Connecting design research with complex adaptive systems for systemic change

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Abstract

Systemic change can be facilitated by using the principles of complex sciences. Design researchers are equipped with many different methods and tools to get a better understanding of the users, stakeholders and to create the intended interventions. A designerly way of working has been widely applied to deal with complex societal problems. Through a multi-case study,

this paper aims to get a better understanding of how design research can contribute to engendering systemic change.

Author Keywords

Systemic change; Complex adaptive systems; Design thinking; Probe; Co-creation; Vitality; Empathy; Multi-stakeholder; Sport; Energy transition.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; See http://acm.org/about/class/1998 for the full list of ACM classifiers. This section is required.

Introduction

Systemic change can be defined as "an intentional process designed to alter the status quo by shifting the function or structure of an identified system with purposeful interventions (New Philanthropy Capital's 2015 handbook)" [25]. Systemic change aims for sustainable, large-scale change by targeting underlying structures, principles and supporting mechanisms of a system [25]. Challenges for systemic change are everywhere. For instance: how to encourage people to stay physically active (and healthy) in a society where the economic model forces them to spend 1/3 (or more) of their "productive" life-time in sedentary mode? What can be done to increase awareness of climate change in a world where economic growth is strongly linked with increasing waste? All these questions require a complex approach where multiple disciplines and factors such as individual motivations, system constraints, behavior, context, governmental policies and industry dynamics must be explored.

Systemic change is inherently complex and dynamic in nature, and is about creating value for all parties involved [2]. These parties can not be studied in isolation and are represented at the micro (user), meso (organisation and community) and macro level (ecosystem and society) [based on Value framework - Den Ouden] [10]. Systemic changes will impact simultaneously at these different levels no matter at which level the changes are introduced.

At the Industrial Design department of Eindhoven University of Technology, our main design research objective is to create value and opportunities in systems with emerging technologies and materials. In addition, we leverage new forms of interaction by realizing and studying networks of systems in a societal context and to design and analyze the emerging interaction patterns using recent developments in data acquisition and data analysis technology. Creating systemic change through design is our ambition. Rooted in the research through design methodology [36], we act as creative technologists to apply a human centered design approach to create smart products, systems and services involving ICT.

In this paper we would like to get a better understanding of how our design research can contribute to the body of knowledge on systemic change. Through the discussion of four design cases, we aim to identify how design research methods and tools contribute to systemic change principles. We conclude with an analysis of the design cases through the lens of complexity science to

- Provide guidelines to design researchers to create systemic change

- Provide design researcher tools and methods to practice the nine principles from complex adaptive systems for systemic change

Case Study Approach

This paper adopts a case study approach to deepen our understanding of the role of design research in the process of systemic change. This research method is particularly useful in studying complex issues in a real-life context [28]. Since case studies are situated in a context specific environment, you can gain profound and comprehensive insights into a small, carefully selected domain [35].

In this paper we discuss four design research cases that illustrate the role of design research within systemic change. In our analysis, we compare the cases to develop overarching insights that may guide future design research for systemic change. The analysis is based on the theory of complex adaptive systems proposed by Zimmerman et al. (2008).

In the cross-case analysis we use the nine principles of complex adaptive systems derived from complexity science [3]. The nine principles are: 1) use a complexity lens, 2) build a good enough vision, 3) balance data and intuition, planning and action, safety and risk, 4) tune to the edge, 5) accept paradoxes and tension, 6) let direction arise, 7) listen to the shadow system, 8) allow gradual change by chunking and 9) mix cooperation with competition. With this retrospective analysis approach, we evaluate the nine theoretical principles in relation to design research practice and provide new insights on the synergy between complexity science and design research for systemic change in a real-life setting.

Case Study 1: Co-creating a collaborative platform visualizing, analyzing and sharing vitality data with multi-stakeholder to capture requirements in depth and define mutual benefits

Data, nowadays, has a significant impact for both individuals and societies [12]. That is to say, the usage of data has a potential to change society in the scale of micro to macro-level [33]. In this case study, we demonstrate the co-creating process of a collaborative platform, which visualizes, analyzes, and shares vitality related data, with stakeholders in the Vitality Living Lab (VLL) project.

To capture complex requirements from the variety of stakeholders and define mutual benefits among them, this research adopts co-creation through the entire design process. Co-creation refers to any type of cooperative activity to share creativities among participants [9]. Within the frame of co-creation, we use the combination of design research methods, which are "competitor analysis,"[15, 34] "in-depth interview" [5] integrating with "card sort"[13, 14] and "quantitative persona." [1, 7, 15, 16, 31]. By using these methods we were able to define problems, gather requirements and build relationships with the stakeholders.

The co-creation process uncovered the stakeholders' visions and requirements for the design of a collaborative platform that shares, visualizes, and analyzes vitality related data. The analysis of the interviews showed distinct similarities and differences among stakeholders. We will continuously take the approach of co-creation with all stakeholders involved in the design process of the platform, as we seek

mutual benefits among them, through coming design iterations. The future challenge will be finding the point that stakeholders have a mutual agreement and maximize a mutual benefit among them through the platform.

Case Study 2 ONE23CYCLE: Exploring Design Opportunities for Healthy Running

Current products to improve the performance of recreational runners neglect the daily lifestyle and dynamics of runners [26]. Although wearable devices and mobile apps focused on running and fitness do a reasonably good job of sensing body signals, monitoring training schedules and measuring daily physical activity [17, 26, 32], they use predefined models from top athletes or standardized personas [4, 21, 32]. This despite the fact that personal factors such as work-related stress, lack of sleep, or high physical activity levels due to unplanned sport activities play a crucial role in the performance of a recreational runner. Therefore, to effectively stimulate recreational runners to implement healthier and better running habits, a change in the approach to design and develop systems for recreational runners can make a difference.

We present a framework called ONE23CYCLE, which models the complexity of running-related injuries in recreational runners and their workload profile from a 24/7 perspective. In our approach, training, off-training and environmental factors were merged together into a 24/7 approach, offering a holistic overview of recreational runners' workload profile. This unconventional and transdisciplinary approach allows us to explore and visualize correlations between variables and parameters which are not commonly used to define risk from suffering injuries, physical health, performance and capacity.

The first step in the design research process was a literature exploration of empirical studies on running-related injuries. In addition, we consulted experts form a broad variety of disciplines, including interaction design, psychology, human movement sciences and sport studies. The expert consults supported the selection and description of the variables and parameters to be included in the framework.

The analysis of the variables and parameters showed a great variety in term of complexity and specificity. The ONE23CYCLE framework combines biomechanics, anatomy, environment, training habits, training errors and off-training factors to construct the individual workload profile of a runner. The model is constructed of one hour of running (training) and its impact on the 23 hours of "non-running" (off-training).

In practice, we believe the implementation of this framework into design and development processes will support end users (a vast community composed by individual recreational runners) to achieve healthier running habits and overall well-being. Even though the focus is on individual runners, this approach aims to have significant impact on different levels such communities, academia and/or industry.

Case Study 3 Workwalk: Design Case to Integrate an Active Lifestyle into Daily Office Life

There has been growing recognition of the integral links between physical inactivity and the development of non-communicable diseases. As a response, a multitude of intervention strategies and designs have been developed to stimulate physical activity at work [6, 8, 11, 18, 19, 20, 22, 23, 24, 27, 29, 30]. However, the vast majority of these strategies and designs consider physical activity a break from work instead of an alternative way of working. A pressing challenge is therefore how we can facilitate physically active ways of working.

In this case study, we present WorkWalk, a human-computer interaction service design that encourages and facilitates office workers to have a walking meeting. The objective of Workwalk is to provide a more active way to have a meeting at work. WorkWalk aims to provide a simple way to integrate physical activity into daily office life by providing clear guidance and structure for a walking meeting without the use of additional applications that could disrupt or disturb a meeting.

The workwalk concept consists of three elements; 1) a visible route marked by a physical dotted line, 2) meeting and information signs and 3) integration with a room booking system. The first element is a 1.8 km route painted on the pavement that serves as a guideline for the walking meeting. In addition to the line, the workwalk has two additional features. First, meeting point signs placed near the entrance of all office buildings that have access to the workwalk. The meeting point signs (fig X) are made of ground stickers and show the workwalk logo, the duration and explanation on how to book a Workwalk. The third element of the Workwalk is the digital integration in the room booking system of the university, making the workwalk available as a meeting location in the same way as 'normal' meeting rooms.

The design process of the workwalk was initiated at a hackathon where a 'design team' was formed of people from different backgrounds who did not know each other beforehand. During the hackathon a first design was developed. This process was guided by several behavior change techniques (Michie, et al, 2011), such as restructuring the physical environment, restructuring the social environment, reframing beliefs and habit formation (Damen et al., 2018). These behavior change techniques were used based on a combination of scientific literature, formal and informal interviews and the shared belief that integrating physical activity with work calls for a paradigm shift in the way we look at and think about office work. By using the intervention mapping protocol of Bartholomew et al. (1998) to inform the design process (Damen et al, 2018), it was possible to formulate programme objectives and related changeable behavioral and contextual determinants of all the involved stakeholders.

In a second design iteration the workwalk was prototyped using 2 km of duct tape at the campus of University of Technology Eindhoven. This prototyping process provided interesting new insights on the implementation process in which new stakeholders emerged, expanding the complexity of the system. A third iteration included industry partners and university campus management teams to realise a more sustainable WorkWalk in its current form. Data on the

WorkWalk bookings, as well as in-depth knowledge on behavioral and contextual determinants of users are currently studied.

Case Study 4: Designing systemic change strategy for energy transition

In 2018, a comprehensive set of climate legislation was adopted by the EU to deliver on its commitment to reduce its greenhouse gas emissions by at least 40% by 2030 as compared with 1990. In addition, the EU renewable energy and energy efficiency targets for 2030 were raised (compared to the Commission proposals) to 32% and 32.5%, respectively. The province of Noord-Brabant has the goal to use 100% sustainable energy in 2050 (50% in 2030), according to the European Climate Agreement and national Climate plans. A Social Housing Corporation in Eindhoven decided to respond to this call for change and started this project with close collaboration with the social design team in VanBerlo.
The purpose of the project was to develop energy transition strategies that support housing corporations and involved stakeholders (including the citizens) to make the necessary changes. The system discussed in the case study is the energy system around the social living environment in Eindhoven. The call for change comes from the Macro level: the European Climate Agreement and National Climate Plan. The targeted change is on the Meso level and Micro level: social housing corporations and involved stakeholders (municipality, district centers, energy companies, etc.) will make necessary changes to make the living environment meet the climate plan; the citizens will have a new way of living with the energy transition demand.

The social design team in VanBerlo followed their design thinking approach (ref).
Exploring the issue through scoping and definition.
Gathering insights through empathic research.
Ideation via themes and frames.
Validation loops using scenarios and prototyping
Applying via implementing and sharpening

This case study focuses on reporting, especially step 2-4, since it will demonstrate where the strategic interventions to engender the expected systemic change come from. The social design team took a facilitator's role in this process. Instead of conducting empathic research themselves they trained the staff from the involved stakeholders to do the field research with the citizens in the living environment. The entire stakeholder team co-created a number of concepts based on a list of related themes and frames as a result of the analysis and reflection on the findings collected by the team. The team made low-fi prototypes and went back to the context and validated their propositions with the citizens together. In the end, all stakeholder jointly prioritized the joint results and made strategic scenarios for future development. They could reflect upon the expected impact on the European Climate Agreement and National Climate Plan.

One remarkable point that became apparent from the process was that the participating stakeholders had very different objectives with regard to energy transition. The housing corporation wanted to learn what they should do to introduce the use of new sustainable energy sources among the tenants, the

citizens wanted to understand why they needed to take action to change and what would be the benefits for them. The community wanted to stress the fact that energy transition should not only contribute to the energy consumption of the neighbourhood, but that it should also be about the well-being of the neighbourhood as it connects to how people live their lives.

During this project the participating staff from the related stakeholders became the active empathic and transdisciplinary researchers. They were able to identify the important changes needed together with the citizens in a co-creation manner. Throughout the process the involved stakeholders from the meso level were able to learn what their intended systemic change could be on the citizen level (micro level) and what changes they needed to bring to their own intervention. In addition, they could also reflect upon the expected impact on the European Climate Agreement and National Climate Plan (the macro level).

Linking to 9 Principles of complex adaptive system

In this section we analyse the four cases according to the 9 principles of complex adaptive systems.

1. View the system through the lens of complexity

Through the lens of complexity, systems are observed from a panoramic perspective rather from a perspective focused on individual components of the system, which offers a deeper and holistic understanding of the system itself, its dynamics, agents, etc.

The four case studies used and described in this paper share in their nature the complex adaptive system metaphor. In case 1 and 4, through co-creation, the different individual perspectives of the system could be collected; in case 2 a new way of evaluating sport injury has been proposed and developed by literature research and expert consultation in different but related disciplines; in case 3 multi-perspectives were needed to get deep understanding of the office dynamics and work context, which were elicited through a hackathon. In their own way, each case was "observed" (developed) through implementing the lens of complexity, not just on how an individual affects the system but also the interaction between each other and with other related organizations.

2. Build a good enough vision

Instead of trying to plan every little detail, provide minimum specifications when specifying the behavior of a complex adaptive system. All challenges dealt with in the cases started with building on a good enough vision. Due to the nature of the complex and wicked problems (wellbeing and energy transition), the design researchers recognized the challenges and risks to fully understand the system at once and decided to start with a good enough vision. From there, they built prototypes (case 2 and 3), they went through a iterative process (case 2, and 4) and they reflected at different moments in time (all cases).

3. Balance data and initiation, planning and acting, safety and risk

This principle connects closely with the previous one. Alternating planning and acting as a part of the design research process is present in all cases described in this paper. Design research shows an iterative design process, which is particularly present in the description of the WorkWalk and energy transition case study (case 2 and 4). Iterations on a design are an essential part of

the process to deepen the understanding of the complexity of a situation and system, as shown by the prototyped duct tape WorkWalk. By using low-fi prototypes, risks were identified and active explorations were made possible in case 4 as well. The technological hi-fi prototype in case 3 made it possible for the stakeholders from different disciplines and the end users able to envision what the intended future would be and possible involved risks.

4. Tune to the edge

This principle relates closely with the complex lens. As mentioned, multiple perspectives co-exist in complex adaptive systems. Actors needs to be active at their operational boundaries in order to create common understanding and make joint efforts towards systemic change. In case 1 Vitality Living lab project and case 4 energy transition project it is clear that the stakeholders needed to collaborate and co-create the intended systemic change based n the common visions. The process of validating those common visions with the stakeholders and the reflection of the shared visions to design process will contribute uniting the stakeholders. Design researchers in these project facilitated the multi-stakeholder to co-create together. In this way, the power difference could be reduced by respecting each other's opinion, and to create an effective information flow among them. In case 2 and case 3, common ground were created to support design researchers to create interventions that could be applied to the complex contexts where different perspectives and expertises play an important role.

5. Paradox

This principle relates closely the previous one but then focuses on the difference among the stakeholders. In all 4 cases, In contrast to the commonality, there were also distinct differences among the stakeholders in terms of their visions, expectations, resources and competencies. This was expected previously and considered as an opportunity for design and creativity. In Case 1 and 4, co-creation approach was applied to turn it into this opportunity for design and creativity. In case 2 and 3 the technological probes/prototypes created provided the opportunities to surface the often hidden conflicts between different perspectives and disciplines for the next creative leap.

6. Multiple actions

Closely related to the complexity lens view and paradox, multiple actions are required to get a better understanding of the follow up strategies in creating systemic change. There were multiple user studies in case 1, multiple design iterations in case 2, multiple explorations with different disciplines, and multiple stages of design thinking activities. They all contributed to create the follow up direction towards a better understanding of the complex adaptive systems. It should be noted that all projects started with a small, but good enough vision and moved to multiple actions to seriously validate this vision and define direction for follow up.

7. Listen to the shadow system

When uncovering the needs of all involved actors in the complex adaptive systems, one should not be satisfied with the formal relationships but be willing to identity informal relationships, gossip, rumor and hallway conversations that can be used to provide contextual information about the behavior and mental models of these actors. Empathic research conducted in the case 2 and 4 contributed clearly to this principle. In the

WorkWalk case, the system cannot be understood by studying individual elements in a vacuum. To understand an office environment as a complex dynamic system it needs to be studied in its complexity and from many perspectives. The adopted design approach in the WorkWalk facilitated the design of the implementation, monitoring and evaluation plan. Breaking down programme objectives into changeable behavioral and contextual determinants enabled the formulation of impact measurements. By means of these measurements it is possible to evaluate the impact of the design on systemic change. In case 4, the related stakeholders were trained to conduct empathic research in the field to get out of their tunnel vision about what were the needs.

8. Chunking

This principle implies a modular and step-by-step approach. In all 4 cases, the design researchers started small, tried to understand firstly a small part of the complex problem through experimenting with prototypes, co-creation with stakeholders and etc. By reflecting on the results obtained, the next part of the system would be explored further. Gradually a better understanding of the system was achieved.

9. Competition/cooperation

Competition and cooperation are not mutually exclusive from each other in a complex adaptive system. For example, they co-exist in a complex business context where a supplier can be a cooperation party but it can also become the competitor of a company. On the micro level, case 2 and case 3 created opportunities for individuals to compete and cooperate for better performance through implementing different motivational strategies for behaviour change. On the meso level, case 1 and case 4 showed how different multi-stakeholder could collaborate to create the intended change. There is still no clear example of this principle on macro level. Theoretically speaking, on macro level, starting small allow pioneers to take entrepreneur actions towards the systemic change. This can stimulate competition with the followers and also creating cooperation opportunities between pioneers and followers.

Conclusion

The reported design research case studies suggest us that the design research tools and methods have a potential to contribute to systemic change by means of addressing the complex adaptive systems. Iterative process and reflective action would allow design researchers to start with a small but good enough vision, explore the systemic problem space gradually through prototyping. The close collaboration with related multi-stakeholders to include the multiple perspectives that could be in common or paradox could allow the design researchers with the stakeholders to develop breakthrough proposals yet act on a common ground. The empathic nature of design research process could help to obtain more in-depth insights related to the user, the stakeholders and the related contexts. Collaboration and competition could be co-created and future directions could be defined.

We also noticed that the design researchers operating in such a complex system are no longer design researchers alone. They became the transdisciplinary researchers and could operate at the edge of the different perspectives, stakeholders and disciplines. Therefore, we call for further research on better understanding of how design research methodology

contributes to create systemic change and future education of design researchers with transdisciplinary expertise.

We also learned that the 9 principles of complex adaptive systems provide a good guidelines for design researchers to organize their systemic change actions.

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