enable everyone, especially people of color, to be economically secure, live in healthy communities of opportunity, and benefit from a just society" (Policy Link). Or "fighting for a reimagined vision of policing in America— one that limits the scope, power, and responsibilities of police" (ACLU). With those phrases identified across twelve organizations (three did not mention a future vision), we moved to affinity diagramming and visual frameworks to identify patterns in the elements of the future concepts.

Table 1. A list of the coded themes that occurred most often in the descriptions of future visions. They are sorted by the number of organizations that made use of the code. We provide an example quote to illustrate each code.

Coded Theme	#Orgs	Example Quote
Policy	9	"…we envision a world in which children's rights and well-being are protected as they migrate alone in search of safety." (KIND)
Equality	8	"...align our beliefs, actions, and institutions with the principles and values that this great nation was built on. In this, "Life, Liberty, and the pursuit of Happiness" will belong to all in equal measure and without failure." (New Detroit)
Harm	7	"…a world in which no group or individual suffers from bias, discrimination or hate." (ADL)
Past Promises	7	"Unlocking the promise of the nation by unleashing the promise in us all." (Policy Link)
Justice	6	"By virtue of being born, each of us has the absolute right to people-centered humane justice, mediation, resolution and violence prevention." (Dream Defenders)
Term: America	6	"…to fulfill America's promise of a caring, inclusive and just democracy." (Advancement Project)
Term: Future	6	"What's the future we are fighting for? The Freedom Papers illustrates our vision for a world that serves the everyday needs of its people - the one we all deserve." (Dream Defenders)
Race / ethnicity	5	"Protecting net neutrality, stopping government surveillance of black activists, achieving meaningful diversity and inclusion behind the scenes in Silicon Valley." (Color of Change)
Wellbeing	5	"...enable everyone, especially people of color, to be economically secure, live in healthy communities of opportunity, and benefit from a just society." (Policy Link)
Ideology	4	"…the opportunity to create and nurture a new personal life story, a new community story, a new organizational story – a whole new race narrative." (New Detroit)
Police	4	"…a reimagined vision of policing in America — one that limits the scope, power, and responsibilities of police." (ACLU)
Structural	4	"Everyone will have equal access to affordable, high-quality health care, and racially disparate health outcomes will end." (NAACP)
Compassion	4	"…to create a more human and less hostile world for Black people, and all people." (Color of Change)
Economics	3	"We must have an economy based on clean energy and the needs of the many – and not one based on war and destruction." (Dream Defenders)
Power	3	"We envision a future where people of color are free – where they can thrive, be safe and exercise power." (Advancement Project)

Of note was that most of the future visions we identified were familiar rather than speculative or hard to imagine. Everyday futures include phrases such as, "to create a more human and less hostile world for Black people, and all people" (Color of Change), or "We can live in a world where people of colour aren't lost to gun violence and incarceration" (Live Free USA). These are not worlds that are difficult to understand. For many of us, this world is already available. Extending access to justice to *all* people is the crucial aspect that positions this world in the future. A second primary pattern was that most organizations focus on governance issues as a lever for systems change rather than personal or ideological change. For example, the ACLU states, "a reimagined vision of policing in America— one that limits the scope, power, and responsibilities of police." This emphasis on governance connects to an understanding of structural racism that is built into the history of the United States.

Figure 2. One of the affinity diagrams from our research team's online synthesis sessions.

Implications: Plural Presents and Respect for the Past

This research activity revealed that many of the visions of what a racially just future might look like are based on acknowledging the plurality of experiences of the present-day and fulfilling promises of the past.

Plural Presents: Descriptions of the Everyday

Far from speculative, many of the future visions call for a world that already exists for many, but not all. The organizations used instances of the everyday alongside broader and more utopian descriptions of a better world. For example, a comprehensive vision of the future would be "a future where justice is real" (Color of Change). While this vision is powerful, situating actions at the human scale can add realism. An instance of describing the quotidian is represented here: "SONG expects that members will not hinder the self-determination of others through acts of racism, sexism, classism, homophobia, hatred, and intolerance" (Southerners on New Ground). With the latter statement, organizations can begin enacting and prefiguring such a future immediately. A strength that design brings to futuring practices is to bring broad concepts about the future into tangible specificity (Kossoff 2011). To design in the everyday context means creating tangible visions that offer a glimpse of what life could look like in the future (Candy 2010).

However, a potential pitfall for designers when creating visions of daily life in the future is to design for a universal and normative experience. In our current world, situated in modernity, capitalism, patriarchy, and whiteness, it is easy to assume existence within this world is a neutral, shared experience (Vieira de Oliveira & Martins, 2018:106). Social impact designers need to recognize that current worlds are not the same for everyone. In examining common visions of the future in International Relations, Mitchell and Chaudhury (2020) "reject the Euro-centric notion that there is 'a' or 'the' single future, just as we reject the notion of a single world, now or never" (p. 310). In the same way, when designing for the everyday, designers need to be mindful that they are not creating realities that work to secure a "Eurocentric," "white-centred" everyday. It is crucial to consider how a future vision centers the voices of those that live on the margins and creates an equitable future (Ortiz Guzman, 2021). Does it work to secure a hegemonic future or establish a vision of diverse, multiple worlds?

In social justice work, where inequality and structural oppression are in primary focus, we need to take care to ask whose present is centred and cared for as the starting point for these visions of the future. Throughout the organizations' websites, there is an emphasis on creating a safe world for everyone, where all people live free from gun violence, where everyone can see themselves represented in media and board rooms. The NAACP website speaks of human needs: "Every person will have equal opportunity to achieve economic success, sustainability, and financial security." This future vision is necessary because those worlds do not currently exist for all people.

Reckoning with the past to make space for the future

History defines the nature of the futures in progress in the visions we collected: the goals, limits, and whose experience receives attention. However, there is less time spent considering the past and its influence on the future within most design practice. For example, designers have adopted the Voros Cone (Hancock & Bezold 1994; Voros 2003, Dunne & Raby 2013) to map the many ways futures might unfold from the present. However, this model doesn't incorporate experiences or perspectives of the past— variables that might dramatically shift the cone's layout were they to be included (Kozubaev et al. 2020). The organizations we studied not only consider the past, but their futures directly reckon with it.

Many organizations call on language from America's foundational claims of freedom and equality to shape the purpose and structure of the future they work toward. For example, Advancement Project seeks "to fulfill America's promise of a caring, inclusive, and just democracy," the language of fulfilling a promise explicitly identifies the uneven distribution of these *common* freedoms. Policy Link also considers the importance of the past, "It requires that we understand the past, without being trapped in it... This is equity: just and fair inclusion into a society in which all can participate, prosper, and reach their full potential. Unlocking the promise of the nation." These organizations imagine that the future can be a world that upholds the vows of the past.

Design has begun to explore methods reconciling the past, such as the ways that Transition Design incorporates the Multi-Layer Perspective (Geels 2005) and Causal-Layer Analysis (Inayatullah 1998). It is essential to see that while there is a value in creating a new world that expands on current freedoms, the communication explored here reveals the priority of resolving the past. The wisdom of these visions comes from people embedded in the struggle, where the violence of the past is still present in the everyday.

Next Steps

This research project is the beginning of several possible research strands. It would be fruitful to repeat this analysis with a set of local organizations to identify a wider variety of types of intervention and action than the national set we collected for this project. Additionally, we will begin conducting interviews with racial justice organizers to understand their internal use of future visions, information not captured by our study of public-facing communications. Ultimately, our research will facilitate organizations to develop their own visions of the futures they want to achieve and to make those visions feel vivid and tangible.

Conclusion

These findings may help shape how social designers draw inspiration from people who are already doing important work. Analysing websites is a way to learn from the community without asking for more labour. This research revealed how much inspiration can be found from secondary sources, even in issues as current and applied as racial justice. Even in this small set of visions, essential questions about design futures arise: How is the past included? Do we recognize multiple everyday experiences? Futures Studies should seek to develop tools and processes that are more appropriate to social justice projects.

We see racial justice organizations as collectives who are actively practicing the application of theory and action. These organizations are on the ground, persuading others to work towards systems change through their calls for equitable everyday lived experiences. We hope that design futures practice can demonstrate the additional value of motivating people through visions of the better world that is possible.

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After Work:

questions concerning transition imaginaries towards a post-work society and the use of second-order design fictions as frames that resist consensus

Dulmini Perera

The consensus among various stakeholders of society that automation will influence the future of work has risen considerably in the post-Corona context. Nick Srnicek and Alex Williams, who are critical of how a minority uses consensus about facts to maintain an existing common sense (a fiction) around the concepts of work and labour. This requires a new common sense collectively established via the workers whose very work lives are at stake within these post-work futures. In their call for a 'new common sense,' they undermine the problems related to 'difference' in sense-making processes when working with systemic(wicked) issues, particularly the struggles of the stakeholders with conflicting value systems and problematic mental models trying to make sense of the transformation process in which they are entangled. The project "After work" addresses the need to look at sense-making and difference not by appealing to common sense but rather by addressing the elements that do not make sense and cause tensions within the system. Second-order Design Fictions (SoDFs), with their ability to frame 'fact' and 'fiction' in a complex manner, are introduced as a methodological tool where the stakeholders can frame and reframe the differences as it appears as tensions within the transformation.

Keywords: wicked problems, difference, change, innovation, Second-order Design Fictions

Introduction

The Church of Work is a Tarot card set that provokes stakeholders to question tensions within their long-time relationship to the institution of work and visualize possibilities of reframing the notions of 'progress' and 'work.' *The Creatives*, an interactive story, invites the readers to explore the semantic confusions regarding terms labour and work. The interactive format allows contradicting futures to exist within the same story. Readers are invited to follow the decisions of the creatives who decide to use the automated future and the Universal Basic Income to develop a new model of creative life. *The Take Times*, a newspaper from the future, describes conflicts of the post-work future and invites one to reflect on how one would interact with news if a workweek consisted only of three days of work. *It's About Time* is a board game where time is exchanged at a time tribunal. The players experience other narratives of time existing simultaneously, which are at present overridden by capitalist time. *Vacation Images of the Everyday* uses postcards to invite people to think of how automation systems have helped them rethink free time and vacation time within everyday care practices. *Domestic Ecologie*s is a "post-it play kit" that helps one reframe their relationship to household objects and the common-sense fictions built around them. Each of these projects presents frameworks that generate playful interactions, identified as second-order design fictions. How can second-order design fictions enable multiple stakeholders to make sense of the processes of transformation (second-order change) they are intrinsically part of while contributing to the invention of a future that comes after work?

In this paper, I will discuss why a nuanced approach towards notions of 'difference' and 'change' is needed when making sense of transformational processes that requires paying attention to elements that create tension in the form of contradictions and paradoxes. Using the concept of second-order design fiction (SoDF) in the context of 'automation' and 'after-work' discussions, I will discuss what this might mean in practice. While the complex relationship between 'fact' and 'fiction' is often misused within the current neo-liberal design logic, SoDF provides an alternative way of working beyond neo-liberal common-sense fictions around technology, work, and progress.

After work imaginaries: problematic mental models and challenges

There is a need to problematize the fears of a post-work future, to make apparent and bring into public discourse what these technological changes (particularly the notion of automation) mean in the context of everyday work life. Srnicek and Williams (2015) have argued that the current hegemony of neo-liberal work models is supported by an ideological infrastructure set in place by a few elites who benefit from the neo-liberal models of work and labour (Srnicek and Williams, 2015). Common sense, or predominately the neo-liberal common sense, is identified as a "fiction" developed carefully via the ideology of a neo-liberal market system. They insisted that a new common sense should be found by those omitted from the current discussions (workers), and that the new common sense should act in a counter-hegemonic manner making way for a necessary transformation (Srnicek and Williams, 2015). Highlighted here is also the fact that a counter-hegemonic project requires an active speculative mode of operations and not only a critique. They depart from the more traditional modes of negational criticism that see 'machines' and 'automation' as problematic categories that lead to alienation. Instead, a post-neoliberal work model is only possible by embracing these systems and working within the systemic complexity brought forth through such automation processes. Srnicek and Williams seek to advocate for a new understanding of work via addressing human relations (labour relations) with technology (Srnicek and Williams, 2015). They also suggest that existing technological infrastructure must be repurposed to free them from the way they objectify unequal power relations. Part of the task of a counterhegemonic project is to reframe these systemic complexities and place them within a participatory framework so that "workers involved in the technology sector who are, through their design choices, building the terrain of future politics "(Srnicek and Williams, 2015, p. 153) may be able to take part in this repurposing project.

Srnicek and Williams (2015), in their demand for a model of change, ignore that such a process would require a left (or in general workers) that understands technology, values design, and identifies design as something not limited to mere objects (Baker, 542). Their argument pays significant emphasis on counter fictional (utopian)imaginaries that can provide visions for a radical change while undermining the contradictions and tensions that emerge within the process of change itself (second-order change). These limitations arise due to how they address the concepts of 'universalism' and 'difference' within their strategy. They are critical of the universalism of the modern narratives of progress and work. However, they argue that universalism can come to occupy differences (specific demands, ideals of the minority). Within this response, they do not move beyond the dialectics of the hegemonic vs. the counter-hegemonic project. Donna Harraway (1991) hints at the danger of a "counter" which is part of a dialectical strategy that either produces a negation or another level of resolution, which though useful in some instances may not necessarily suit the task of reframing complex systemic relations without ending up with a universalism that reduces difference or essentializes certain normative categories within the system. The necessity to move away from dualisms and the need to maintain the permanent partiality of limited views is emphasized as a mode of working through the complex relation between complex technical and human systems (Harraway, 1991). The participatory project of developing a new commons sense(fiction) as suggested by Srnicek and Williams (2015) remains problematic particularly in the ways they ignore the conflicting mental models both at the personal level (fictions one would tell oneself and related value frame works) and collective state / institutional levels (fictions constructed by institutions and related value frameworks).

The COVID-crisis has disrupted the conventional common sense (fictions)around three problematic and entangled conceptual areas related to work. Namely, the distinction between work and labour, mental models related to automation and machines, and the notion of free time as opposed to work time. First, there needs to be a considerable discussion beyond an academic one that addresses the semantics of work and labour and how they intersect with questions of value and meaning. What does one mean when one uses the terms work and labour? How do these terms relate to notions of automation? Questions such as care work and creative work that belong to immaterial work must be addressed with more attention and placed at the centre (Hester, 2016; Graber, 2016). Second, there needs to be a better understanding of automation and machines and what these words mean within worker's imagination. For most stakeholders, automation conjures the idea of an industrial machine or a solid object such as a coffee machine, a ticketing machine. What is often omitted in this discussion or imaginary is the understanding of "automation as a process" (Hui, 2017; Bratton, 2019). Yuk Hui (2017) highlights the significance of exploring Karl Marx's notion of "fixed capital" in the context of contemporary automation processes, which is radically different from the industrial machines that were implicated within the original theory. The investment in fixed capital can reduce necessary labour time and increase both surplus labour and value. Free time in the original theory is understood as both idle time and time for higher activity (Marx, 1967, as cited in Hui, 2017). Yet Hui (2017) reminds us that fixed capital is always *double*. It is capital for capitalists (who then extracts the surplus value) but also tools for workers (tools which in turn creates psychosomatic relation with the workers and extends beyond a factory). The way capital is framed within the counter- hegemonic project envisioned by Srnicek and Williams (2015) is reductionist as it reduces automation to something that only relates to work environments. Nevertheless, automation is everywhere and has become radically environmental via smart technologies. In other words, one cannot reduce the capitalist work narrative only to the worksite (factory/office). Automation understood in this way then forms an ecology (Bratton, 2019). Benjamin Bratton (2019) further elaborates how this radical environmentality functions where action (work process) and sense-making itself is coded into complex adaptive relays running through living bodies and non-living systems. As such automation encodes abstractions that then persist through generations and result in narrow purpose instruments that become norms within the operation of these systems (a language, a work schedule, a formula, a bias). Eubanks (2019) has highlighted how previous faulty abstractions get embedded within the service systems as a given part of a niche that are implicitly applied within decision made about stakeholder futures.

Bratton (2019) suggests how within such a context discursive consensus driven politics loses relevance as a reference model as it is impossible to locate these contexts across place and time. While there are many attempts at inviting the stakeholders to co-deign the systems to get rid of these faulty norms, studies such as that of Bath (2014) indicate that as long as the participants of the co-design process maintain certain faulty mental models these faulty values can reappear within the system regardless of the multiagent design process. More design work is required to help workers shift the consensus around faulty mental models surrounding the ideas of how automation functions as a complex ecology. Third, (Hui, 2017) highlights how equating free time from work with playtime, becomes problematic within such a model of automation. He highlights how contemporary machine systems allow playtime to be converted to broader projects of self-optimization and other forms of profit generation. Hester (2016) extends this argument to questions concerning domestic technologies and reproductive labour and how this has resulted in some instance not in simplifying domestic labour but instead added to higher value standards of domestic work accomplishment and in turn requires more work to be performed within the extra time. As such looking at the tensions relating to the various modes of experiencing time, particularly capitalist vs. other systems, rethinking linear time narratives associated with progress is particularly necessary to explore absurdities in the system.

Beyond common-sense: Sense making and the limits of methodological tools

Perera (2020; 2021) has explored the relevance Horst Rittel and Melvin Webber's (1973) work on second-generation methods for exploring difference within the sense-making processes in the context of wicked problems. She suggested that exploring such difference also meant the incorporation of tensions in the form of "the many components that do not seem to fit together, elements of a system that does not have a recognizable pattern, differences in different voices, differences within and across one's senses"(Perera, pg. 190). While Rittel and Webber's (1973) work has been particularly helpful in exploring differences broadly via co-design and participatory frameworks, Perera (2019) highlight that the 'conversational' element in itself does not guarantee towards the formation of new value frameworks that escape previously established normative systems. In other words, it is suggested that such conversations via too much focus on consensus run the risk of developing a new consensus that tends to repeat faulty values (Perera, 2020; Sweeting,2019). Berg (1995) and Bath (2014) have exposed this replication of faulty values within participatory projects by using case studies related to domestic technologies and automation. Drawing from Gregory Bateson's notion of 'play,' Perera (1999, 2020) suggested how a communication frame could act as a playframe that can aid towards a transition in value frameworks when the communication frame allows for reframing the tensions, paradoxes that emerge within the second-order processes of change so that these elements can be reintroduced to policymakers and the general public. Within this model 'this is play' does not refer to the act but the setting up of the 'frame'.

The problem of 'good sense'(common sense) is that it equates sense with categorical identification and posits sense as a superior condition of a possibility of truth (Perera, 2020). In play, concepts exist at more than one level of abstraction. The play frame invites different levels of communication to coexist. When one is free or open to these 'othered' components, one can slide between concepts transversally. The playful functions as something that works against agreement formation within the information model or anything that blocks a system from adapting to change. The playful works by continually unpicking consensus while simultaneously allowing it to be remade as required. It allows the system to open for second order change to prevent previous consensuses (common sensical fictions) from becoming part of the present problem. Play, or the 'play frame' that sets up a meta- communicational framework can take many forms. Second-order Design Fiction as identified within this project is an example for one such form that the 'play frame' can take.

Second-order design fictions: communication frames that reframe tensions

Dunne and Raby (2014) and Julian Bleecker (2009) have in their respective discussions outlined how design fiction (DF) and related "diegetic prototyping" methods can provide a helpful communication frame that allows exploring the complex relationship between fact and fiction. Design fiction acts as a communication device between the innovation industry and the public, creating feedback between the two systems. Taking from the facts in the industry and converting it to fiction, DF's propose possible future directions of technological developments to the public. Based on how the audience receives the fiction, the DFs propose to the innovation industry what set of facts matters. Nevertheless, in think-tank settings, design fiction is often used to diegetically speak about and advance a particular idea of futures (change) at the expense of others. Fictions are used to create a new consensus around technological products that appear as potential solutions. In addition, these diegetic prototyping practices often pay insufficient consideration to the "de-futuring causality," the idea that selecting a future, in turn, de-futures other possibilities (Fry, 2019; Fry and Perera, 2021). The SoDF as a play frame attempts to work beyond the deficiencies of the DF and address the complexities inherent to understanding questions of technology (automation as ecology) and the transformation process in the following manner.

1. SoDF's attempt to de-link design fiction with market-driven narratives of innovation exposes the insufficiency in how concepts such as work, progress, futures, and technology are defined within familiar institutional and organizational contexts. SoDF is a critique against what Vinsel and Russel (2020) have identified as the problems of "innovation-speak." Innovation-speak posits difference as the generation of the new, and that the new is inherently good, and the task of progress is to move fast and keep producing things constantly. Innovation functions as the proxy for values perceived to be lacking in society. In automation, one sees this as a suggestion of technological solutions to profound social problems leading to a devaluation of maintenance and care as an essential aspect of work. (*Vacation Images of the Everyday* and *Domestic Ecologies* are good examples where the SoDF allows to reframe these common-sense fictions and therefore reframe the stakeholders' relation to the notion of automation in the contexts of domestic environments).

2. SoDF is not only focused on change but instead pays considerable attention to second-order change. Second-order change considers how technological changes become embedded within contexts. When design fictions are focused on change, they prioritize 'disruptive innovation' as an essential condition of progress and promotes disruption for the sake of progress. The effects of the destruction caused by the speed of market- innovation to the ways of being and the problematic ways these changes affect the stakeholders are ignored. These disruptions cause most tensions within the sensemaking process of the stakeholders. SoDF as a play frame addresses these things that are other to the established logical categories and help reframe these tensions that later appear as contradictions, paradoxes within the transformation process. SoDF then assists the stakeholders to reframe their relation to the change itself.

3. SoDF can be used to dismantle the faulty notions of a 'technological universal' that are often implicit in automation and change discussions. Allowing stakeholders to work with SoDFs, in turn, will enable them to deal with the enablers and constraints of the contexts in which these technologies are used and situated and allows a respectful engagement with these multiple ontologies.

4. SoDF is not the name given for a product. It is a method of making the problem present. SoDF assists in reframing the relation of the stakeholders to the process of design and question their relationship to established fictions. As shown in the examples, the setting up of the SoDF frame can be done in the most suitable medium for the community where the facilitators are located. The facilitator works within the

community to identify the most appropriate medium for working with these common sense fictions. Finding that medium, is a part of the challenge of developing SoDF's. Some communities can work with playful dialogue reflection (ex: the interactive story form of *The Creatives*, the newspaper in *The Take Times*). Some communities may not have time for verbal exchange but would be willing to interact via short written comments playfully (post-it kits in *Domestic Ecologies* used in student housing, in the project *Vacation Images of the Everyday* postcards were placed in all forms of public spaces). The Tarot-card kit is a possible example of working with stakeholders who hold radically different ontological presuppositions of time and space (ex: non-linear time).

5. The SoDFs assist in reframing significance of the second order task of constantly reframing design's relationship to change and questioning the role of technology within the process particularly when dealing with systemic issues. SoDF invokes a recursive mode of continually exploring difference, helping the stakeholders create a design conversation (internal or with others) about automation and value, and designing a meta-framework for a continuing conversation on the changing nature of those values (Dubberly & Pangaro, 2019). Second order design fictions matter not because they provide blueprints for a future after work, but rather help work through the unresolved tensions of the present while working towards post-work futures.

Figure 1. Rethinking archetypes related to work. The church of work, © Victoria Grossardt.

Figure 2. Past, present and futures of work. The church of work, © Victoria Grossardt.

Figure 3. Dismantling the church of work, rethinking institutions. The church of work, © Victoria Grossardt.

Figure 4. A newspaper from a post-work future. The Take Times, © Lara Schuster.

Figure 5. If you had more ‘free time’ would you read newspapers differently? The Take Times, © Lara Schuster.

Figure 7. What kind of news is produced in an after-work future? The Take Times, © Lara Schuster.

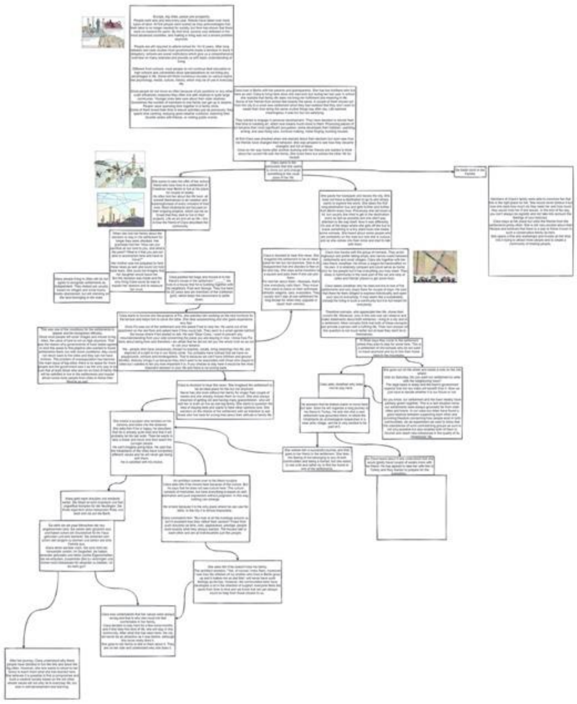

Figure 7. tensions as multiple storylines. The Creatives, © Egor Gavrilov.

Figure 8. A programmed version of the interactive story .The Creatives, © Egor Gavrilov.

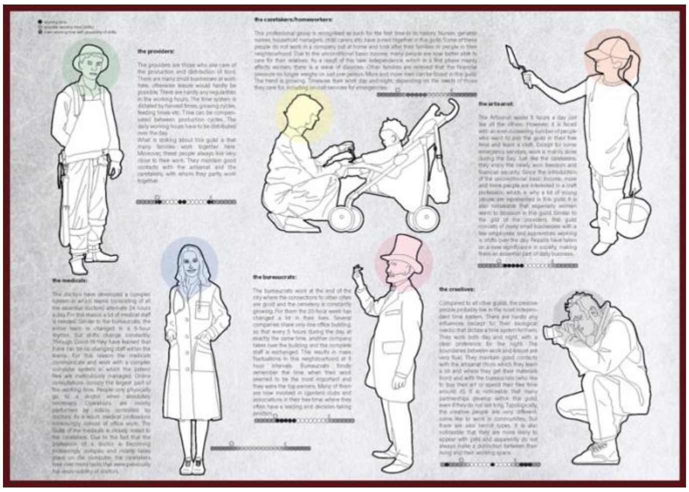

Figure 9. ontologies of time within different social guilds in tension with neo-liberal time. It's about time, © Zoe Pianaro

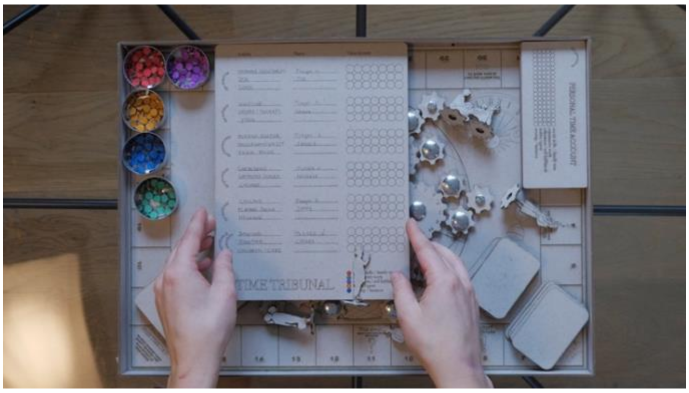

Figure 10. Time tribunal. It's about time, © Zoe Pianaro

Figure 11. Establishing a functional system via trading time. It's about time, © Zoe Pianaro

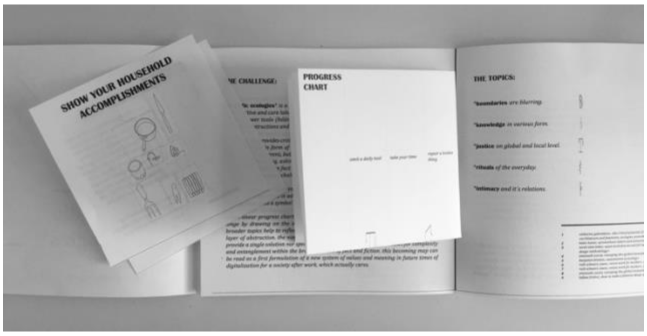

Figure 12. Post-it kit and non-linear progress chart. Domestic Ecologies, © Leonie Link

Figure 13. Playing the 15 days post it challenge. Domestic Ecologies, © Leonie Link

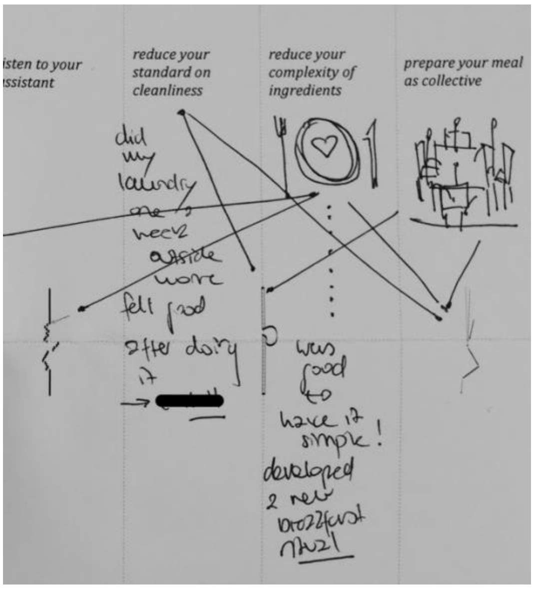

Figure 14. Recording daily progress within the non-linear progress chart. Domestic Ecologies, © Leonie Link

Figure 15 Postcards in the patients waiting room. Vacations images of the Everyday, © Jasmin Chu

Figure 16. Postcards in the bio-market. Vacations images of the Everyday, © Jasmin Chu

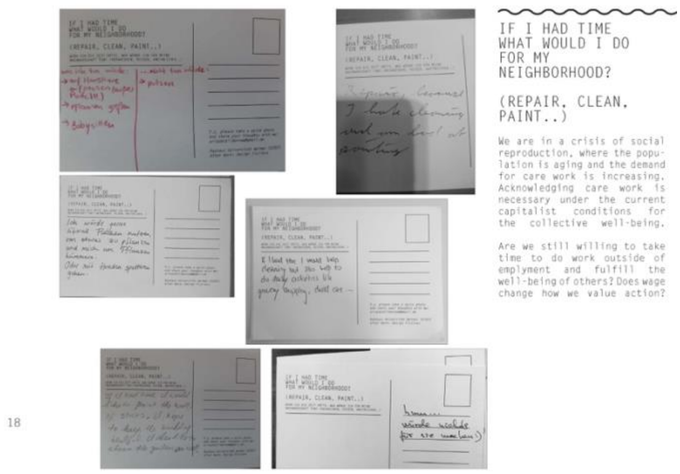

Figure 17. Recordings of responses and discussions. Vacations images of the Everyday, © Jasmin Chu

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Metaphors and Systems

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A variety of metaphors are commonly used in systemic design to make abstract concepts more concrete, externalised, and engageable-with, to enable constructs to be discussed and dealt with, and to generate new ideas. This practice builds on a long history of metaphor use in systems theory and cybernetics, and can involve a focus on language, drawing and diagrams, or physical modelling, among other approaches. However, the implications of common metaphors used in systemic design have perhaps not been elaborated and examined. This short paper proposes a discussion and activity over the course of RSD10 in which conference participants contribute and reflect on metaphors in use, tacitly or otherwise, and consider the possibilities offered by alternatives.

Keywords: metaphors, systems, design

Figure 1. *New Metaphors* (Lockton et al, 2019b), exhibited at RSD8, includes a range of metaphors which can be used to illuminate abstract properties of systems, from ‘things growing on things’ to ‘finding a niche’.

Systems and abstractions

We know that systems don't exist. Well, we act as if they do—otherwise what are we doing here?—but we also know that the idea of a system is a construct[1], an abstraction, a fiction which helps us model, understand, and grapple with the often invisible but nevertheless important relationships between things, static or dynamic. The 'things' themselves are often (or always, depending on how radical you are) also constructs, of course. We know that "all models are wrong" (Box & Draper, 1987: 424), but we also know that we cannot avoid modelling in order to deal with and make sense of the world. We know that our system maps are not the territories themselves, but as systemic designers we are also acutely aware of the extent to which the choice of scale or complexity or degree of abstraction in our maps in some ways 'creates' or reifies that territory. A box—black or otherwise—labelled on a diagram becomes a stand-in for what it is labelled as, collapsing complexities, histories, interpretations, fuzziness, into a unit which can be manipulated, connected, treated as real. Nold's (2021) distinctions between dualist & structuralist, and socio-material & post-structuralist ways of approaching systems in design are relevant here.

Systems modelling can bestow affordances upon ideas which they perhaps would not otherwise have: they become variables to be quantified and measured and managed[2]. Whether we make distinctions between entities or treat them as the same thing, introduce hierarchies or not, and where we draw the boundaries, are all important questions. While some disciplines dealing with abstractions seem to get by through tangling themselves in exhausting linguistic and semantic games, and others tend towards tight definitions which enable even algebraic manipulation, design has a somewhat different approach. Designers (tacitly or explicitly) often work through turning imagined ideas into something real, or at least engageable-with. A gigamap or physical model of a system can enable stakeholders to point to, and discuss, abstract concepts alongside 'real' ones, just as a design concept or prototype can turn invisible ideas into something tangible that people can respond and react to.

Metaphors: from abstract to concrete

The designer's toolbox is full of methods for translating the abstract, invisible, and constructs into varying degrees of concreteness. One of the major ways in which this translation happens is through the strategic use of *metaphors*, initially often used by designers to introduce people to new things (types of product, modes of interaction) by giving us a link to something we already understand. Over time they can become so familiar that we no longer think of them as 'metaphors' any more—do we even notice the metaphorical dimensions of desktops and windows and folders and files? What about breakout rooms, the cloud, feeds, threads, forums, the net, browsers, the web, websites, or the notion of a 'site' itself? As with other kinds of models, metaphors are not the thing itself—they are always an abstraction or a concentration on some features to the exclusion of others. The choice of metaphors has implications, connotations, complications and implications—it is never a neutral choice. Nevertheless, if these limitations are borne in mind, metaphors can be used as a kind of disruptive improvisation technique for helping us think differently and reframe issues. The *New Metaphors* card deck (Figure 1) which my students and I created (exhibited at RSD8) is one approach, which has been applied to areas including robots (Alves-Oliveira et al, 2021), health decisions (Kirchner et al, 2020), and augmentative and alternative communication (Valencia et al, 2021), but there are many others (e.g. Hurtienne et al (2020), Mothersill & Bove (2019), Gero & Chilton (2019), Logler et al (2018)), working at various degrees of 'system-ness'.

While thinking metaphorically can be useful for idea generation during design processes, it is at the more systemic levels of characterising (and reframing) the systems we are in where there are perhaps more transformative possibilities. From transitions, pandemics, and climate crises to mental health and social justice, many challenges facing humanity today and in the future are complex, involving relationships and time-scales which are difficult to understand and represent in simple terms. By mapping features of an existing or familiar situation onto a new or unknown one, it can make it easier for us to grasp it more quickly, and to understand where leverage points (if that is the right metaphor) might be; or, in a less instrumental way, give us a more nuanced understanding of the system: here, different metaphors can be kinds of *lenses* for viewing or examining systems in different ways (Lockton & Candy, 2018). Exploring the metaphors that different stakeholders or participants in a system *currently use* to make sense of it—or creating tools to help express those metaphors,

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[1] It's interesting to consider that 'constructs'—and the idea of constructivism—are perhaps metaphors in themselves.

[2] Sometimes described as the reification fallacy. Scott (2019: 100) notes "our proneness to… assuming that anything that has a name must exist or have a definable *essence*".

whether physically (e.g. Rygh, 2018), through methods such as drawing (e.g. Bowden et al, 2015), or through language (e.g. Inayatullah, 1998; Dudani & Morrison, 2020) can be a valuable first stage of a participatory process, and surface and reveal different understandings, experiences, and assumptions as part of perhaps conversational approaches—for example, Vink's (2017) work on the metaphors people use around design itself.

Exploring metaphors and systems

Metaphorical thinking has a long history in systems theory and cybernetics, including the cultural and anthropological approaches of Margaret Mead and Mary Catherine Bateson (1984), and the more often ecologically inspired metaphors explored by Gregory Bateson (1972) and more recently Nora Bateson (2015) (and in a quite different context by Beronda Montgomery (2021) among others). Gordon Pask (1975: 13) discussed the importance of "establishing isomorphisms", i.e. correspondences in structure between systems, making cybernetics "the science or the art of manipulating defensible metaphors; showing how they may be constructed and what may be inferred as a result of their existence". But we might think even more fundamentally: the etymology of *cybernetics* as a term itself is rooted in the metaphor of a ship's helmsperson, in the same was as *government*[3]. Table 1 shows a few metaphors in common use in systems terminology. Quite apart from the metaphor of 'playing with tensions' as the theme of RSD10 itself, within the RSD community, the diverse range of explorations of systems and how to describe, visualise, characterise, and influence change within them has included some excellent work using metaphors, analogies, and related concepts to help illuminate and communicate.

Among notable examples: Boehnert's (2018) work on the visual representation of complexity offers a vocabulary of icons representing systems concepts, many of which have a metaphorical dimension, including tipping points, stability, and path dependency. Stoyko's (2016, 2019) ambitious SystemViz Codex includes a huge variety of metaphors for properties and features of systems, ranging from parasitism and cruft to liminality, mutation, goal drift, and noise. Silverman and Rome (2018) propose "imagin[ing] by analogy" as part of their regime shift canvas; van der Velden (2017) explores how Kate Raworth's (2017) popular 'doughnut economics' metaphor applies in a systemic analysis of mobile phone lifecycles; Peter (2018) applies the metaphor component along with other parts of Inayatullah's (1998) causal layered analysis to economic systems; Snow (2018) compares how the application of metaphors from biology and metaphors from physics to economic systems inform different kinds of visual models; Ruttonsha (2018) uses the metaphors of tension, targets, traction, and embodiment to examine cities as part of a relational dynamics approach.

[3] *Fundamentally* and *rooted* are also metaphor, even if we don't notice, as Lakoff & Johnson (1980) might have pointed out.

Figure 2. A 'tangible thinking' model of (inter)disciplinary challenges, constructed by participants at RSD8 (Lockton, Brawley, Aguirre Ulloa, Prindible, Forlano, Rygh, Fass, Herzog, and Nissen, 2019a).

The 'tangible thinking' approaches taken by Rygh & Clatworthy (2019), Aguirre Ulloa & Paulsen (2017), Fass (2016), Metzner-Szigeth et al (2018), Ricketts & Lockton (2019), Lockton et al (2019a; Figure 2), and Luria et al (in press) also, explicitly or otherwise, make use of metaphors as a way to translate or reify abstract systemic concepts in forms that can be shared and in some cases collectively constructed, from topological metaphors such as landscapes (e.g. Ricketts & Lockton, 2019) to relational metaphors such as material properties (Aguirre Ulloa & Paulsen, 2017), to performative metaphorical approaches where elements change over time (e.g. Fass, 2016).

Discussion: Towards a menagerie of metaphors for systemic design

While I am wary of trying to formalise or systematise(!) the variety of approaches to metaphors and systems into anything claiming to be a 'definitive' **framework**, it seems as though it could be useful for the systemic design community to **reflect** on the ways in which we use metaphors, consciously or not, partly to **support** some **cross-fertilisation** of ideas and approaches. For example, if (as I have also done in the sentence above) we take this extract from the RSD10 conference theme, and highlight some of the metaphors used…

> "The main conference theme **explores** design and systems thinking practices as **mediators** to deal **fruitfully** with **tensions**. Our human tendency is to relieve the tensions, and in design, to resolve the so-called **"pain points."** But tensions reveal paradoxes, the **sites of connection**, **breaks in scale**, **emergence** of complexity. Can we **embrace** the tension, the paradoxes as **valuable** social **feedback** in our **path** to just and sustainable futures?"[4]

…each has consequences and connotations if we act as if they are real rather than abstractions. What are the implications for our work as designers if we use these kinds of metaphors as starting points, as opposed to others? Would our approach be different if (for example) we used a different metaphor to capture the idea described here by '**tensions**'? How does something like the notion of a **path** to just and sustainable futures fit (or not) with other ways of thinking about futures?

With this short paper, I propose a discussion, and an activity over the course of RSD10, in which conference participants contribute and reflect on metaphors in use in systemic design, tacitly or otherwise, and consider the possibilities offered by alternatives. I would then like to invite anyone who is interested to work together on exploring and making sense of the metaphors contributed, to produce a more substantial paper together which clusters and teases out some patterns and possibilities, with the aim of producing a useful reference or tool.

Table 1. A small selection of metaphors in common use in systems terminology (of course, there are many, many more)

soft and hard systems	loops	feedback and feedforward
layers (pace layers, shearing, other)	knots and double-binds[5]	leverage points
horizons and foresight	paths	frontiers
transitions	landscapes	connections
forces	emergence	networks
stability and equilibrium	black (and white) boxes	goals and targets
boundaries	circularity	steering
nested systems	maps	probing

[4] http://rsd10.org/call-for-papers/ (accessed 24 May 2021)

[5] As I tentatively explored at RSD7 (Lockton, 2018)

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Making metaphors matter within SOD

Palak Dudani, Independent Designer - Researcher

This paper builds on the theme of tensions by focusing on the sub-theme of 'Value Conflicts'. The role of values and worldviews within complex systems is exemplified via the use of metaphors for associating with, embodying, materialising, diversifying and probing aspects of complex systems in relation to design work. The paper takes a relational and reflexive view on systems oriented design (SOD) and is based on an explorative study conducted as part of a systems oriented design master thesis project. The study looks at the Norwegian housing system and explores the systemic complexities by engaging a diverse set of stakeholders. The paper highlights how the use of metaphors contributed to the critical systemic enquiries in the study and supported the author's SOD explorations in imagining alternatives within housing in Norway.

Keywords: Metaphors, Systems Oriented Design, Reflexivity and Relationality, Diverse Actors, Values & Worldviews

Introduction

This paper builds on a design master thesis study at Oslo School of Architecture and Design. The study looked at the Norwegian housing system and its complex relationship with welfare policies, market economics and impact on overall citizen wellbeing. It focused on rental market and its tendencies to create long-term vulnerablities for certain residents. (Dudani, 2019a) Situated in Tøyen Gronland, an immigrant majority residential area in Oslo, the study engaged a diverse set of stakeholders such as renters, public housing residents, municipality players, housing cooperatives and associations, researchers, policy and legal experts and urban designers among others. The aim of the study was to explore the complexities, tensions, and concurrences between the interpretations, values and worldviews, and speculate a systemic design response that proposes alternative imaginations. This paper highlights the role of metaphors in enriching the understanding of the complex systems and supporting new pluraliversal imaginings.

Metaphors, Systems and Design

In Contemporary Theory of Metaphor (1992) Lakoff describes "the word metaphor was defined as a novel or poetic linguistic expression" however "[...] the locus of metaphor is not in language at all, but in the way we conceptualize one mental domain in terms of another." This is to say that a metaphor is not simply an ornamental device in language but a conceptual tool for structuring, restructuring and even creating reality (Lakoff & Johnson, 1980). These personal, internal representations of external reality can be described as mental models that people use to interact with the world around them (Craik 1943, Johnson-Laird, 1983). For ordinary people then, metaphors can represent a kind of mental model where everyday forms of speech and associations (light as a feather!) are used to help make sense of the world.

When seen from the lens of design research and practice, metaphors helps conceptualise and engage with evolving relationships in culturally situated meanings and materialities. As hybrid materialities and forms of artifacts influence how 'interaction' is perceived (Jung, et al. 2017) many examples of metaphor use can be seen within design activities. Metaphor Cards by Logler, Friedman and Yoo (2018) is an example of a toolkit treating metaphor as a generative tool, where the associative and relational qualities create opportunities for new ways of seeing objects or phenomena. This may aid designers in imagining future technologies and ways of being in the world. Similarly, Lockton et al. (2019) have created workshops to support designers exploring novel metaphors for hard-to-visualise phenomena. The use of metaphors has also been explored in the context of complex systems.

Rygh and Clatworthy (2019) demonstrate how metaphors and affordances in physical objects can be explored for design and use of tangible tools within health service-ecosystems.

This paper explores the potential of metaphors to assist a SOD view of complex systems, relations of dwelling and potential for creating shared understanding between diverse actors. I view the role of the metaphor as being able to work abductively, to bring forth the rich locally situated experiences and insights that are not so literal or tangible, but at the same time allow designers to work with the symbolic, the processual, the reflexive. Just as complex systems are dynamic, changing, always in-flux, metaphors can also be seen as negotiative, and act as communicative devices that allow designers to engage with the fuzzy, indeterminate, relational, poetic, and emergent qualities of complex systems. By highlighting five thematics that have been devised in a RTD practice, with examples of metaphors in use, the paper shows possibilities of how metaphors can support frame-consistent knowledge structures and invite structurally consistent inferences (Thibodeau & Boroditsky, 2011). The paper concludes by presenting the Design Analysis Framework (Dudani, 2020) elevating how speculative projections about possible alternative systems that can be supported through metaphorizing.

Methodologies and Methods

The paper builds on an exploratory, speculative and reflexive SOD study. It uses a Research Through Design (RTD) approach where the design practice is central in production of knowledge. (Sevaldson 2010, Stappers & Giccardi, 2017; Zimmerman et al, 2020). The work is concerned with situated knowledge generation with a focus on the doing or '-ing' in design research (see Lury et al, 2018) and uses mixed qualitative research methods (Edvardsson, Tronvoll and Gruber, 2011) located in Qualitative Inquiry (Denzin & Lincoln, 2005). The study also uses narrative and metaphors (Lakoff and Johnson, 1980) in order to bring in a more cultural, place-based and qualitatively rich view into the analysis of existing systemic complexities, contexts and conditions. The study's overall systems approach is influenced by Escobar's (2018) view on pluralistic futures, Vaughan's (2018) approach to 'care', and the ongoing research within Anticipation Studies (e.g. Poli, 2013; Celi & Morrison, 2018).

Design Techniques and Tools

This paper refers to a master's design thesis, author's post-graduation reflection and further analysis. The study used participatory visual methods (Gubrium & Harper, 2016) in engaging with key actors and diverse stakeholders within the Norwegian housing sector. Systems oriented design (SOD) can be defined as a skill-based approach which enables designers to capitalize on the inherent systemic nature of design by visualizing the whole Gestalt of the system (Koffka, 2013). SOD tools such as rich design space and gigamapping (Sevaldson, 2011) were used to visualise the tensions and frictional hierarchies within systems – making it possible to create holistic overviews and find ways to approach the dynamic complexities in a more pragmatic way (Sevaldson, 2013)

Table 1. A relational typology of systemic design actions, and qualities that come through by the work of metaphors within SOD

Systemic Design Actions	Metaphor Thematics	Qualities that come through
Analysing	Associating	Reveals other domains of knowledge (cultural, social)
Locating	Embodying	Elevates the experiential
Mapping	Materialising	Makes the intangible, tangible
Network-finding	Diversifying	Highlights facets of complex systems by place-based views
Suggesting	Probing	Support critical questioning and searching for the invisible

The Five Thematics: The work that metaphors do

In this section, I will elaborate on the five metaphor thematics (Table 1) which highlight the work that metaphors can do within systems oriented design projects.

1. Associating

Metaphors help us access and build associations with cultural knowledge, where different stakeholders can use familiar concepts as scaffolding to form and express their unique understandings of a complex system that is otherwise challenging to comprehend. The every-day ness of metaphors support forming a more culturally rich view of complex systems. For example, one of the residents of Tøyen Gronland described their understanding of the Norwegian housing system using the Norwegian saying “faller mellom to stoler” or “falling between two chairs” which can be equated to the English version “falling between the cracks”, a common experience of certain residents when they transition from public housing to private rental market. Though it’s interesting to also note that the Norwegian version emphasises falling ‘between two things’, bringing specificity to their discription which is missing in the generalisation of ‘cracks.’ As each metaphor represents a view on reality, which values are brought forth through them? How can we as systemic designers, navigate the tensions created by the many singular representations of realities, pointing to potentially conflicting values? How can they work towards building a collective one?

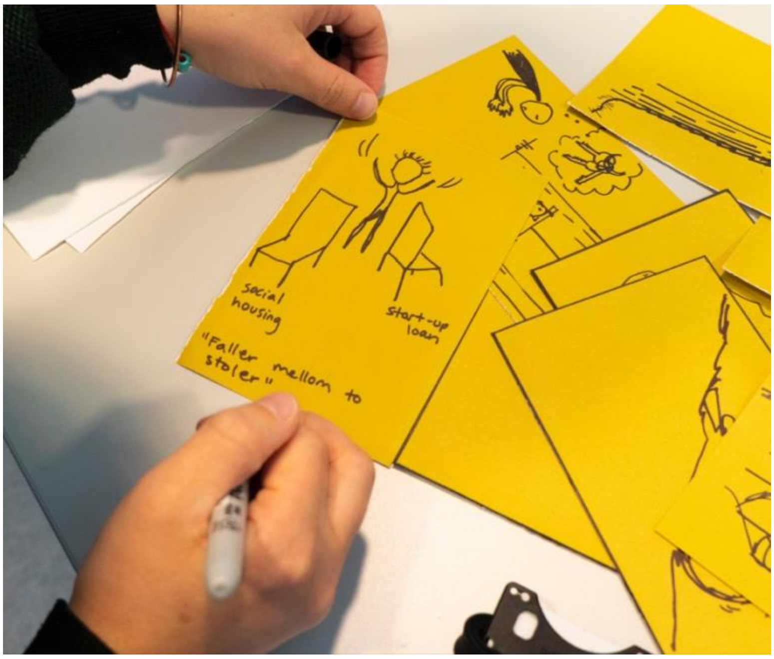

Figure 1. “Faller mellom to stoler” is a Norwegian expression that translates to “Falling between two chairs” (Dudani, 2019b).

2. Embodying

Metaphors make it possible for stakeholders to bring forward the embodied and experiential knowledge of ‘knowing how to be/live’ within a complex system. For example, one of the participants described the use of a ladder as way to express her experience navigating and moving within the rental housing system, saying “In the UK, you atleast have rungs at the lower part of the ladder” describing the experience of being within the housing system as a climb, where you ascend, descend or stay stuck; finishing with “in Norway it seems like it’s simply missing”. Different stakeholders talk through these metaphors, making their own metaphors as needed. As metaphors code the diversity of experiences, what do the paradox and commonalities reveal about the complex system?

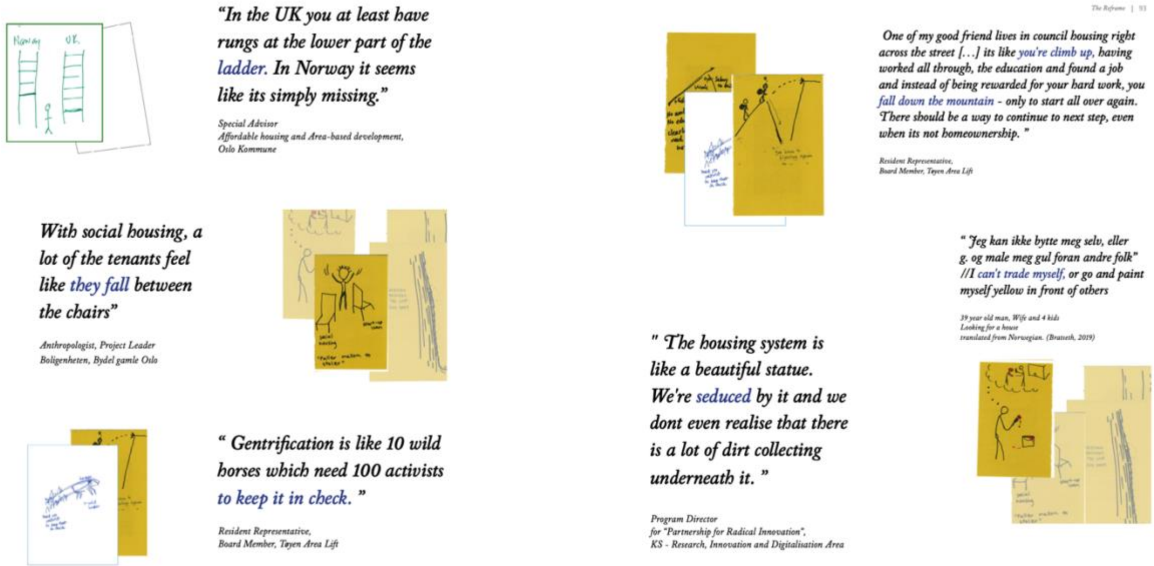

Figure 2. A collection of metaphors, representing embodied experiences communicated by the participants using stories and their own metaphorical framings (Dudani, 2019b).

3. Materialising

Metaphors make it possible to code stories and open ended narrative into tangible forms. This materialising enables a systems designer to plug them into existing systems mappings. As I collected about 20 or so metaphor cards, the mapping reveals underlying patterns where the resident beliefs' shift from feeling 'completely responsible' (complete onus) of their life outcomes, to realising that the system is not really built for them (self recognition). The trend moves towards a pacification where the residents' start giving up against the force of the system. Ultimately the system takes over in its massiveness, where descriptions like 'feeling trapped' or 'squeezed between the wood and bark' were used. While the metaphors can help make visible the (however opposing) worldviews, which elements are metaphors unable to materialise?

Figure 3. A mapping of metaphors showed different worldviews on how the rental market, and by extension the Norwegian housing system was experienced by a diverse group of stakeholders. (Dudani, 2019b).

4. Diversifying

Different actors experience a complex system differently, its effects brought forth through varied life situations, value sets and worldviews. By capturing and visualising the cultural and social richness of stakeholders' lived experiences, metaphors allow us to acknowledge the true diversities and multiplicities, representing the many facets of a complex system. During my study, I spoke with about 11 actors from Tøyen-Grønland (either living or closely associated with the area). The participants represented a diverse range of tenure status, age, gender and sexual orientation, professional affiliation (national level to grassroots level) and ethnicity (native Norwegian to immigrant born persons). As metaphors bring the more qualitative richness and diverse point of views to complex systems, how can a systems design-approach leverage the potential frictions to build common grounds? How can it foster conditions for collaborations?

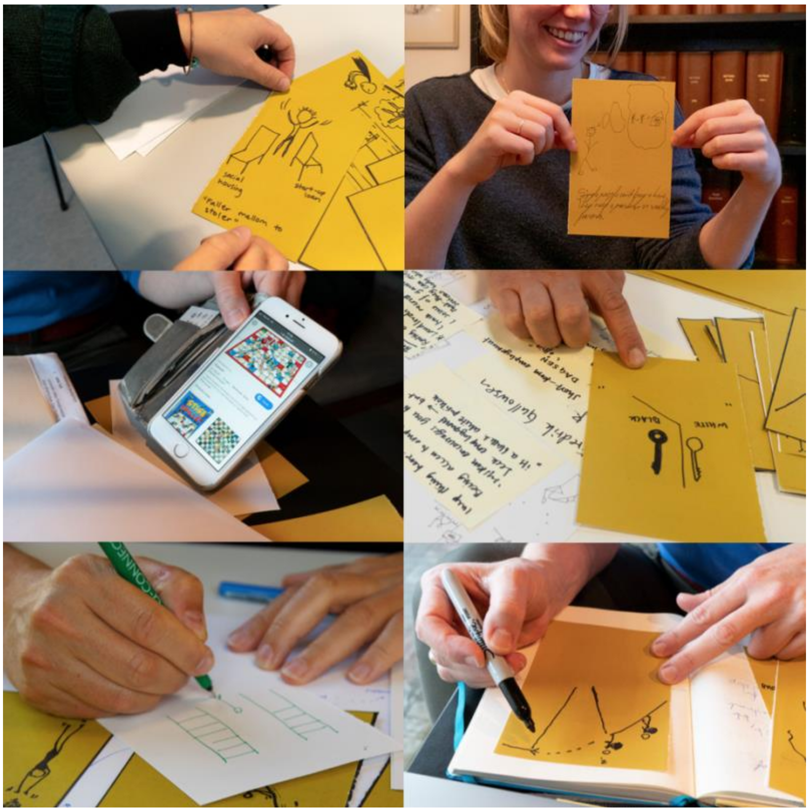

Figure 4. Image showing some of the actors who shared their metaphors with the author (Dudani, 2019b).

5. Probing

Once materialised, metaphors can be used to probe into complex systems and find underlying assumptions. During my study, I found that my own investigations into understanding the Norwegian housing system mirrored the steps described within the Causal Layered Analysis or CLA (Inayatulla, 1998). I was able to use the metaphors as way to question and demystify the mindsets and embedded values at the root of the existing housing system. This move between analysis and design resulted in Design Analysis Framework (Dudani, 2020), which makes it possible for a designer to approach and make sense of the many paradoxes and tensions within complex systems.

Figure 5. The images show workshop participats using metaphor cards to explore connections with CLA. A workshop by author at RSD8, IIT Chicago 2019. (Dudani, 2019b).

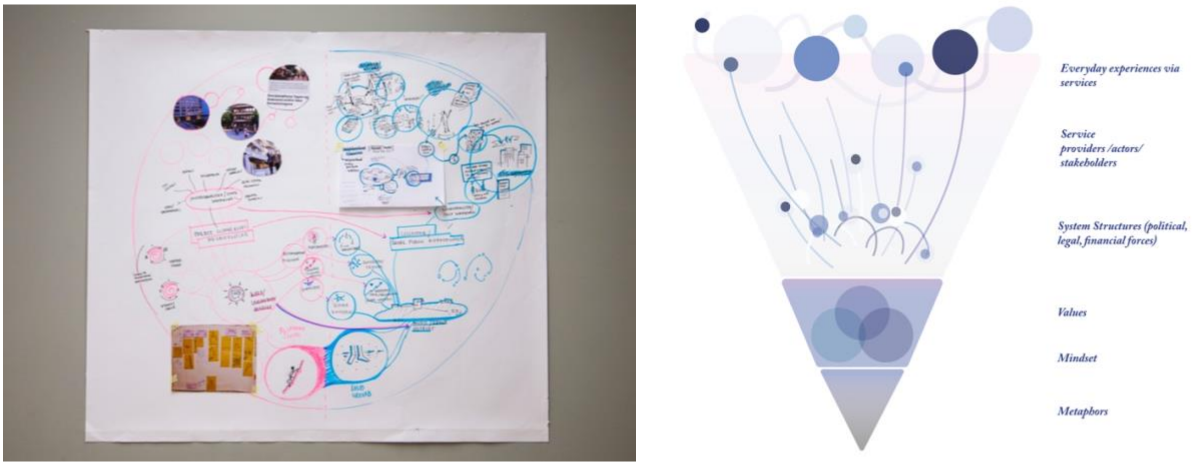

Figure 6. A sketch an analysis framework in progress, showing the role of metaphors in elevating worldviews and values (left), the Design Analysis Framework (right) as presented by the author at RSD9 Symposium, 2020. (Dudani, 2020)

Reflections: On designing with systems oriented view

In this section, I reflect on the five thematics and highlight their role and contributions within an SOD view.

Associating brings forth socially and culturally rooted mental models of sense making for working with complex systems while **embodying** highlights the ability of metaphors to grasp lived experiences, fostering a localised and uniquely place-based understanding of complex systems. **Materialising** ability of metaphors can make tangible the otherwise intangible qualities, making it possible for systemic designers to deliberately bring the softer, fuzzier and the poetic into the (too often) logical or pragmatic systems visualisations and framings. As systems oriented designers, we know our systems representations such as gigamapping etc, can only express a singular (and rather incomplete) view. As systems are layered and complex, they're also experienced differently depending on the angle of view or the vantage point**. Diversifying** highlights how metaphors allow us to take into account the situatedness of many angles and facets of a complex systems. **Probing** using metaphors allowed me to form my own understanding of how I can approach complex systems within my study. Metaphors made it possible to question and dig deeper into underlying worldviews, mindsets and values held by stakeholders, but more over, reveal the embedded assumptions that's at the root of it all. Capturing that essence into a metaphor also made it possible for me to ask – what if we flipped the metaphors of the current housing system – what might the alternative system look like then?

Building on my reflections and learnings on metaphors, I've developed Design Analysis Framework (Dudani, 2020) which was presented at RSD9. As part of my last research project, I also designed the BALLUSION workshop which explores words as design material for working with metaphors that may shape our imaginings of futures. The metaphors (seen as yellow cards in the Figures 1-5) are currently in production and set to be used by local anthropologists within their ongoing housing projects. This will be shared in the presentation. As I move to an industry role, I would like to open up this up for discussion with conference attendees on their experiences and learnings on how such use of metaphors can be brought into a design studio/commercial design space.

Conclusion

This paper highlights the role of metaphors in working with complex systems using a systems oriented design view. Though the five metaphor thematics, the paper exemplifies how the softer, transient, dynamic and emergent qualities of complex systems can be elevated. From only one exploratory study case, I have tried to suggest that metaphors can have a meaningful contribution towards systemic design approaches in understanding existing complex systems as well as imagining alternative ones. I share my reflections and learnings and welcomes further discussion on how these can be taken forward.

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Track 16:

On Critical Contexts & Circularity

Chair: Dr. Silvia Barbero

Arctic Design

The systemic development of a new domain

Svetlana Usenyuk-Kravchuk, Nikolai Korgin

The paper presents the early stage of developing Arctic Design as a general theoretical framework for design/development actions in extreme environment. The main strands of research include (1) the self-definition of the domain through compiling a subject area ontology; and (2) modelling strategies for sustainable interaction between humans and technologies in an extreme environment through developing artistic/imagery characteristics corresponding to the environmental/climatic, socio-cultural and psychological peculiarities of use. The paper outlines the research basis, expected results and a brief report of what has been done to date.

Keywords: Arctic Design, methodology, subject area ontology, complex evaluation mechanism, work-in-progress

Introduction

The paper presents the early stage of developing Arctic Design as a general theoretical framework for design/development actions in the extreme environment, focusing on human adaptation, safety, and wellbeing. In the Anthropocene epoch, when any environment is under the probability of becoming extreme over the next decades (Smith, 2012), the very concept of the Arctic goes beyond its geographic boundaries. From the Arctic as a world's periphery, we move towards the Arctic as a natural lab to observe anthropogenic climate change, accelerating resource extraction, mass tourism, and other manifestations of Arctic modernities (Körber et al., 2017). This lab provides a testing ground for new life-support solutions and further perspective for a radical reconsideration of the existing technology-augmented way of living.

However, at its current state, on both national and international scale, Arctic Design exists in the form of heterogeneous (mainly educational) initiatives (Jokela & Coutts, 2018; Tahkokallio, 2012; Usenyuk-Kravchuk et al., 2018) and often understood to onlookers as a set of methods and approaches to the “acclimatization” of existing products and services. Considering the relevance and existing demand for Arctic Design expertise, there is a need to develop a comprehensive theory by structuring and analysing the practical and methodological experience to date.

Research Basis

At the heart of the study, there is the consideration of Arctic Design as an individual's activity to organize autonomous life support in an isolated/extreme environment through creating technologies. The research team that brings together designers and mathematicians is focused on the development of an Arctic Design methodology, the potential for synthesizing mathematical models to analyze the empirical material collected during fieldwork 2017-2021, as well as testing proposed models on the example of a new transport unit for the conditions of the Russian North.

To create a new domain of theory and practice, namely Arctic design, two complementary strands of the inquiry are outlined as follows:

(1) Theoretical, that stems from the need to "pack" existing disparate methods and approaches to design for the extreme environment of the North/Arctic into a single methodology with the possibility of subsequent application

in interdisciplinary search for solutions to global problems related to the interaction between human, technology, and nature (Usenyuk-Kravchuk et al., 2020).

(2) Practical, that stems from the need to develop and implement sustainable interaction strategies between human and technology in the context of large-scale development of northern territories accompanied by an influx of non-indigenous population and ex-situ technologies (technologies created outside the territory of main use) (Usenyuk et al., 2016).

Based on the considerations above, there are two groups of research objectives, which, when achieved, would lead to the creation of a coherent theory of Arctic design with a practical application.

(1) Sectoral self-determination and interdisciplinary collaboration:

The challenge of "packing" existing disparate methods and approaches to design for an extreme environment (the North) includes an analysis of Arctic design for the availability of structural components in the methodology (as the organization of activities): subject, object, form, means, methods of activity and its outcome, and the process of carrying out these activities. Through the definition and specification of these components, the analysis will also make it possible to draw conclusions about the possibility of creating an Arctic Design methodology and formulate a list of research areas needed to be explored to identify any missing components.

(2) Developing and implementing strategies for sustainable human-technology/technology interaction in the Arctic/North environment:

Practical solutions to the problems of northern development related to the use of ex-situ technologies (technologies created outside the territory of main use) include promoting the emergence of locally relevant technologies to improve the lives of people living in remote, sparsely populated areas with a harsh climate; promoting self-organization of local communities of innovators; developing and supporting cooperation within and between these communities with an underdeveloped production, transportation, and digital infrastructure. The empirical material collected during fieldwork 2017-2021 suggests that ingenuity, self-organization and cooperation are the hallmarks of northern communities defined by harsh climatic conditions, reflected in the design as autonomous life support activities in an isolated/extreme environment. Within this task, the influence of the cooperation factor within the philosophy of competitive cooperation (coopetition) will be simulated, and the self-organization of these "communities of invention" will be described.

Expected results

The novelty of the study lies in a combination of humanitarian and artistic tools of technical aesthetics with mathematical methods of the theory of management of organizational systems. This project proposes to "test harmony by algebra" – that is, by making a qualitative leap from empirical data to a set of mathematical models that formalize the subject area and support forming a holistic methodology of Arctic design. Expected results include establishing a new "Arctic Design" domain with both practical and applied meaning. The understanding and description of this domain at the level of activity organization (methodology) will be conducted for the first time in international research and design practice. Interdisciplinary cooperation guarantees both an increase in scientific knowledge and the practical implementation, i.e. testing theoretical outcomes on a new type of small-sized cross-country vehicles.

The theoretical significance of the expected Arctic Design methodology is based on its possible application in searching for solutions to global problems related to the interaction between human, technology and nature in various extreme contexts. The practical significance of the results is that they would open the way to developing and implementing sustainable human-technology interaction strategies in the context of large-scale development of the North. This includes assisting in the emergence and introduction of locally appropriate technologies to improve people's lives in remote sparsely populated areas with a harsh climate and assisting in cooperation between users to create technological innovations in the undeveloped production, transport, digital infrastructure.

In addition, the expected results provide opportunities for further theoretical and methodological research both within the established direction and in interdisciplinary cooperation, including the writing of dissertations on relevant topics. Also, the research results can be used in the development of curricula, courses, seminars in the system of professional education of designers, including retraining programs and professional development of specialists in the system of non-degree additional education.

First year report

In the first year of the study, the team worked on developing an integrated methodology of Arctic design, in two directions, as follows: (1) the self-definition of the domain through compiling a subject area ontology; and (2) modelling strategies for sustainable interaction between humans and technologies in an extreme environment through developing artistic/imagery characteristics corresponding to the environmental/climatic, socio-cultural and psychological peculiarities of use.

Within the first strand, the team worked on compiling the ontology of the subject area of "Arctic design" and synthesizing basic mathematical models that formalize the interaction of subjects and objects of Arctic design in the framework of the developing ontology. Our sampling logic guided by our analytical aims represents a specific range of variation on dimensions of interest: from geographical to cultural. We focused on three areas/countries representing different parts of the Arctic and, consequently, different approaches to Arctic design, namely Russia, Finland and Canada. To ensure the possibility of comparing the terminological structures in different languages, the information technology used (originally developed to work with texts in Russian) has been refined for the multilingual presentation of the analysis results. The results of the extraction of key terms for further analysis are available at the following links on the Internet:

1. The results of the analysis of the corpus of texts centred on the Finnish/Scandinavian Arctic (in English): https://lab57.shinyapps.io/arctic/

2. The results of the analysis of the corpus of texts centred on Canadian Arctic (in English): https://lab57.shinyapps.io/arctic_na/

3. The results of the analysis of the corpus of texts on the Russian Arctic (in Russian): https://lab57.shinyapps.io/arctic_rus/

4. Results in Russian translated into English (optimized, refined): https://lab57.shinyapps.io/arctic_ruen/

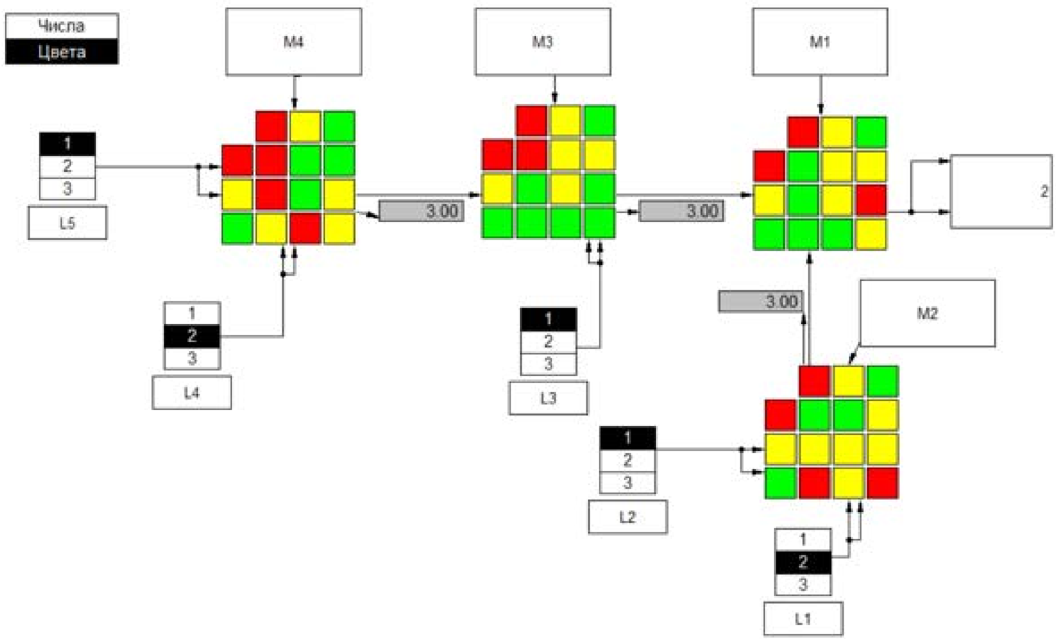
The subject area experts from Russia, Finland and Canada are currently conducting a comparative analysis of the lists of key terms to develop their detailed definitions.

As part of the task of synthesizing a set of basic mathematical models that formalize the interaction of subjects and objects, parallel to the process of building an ontology of the subject area, work was carried out to formalize the factors that influence the success of Arctic design projects with the help of the method of identifying mechanisms of complex evaluation currently being developed at the Laboratory 57 of the ICS RAS.

As an experimental, analytical material was presented a sample of student projects of equipment, housing and vehicles designed for environmental extremes of the Russian North at the Department of Industrial Design of the Ural State University of Architecture and Art for 40 years of existence Arctic/northern thematic focus (Fig. 1).

Figure 1. Examples of student projects selected for identifying the mechanisms of complex evaluation. Arctic Design School, Ural State University of Architecture and Art, 1987-2019.

The development of the comprehensive evaluation mechanism was carried out as follows: initially, 5 criteria traditionally used in assessing educational design projects (without considering the specifics of the Arctic design field) were identified as components of the multidimensional assessment. They were as follows: relevance/topicality, economics, ethics/ecology, aesthetics/imagery, and the technological part. Based on the list of projects, unified representation of their characteristics and evaluation of their success, all binary tree structures of aggregation of values of initial characteristics of projects in evaluating the projects' implementation success were identified (Fig. 2).



L1	L2	L3	L4	L5
relevance	economics	ethics/ecology	aesthetics/imagery	technology

Figure 2. The complex evaluation method: Possible convolution tree structures. N. Korgin and V. Sergeev, ICS RAS, 2021.

In identifying the specifics of the subject area, the team revised the list of criteria, and 6 concepts/criteria critical for the Arctic design objects were proposed, as follows: geography, resource, culture, ideology, technology, aesthetics. Calculations on these six criteria are planned for the second year of the project.

In the second direction, the project team used the described approach to building structural models of the subject area to formalize the principles of evaluating the applicability of the methods developed by the Arctic design school: artistic composition, the factor method, and the co-authorship method. In this direction, we performed the following types of work during the first year:

To iterate the cycle "empirical data – project proposal – approbation – feedback", we made two field trips: to the Northern Caucasus and Kola Peninsula. The concrete object of our designerly investigation (and further action) was a prototype of a small-size electric-powered cross-country/over-snow vehicle – "electric snowbike" or "e-bike" – jointly developed by E-max Laboratory, Moscow, and ICS RAS on cooperation in the field of experimental electric-powered platforms. Initially, this electric snowbike is a constructive "skeleton" of a vehicle made through small-scale/"garage" production (Fig. 3).

Figure 3. Left: 3D scan and 3D model of the snowbike, N. Korgin and N. Klyusov, 2021. Right: N. Korgin on the test drive in Kola tundra. Photo: A. Raeva, 2021.

The research task for the project team was to transform the specific results of the experimental creativity of DIY-makers into a full-fledged "transport product" with the necessary marketable characteristics, using the methods of arctic design.

The expeditions included running tests in potential target (both climatic and infrastructural) conditions of the vehicle application, as well as analyzing the requests of potential target audiences: from tourists and scientists to representatives of the indigenous population of the North, employed in traditional industries (reindeer herding), using the methods of structured and semi-structured interviews, and participant observation. The obtained data were synthesized in the series of design propositions for the prospective shape of a snowbike, developed using the Arctic Design School methods (Garin & Kravchuk, 2020) (Fig. 4).

Figure 4. Design propositions. N. Klyusov, A. Raeva, 2021.

Discussion and conclusion

Within the systemic framework, where design is understood as “an advanced practice of rigorous research and form-giving methods, practices of critical reasoning and creative making, and sub-disciplines and deep skillsets” (Jones, 2014), the Arctic vector suggests applying them to facilitating non-biological human adaptation and wellbeing in the extreme environment. This vector provides an alternative sensibility to the established concepts and approaches in the design domain and yields fruitful insights into tacit issues of human-nature-technology interactions usually concealed in the milder climates and more “civilized” environments.

The systemic and dynamic understanding of the Arctic/Northern sites under study opens up a unique window “on the universe, revealing only at this place something that cannot be moved or replicated in the laboratory” (Gieryn, 2006, p. 6). Furthermore, the Arctic/North becomes a useful and inspirational metaphor pointing to remote, sparsely populated and relatively isolated areas with a lack of urban industry and infrastructure and a harsh, challenging, and fragile environment. However, the overall meaning of “arcticness” in design may be contradictory. On the one hand, it may enhance general credibility for developing reliable technology that could also work in less extreme contexts (becoming literally “placeless”, i.e. beyond the certain place), and, on the other, it challenges the very concept of “placelessness”, which is unachievable, useless, and even harmful in case of the Arctic applications, because the Arctic in general and its Russian part, in particular, is very patchy and climatically diverse and thus requires highly specific place-based design solutions.

The Arctic design concept yields several implications for practice joined into two main groups (with the example from the transport vehicle design sector):

First, the attention to locally originated / place-based design solutions which generate enduring design principles – from traditional artefacts facilitating the indigenous nomadic way of living to DIY objects and practices of making locally adequate vehicles from industrial scrap (Hyysalo & Usenyuk, 2015; Usenyuk et al., 2016; Usenyuk-Kravchuk & Hyysalo, 2021) – helps to clearly distinguish "true Arctic design" from “acclimatization” of existing products/services and use of imported ex-situ technologies. The locally originated/modified objects, when seen as a tangible embodiment of the features and requirements imposed by both the user and the environment of use – from ergonomics and cultural identity to climatic factors and landforms – indicate to manufacturers means and ways of being mobile on a particular territory. Here designers' task is not to improve/embellish the observable shape but to carefully examine it for "what, why and how to make" for developing a locally adequate yet industrially manufactured product (Usenyuk-Kravchuk & Hyysalo, 2021).

The second implication is in line with the systemic focus of this conference: the Arctic design comes out as a conscious attitude to the design process that “reinforces the self-organization of co-created content and purposeful interaction within the boundaries and norms of the social system” (Jones, 2014). Our empirical data from the field provide learning examples into the so-called competitive cooperation (coopetition) and the self-organization of “communities of invention”. Here coopetition is understood as the systematic pursuit of being the best within the established and regularly exercised intra-community collaboration to achieve a comfortable living in a particular locality. This should be clearly distinguished from the pure competition where the aim of “bestness by all means” can destroy the originally cooperative and adaptational character of design/making endeavours in the extreme environment. The competitively augmented collaboration between actors in the design process strength-ens the spatial and socio-cultural embeddedness of both makers/users and their objects that leads to design solutions and design strategies that are in long-term possession and control by local makers and users (Botero & Hyysalo, 2013; Usenyuk-Kravchuk & Hyysalo, 2021).

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Leveraging Indigenous Knowledge, Collaboration, and Emergent Technology

How to Embrace Tensions in Conservation Interventions in a Vulnerable Himalayan Region

Twisha Mehta and Jenny Bentley

Our case study is set in Lachen, a remote village in an ecologically vulnerable Himalayan region in Sikkim, India. Numerous conservation initiatives have been planned and implemented in the region, but didn't necessarily succeed due to the cultural, political and geographical complexities of the place. As a team of designers and an anthropologist, we tackle these complexities through a systems thinking approach, one that has led to designing an interpretation center in the region via co-creation. In the initial stages of our project, we found tensions in perspectives and values within the system that drove us to seek innovative ways to embrace these paradoxes by using ethnographic methodologies and emergent technologies to rapidly reconstruct relations in this system. Through this paper, we ask how we can measure the impact of this resilient model and how we can find ways of improved mutual communication between the multidisciplinary collaborators in order to enhance understanding for the modalities of a systems thinking design approach.

Keywords: Conservation, Himalayas, Systems Thinking, Indigenous Knowledge, Emergent Technologies

Introduction

Climate change is one of this century's most complex and challenging issues. As intersectional macro systems, such global challenges produce place-sensitive impacts and dilemmas (IPCC, 2014; Agrawal and Perrin, 2008). Our case study is located in the village Lachen, in a remote eastern Himalayan region of North Sikkim, India, that is particularly vulnerable to climate change. Here, the median temperatures are rising higher than the global average and glaciers are melting faster than in other mountainous regions (Saluja et al., 2019, 12; Kothari et al., 2017). Subsequent phenomena such as species movement or extinction, disasters like floods, or increased parasite-infestation of livestock threaten natural resource-dependent livelihood and lastly human and non-human well-being (Sharma et al., 2009). Additionally, unsustainable tourism, lacking waste-management, large-scale infrastructure projects, and so forth take its toll on the ecosystem (Kothari et al., 2017). Further, while the regional indigenous knowledge and livelihood practices that shape the interaction with and sustenance of the ecosystems bear high potential to contribute to conservation, we find they feature marginally in interventions; moreover lifestyles and economic activities have fundamentally changed in the past decades (Ingty, 2007; Lachungpa, 2009).

In this space, an array of entities ranging from Sikkim state government, the Indian government, as well as international agencies (UNDP, UNESCO) and NGOs (WWF, ECOSS) push forward well-formed interventions for the large-scale problem of climate change that target the exigencies of conversation. Due to the system complexity and to each project's specific constraints (financing, institution, set targets and so forth) these interventions orientate towards solving determined issues, defined certain goals, and envisioned needs. As a consequence, they contribute little to the understanding of the interdependencies and interactions beyond the specific system element they put focus on.

We argue that a separate systems-driven intervention with the focus on communication between the various conservation stakeholders, knowledge systems, and resultant interactions with the environment is urgently required in order to make interventions self-organized and improve resilience (Jones, 2018). On this backdrop, within the UNDP-led SECURE Himalaya project, the Sikkimese multi-disciplinary design studio Echostream suggested the formation of an interpretation center in Lachen. To do this, Echostream brought together a team of designers and a social anthropologist in order to combine different methods these disciplines offer and enhance mutual learning (Meadows, 2008). To meet the requirements of the complex, multi-system, and multi-stakeholder services, we use a system design approach (Jones, 2018). The center will curate the different stakeholders' knowledge, specifically including local and indigenous knowledge systems. With this education-based collaborative capacity-building approach, we aim at facilitating co-designed and co-managed conservation interventions, amongst others to protect the snow leopard and its habitat – as defined in the SECURE Himalaya project – that will support the Lachenpa in sustaining a livelihood, protecting their ecosystem, while adapting to the impact of climate change. As such, the center addresses several SDGs in an innovative way (SG 4, 8, 12, 13 and 17).

In the first stages of our research and design process we encountered several tensions between different elements as well as in the relationships between these elements, caused by the complex intersectionality of the macro systems climate change, environmental conservation, and economy. In our paper, we present two of them and lay out our strategy to embrace them with conducive means and without reducing the complexity or valuing one element over the other. This paper is based on an ongoing project and thus builds on initial findings and proposed solutions.

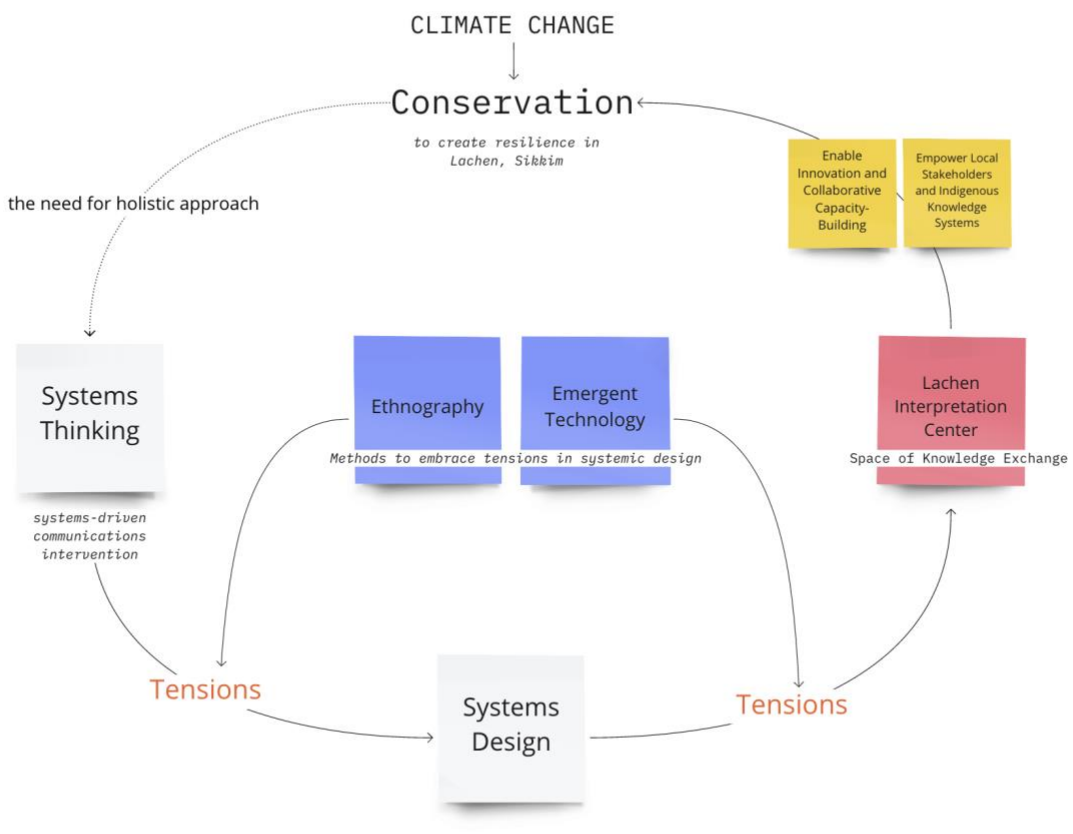

Figure 1. Process of facilitating the Lachen Interpretation Center

Multiple stakeholders and a complex knowledge-scape

The first project-inherent tensions build up along the stakeholders' diverse macroscopic and microscopic knowledge that derive from different ontologies and resultant problem-solving approaches and activities. While it has become accepted that indigenous knowledge systems can contribute to conservation, the inclusion of the diverse cultural, economic, and religious practices as well as belief systems in collaborative approaches remains challenging (Nadasdy, 2005). An open question is how and on whose terms to break ontological boundaries with regard to indigenous spiritual approach to environment (Houde, 2007; Chandler and Reid, 2018).

In Lachen, the majority of permanent residents are Lachenpa and, in higher pastures, nomadic Drokpa, creating a significant indigenous knowledge base with diverse local conservation experts. Moreover, there is a strong legally recognized indigenous governance system, the *Dzumsa*, consisting of one male representative of each indigenous household (Chettri, 2013; Bourdet-Sabatier, 2004). It holds power over local decision-making, drafts and enforces local laws. Placed under the responsibility of the Dzumsa, the center aims at empowering the indigenous institution to contribute a local solution to this important global issue and thus to institutionalize the dissemination of conservation-relevant information. At the same time, many Lachenpa leave the village for education purposes or job opportunities, creating a vacuum in the transmission of indigenous knowledge on exchanges with nature; this disjuncture impedes the inclusion of indigenous knowledge in conservation strategies.

In order to conserve the local ecosystem and mitigate the impact of climate change, other stakeholders come into play. Lachen is a sensitive border region with a strong army presence and a subsequent lack of local control over vast tracts of traditional lands. Similarly, past regulations have turned some of the Lachenpa's lands into protected forest areas or restricted national parks, rendering them beyond local ownership and governance. Thus, the army and the state forest department are important players. In the tourism sector, most people running the hotels and interacting with the visitors come from outside the state. Further, various scientists with expert knowledge on specific aspects of the ecosystem make important contributions. All these actors have in common that often they are not aware of indigenous practices and belief systems.

Echostream decided to include an anthropologist in order to embrace these challenges. The methodology of ethnography brings in sensitivity to indigenous knowledge systems as well as the abilities and methods to include local resource people and, when necessary, translate their knowledge into the realm, in which the conservation interventions take place. Further, in comparison to an intervention-based approach – as taken by conservation experts and many designers – ethnography focuses on understanding perspectives and positionings without the end-goal of changing them or implementing them as solutions to specific problems. It has an inherently descriptive component (Geertz, 1973). Hence, the interpretation center's goal is not to teach "conservation" or implement "interventions", but uses a multi-vocal approach to visualize knowledge, even if conflicting, on interactions with the environment, with a special focus on indigenous knowledge systems. We plan to look into intersections and commonalities, but also build different scenarios modeling variations of futures based on various existing and envisioned exchanges with nature. The interpretation and learning effect is left to the individual that interacts with the displayed systems. Hence, the center can include different ontologies and bears potential to become a collaborative space of knowledge exchange and multi-directional capacity building. In this way, it will support the development of long-term information and education strategies that integrate the local indigenous knowledge systems and their conservation goals.

Short-term vs. long-term values: The dilemma of mass tourism and sustainability

Lachen is a popular tourist destination, with tourism increasing by a shocking 200 percent each year. Most households are directly or indirectly dependent on this economic sector to sustain their livelihood (Lele et al. 2019). Tourism has undoubtedly brought economic benefits, however, its environmental impact has rapidly increased in the last 20 years, resulting in a heavy urban expansion, an excessive rise in vehicular movement, and issues of waste and pollution (Kothari et al., 2017). Further expansion of such mass tourism will put pressure on Lachen, a village that has already reached its carrying capacity (Lele et al., 2019). Hence, we find that tensions arise between the short-term values of economic benefits for Lachen and long-term values of ecological preservation in the village. Consequently, these tensions interfere with seeking a common ground for conservation interventions.

Moreover, the interpretation center itself intensifies such tensions. While it is conceptualized with the intention of sensitizing on ecological conservation, paradoxically, it will require tourism to help sustain it. Resultant increase in tourist footfall will in turn increase carbon footprint in the region, lastly sabotaging the system's goal in the long run. Using these paradoxes as ground to innovate a model that embraces these tensions while combating the hurdles posed by the second wave of the COVID-19 pandemic, we leverage emergent technology. With a push from the constraints on access due to ever-changing lockdown restrictions, we plan to reconstruct and prototype this model as a virtual interpretation center, one that will still be linked to the physical space. By adapting augmented reality (Kečkeš and Tomicic, 2017), real-time viewing of 3D Modeling, and Geographic Information System (GIS) this digital space will provide an enhanced experience of Lachen.

By adopting the essence of mass tourism through this digital space, we play with the initial systems boundary (Meadows, 2008) that was restricted to the location and landscape, and invent around it to allow for real-time interactions, critique, and collaboration between the local and global community, increasing the capacity for empathy across borders. This space will be able to engage with millions of “visitors” rather than only thousands of tourists in the physical space that end up burdening the ecosystems. The virtual interpretation center allows for global access to the unique conservation activities and narratives of this Himalayan region. Global acknowledgement will provide important social feedback and validation that will encourage the community to not only continue their efforts but will also propagate using this model in similar landscapes.

Through this remodeling, we are able to interplay the idea of generating income through “virtual tourism” while disseminating knowledge on conservation. Opening the interpretation center to a global audience will aid Lachen in generating revenue and contribute to its local industries. Creating takeaways from these virtual experiences in the form of local souvenirs through e-commerce will be one way of distributing Lachen’s culture and showcase the impact of community-based conservation methods.

Additionally, this innovative approach enhances our possibilities in tackling the first tensions, mentioned in section 2. Interactive technology and the internet enable the interweaving of conventionally disjoint narratives, in this case especially the indigenous knowledge systems and knowledge from modern conservation science. Experiencing information in physical spaces is often limiting, as its linearity creates unintentional hierarchies. Such hierarchies and validating can be avoided by leveraging hypertext and hypermedia. By giving equal importance to the different ontologies through a multi-narrative structure, our use of emergent technology upholds the values of our ethnographic approach. Lastly, this approach is possible because the majority of stakeholders – also those in the remote location of Lachen – have access to a relatively good internet and own smart devices.

Outlook

This project is a co-creation facilitated by a team of designers and an anthropologist. This collaboration led to using ethnography as a methodology and implementing design interventions using emergent technologies in order to embrace tensions, give justice to the intersectional systemic complexities, and offer a place-sensitive approach that empowers local stakeholders and their knowledge systems. Currently, we have indications that our project will, first, create a baseline for better climate action and conservation interventions that include indigenous knowledge systems, institutionalized through local governance, and, second, diversify economic opportunities and thus decrease the dependencies on the initial systems boundary given by the physical space of Lachen.

As our work is in progress, currently we are seeking inputs on how we can measure our success in embracing these tensions and lastly also the impact of our project through innovative means. The measurement of (positive and negative) impact is crucial in order to potentially be able to scale our model and experiment it in different localities. Considering the pressing challenges of climate change in the Himalayan region we see scope for such systematic and potentially interlinked communication-based design interventions.

Further, designing in such trans-disciplinary contexts, we continue to enquire ways to enable a fruitful understanding of systems thinking and design as well as our specific collaborative design process between all the actors – including local stakeholders or conservation experts. We seek to discuss best practices for creating models for communicating complex systems and design approaches.

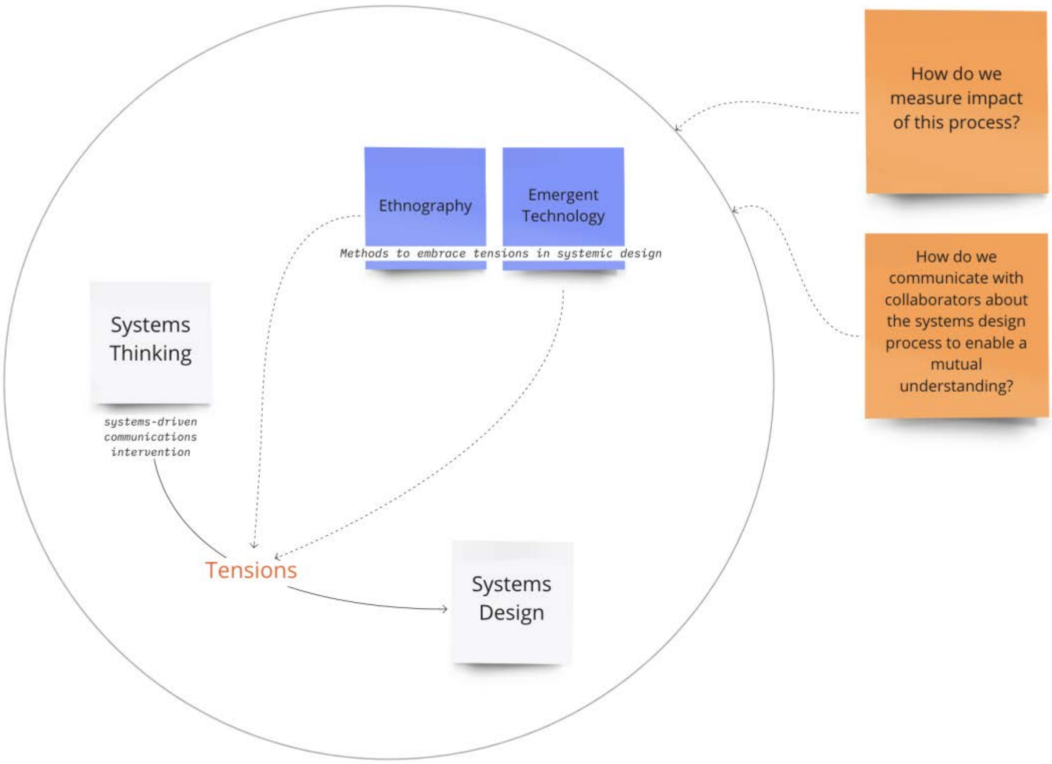

Figure 2. Enquiry into impact measurement and communication methodologies of systemic design processes

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Design circular colours.

A cross-sectoral project for the systemic design of regional dyeing value chains.

Amina Pereno, Asja Aulisio, Silvia Barbero

Dyeing plants are an endemic resource that powered the European textile industry for centuries until the advent of synthetic pigments led to their complete abandonment. Today, interest in natural dyes is growing again, but the socio-technical complexity of modern supply chains requires more than technological updating. The problem must be framed through a systemic perspective that allows grasping the past and the present to foster a new, sustainable development of the sector. The ECOLOR project aims at investigating the development opportunities of natural dyeing value chains in the Piedmont Region (Italy), within a circular economy framework. Design acts as a process facilitator, mediating between different academic disciplines and multiple industrial and regional stakeholders to ensure a broad approach to the topic. The paper presents the methodology adopted, which combines the experimentation of industrial technologies with the exploration of socio-technical systems through specific systemic design tools, such as the Holistic Diagnosis, to define potential circular solutions. The study opens reflections on a multi-level approach to technology that does not neglect the socio-cultural dimension of local value chains. Moreover, it presents the potentials and limits of an interdisciplinary and cross-sectoral design process, laying the foundations for future implementation of local circular systems.

Keywords: socio-technical systems; sustainability transition; circular economy; dyeing plants; cross-sectoral collaboration

Introduction

The rise and fall of natural dyeing

Over five centuries, natural pigments have been central to the European textile industry, which has developed artisanal and, later, industrial knowledge and technology to extract colourings from local dyeing plants. In each country, textile districts have arisen and deeply influenced the social, urban, and even toponymy features of the cities involved. The import of better performing pigments from abroad soon changed the relationship between industrial production and local cultivation.

In the 20th century, the advent of synthetic dyes marked the end of dyeing crops, as they offered uniform hues at a much lower cost than natural pigments. Today, synthetic colours are still unrivalled, but in recent years, growing awareness of environmental sustainability has encouraged new programmes, supported by the European Union, to recover natural pigments. Indeed, natural substances' advantage is to reduce pathogenic and polluting effects and to offer vegetal by-products potentially recyclable in other supply chains.

However, optimising technological applications is not enough to give new impetus to natural dyes. We urgently need to reconsider the use, applications, know-how and social and industrial values of dyeing plants to foster a sustainability transition of the dyeing industry.

From technical challenges to a systemic vision

The circular economy concept introduces an original approach to technology, as it comprises sustainable innovation within a broader economic model that is "restorative and regenerative by design and aims" (EMF, 2015, 2). Thus, it encourages production models that moves beyond mere process innovation. In this respect, a systems approach acknowledges the functioning of technology as a linkage between heterogeneous elements and embeds the technological dimension within a cluster of elements that fulfil societal functions: a socio-technical system (Geels, 2004; 2005). In the words of Hughes (1986), "disciplines, persons, and organizations in systems and networks take on one another's functions as if they are part of a seamless web." (p. 282).

In the 15th century as today, the interaction of heterogeneous professionals and organisations has generated different natural dyeing systems. However, today's scenario is undeniably more complex and poses important challenges from a social and technical point of view. Developing a circular dyeing chain requires technological experimentation to improve dye extraction and extend their application to new sectors (packaging, animal husbandry, nutraceuticals, among others). At the same time, technological solutions should be framed from a systems perspective (Farla et al., 2012), building a holistic vision of the socio-technical system in which actors and processes interact. Therefore, systemic design methods and tools can establish learning processes for understanding and developing circular systems (Pereno & Barbero, 2020), but also for co-designing new processes, services, systems and ways of living (Boehnert, 2018).

The ECOLOR project, funded by the EU ERDF programme 2014-2020, has this double aim. Firstly, to understand the past know-how and the state of the art of dyeing plants in the Piedmont Region (Italy) to define innovative industrial applications. Secondly, to design the value chain based on a systemic approach that fosters the development of a circular system, actively involving different disciplines and stakeholders.

The paper presents the methodology developed, the actors involved, and the expected results, proposing a reflection on the role of systemic design in developing socio-technical systems within a circular economy framework. The presented project (re)builds a decayed regional supply chain, and opens several possible pathways and reflections for practical implementation of systemic methods.

Methodology

Design as a facilitator of cross-disciplinary collaborations

Within the ECOLOR project, the design team acts as a facilitator at both process and creative input level, by coordinating different stakeholders in the design activities as well as in the broader system being affected by the project findings (Minder & Heidemann Lassen, 2018). The ability of "frame creation" (Dorst, 2015) is fundamental, as it allows systemic designers to go beyond technological borders to build a frame for analysing complex problems and defining innovative solutions within socio-technical systems. This ability allows designers to mediate between different disciplines, enhancing the co-creation of a project pathway aimed at valorising cultural and historical value chains, such as the dyeing plants one, from an innovative perspective.

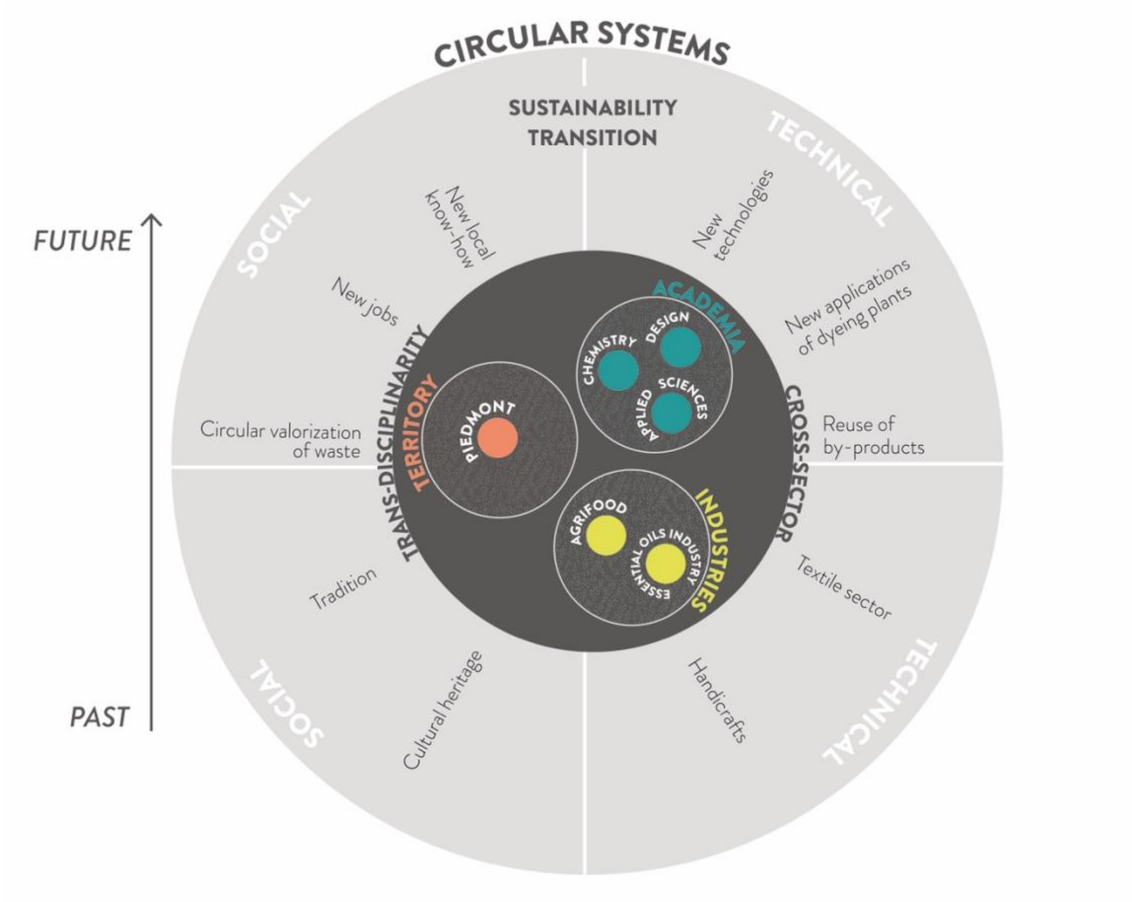

Figure 1. ECOLOR concept visualisation schema.

Figure 1 shows the research concept, which faces multiple tensions due to both the balance between different sectors and disciplines and the need to reconcile historical roots with a new social and technological context. Unlike other circular economy projects, we are not dealing here with a value chain undergoing transition but with a system that has died and must be brought back to life. This *'tabula rasa'* offers the possibility of making a major leap in the sustainable transition of dyeing industry, but at the same time the clash between different visions is delicate to manage. For some project partners, this is a matter of technological innovation, while it is crucial to work on the social impacts of the new model.

Indeed, the system must consider relations with the regional context, evaluating by-product valorisation solutions not only from a technical but also from a socio-environmental point of view: are new professions required? Is it possible to boost other local industries by promoting a sustainable transition? What impacts do the new crops have on local eco-systems?

This multiplicity of impacts necessarily requires close cooperation between different disciplines: Systemic Design and Applied Science and Technology from Politecnico di Torino, and Chemistry from the University of Turin. Two local SMEs are also involved: Agrindustria Tecco, which operates in the transformation of vegetal by-products into industrial value-added products, and Augusto Bellinvia, which deals with the extraction of flavourings and substances of natural origin. The cooperation with Proplast - Plastics Innovation Pole - underlines the strong relationship with the Region in which the project is located. Proplast is the co-manager of the regional innovation cluster on Green Chemistry and Advanced Materials. The cross-sectoral dynamics (European Commission, 2010) define a valid theoretical approach for the systemic exchange of competences between Academic Departments and Industrial partners involved, aimed at fostering a synergic work among all stakeholders.

The methodological process

The operational steps of the research are structured in four main sections (Fig.2) that set out the timeframe of the work.

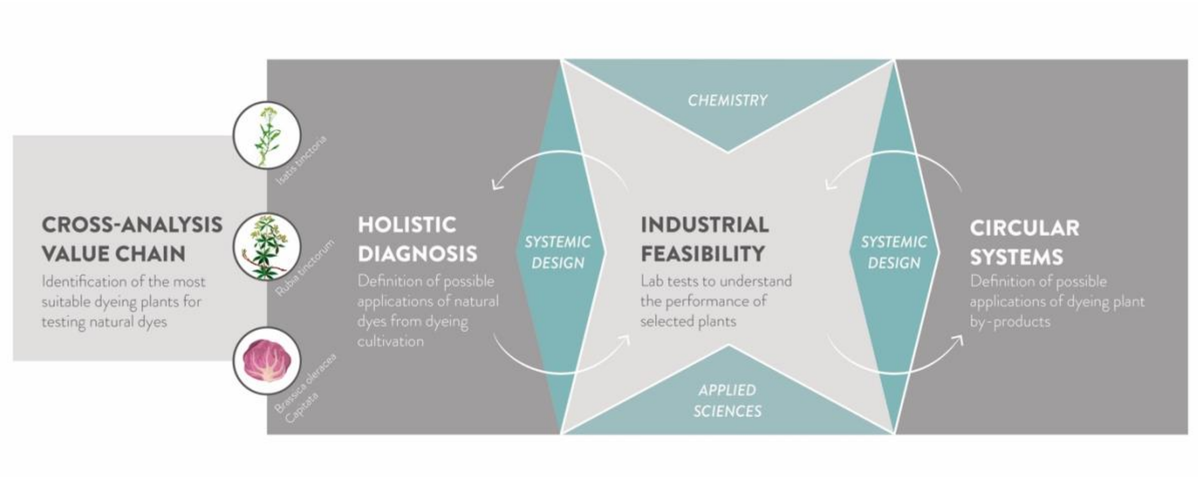

Figure 2. ECOLOR methodology steps schema.

Cross-analysis of the value chain. The first step provides the cross-analysis of local value chains, identifying which dyeing plants still exist and which ones can be re-introduced on the regional territory. This is a key step to understand the diffusion, the properties, the biological-morphological characteristics, but also the current uses and the critical points of use and management of the process by-products. This preliminary analysis led to the identification of three different types of crops from which to extract natural dyes. The *Isatis tinctoria*, which has strong historical and cultural roots in the Piedmont region, the *Rubia Tinctorum,* which has already been successfully tested, and the *Brassica oleracea Capitata* (red cabbage), which can be obtained from food waste and surpluses.

Holistic Diagnosis. Creating innovation, at any level and in any field, means first of all identifying and relating to a socio-cultural reference context, made up of people, stories, traditions and knowledge. To do so, after defining cross-analysis regarding the use of dyeing plants today, it is also crucial to prepare an analytical work step according to a holistic perspective (Battistoni, et al., 2019) of the territory, taking into consideration socio-cultural, environmental and economic aspects. The Holistic Diagnosis step helps at mapping the state of the art of the regional context, it takes advantage of different means of investigation, at different levels, from scientific data collection to semi-structured interviews, to provide an overview of the system's elements and their relations. All this information has to be visualised in an accessible way, capable of supporting data interpretation for a wide and inclusive variety of actors.

Industrial Feasibility. This first step focuses on the processing of dyeing products and the extraction of natural dyes. The industrial partners are in charge to identify the most suitable methods and parameters for grinding and drying the dyeing products; the Applied Technology team monitors the processes in real-time through spectroscopy tools. The second step concerns the testing of the dye extraction from vegetal substrates, assessing different extraction agents to optimise the process. Finally, the Chemistry team carries out the chemical characterisation of the colourants.

Circular Systems definition. In the final stage, the systemic design team carries out a detailed analysis of the dyeing by-products identified in the Holistic Diagnosis to define, with the support of chemists and engineers, the potentialities of different solutions. The aim is not just to assess the technological valorisation of by-products, but to systematise solutions to explore how they fit into the socio-technical system and can foster the development of cross-sectoral circular systems. The output of this process is a theoretical system in which heterogeneous professionals and organisations are interconnected, thanks to solutions that promote socio-economic models of circular economy, that is, restorative and regenerative models that enable the flow of material resources and know-how, based on an ongoing dialogue between stakeholders.

Ongoing activities and expected results

The activities carried out in the ECOLOR project are aimed at defining the technical feasibility of new production processes for natural dyes and investigating the possibilities for the circular development of the value chain.

In this regard, the tangible example is highlighted concerning ongoing experiments on *Brassica Oleracea Capitata*. The aim of the experimentation is to address circular economy aspects from the raw material supply, intercepting surpluses, and production waste of this product for dyeing applications. This approach motivates the active involvement of different actors of the supply chain which sees the extension of the technical fields' application of the product.

Future projects will address the validation of dye processing and extraction technologies on a full industrial scale, as well as the organisational implementation of the circular model. The research is currently undergoing Holistic Diagnosis and, concurrently, the testing of pigment extraction from the three dyeing plants identified in the preliminary study.

Although still at an early stage, the research is expected to achieve short-, medium- and long-term results (see Table 1), bringing benefits to the three macro-areas identified in the concept phase: academia, industry, territory.

Table 1. Matrix of expected results in relation to timeframe and macro-areas involved.

	ACADEMIA	INDUSTRY	TERRITORY
Short	Exploring co-design approaches between heterogeneous disciplines and organisations	Assessing the feasibility of new natural products and circular processes	Transdisciplinary and cross-sectoral collaboration between local stakeholders
Medium	Practical implementation of systemic design methods and tools in a circular value chain	Adopting a systemic approach to new circular business lines	Defining new systems for the valorisation of food waste and losses.
Long	Definition of cross-disciplinary methodologies for the sustainability transition of regional value constellations	Adopting a systemic approach to transitioning businesses towards a circular economy model	Giving new stimuli to an abandoned regional value chain and creating new job opportunities

Each macro-area includes different academic, industrial and regional stakeholders (cf. Methodology), who have specific project goals and benefits, such as a new product or a pilot test. However, it is worth stressing how the transdisciplinary approach adopted and, in general, the pursuit of a systemic and circular model leads to a shared vision of the expected results. ECOLOR's experience already shows that a systemic perspective strongly influences the approach of the stakeholders involved. A technological pilot project on natural pigment extraction would have kept the focus on technological results. A circular design project, on the other hand, explores new technologies within the socio-technical system: in this perspective, the scope for experimentation is widened exponentially and a technological "failure" can be easily turned around for new cross-sectoral applications.

Discussion and conclusions

The systemic approach at the heart of the study promotes research from a circular perspective, laying the foundations for the development of local and sustainable dyes in industry and considering the economic and environmental potential of the entire value chain. The industrial application sectors identified for further experimentation within new projects are food and cosmetic packaging, food industry, textiles and cosmetics. The risk of reducing research to technological achievements is high and would lead to little positive impact on the socio-environmental context. For this reason, the ECOLOR project aims to define all the possible impacts of circular solutions and the stakeholders that may be affected and involved.

The field of action expected is broad and increasingly interconnected, fostering continuous knowledge exchange through cross-sector academic and industrial partners. As a result, the complex issues need to be approached from multiple angles, regardless of "disciplinary boundaries" (Nicolescu, 2002, p.43). Hence, the next steps will allow the definition of an increasingly transdisciplinary research project, in which the inclusion of humanities could support the engagement of civil society. The designer's role is to mediate between technological innovation - necessary for industrial sustainable transition - and social and environmental impacts. These two aspects interpenetrate enhancing the definition of innovative processes capable of promoting cultural change.

The current research stage opens up the reflection on the challenges of co-design processes within trans-disciplinary and cross-sectoral teams, which are often affected by diverging objectives and technology-oriented approaches that overshadow systemic vision and medium- to long-term goals. This is further complicated when long-term projects are undertaken, as they should involve new professionals to respond to the needs in terms of sustainability of the industrial sector of natural dyes and their possible applicability.

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Track 17:

Philosophical Accounts Of Tensions & Sensing Wholeness

Chair: Dr. Marie Davidova

The Question of Intimacy

Michael Arnold Mages, PhD, Northeastern University, Department of Art & Design, Boston, USA
Stephen Neely, PhD, Carnegie Mellon University, School of Music, Pittsburgh, PA, USA

Person to person communication, when meeting the human ideal, requires individual embodied participation, and more so, an intimacy with an *other* through an evolving shared co-presencing, co-embodied, co-experiencing. Communication as a rich sharing is not centered on a simple successful transfer of words, but rather on a replete and cyclical shared enkinaesthietic experience where those communicating become more than two people together, and find opportunities for co-sensing and co-experiencing. The present study offers a philosophical engagement with current telematic communication systems where we contrast the human-ideal of intimate communication and co-presence with examples of fractured palettes, where variables of the aspired-to enkinaesthesia are out of sync, disjointed, or misaligned. The paper concludes with implications for further research along these experiential lines.

Keywords: enkinaesthesia, experience, embodiment, HCI, conversation

Introduction

Throughout the past year and a half, we have existed in the uncanny valley of telematic living. We had a not-quite holiday dinner with our college-aged children who shouldn't travel home due to the dangers of COVID. Not quite, did we visit on special days with our parents and grandparents. Not quite did we build social connections with our students as we taught them in environments that were not quite classrooms. In place of a year of connections and deepened relationships, the many layers of coping solutions have left us with memories of these not quite moments, and frustration, unease, and exhaustion. The sudden immersion into a network of telepresent communication systems has offered some viable opportunities: expanded access for participants, expanded opportunities to hear diverse and geographically distant voices, and affords multichannel communication for those who are perhaps less willing to speak. Yet, it has become clear to the authors that designing these teleconferencing systems was approached as an engineering problem, as a set of solutions for the technical problems of teleconferencing, leaving questions of the experiential, emotional, and somatic unaddressed. Here the authors' past year of research explores the various ways that the designed telepresent communication experience foregrounds (or sadly misses) socio-technical attention to human needs and desires.

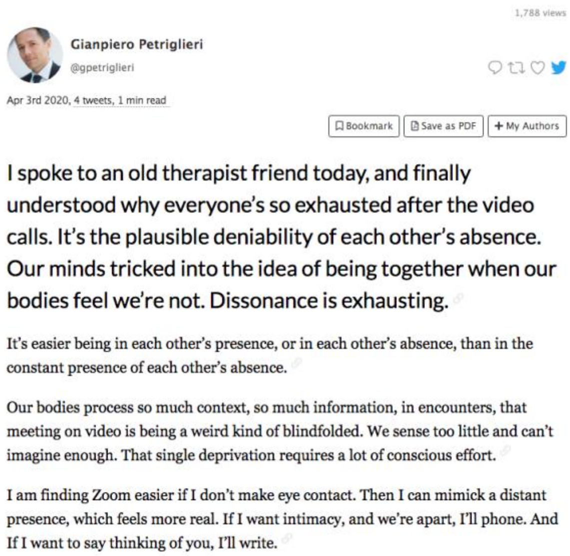

Figure 1. Petriglieri, G. [gpetriglieri]. (2020, April 3). [Twitter moment].

Engineers of early telepresence technologies (telegraphy, radio, telephony) were unconcerned with questions of holistic experience through these mediums (i.e. creating *an experience* (Dewey 1934)). Communication over distance was the instrumental end, and questions of experience were addressed only insofar as the failings of the technology interfered with the clarity of the messaging. The Shannon-Weaver model of communication and its antecedents were quite sufficient (Jakobson 1960; Berlo 1960; Becker 1971) and reduced communication to a discrete signal that must be transferred from one source to another in spite of various conditions that might interfere with clarity. Principal innovations in successive models included a richer accounting for Shannon's problematic noise (Hill, Watson, Rivers, Joyce 2007). Yet, despite the range and complexity of "noise" that might interfere with a successful communication, it was assumed that a successful transfer of signal amounted to a successful communication. Other models included an understanding of a field of experience (Schramm 1954, Maletzke 1963, Arnold Mages 2018) yet these models focus primarily on the construction of memory through the communication experience and do not offer a holistic view of the embodied experience as an aspect of communication.

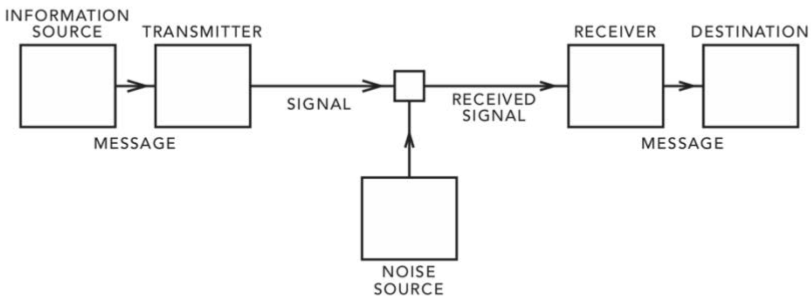

Figure 2. Shannon, C. E. (1948). *A mathematical theory of communication* (page 381)

Dubberly & Pangaro (2009) offer a useful extension of the cadre of Shannon-Weaver based communication models to account for the feedback and constructivist perspective of conversation, detailing one exemplar, the conversation for agreement. Dubberly & Pangaro's conversational models are significantly richer extensions of Shannon-Weaver, yet even so, choose not to engage with accounting for effects of embodied co-presence. In these models, communication is both described and diagrammed principally as a cerebral activity. Communicating humans are literally rendered as heads without bodies, (Figure 3) and thought is modelled separately from cognition. Attention to a holistic experience is unacknowledged as an aspired-to ideal. We argue in this paper that meaningful communication may not be thus separable from a meaningful communicative experience. Simply completing the cycle of communication exchanges through flickering imagery and sound that ebbs and flows as it is compressed and decompressed across the network is insufficient to be described as the kind of intimate sharing that might be meaningfully understood as co-presence. Perhaps there are deeper levels and aspects of the engaged, mutually present communication experience that are available for design that have been, so far, neglected.

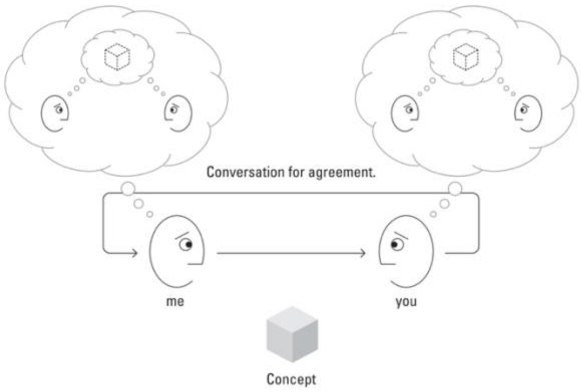

Figure 3. Dubberly & Pangaro (2009 p23) *The Conversation for Action.*

In the current context of 2021, it seems all too clear that while we have impressive technology to successfully transfer our audio and video signals, even able to trade these signals in large conferences with hundreds of participants, the aspiration for using these technologies to create a back and forth that compares to in-person conversation is still out of reach. How might one foster a more holistic communication? While we continue to strive for meaningful shared experience with our family and colleagues, the common reflection on video tele-conferencing is “Zoom fatigue” — the result of striving to achieve shared meaning through this medium. What is fatiguing or less/un-rewarding in the digital communication models? Or we might simply ask, what is so different between remote and in-person dialogue?

Communication through telegraph, telegram, or email permits the transfer of ideas but does not aspire to any sort of embodied intimacy. These technologies permit the transfer of signals without any overture to the experiencing body. The temporality is specifically separated, discreet, binary – we take turns – the rules of the exchange are clear and consistent and as a result, reports of “fatigue” associated with these early technologies are rare.

At its root, the basic difference is one of community rather than simple communication. Holistic communication — that is, intimate communication — is not centered on the successful signal transfer, but rather on a replete and cyclical shared experience. Accounting only for the transfer of ideas omits a significant part of the aspired-to exchange. We are neither minds nor bodies, but inseparable mind-bodies. When bringing this mind-body into a shared space with others, it is in the enkinaesthetic, or the shared “entanglement of our own and the other’s felt action” (Stuart 2012), where intimacy is proven. (Radman, 2013; Stuart, 2021). While successful cognition of spoken words is often a critical component, the dialogue experience is forced to be literally distant without the variables of embodied, entrained experience of two entities acting together. Person to person communication, when meeting the human ideal, requires not only individual embodied participation of word or sight, but more so, an intimacy through an evolving shared co-presencing, co-embodied, co-experiencing.

Whisper in my ear

Consider the child’s (or lover’s) game of cupping a hand and whispering in an ear. Whispering in an ear does not contain any visual information yet can be among the most intimate of exchanges. The exchange engenders an intimacy as (1) only the two bodies participating can know the exchange (creating a sense of privacy) – (2) the lowered volume levels encourage a closeness without losing clarity (drawing the attending parties to focus on each other to the exclusion of the rest of the environment) – (3) the leaning in, touching of hand to ear, and heat of the breath on the receiving ear – all contribute to a heightened experience. The telephone capitalized on much of this experience, gaining a fair amount of intimacy without any need for visual information. The closeness of sound directly (and solely) to the receiving ear without a video component makes for a very specific version of communication, one with a model of in-person communication. The resulting experience is congruent with the variables at play. *I can hear you*; *I can feel your presence without any visual cues, as though you are whispering in my ear*. One might even find themself pressing the phone ever more tightly to the ear in an intimate conversation.

An incongruent conversation

> I doubt that one could get a sense of how much to trust another person as we stare into each other's prosthetic eyes, even if we were at the same time using our robot arms to shake each other's robotic hands. Perhaps, one day we will stop missing this kind of trustful contact and then touching another person will be considered rude or disgusting. E. M. Foster envisions such a future in his story:
>
> When Vashti swerved away from the sunbeams with a cry [the flight attendant] behaved barbarically—she put our her hand to steady her. "How dare you!" exclaimed the passenger. "you forget yourself!" The woman was confused, and apologized for not have let her fall. People never touched one another. The custom had become obsolete, owing to the Machine.[24]

Figure 4. Hubert Dreyfus (2000), citing E.M. Forster's story "The Machine Stops" (1909)

We can contrast the shared intimacy of whispering in an ear with communication through the various current audio-video platforms. By default of the audio+video multimodality and the *in time* reality of live exchange, we come to the conversation assuming a "shared experience", in the model of in-person communication. However, there is an incongruence in the designed interaction. While we appear to be in the same *room*, and we have the *live* back and forth interaction, there are several aspired-to, shared embodied (enkinaesthetic) cues that are notably absent. Where we have a model for sightless intimacy (as in whispering in an ear), there is no analog model for disembodied audio-visual intimacy. The multimodality of audio+visual draws "our minds into the idea of being together when our bodies feel we're not" (Petriglieri 2020). Here there are just enough cues for co-participation that the user is tempted to search for an authentic experience (Dewey 1934) via an intimate community– *I have a feeling body, I see and hear your investment in the call* – yet with the noted absence of the collective body, the entrained enkinaesthetic communicating bodies, the intimate experience is mostly absent. The inverse of low cubicles in an office space which divide without separating, the Zoom conversation elides participants without bringing them together.

The implicitly embodied conversation

The sudden plunge into full-time digital communication revealed a number of assumptions and gaps in the audio-visual platforms. When digital audio-visual communication became the primary mode for business, schooling, and social communication, we found ourselves in a so-called immersive experiment hoping for the best. Aspects of the platforms that were less bothersome in the prior years now started to show deficiencies. The millisecond lags between utterances in conversation and the inability to achieve "direct mutual gaze" likely increased feelings of distrust and unease (von Grunau & Anston 1995; Roberts & Francis 2013). We are not just our thoughts, but are fully embodied beings (Heidegger 1996; Merleau-Ponty 1962; Dewey 1934; Lakoff & Johnson 1999). Our thoughts and our bodies are intertwined in communication as a holistic activity. The nonverbal cues like touch, body posture, and mimetic responses (Cox 2001) of head nods, posture shifts, and phatic utterances — all significant cues to shared experience — are greatly limited or completely impossible in the digital platforms.

At universities all around the world, classes conducted during the COVID pandemic were forced from their normal routines into virtual classrooms. As an educational institution, Northeastern University assumed a leadership role developing hybridized "technologically enabled presencing" in the classroom (Northeastern ITS 2019; Northeastern University n.d.). Classrooms were outfitted with motion- and voice-sensing cameras and microphones that purport to permit parity between the remote and in-person learning experience. From the engineering perspective, the technical problems of online co-working with students are solved. Given the merest sound or movement in the classroom, motorized cameras and microphones reorient almost instantly to capture the questions or contributions of a participating student. The various parts of the classroom, the whiteboard, the instructor's projected slides, the instructor's notes outline for students are instantly shared and available. Yet the enkinaesthetic co-presence is not addressed. Communication, if it is to achieve the human threshold of intimacy, is not separable in the fashion of Shannon-Weaver.

The actual experience of teaching in a hybrid classroom involves dividing attention between remote and in-person participants. In the design studio, in the time of COVID-19, in-person students face the walls to minimize breathing into one another. Or students are placed socially distant in a lecture hall seemingly too large for the size of the class. Improved HVAC subtly increases the noise level, while the sum of presences of the online participants are collapsed into a rollable LCD screen and ceiling-mounted speakers. The result of trying to do both results in neither being done well, and these interventions succeed in distancing not just the bodies, but the beings one from another.

The overtly embodied classroom

The shift from in-person teaching to hybrid or fully remote teaching was a particular challenge to overtly embodied classrooms in the fine arts (dance, acting, etc.) and athletics (yoga, weight training, etc.). Historically, these classrooms have thrived as the participating bodies do not merely co-inhabit the space, but because these settings foster a co-presencing of mind-bodies. Participation in the overtly embodied classroom often assumes communication through subtler enkinaesthetic relations. When everyone was forced to move to digital platforms, the routines of these classrooms were more obviously disrupted. Rather than spoken dialogue, it is the enkinaesthetic bodily presence that serves as the primary mode of communication in these classrooms. When dialogue is primarily embodied – exchanged primarily through shared motions or gestures – rather than verbal, the Zoom-type platforms are revealed to have even fewer solutions to offer. The frictions of timing lags and absence of direct mutual gaze are only the beginnings of a list that in these classrooms now also includes the absence of literal haptic and soma-deep touch (Neely 2019) and the altered orientation and proximity of a disembodied camera view. The enkinaesthetic entrainments of an in-person environment are now nearly impossible due to timing lags and literal distance.

While the deficiencies of the platforms to foster any meaningful enkinaesthetic presence is obviously a serious shortcoming for the overtly embodied classroom, the authors here note the identical hindrance for any shared community (implicit or overt) in any digital audio+video platform. Again, we direct the reader's attention not just to the goal of exchanging discrete packets of information, but to the aspiration for an intimate communication, an aspiration for a more-human dialogue, a reality which is more embodied than not.

Fractured vs Cohesive reality – Metaphysics of presence

What we end up with in the Zoom meeting, is a metaphysics of presence that is both loosely connected to a notion of what is real and present, and also loosely connected to a telematic *other*. What Derrida (1973) draws out in his exploration of *the blink* in his critique of Husserl's notions of a unified presence where "nonpresence and nonevidence are admitted into the blink of the instant." (p 65) is this ongoing confrontation between being *there* and *not there*. These blinkering shifts of modality between one reality and another are the modus operandi for the experience of the Zoom meeting, an unstable fluctuation across fractured and transactional presences.

It is through this shifting modality that students are now striving to make sense, make meaning, and even work together. Paul Dourish, coming to an understanding of embodiment through Husserl, Heiddeger, and Merleau-Ponty writes, "Embodiment is the property of our engagement with the world that allows us to make it meaningful. Similarly, then, we can say: Embodied Interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts." (Dourish 2001, p 126). While our everyday acts of meaning-making, creation, and manipulation are undeniably important, following on Gendlin (1999) it is through embodiment that this myriad of interactions depends upon our physical manifestations.

Embodiment requires a cohesive palette. In a partnering of ballroom dancers – the bodies, the room, the gesture, the music, the air – are all shared. In a dialogue between whispering children – the ears, the cupping hands, the warmth of breath, the spoken words, the participating bodies – are all shared. There are not discreet hands/breath/warmth/ideas, but rather, a cohesive co-presence. We contrast this human-ideal with examples of fractured palettes, where some variables of the aspired-to enkinaesthesia are out of sync, disjointed, or misaligned.

Table 1. Opportunities for designed intimacy: A collection of shared senses

Sight	Mimetic actions such as joint or in-dialogue nodding (Cox 2001)
	Eye contact as direct mutual gaze. (von Grunau & Anston 1995; Mason, Hood, & Macrae 2004; Nurmsoo, Einav, & Hood 2012)
	Considerations of aperture. i.e., Perspective of a single eye or perspective from an immobile head that is out of one's own control. Varying visions of the "room" separate by placing individuals in different spaces, rather than shared spaces.
Sound	Mimetic phatic utterances i.e., "mmm", "Uh huh", "how are you?", breathing, sighing, lip smack, etc.
	Environmental/ambient sounds aid in the creation of the shared space
	Innovations in spatially-informed audio recording techniques: binaural recording (Blau, Budnik, Fallahi, Steffens, Ewert, & van de Par 2021) triphonic spatial audio (such as the Syng Cell Apha (Levy 2021)) and others
Smell	Olfactory shifts signal motion in the living/experiencing/embodied environment
Touch	Touch immediately and unconsciously aids in coupling (Chatel-Goldman et al., 2014) i.e., handshaking
	Shared soma-deep experience – the inwardly understood sensation of kinaesthesia such as shared motion of nodding, the shared crusis of climatic speech (Neely 2019)
Repleteness	In the communal space/experience there is a bottomless opportunity for risk and intimacy (Dreyfus 2000).
	In communal space a participant may support or disrupt the collective experience in any number of ways.
Entrainment	Unison experience vs. millisecond or technical glitch lags (Coan 2015)
Attention	Focused, immersed vs. multitasking vs. attention
Cohesive vs Fractured Embodiment	Embodiment, and shared embodiment as enkinaesthesia, requires a cohesive palette (Neely 2019), i.e., subtle facial expressions, full bodily gestures, conscious and unconscious cues.

The various senses and potentials described here should be thought of not as a totalizing list of what has happened, but read as a set of creative prompts, opportunities for exploration or points of departure that offer more latitude for understanding what a holistic telepresence experience might feel like. Sensory opportunities have been explored in a rather straightforward way, for instance, adding shared smells to an experience through burgeoning digital scent technology. Yet, what we would describe as the deeper opportunities for shared embodied co-presence, touch, entrainment, repleteness are typically out of reach for these technologies. In this paper we ask, rather than experiencing intimacy, consequence, and risk as a by-product of online interactions, how might we design for the holistic intimacy of the whispered conversation in these telematic connections?

"You're still muted"

In 1990, Roy Ascott lauded the capacity of experience that was available telematically, attainable through networked art experiences, "...networking provides the very infrastructure for spiritual interchange that could lead to the harmonization and creative development of the whole planet." Yet 30 years later, we see only the most quotidian examples of co-presence (merely attempting a telematic conversation with a co-worker) fall victim to the slings and arrows of outrageous demands for a holistic co-presence.

In one attempt to call attention to the limitations of telematic embodied co-presence, Paul Sermon created *Telematic Dreaming* (1992) where two people in two different rooms shared a bed with the projection of the other. Sermon continued these investigations of apparent intimacy and non-intimacy with a series of Telematic Quarantine performances (2020). In an online live-streaming performance, a variety of performers visit Sermon during quarantine in a virtual house, sit together on his virtual couch, and attempt to share a virtual meal, complete with smells, tastes and environmental sounds. The modality of the place that is shared is a posterized image of an interior domestic environment, yet none of the performers quite mesh into this online virtual environment. Feet appear to float in the air, performers walk through the couch that is apparently in use, and performers can never quite make eye contact with one another.

There is no deficit of research being conducted on extending the technical aspects of augmented and virtual realities. In fact, the so-called problems of Sermon's performance detailed above are technically solve-able, and perhaps with the right software, are even solved today. Although these technical aspects of telematic experience are not insignificant, the line of inquiry that we would argue holds the more salient questions are the questions of designing for telematic experiencing. Promising lines of research in virtual reality (Smith, Neff 2018; Roth et al., 2019) explore these experiential aspects of the embodied experience. Yet even in this work, it is the perhaps unreachable goal of having a fully human experience mediated through technology that predominates. The goal of making the virtual experience as real, as affective, or as intimate as the in-person is, like the fabled race between Achilles and the tortoise, a goal that will never be reached. We argue that these systems of systems have a more compelling destiny that might be realized through more productive inquiry, and it is this question pointed to by Ascott 30 years ago: how might this technology extend ideas of human presence, and deepen relations?

What are the ways in which this technology might be explored experientially? How might experiencings of telepresence leverage the benefits of this technology rather than continue to mind the gap of the failings? Perhaps it is our animal nature, as described by Jacques Derrida, where in our zeal to attain Shannon-Weaver's utility of noise-free communication, we can't let the thing be what it is (Derrida & Mallet, 2008 p 159). Perhaps it is time to apply Guy Debord's social critique of the 1980's to these technologies. In 2011 the artist collaborative Benrik (Ben Carey and Henrik Delehag) delved into Debordian-inspired questions of how people might be lifted out of a series of undifferentiated day-to-day experiences. The Situationist app offered serendipitous meetings with strangers, to engage in fleeting and playful *situations*. The experience uses locative media to pair app users when they are close to one another. Both users are sent a picture of the other, given 5 minutes to find each other, and instructions for a short performance together, such as "Hug for 5 seconds exactly." "Ask me what I think of the war." "Give me the finger." and "Ask me for my autograph." After the performance, participants walk away from each other. While the app was banned by the Apple Store after only 6 months due to unauthorized use of Apple's location services (Sweeny 2013), it is this kind of intervention that brings people together in novel, engaging ways, that suggests what future technologies might offer.

Conclusion

"[The] acceptance of the other person beside us in our daily living [...] is the biological foundation of social phenomena: [without this] there is no social process and, therefore, no humanness." —Humberto Maturana (1992, p. 246)

Maturana reminds us that at the root of communication is the will to be more human. While information transactions can be conducted through a variety of technologies, it is the colliding of information exchange with the ever-present need for authentic communication that has created the current frictions. Email and telegraph are obviously outside of the authentic embodied communication loops. Whispering in an ear and the hands-on work of a yoga class are certainly fully embodied. How might we characterize or make best use of these hybrid technologies that offer some of the communication cues but are forced to leave others out?

While industry and the academy continue to search for the more authentic telepresent experience, the authors offer the prior discussion of theory and case studies encouraging continued research exploring enkinaesthetic experience. We offer the enkinaesthetic as a critical variable in the design of telepresent communication systems, and by extension, a primary/foundational variable of all designed experience.

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Reverberations at the Edges

Politics of designed im/materiality

Esther Y. Kang

U.S. politics foster a conflicting mode of existence—one that centers heterogeneity and individual freedom. The contradictory nature of these two characteristics divorce the individual from networks and cause a collective state of disparate dissonance. This brings to the fore the line of inquiry on hegemonic influences on the concepts of objectivity, normativity, and standardization as systems are designed and developed in the US. The assumption of a system's inherent apolitical nature overlooks the foretelling promise of marginalized groups' intuit on what may be at stake and what may be a great potential due to points of tension in a system. This conjures the affective world of politics and the political in the designed im/material worlds.

Keywords: design politics, oppressive systems, affect

Political ruptures direct our attention to points of friction that have been reverberating through layers of complexity for long durations of time influencing the components that design the conditions of a place—economies, politics, cultures, relationships, and biomes. Each echo shapes the contours of seemingly discrete social contradictions that typically reveal themselves most prominently in the material and immaterial everyday lives of individuals in the margin. Similarly, the types of tensions a marginalized group faces and the extent to which they are affected varies according to one's place on a social stratification. In this light, it is critical to understand the power asymmetries that are at the crux of such tensions by conducting a deeper exploration of the affective qualities that signify these complex dynamics.

In the US, manmade systems are often portrayed as entities independent from consciousness, cultures, and histories. Upon their initial introduction to the public, common approaches to systems—material and immaterial aspects of life that range from services, policies, to digital architecture—are as though they are an apolitical means to an end fracturing critical reflection on the affordances carried through the decisions made to design such systems. A contrasting argument is one that foregrounds the theory that systems are an extension of multiple logics making it highly susceptible to enabling a particular type of cosmology to move forward as others fall by the wayside. This crystallization becomes fraught with politics as it meets a designed im/material hegemonic society that lauds its heterogeneity in representation yet lacks in substance seen in many Western contexts particularly the US.

The mismatch between systems with a hegemonic logic and societies rich with difference strikes any that deviate away from a standardization derived from a dominant culture subjugating a particular type of difference. This, in essence and materially, creates multiple forms of marginalization. Design's rapidly growing involvement in historically unconventional yet highly charged settings, such as policy-making, city planning, and service delivery, bring to light the complex relationship between designed products and the contexts in which they live. These insights bring to the fore the stark contrasts that exist as human variability meets designed material worlds and shapes lived experiences, differently. Despite aspects of design originating in a Scandinavian social movement (Greenbaum, 1991), its application to complex US-based issues translates differently. In the states, it becomes a one-dimensional approach made evident through fixed frameworks and ethnocentric logics seen through aesthetics familiar to a dominant culture and modalities attached to extractive and racial capitalism (Robinson 1983, 9-28; Kelley 2017). Such logics design a mainstream and fringe (Mata-Marín 2020, 130-164); delineate a *we* and *them* (Wynter 1976); set a social strata for man from "full human, not-quite-human, [to] nonhuman" (Weheliye 2014, 12). These manmade distinctions are absent from design's consciousness spurring misdiagnoses of these points of friction while deepening existing ones and inadvertently designing new ones. Design's blind spot of what's at stake and for whom makes it integral to understand new dimensions of design to account for depth, complexity, and livelihoods.

Despite such high stakes, foundational to the designs of systems in the US has been the notion of democracy and the impression that achieving some form of it would yield dynamic harmony. However, the points of tension in the designed immaterial and material worlds reveal discrete and overt contradictions that expose the dimensions of life and privilege. In this light, it is important to further scope work done at the intersection of policy-making and the livelihoods of marginalized communities. Since, at this juncture, the term marginalized community is used broadly, I will provide a range of policies that have targeted disenfranchised communities to illustrate ways in which the U.S. has followed through with their beliefs in democratic values and ways in which they have faltered repeatedly underscoring the problematic nature of viewing systems as apolitical entities.

Immigration

President Obama authorized the Deferred Action for Childhood Arrivals (DACA) program in 2012. It is the first large-scale immigration policy to affect undocumented youth by providing temporary relief from deportation, renewable work permits, and temporary social security numbers. DACA also provided opportunities for more access to higher wages, driver's licenses, health care, and the ability to open a bank account (Hsin and Ortega 2018, 1487-1506). Some analysis has found that DACA best serves those with higher levels of education and access to more resources through their families. It also is unclear whether it improves social status in the longrun; however, it has alleviated stress, albeit shorterm, for undocumented youth who were brought to the U.S. at the behest of a legal guardian (Gonzales, Ruszczk, and Terriquez 2014, 1852-72).

Ethnic Enclaves

Asian ethnic enclaves such as chinatowns, japantowns, and little manilas formed as a result of widespread racism and anti-immigrant sentiment. With the California gold rush in the mid-1800's, many Chinese migrants moved to the coast to work as miners. Later, many took jobs as laborers and had a hand in building the transcontinental railroad. Within roughly two decades, the Chinese community grew 60x expanding their reach from California to Montana and made up a quarter of the workforce (Lee 2016; Kandil 2019; Wu 2015). With this rose an anti-Chinese movement, this resulted in massacres—such as 150 armed white miners in Rock Springs, Wyoming, murdering 28 Chinese people and burning their homes and businesses to drive Chinese immigrants out of their rural town—evictions, and legal restrictions (Lee 2016; Kandil 2019; Wu 2015). Chinatowns resurfaced with the enactment of the Chinese Exclusion Act of 1882 instilled by the federal government; these ethnic areas acted as refuge for those that remained in the U.S. Building upon the history, present day ethnic enclaves, like chinatowns, aim to become historical landmarks to sustain the sense of refuge (Lee 2016; Kandil 2019; Wu 2015).

Justice System

Michelle Alexander argues that slavery was repurposed and presently takes the form of the criminal justice system (Alexander 2010). This theory typically takes the shape of service requirements that people in the justice system need to fulfill while serving time in prison. Some services are minimal, such as picking up trash along the side of the road, to life endangering tasks. In recent accounts, a Southeast Asian refugee from Laos, Kao Saelee, was arrested for armed robbery around 2008 (Levin 2020). After twenty two years in prison, he was beginning to see the horizon as plans for his release were crystalizing. His final call to service was to fight the Northern California wildfires (summer 2020). However, upon ending his service, U.S. Immigration and Customs Enforcement (ICE) detained him for deportation and sent him to a federal facility in Louisiana (Levin 2020).

Additionally, the ways in which policies were designed expose the fault lines in certain points of tension seen in an overlooked area: unintended consequences that result in exacerbating the initial problem. Here are a few examples of policy-making practices that deeply backfired on marginalized communities and those adjacent to them.

Implementation of policies in response to inequities

The Department of Immigration and Citizenship Enforcement finds itself in several precarious situations as it enacts immigration policies. Raids and other practices are often myopic in approach. For example, an ICE raid took place at an agricultural farm in 2008 where 400 arrests of undocumented workers took place (Harrison and Lloyd 2011, 365-85). This caused Agriprocessors, the company where the raid took place, declared bankruptcy. In addition to this agency experiencing backlash, this example is also an example of policy drift—the transformation of a policy's outcome due to the failure to update its rules or structures to reflect changing circumstances (Galvin and Hacker 2020, 216-38). ICE was created in response to 9/11 to enact stricter immigration policies. Since its inception, the department has not adjusted their approach causing ripple effects as illustrated here; the stale nature of ICE is also reflective of "America's gridlock-prone polity" (Galvin and Hacker 2020, 216-38) where change to a policy confronts many institutional barriers.

Both of these examples illustrate the unintended consequences resulting from a policy that was meant to rectify and/or bring relief —though the initial policy may be seen as problematic, such as redlining. In either direction, whether the policy is seen as problematic or not, unintended consequences dramatically shift the ecosystem they reside in. This brings to light the need to reevaluate the ontological nature of systems and their relationship to enactment.

This brings to the fore the need to understand emotional dimensions of these designed im/material worlds to understand the affective qualities of politics and the political. This paints a robust picture of power asymmetries while providing a new dimension to understanding how one can approach an intractable social issue. This has often been referred to as the affective turn building upon the ontological turn as stated by Boaventura de Sousa Santos and through the Epistemologies of the South (ES) framework.

This framework includes three key pillars:

- *Sociology of absence:* underscoring that the absence of or omission of results in the erasure of "entire worlds" (Escobar 2020, 69) and a propelling of active erasure thereafter. This causes a world and surrounding worlds to be complicit in deeming it nonexistent with the inability to think of an alternative as it does not exist.

- *Sociology of emergence:* underscoring the possible responses to dominance—whether in the form of erasure, repattening, amongst others--is the emergence of several discrete to dramatic alternatives (Escobar 2020. 69-70)

- *Intercultural translation (across knowledges and struggles):* another way to think of this is "relational ontology" (Escobar 2020, 71); this is a new orientation deeply rooted in relationality understanding both "nothing preexists the relations that constitute it" and the tension that arrives when multiple worlds try to equally exist together (Escobar 2020, 72-73)

This framework begins to identify emergent spaces so that one may find a new orientation to their world, and multiple worlds. Similarly, and particular to the U.S. context, Audre Lorde states "certainly there are very real differences between us of race, age, and sex. But it is not those differences between us that are separating us. It is rather our refusal to recognize those differences, and to examine the distortions which result from our misnaming them and their effects upon human behavior and expectation" (Lorde 1980).

Returning to the affective turn, this provides a holistic understanding of a context as it pertains to the immaterial and how one can think through points of tension. Identifying the emotional thread that connects webs of designs, immaterial and material, one will be able to gain a type of depth that existing analysis would not warrant. To further provide context, here is a way feeling, emotion, and affect are distinguished. Feelings are personal and biographical. Emotions are social. Affects are [dimensions of intensity or] prepersonal (Schouse 2005). For instance, to understand a charged room or a collective sigh of relief or similar trigger points across a generation unveils multiple dimensions and scales of tension--publicly displayed, publicly felt, and understood beyond speech.

Seemingly discrete political contradictions shape to a given context, and points of tension are the gateway to identifying the underbelly of oppressive systems. Understanding the cosmologies of fringe communities reveal the acuity of such tensions; it concurrently exposes emancipatory and liberatory spaces through the ontologies and epistemologies of communities impacted by several issues. In this light, it is vital to have a critical understanding of the role of design*ing* and design*s* as design*ed* material and immaterial worlds meet variability across species differently and affectively.

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Transversal Design

Glimpsing the Emergent Whole, with the Trouble

Cheryl Hsu

In increasingly fragmented environments leading to growing distrust of large-scale systems, how might designers work in service of building a sense of collective "wholeness" without "totalizing" one perspective or worldview? This short paper draws from philosophical inquiry and participation with emerging relational practices of Collective Presencing and People Need People (PNP) Warm Data Labs, to explore how design can revitalize its optimistic commitment to designing the conditions of symbiotic systems of *living wholeness*, while engaging the epistemic humility of approaching it with what feminist scholar Donna Haraway describes as *"living with the trouble."*

The author proposes a **transversal design approach,** wherein the building tensions in and through a plurality of perspectives and relationships can creatively lead to *transversal* encounters of glimpsing "wholeness": the creative moments where the "us" and "them" might become the emergent "we". These glimpses of the "wholeness" -- whether it is of the group, of the problem, of the system(s) – are what catalyze the collective emergence and alignment around shared vision and action.

Keywords: pluriverse; transversalism; wholeness; awareness-based systems change, warm data

Introduction

In increasingly fragmented environments leading to growing distrust of large-scale systems, how might designers work in service of building a sense of collective "wholeness" without "totalizing" one perspective or worldview? Humans co-exist in what Arturo Escobar describes as a **pluriverse**: a world of many worlds (Escobar 2017). In seeking collective transitions towards preferred futures, tensions are both difficult and fruitful as "we" collectively explore how to navigate the borderlands of what is possible. When systemic designers create context-bound containers to address complex problems, they invite and weave together the stakeholders that meet the *"requisite variety"* (Jones) of "bringing the whole system in the room". In these co-design environments, systemic designers must host and steward the agonistic politics (Mouffe 1993) and frictions of negotiating differing positions and worldviews towards a sense of "wholeness".

In these containers, radical innovation happens when building tensions in and through a plurality of perspectives can generatively lead to ***transversal*** encounters of glimpsing "wholeness": creative moments where the "us" and "them" might become the emergent "we". These glimpses of the "wholeness" -- whether it is of the group, of the problem, of the system(s) – are what catalyze the collective emergence and alignment around shared vision and action.

Yet these **glimpses of emergent wholeness** are ephemeral and elusive; these moments cannot be designed, but their conditions can be cultivated through *relationship*s, or what Nora Bateson calls "warm data". These glimpses of wholeness are closer to the abductive leap of design **synthesis**, a *creative moment* of "a-ha" that designer Jon Kolko refers to as the "magic of design". In this moment, a group of stakeholders achieving a sense of the elusive "we" is what generatively transforms differences and conflict into collective action. This transversal encounter of "wholeness" moves beyond mere consensus or compromise, or even a "synthesis" of parts, but is a brief gathering moment where stakeholders become part of a larger whole. This sense of "wholeness" is not fixed, universal and impersonal, but are *ephemeral events* in a process of becoming, achieved through and with the unique perspectives of each individual.

This paper explores emerging practices that focus on emerging relational practices of Collective Presencing, and Warm Data Labs as examples of robust containers that cultivate the capacity for collective emergence. These relational containers are in service to ***transversal glimpses of the whole*** that lead to **radical collective innovation.** Rather than mediating towards agreement or consensus, these practices embrace a living improvisational field of "staying with the trouble" of dancing with plural perspectives. This approach invites systemic designers to radically trust and follow the direction of relationships, rather than chasing problems and solutions, in order to build the capacity for the collective emergence of the transversal.

Navigating Pluriversal Tensions towards the Transversal

The difficulties we presently face in navigating urgent, globally entangled problems -- increasing social inequality, political instability and ecological collapse -- reveals the limitations and cracks of our current systems. As Escobar writes in *Designs for a Pluriverse*: *"we are facing modern problems for which there are no modern solutions"*, so how might we midwife the possibilities that are truly new? (Escobar 2017).

Rather than focussing on problems and solutions, there is potential in the nurturing **relationships** – or what Arturo Escobar calls the "political activation of relationality". Changing relationships with each other, with more-than-human actors, and with the "whole" holds the possibility of leading to truly radical innovation that is a discontinuous leap from known paths. However, if change needs to happen at the speed of relationships, and relationships are built at the speed of trust, perhaps there is wisdom in heeding the paradox that philosopher Bayo Akomolafe shares from his Elders: "The times are urgent, let us slow down."

Tension is a part of complex living systems because we are constitutive of a **pluriverse**: a teaming world of many worlds – each rooted in the situated contexts of cultural, place-based, social, political and economic forces. As systemic designers, we must slow down to meet the generative, creative tensions of co-navigating with a pluralism of different epistemologies and ways of being-in-the-world as we shape and build new systems. However, in bringing together different stakeholders, simply focussing on tension and difference may reify boundaries between identity groups, while focussing on homogenizing consensus may collapse the uniqueness of positionality into an undifferentiated collective. How do we "stay with the trouble" of cultivating relationships that can generatively transform tension into *sympoeisis*, the true "making-together" new possibilities (Haraway 2016). This approach to symbiotic world-building goes beyond the human: living ecologically together on the planet requires us to explore new planetary paradigms that are not simply anthropocentric and globalist, but explore new possibilities of how humans can co-habit with more-than-human actors.

Yet on the ground, system designers open up to the tensions of divergence in service for the generative moments of **convergence**, of what this paper calls "transversal glimpses of wholeness". Given the complexity and ineffability of the relationships that make up the "whole" system in its constant state of becoming, systems cannot be mapped or known in its totality. However, there is still a possibility of grokking a "sense" of the system through **"transversal glimpses of emergent wholeness"**: critical moments where stakeholders involved in systemic design projects encounter a mutualistically felt sense of being **participating in something bigger**, an experience of cohering into larger "we" of ecological wholeness.

Glimpses of Wholeness in Relationality

Emerging relational practices like Collective Presencing and Warm Data Labs focus on the cultivation of relationships into fields of potential for collective emergence, or participation with what Nora Bateson calls "complex living order." This section explore the author's learnings and experiences participating in and co-hosting these practices.

Collective Presencing is an emerging practice developed by Ria Baeck, that relates to Otto Scharmer's awareness-based systems change approach, which proposes that one "cannot change a system unless you transform consciousness", and "one cannot transform consciousness unless you can make a system see and sense itself." Since we are all constitutive of the systems that we inhabit, Collective Presencing invites participants to come together to relate not just with each other, but to the "middle" – an emergent actor that gestures towards the elusive "whole". What Collective Presencing practices allow participants to do is to invite " the middle" into the collaborative process; so that rather than simply speaking to each other, participants source from and create from the "middle" – a separate "stakeholder" that is co-created by the shared attention and presence of the participants. As opposed to synthesis, what emerges is what philosopher Jean Gebser calls *synairesis,* which is a quality of grasping the whole through a qualitative sense of integrity, intensity and verity.

Another practice that cultivates space for the emergent living "wholeness" are the Warm Data Labs and People Need People (PnP) sessions created by Nora Bateson, where the focus of the gatherings is around the creation and sharing of **warm data:** transcontextual information about interrelationships that make up complex systems. In a PnP session, a group of participants may be hosted to speak to topics and content that arises from the confluence of multiple contexts that weave around, rather than point to, a specific problem or intention. The purpose of a PnP session is not to arrive at a specific solution or outcome, but to robustly hold space for and nourish opportunities for participants to newly encounter one another away from prescribed roles or known scripts.

Both of these practices focus on the cultivation of relationships, purposefully *not* around fixed goal or problem, but around the creation of shared field and context on the basis of warm relationality. These practices invite encounters of collaboration on a radical level where participants are not gathered around a mission of a "desired future" that they must be collectively motivated to reach, but are invited to participate together in active relationality as the unfolding of the future in the present. Perhaps these relational practices are not sufficient *alone* in designing systemic transitions, but constitute what feels like a vital step of developing relational wholeness *prior* to collective sense-making and problem-solving.

The Possibilities of Transversal Design

The proposal of **"tranversal design"** borrows from the feminist understanding of **tranversalism** as an emerging form of cosmopolitanism that is not globalist, but staked on pluriversal "standpoint epistemology", recognizing that the world is seen differently from different situated positions, and that these differences are fundamentally important (Yuval-Davis 1999; Hosseini 2015). The transversal "wholeness" of the collective is not an totalized, undifferentiated shared identity, nor is it merely a fragmented collection of different irreconcilable parts: it is an ephemeral glimpse of the "living whole". Furthermore, the author is interested in how the transversal can integrate the post-human dimension, where designers might see how systems are relationally and materially weaved together as transversal assemblages -- cyborg identities that co-constitutive of humans, non-human actors and media technologies (Braidotti 2019) . If the "stakeholders" in systems are not solely human, how do we begin to explore systemic change and design as a co-operative trans-species effort?

The spirit of Systemic Design is transdisciplinary by nature - it brings optimism and vitality in gathering across disciplines and silos to bring the "whole system into the room" and discover the generative overlaps. Yet what constitutes our definition of the "whole"? Who gets to determine what the preferred "whole" should look like? We are confronted by the hubris in how our socio-technical systems are designed from a predominantly Western-Globalist epistemic lens. From one totalizing perspective, we are planetary actors on Buckminister Fuller's "Spaceship Earth", with the mission to engineer our systems towards a *critical path* of mitigating climate crisis and ecological destruction. Yet at the same time, the earth is closer to a complex, mysterious living organism of many living organisms, better represented by the Gaia Hypothesis co-developed by microbiologist Lynn Margulus and chemist James Lovelock -- a synergistic and auto-poetic, complex system that is unfolding through symbiotic relations of living matter.

This short paper is a starting point in making sense of new ways of which systemic designers steward the conditions of navigating through the tensions of plural differing perspectives towards the "transversal" -- helping catch glimpses of a sense of "living wholeness" that gestures to what Christopher Alexander calls the *"Quality Without a Name*". I begin with the starting sketches of principles towards glimpsing **transversal wholeness:**

1. Wholeness is ineffable and ephemeral.

2. Wholeness is in a constant state of becoming.

3. Wholeness can only be glimpsed through the Particular.

4. Wholeness is felt and sensed, not understood and mapped.

5. Wholeness is transcontextual.

By inviting these ineffable glimpses of the transversal whole, I believe that it can transform the possibilities of what "we" can collectively imagine across and through difference, and bring form to in terms of new systems. We begin to dance with the systems that we create. Affordances for this possibility can be seen the creation of space for the emergent "middle" in Collective Presencing, or the interweaving of relationships rather than outcomes in Nora Bateson's Warm Data Labs. So the **transversal designer** might be what Bruno Latour characterizes as a *Cautious Prometheus*: we are moved to participate with humility in the midst of agonistic pluralism, yet we seek towards the optimistic possibility of stepping into the collective patterning of the "emergent whole".

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