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RSD7 2018

RELATING SYSTEMS THINKING AND DESIGN 7th SYMPOSIUM

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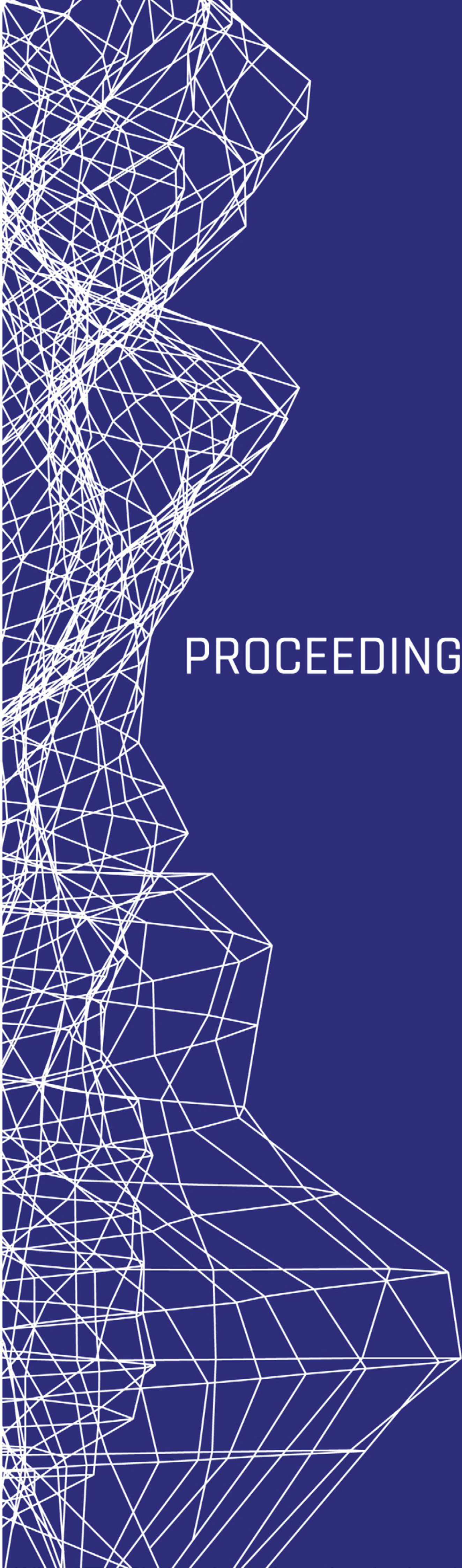

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Relating Systems Thinking and Design Symposium 2018
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WORKING PAPER

Integrating Systems Design and Behavioral Science to Address a Public Sector Challenge from Within

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Government of Canada[1]

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Abstract Many current public sector challenges are characterized by layers of complexity; to address them, no single discipline or approach would be sufficient. Systemic design -the marriage of systems thinking and design thinking- has been identified as one promising avenue for tackling complexity. In the case of complex societal issues where human behaviour is at the core, we propose leveraging behavioural science within a systemic design framework. This paper outlines a case study of a systemic design project undertaken by Employment and Social Development Canada on an education savings incentive called the Canada Learning Bond. The project explored decision-making and perceptions of education, savings, and finances among families living on low incomes, and it demonstrates the practical application and value of systemic design and behavioural science in a public sector context.

Keywords: education, public policy, behavioural science, design thinking, systemic design

[1] Opinions expressed are those of the authors.

1. Introduction

Many public sector challenges are characterized by complex, intertwined sets of problems. With their emergent elements and high degrees of unpredictability (Buchanan, 1992; Glouberman & Zimmerman, 2002; Snyder, 2013), such problems cannot be simply addressed using conventional models and analytical techniques (Duit Galaz, Eckerberg, & Ebbesson, 2010). No single discipline, methodology, or problem-solving framework would be sufficient to address them (Jones, 2017; Snyder, 2013). To tackle such complex challenges, governments need to go beyond conventional methods; public servants need to be better equipped with innovative, adaptive tools and techniques that foster active collaborations to offer more holistic, systemic approaches to problem-solving.
In light of this need, we see the emergence of public sector innovation labs that bring together multidisciplinary teams to experiment with new approaches to problem-solving. In the Government of Canada, the Innovation Lab in Employment and Social Development Canada (ESDC) was established to engage with Canadians, stakeholders, and internal clients to gather new insights and fuel collaborative conversations to develop and experiment with new approaches that are responsive to the needs of Canadians.

This paper outlines a case study of a project undertaken by ESDC on an education savings incentive called the Canada Learning Bond (CLB). The project explored decision-making and perceptions of education, savings, and finances among families living on low incomes. To tackle the complex nature of these issues, the project incorporated a range of methods from systemic design and behavioural science, and also drew upon theory of change, an approach from program evaluation. This unique combination of methods creates a compelling case study in public sector design. In reflecting on this experience, we would highlight learning around the mixed-methods research approach, the interactions of these methods, and how this impacted the process and insights gained during the project. In the next sections, we first provide an overview of systemic design and behavioural science - two research approaches that have recently been co-located within the Lab at ESDC with the expressed intent to integrate these methodologies - and then we present the case study on the CLB.

1.1. Systemic Design

A marriage of systems thinking and design thinking, systemic design has been identified as one way to tackle complex policy challenges (Conway, Master, & Therold, 2017; Jones, 2017). Systems thinking seeks to understand the complexity of cause and effect dynamics by visualizing how these dynamics are part of a larger inter-connected system. By broadening the boundaries and surfacing deeper problems, systems thinking can identify new and strategic opportunities in a problem space and lead to a better understanding of side-effects and unintended consequences of a given intervention (Senge, Smith, Kruschwitz, Laur, Schley, 2008).

Design thinking is an exploratory problem-solving approach with a bias for action (Camacho, 2016). The Lab has built on the classic double diamond approach developed by the Design Council (2013).

Like many labs, ESDC's approach (see Figure 1) places an emphasis on exploration to identify the right problem, idea generation, and iterative prototyping and testing of ideas to land on the right solution. Design thinking derives its inspiration from the experience of the "end-user", the person who will ultimately use a service or product – an approach that can stand in contrast to traditional expert-driven policy-making (Design Council, 2013). Design thinking prioritizes putting concrete prototypes into the world, which are tested with end-users to ensure that the proposed solution has traction on the ground. This approach is intended to enable new ideas to be tested in an incremental iterative fashion to gather data on uncertainties of the proposed solutions before committing to the costs of a large-scale roll out.

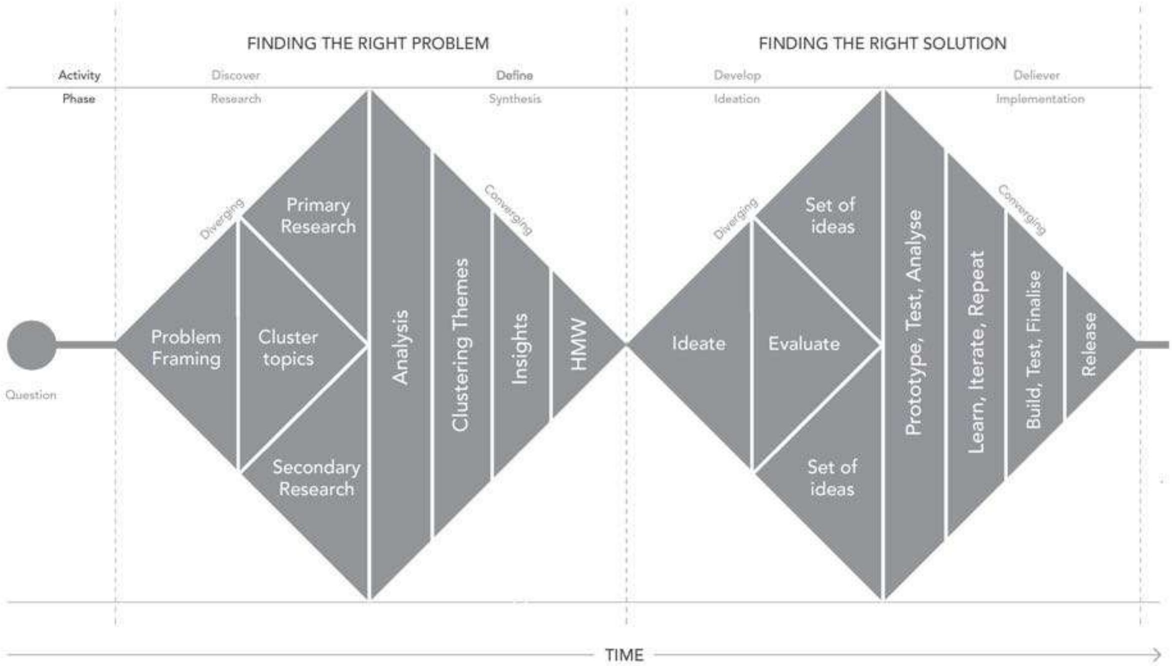

Figure 1. ESDC Lab's design thinking process.

Both design thinking and systems thinking share a commitment to leverage the knowledge and perspective of diverse actors to better understand what is happening on the ground to identify opportunities that will work. By bringing together the holistic approach of systems thinking with design thinking and its bias to testing and iteration, systemic design seeks to develop more robust solutions at the right scale (Jones, 2014).

1.2. The Value of Integrating Behavioural Science with Systemic Design

Over the past few decades, social and behavioural sciences, such as psychology, cognitive science, and behavioural economics have substantially advanced our understanding of human behaviour and decision-making. Insights emerging from these areas offer a significant opportunity for policy makers to understand people's actual experiences and behaviours in relation to policies, programs, and services. Research in these areas does not just describe the 'what' of human behaviour, but has continually advanced its techniques to explore the 'why' underlying those behavioural patterns and to gain a thorough understanding of the cultural and situational factors that influence behaviour. There has been growing interest in applying behavioural science to address policy challenges (Sanders, Snijders, & Hallsworth, 2018; Whitehead, Jones, Howell, Lilley, & Pykett, 2014). But to date, most of its applications to public policy have been limited in scope, focusing on individual behaviours. Indeed, this has been one of the major critiques of the field (Sanders et al., 2018). However, the potential for applying behavioural sciences within more holistic frameworks to address more complex policy challenges has been recognized as a necessary and valuable avenue for the field moving forward (Sanders et al., 2018).

As acknowledged earlier, no single discipline offers a silver bullet to address complex problems. Thus, relying on existing theoretical models and methods in behavioural sciences *alone* would not be sufficient for addressing complex problems (Duit et al., 2010; Spencer, 2018); however, leveraging existing knowledge and methods from behavioural science within a systemic design framework offers a unique opportunity for tackling complex problems where human behaviour plays a substantial role. When applying systems thinking to issues involving the natural environment, this work tends to be informed by our knowledge of the natural sciences. Likewise, when applying systems thinking to wicked societal problems in which human behaviour is at the core, knowledge from behavioural science can be leveraged to ensure that the models we develop reflect a realistic view of how people think, feel, and behave in given situational contexts. This requires active interdisciplinary collaborations, built on in-depth understanding, rather than mere borrowing (Dorst, 2017). In the next section, we present ESDC's case study on the CLB, demonstrating the value of collaborations leveraging systemic design and behavioural science together in a public sector context.

2. Case Study: The Canada Learning Bond Project at Employment and Social Development Canada

The CLB project is a systemic design project that was born out of behavioural science trials. The integration of behavioural science and systemic design continued to characterize this project as it unfolded, highlighting the complementarity of these two disciplines in driving public sector change from within.

The Government of Canada encourages the use of Registered Education Savings Plans (RESP) to save for the post-secondary education of a child. This includes the CLB, an income-tested education savings incentive available for eligible children from families living with lower incomes (ESDC, 2015; Parkin, 2016). When a parent goes to an RESP promoter and opens an RESP for their eligible child, the government will deposit money in the account towards the child's post-secondary education. It provides an initial payment of $500 into the RESP plus an additional $100 for each year of eligibility to a maximum $2,000. No personal contributions are required to receive the CLB. As of 2017 take-up was 36.5%, with 1.9 million children that have yet to receive it. The Government of Canada also offers another incentive for those who save money in RESPs called the Canada Education Savings Grant. Unlike the CLB, this incentive is available to eligible children who have RESPs regardless of their family income, but it is conditional upon money being saved in the RESP. Subscribers face many decisions: the RESP promoter, the RESP product, and investment options.

As an initial attempt to address low take-up of the CLB, the program turned to behavioural science trials. Different variants of the letter sent to eligible families were designed based on general insights from behavioural science literature, and the effectiveness of each of these letters was assessed in a series of randomized controlled trials (ESDC, 2017)[2]. The results indicated that sending letters to parents of eligible children resulted in a statistically significant but modest increase in program take-up. Simple changes to the messaging around the CLB did not seem to have a large impact, and in some cases, some of the new messaging techniques seemed to reduce, rather than increase, program take-up.

While the problem initially appeared at the surface to be a simple one of awareness, taking this client-centred approach revealed its complexity and the need for a more holistic approach. With this recognition, the CLB systemic design project was launched, championing a way to better understand the lived experience of Canadians, which we outline in the next section.

2.1. Research Approach

Within ESDC, the Canada Education Savings Program (CESP) is responsible for delivering the CLB. In the CLB project, CESP and the ESDC Innovation Lab partnered on a journey to understand the needs of Canadians living with low income, to help increase the uptake of the CLB. As part of this, program employees were embedded within the Lab team, in order to have an organizational bridge to support the implementation of ideas.

In the CLB project, the team sought to better understand the dynamics underlying the results of the letter trials, with a focus on the broader context of education, decision-making, and savings in families living with low income, adopting a systems-level approach, which enabled us to explore the many individual-level and system-level factors that are entwined with parents' willingness and ability to save for their children's education.

At the early stages of research and problem identification, the team held conversations to develop a common understanding of what we think we know, including evidence from relevant behavioural science findings captured using discussion cards. A key outcome of these conversations was the identification of assumptions held within the organization and externally, and an analysis of weak

[2] A randomized controlled trial is a research method used often in social/behavioural science to assess the causal impact of introducing variants of interventions (in this case, letter variations) on outcomes of interest (CLB uptake).

assumptions and strong assumptions. It is common when dealing with programs that tackle complex social issues for different actors to have different assumptions, and different narratives of how and why a program works (Weiss, 1995). Some people talked about the CLB as a benefit that should be easily accessible for everyone, reflecting the objective of equitable attainment of post-secondary education. Others spoke of it as a savings incentive or even talked about RESPs as an investment product, which reflects a perspective of the program as a savings incentive for those that are in a position to save.

By surfacing these narratives, and the assumptions embedded in them, the team was able to tease apart expectations and lines of reasoning. As part of this, the team conducted a theory of change analysis to make explicit the assumptions embedded within the design of the program itself (Weiss, 1995). Theory of change is typically an evaluation approach, and is often described as "a logic model on steroids" (Patton, McKegg, & Wehipeihana, p. 170). Logic models articulate how a program will have its intended outcome. Theory of change augments this by identifying the cause and effect hypotheses that implicitly lie between early efforts (inputs, activities, and outputs) and longer-term outcomes. The theory of change analysis included an examination of the evidence pertaining to the assumptions of causation in the program, and identifying contextual variables. The theory of change helped focus the inquiry by identifying which assumptions in the program design are well supported by existing literature and which could benefit from further exploration. It also directly informed the level of analysis of the systems map, by rooting the analysis in the ultimate outcomes of the program, which is the attainment of post-secondary education of the child, rather than, for instance, the opening of an RESP.

The problem exploration phase included the co-development of a systems map to ground the systems analysis. The team engaged key stakeholders to leverage system-wide knowledge and insights in a participatory systems mapping exercise (for details on a similar approach, see Sedlacko, Martinuzzi, Røpke, Videira, & Antunes, 2014). Systems mapping enabled the team to ground the inquiry in a broad context by mapping the various factors that contribute to children's post-secondary education attainment. This expansion of the frame of inquiry enabled an exploration of root causes to better understand and consider factors and ideas that traverse program and jurisdictional boundaries, enabling us to identify ideas at this higher-level scale of problem-solving. The map centered on the child, around three essential conditions for post-secondary education attainment: motivation, capability, and opportunity (See Figure 2). These key conditions were identified based on a behavioural science framework called "The Behavioural Change

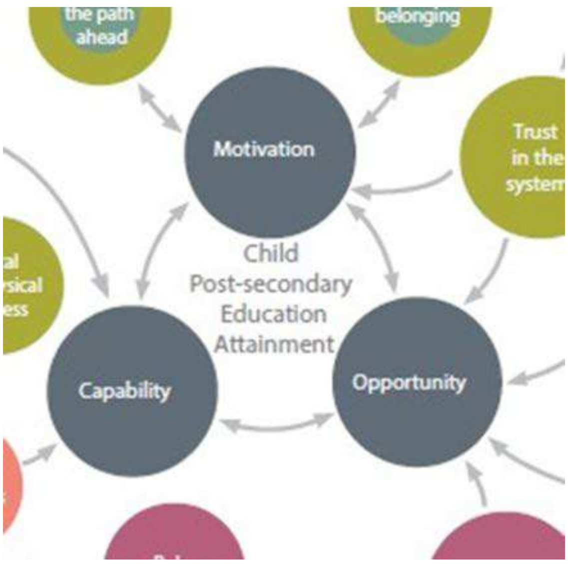

Figure 2. The systems map centered around three behavioural anchors: motivation, capability, and opportunity.

Wheel" (Michie, Atkins, & West, 2014) and they provided a coherent framework for the map, enabling us to identify leverage points that are directly tied to behavioural outcomes – but no easy answers. Putting the child at the centre kept us focused on the larger systemic issues. Leverage points identified through this process included friends and families, trust in the system, the affordability of education, the financial capability to save, seeing the path ahead, community support, parental life-long learning, informational needs, and financial literacy.

Developing the systems map was not easy, reflecting the complexity of the issue, which spans motivations of parents and children (and even earlier generations), phases of childhood development over the course of 18 years, and the evolution of family dynamics and economic status over that same period. These complexities were timely reminders of the need to be humble in the face of a difficult challenge.

Understanding the challenge required working closely with a broad variety of actors in the system, most importantly end-users: Canadian families living with low income. The team travelled to multiple locations across the country ensuring that a diversity of end-users was reflected. We met single mothers, underemployed parents, grandparents, as well as youth and children. We interviewed people where they felt most comfortable: sometimes in community centers and other public spaces, while others welcomed us into their own homes where we were able to have our conversations over dinner. We talked to Canadians living in rural, as well as urban, communities and visited First Nations. We also ran workshops with parents and youth using a gamified approach called Welcome to My World (Gray, Brown, & Macanufo, 2010) to facilitate conversations surrounding education, decision-making, and savings; and an adapted game of Chutes and Ladders to discuss barriers and enablers to educational attainment.

2.2. Insights

Exploring the program through systems mapping and fieldwork revealed useful design insights:

1. Awareness of the CLB is an issue.
Clients need to be better informed about what is available to them. Many of the parents that we spoke with were not aware of the CLB, but when it was explained to them, they wanted it for their children. A single channel (e.g., one or several letters sent to families) was not enough for most. Increasing awareness requires the use of diverse methods of outreach and touchpoints to reach parents, children, and potential influencers in the system, including community outreach and social media.

2. Promoting the CLB requires a multi-sectoral effort.
We spoke to a wide range of community organizations that see a need to support parents in their journey. They tend to promote the CLB as a benefit (vs. an education savings incentive). Many parents needed help with the sign-up process for an RESP from community organizations. We also spoke to potential influencers in the system such as social workers and teachers; most had never

heard of the CLB before.

3. It's complicated: the messaging, choices, and process can be overwhelming.
As people navigated through the journey to get the CLB, they encountered different layers of complexity: in the messaging, the choices presented to them, and the process of opening an RESP and requesting the CLB. Much of the complexity is associated with the requirements of the RESP mechanism, which requires clients to enter into a financial relationship with an RESP promoter.

4. Parents need to feel safe when investing for their children.

The CLB's link to an investment vehicle affects the conditions that shape the decision-making context. It raises considerations about how people are informed and how the program design takes account of the distinct behavioural and psychological characteristics associated with living in low income. We heard about financial risk that ranged from losing money that was invested, to committing to locked-in, monthly contributions. Parental emotions can also factor into financial risks; parents often expressed that their calculations around education savings were connected to feelings of love and guilt, and these emotions can also create vulnerabilities when making financial decisions.

5. Aspiration is not enough. The systemic barriers to education are too hard for some families to overcome alone.
The systemic barriers to education are too hard for some families to overcome alone. The majority of the parents we spoke with were passionate about their children pursuing post-secondary education, even if the parents themselves had not found their own way to it. However, aspiration for higher education or a 'better' life is not enough. Many other conditions are needed -besides money- for educational attainment to be possible. Many challenges stand in the way including geography, disability, illness, academic achievement, the stigma of living in poverty, and experiences of racism.

6. People aren't finding their path in life. This is resulting in lost potential for themselves and Canadian society.
Some parents have not finished their own education and cannot see a future path for themselves, let alone for their children. The pressures of early pregnancy and child-rearing (for men and women) make it difficult for some to role-model educational attainment and career success within the family.

7. The needs of the present compete with the needs of the future.
Some low-income families are in survival mode, struggling to survive their present circumstances. With imminent short-term needs consuming their attention, it is incredibly difficult (mentally and physically) for them to plan or save for the distant future.

8. For some, avoiding the embarrassment of asking for help takes precedence over thinking about the future.
Topics such as finances, education, and career development/upskilling are closely intertwined with

identity and emotional wellbeing. Conversations around these topics can cause discomfort and vulnerability in many teens and parents. Those who are most vulnerable, experiencing mental health issues or addiction, may avoid asking community support services for help with navigating the system.

9. Foundational identification, which is required for accessing the CLB, is also necessary for full participation in society.
Access to ID is a significant barrier for some, particularly Indigenous Peoples. While the Federal Government does not require fees, at the provincial level there is a cost to applying for a birth certificate, which can make the difference in access for low income families. ID unlocks access to the CLB but also other life milestones, such as driving and employment.

Taken together, these nine insights helped uncover the problem spaces to focus on. The team identified three design criteria we used to evaluate ideas: increasing awareness, increasing ease of access, and increasing financial security. Additionally, we identified that the circumstances facing some Canadians make it challenging for them to even consider education and education savings. We asked ourselves: what else could we do for people in this situation?

The team developed a number of solutions that had been identified in the workshop process, some incremental and some transformative, and conducted some initial testing. Thus far, this has included concept testing with stakeholders as well as randomized controlled trials in regularly-scheduled letters testing new language and addressing areas of complexity and uncertainty that were identified in the qualitative research. Further testing and iteration is needed for more intricate ideas that have been developed to see whether they could trigger the desired changes in the system.

3.0 Discussion and Conclusions

This paper outlined the journey of the Innovation Lab, demonstrating how leveraging behavioural science within a systemic design framework can deepen our understanding of complex public sector challenges, and create opportunities for addressing them from within.

The use of mixed-methods provided a rudder to the inquiry – with findings from quantitative and qualitative research approaches mutually reinforcing each other and providing new directions for the study as it evolved. We did not follow a preset course, but rather responded to what we were hearing. The team continually experimented with ways to actively engage with insights from behavioural science along the way; an avenue that can still be further explored in future work. Having a diverse team with different disciplinary backgrounds immersed in the challenge was necessary to lay the ground for this agile use of mixed-methods.

Similarly, the theory of change analysis may not be typically used in systemic design, but integrating it added clarity and rigor to the analysis of assumptions and would be recommended for future research as part of the systemic design toolkit. Both the theory of change and systems mapping approaches directly impacted the framing of the problem spaces, allowing for a deeper understanding of the problem and outlining the necessary and sufficient conditions for long-term change. The systems map highlighted this bigger picture narrative, while keeping the essential conditions for behavioural change in perspective as we explored options.

By integrating tools and methods from design thinking, systems thinking, and behavioural science, ESDC championed a holistic approach to understanding the needs of Canadians within the Government of Canada. Engaging with the lived experience of Canadians provides a breadth of learning that provides holistic insights that can support policy, program development, and service delivery. Senge and colleagues (2008) wisely note that successful collaboration is easier to espouse than achieve. This project continues to provide lessons on how to best engage partners across a vast country like Canada – "getting the system in the room" (Senge et al., 2008, p. 234), while ensuring respectful partnerships, humility, and open communication, without over-burdening communities. A sustainable and ethical innovation strategy has emerged from our work and continues to evolve.

The experience of leading a design-based innovation process from within the Government of Canada, in close collaboration with those directly responsible for program delivery, has yielded many lessons in driving change from within. The ability of systemic design to spark innovation and support meaningful change within government can be shaped by deliberate attention to active multidisciplinary collaboration, respectful negotiation, and mobilization of leadership. Importantly, systemic design is ideally suited for identifying opportunities that cut across traditional organizational boundaries. Successful implementation of such ideas requires collaboration and an expansive search for champions. In doing so, we see change. It is fostering a cultural change in our organization and has sparked conversation across government on how we understand our clients, their needs, and the prioritization of sustainable policy frameworks.

References

Buchanan, R. (1992). Wicked problems in design thinking. *Design Issues, 8*(2), 5-21.

Camacho, M. (2016). Christian Bason: Design for public service. *She Ji: The Journal of Design, Economics and Innovation*, *2*(3).

Conway, R., Masters, J. and Therold, J. (2017). From design thinking to systems change. *RSA Action and Research Centre*. Retrieved from: https://www.thersa.org/globalassets/pdfs/reports/rsa_from-design-thinking-to-system-change-report.pdf.

Design Council (2013). Design for Pubic Good. Retrieved from: https://www.designcouncil.org.uk/sites/default/files/asset/document/Design%20for%20Public%20Good.pdf.

Dorst, K. (2017). Stepping Stones between Design Research and Cognitive Science. *She Ji: The Journal of Design, Economics, and Innovation*, *3*(2), 105-106.

Duit, A., Galaz, V., Eckerberg, K., & Ebbesson, J. (2010). Governance, complexity, and resilience. *Global Environmental Change, 20*(3), 363-368. doi: 10.1016/j.gloenvcha.2010.04.006.

Employment and Social Development Canada (2015). *Canada Education Savings Program (CESP): Summative Evaluation Report*. Retreived from: http://publications.gc.ca/site/eng/9.808773/publication.html

Employment and Social Development Canada (2017). *The Canada Learning Bond nudge trial: Testing the effectiveness of Behavioural Insights through a promotional mailing*. Working paper.

Glouberman, S., & B. Zimmerman (2002). Complicated and Complex Systems: What Would Successful Reform of Medicare Look Like? *Commission on the Future of Health Care in Canada, Discussion Paper 8*. Retrieved from: https://www.alnap.org/system/files/content/resource/files/main/complicatedandcomplexsystems-zimmermanreport-medicare-reform.pdf

Gray, D., Brown S., Macanufo, J. (2010). *Gamestorming* . Sabastapol, CA. O'Reilly Media Inc. Retrieved from: https://gamestorming.com/welcome-to-my-world/

Head, B. W., & Alford, J. (2015). Wicked problems: Implications for public policy and management. *Administration & Society*, *47*(6), 711-739.

Jones, P. H. (2014). Systemic design principles for complex social systems. In *Social Systems and Design* (pp. 91-128). Springer, Tokyo.

Jones, P. (2017). The systemic turn: Leverage for world changing. *She Ji: The Journal of Design, Economics, and Innovation* , *3* (3), 157-163.

Michie S, Atkins L, & West R. (2014). The Behaviour Change Wheel: A Guide to Designing Interventions. London: Silverback Publishing. Retrieved from: www.behaviourchangewheel.com

Parkin, A. (2016). *Family savings for post-secondary education: A summary of research on the importance and impact of post-secondary education savings incentive programs*. A report prepared for The Omega Foundation.

Patton, MQ, McKegg, K., & Wehipeihana, N. (Eds.). (2015). *Developmental evaluation exemplars: Principles in practice* . Guilford Publications.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, *4*(2), 155-169.

Sanders, M., Snijders, V., & Hallsworth, M. (2018). Behavioural science and policy: Where are we now and where are we going? *Behavioural Public Policy*, *2*(2), 144-167.

Sedlacko, M., Martinuzzi, A., Røpke, I., Videira, N., & Antunes, P. (2014). Participatory systems mapping for sustainable consumption: Discussion of a method promoting systemic insights. *Ecological Economics, 106*, 33-43.

Senge, P.,Smith, B., Kruschwitz, N., Laur, J., Schley, S. (2008). *The Necessary Revolution: How Individuals and Organizations are Working Together to Create a Sustainable World*. New York, New York. Doubleday.

Snyder, S. (2013). The simple, the complicated, and the complex: Educational reform through the lens of complexity theory.

Spencer, N. (2018). Complexity as an opportunity and challenge for behavioural public policy. *Behavioural Public Policy*, *2*(2), 227-234.

Weiss, C. H. (1995). Nothing as practical as good theory: Exploring theory-based evaluation for comprehensive community initiatives for children and families. *New approaches to evaluating community initiatives: Concepts, methods, and contexts*, *1*, 65-92.

Whitehead, M., Jones, R., Howell, R., Lilley, R., & Pykett, J. (2014). Nudging all over the World. *ESRC Report, Economic and Social Research Council, Swindon and Edinburgh*.

Permeating the barriers between the individual and policy designers in Pakistan: applying systemic design to gender transport poverty

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Abstract Transport poverty and the associated, multiple levels of deprivation experienced by women is a wicked problem. Gender transport poverty in Low Middle Income Countries is an issue of longstanding concern but is one in which little headway seems to be made. The WEMOBILE project has used (auto) ethnographic and empathic design approaches to study gender transport poverty in Malaysia and Pakistan. The paper explores the insights provided from employing a systemic design lens to comprehend the structural barriers, systemic architecture of the problem, interconnections and linkages with other elements and factors, and the gaps which hinder the effectiveness of existing solutions, and secondly how such an approach may be used to (*re*)present issues around gender transport poverty in ways which can lead to policy and operational changes.

Keywords: empathy, co-design, gender sensitive transport, systems thinking, LMICs, Pakistan, ethnography

1. Introduction

This section introduces the challenge in terms of UN goals, before discussing gender transport poverty, and how this is manifest. The aims of the WEMOBILE project are presented along with the methodology used to understand the effects of gender transport poverty. The second half of the paper looks at the application of systemic design thinking and how the diagrams could be used to represent issues to policy makers to effect sustainable change.

Women's mobility has been recognized as a key issue by the United Nations. UN Goal 5[1] addresses gender equality along with the Millennium Development Goal 3[2], which aims to promote gender equality and empower women. Globally, women and girls continue to suffer discrimination and violence. Gender equality is not only a fundamental right but is also seen as necessary for a peaceful, prosperous and sustainable world.

Globally women do not enjoy the same mobility freedom as men. For example, women face more harassment on transport and in public spaces (e.g. Thompson, 1993; Osmond and Woodcock, 2015; Madan and Nalia, 2016), are more seriously affected by road rage (Gil, 2018), do not have their journeys adequately represented in future transport scenarios (CiViTAS, n/d), are underrepresented in STEM subjects (only 24% of women graduate from Science, Technology, Education and Mathematics[3]) and in transport employment (with only 22% of the transport workforce being women in Europe[4],[5]). 'Work arounds' have included gender-segregated transport (e.g. Dunckel-Graglia, 2013; McLeod, 2018), zero tolerance of harassment on public transport, gender aware planning (Rakodi, 1999) and products designed to increase attention to the aggressor (Saul, 2017).

UN Goal 11[6] relates to the need to make cities inclusive, safe, resilient and sustainable. It is predicted that by 2030, 5 billion people will live in cities. Cities need efficient urban planning and management. Currently cities are not coping with rapid urbanisation and related problems of sanitation, transport and pollution. Women are key drivers in sustainable forms of transport.

Gender transport poverty is a wicked problem, which 'cannot be adequately comprehended in isolation from the wider system in which they are part' (Burns, 2017). Wicked problems (Rittel and Webber, 1973) are defined as social or cultural problems difficult or impossible to solve, for example, because of incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnectedness with other problems. An approach is needed to untangle wicked problems, such as gender transport poverty. This paper argues that systemic design research may provide this.

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[1] https://www.un.org/sustainabledevelopment/gender-equality/
[2] https://www.un.org/millenniumgoals/gender.shtml
[3] https://www.stemwomen.co.uk/blog/2018/03/useful-statistics-women-in-stem
[4] https://www.etf-europe.org/wp-content/uploads/2018/09/EU-Declaration-equal_opportunities-EN.pdf
[5] Although no figures exist for Low middle-Income Countries, this is likely to be substantially less than 22% of women are in paid employment
[6] https://www.un.org/sustainabledevelopment/cities/

Mobility issues in Low-Middle Income Countries are systemically linked to socio-political and cultural problems. It is not just that women have to take longer, more expensive and inconvenient journey or are denied the ability to make that journey it is the wider implications of this e.g. stress of managing unintegrated journeys, ill health caused by exposure to high levels of pollution whilst walking, injuries sustained while riding side-saddle on motorbikes or by trapped clothing on vehicles. These are systemic issues. The Centre of Economic Research Pakistan survey found that nearly 30% of respondents considered it "extremely unsafe" for women to walk in their neighbourhood," and around 70% of male respondents discouraged "female family members from taking public wagon services" (Sajjad et al., 2017). The gender gap in policy designers and transport service providers means that women transport users in LMICs not only do not have a voice, but that there is an urgent need to find new ways of presenting their problems to increase not only gender sensitive transport planning but also to provide methods and information for more human-centred approached to the development of sustainable transport systems.

2. The WeMobile project

WEMOBILE (https://womenmobility.com/) (funded by 18 months by the AHRC (UK) under the Global Network fund) is a collaborative, international project between UK, Pakistan, Malaysia which aims to use empathic and participatory design approaches to enable policy designers and other stakeholders to understand women's mobility problems in LMICs. It aims to capture and (re)present the problems women in LMICs face in their everyday travel. Whilst all sectors of society may face such problems, the burden of women is disproportionately higher as they earn less and take on multiple roles (e.g. wage earner, housekeeper and care giver).

The overall goals of WEMOBILE are:

- To raise awareness of barriers to women's mobility and the effects of this e.g. in terms of access to employment and other opportunities and in relation to quality of life.
- To foster research co-operation between Malaysia, Pakistan and UK in addressing issues relating to barriers to women's mobility in order to provide a foundation for future research applications.
- To share and exchange knowledge.
- To act as a catalyst for integrating national work in each country, adding value and weight to the voices of local, national and international organisations.
- To support early career researchers.

In terms of methodology, the objectives have been met through targeted workshops in Malaysia and Pakistan; small scale empathic and co-design activities with female transport users in each country to provide culturally specific, authentic experiences of mobility problems faced by women and context specifics concept solutions and recommendations.

2.1. Systemic design applied to gender transport poverty

Designers have been addressing wicked problems for decades – not only in terms of design of artefacts but also in terms of the design methods, questioning and engagement with multi stakeholders. In the debates (e.g. around problems of ageing, sustainable energy and transport) design provides a 'practical problem-solving epistemology' (Jones, 2014). Cross (2001) explained:

> "So we might conclude that design science refers to an explicitly organised, rational and wholly systematic approach to design; not just the utilisation of scientific knowledge of artefacts, but design in some sense a scientific activity itself.'

The WeMobile project draws together designers, planners and ergonomists using design research methods to understand the lived experienced of female travelers in Pakistan and Malaysia (as representative LMICs. The five principles of systemic design practice as outlined by Jones (2014) has led us to the following conclusions for Pakistan:

1. There is some understanding of women's mobility problems
2. Piecemeal solutions have been attempted
3. There is (some willingness) to address gender transport poverty (but see some of the comments from the world café)
4. Dialogic processes and iterative inquiry are lacking. A structured approach is needed which enables all stakeholders to have a holistic view of the problem.
5. A holistic and inter-connected approach is lacking that leads to solutions resulting in creating new problems instead of solving old ones.
6. People are willing to support, contribute, and work towards improving mobility for women.

Systemic causal loop diagram (Gharajedaghi, 2011) can be constructed from literature and primary research and enable visualisations and interconnections to be made between concepts, elements, phenomenon, and stakeholders. They enable stakeholders to gain an overview and common understanding of the problem space and to see where interventions may be made. They also give an understanding of the relationship between two elements with a '+' or a '-' sign implying similar or inverse impact, respectively. The systemic causal loop diagram shown in Section 4 have been constructed from an analysis of the information provided in stakeholders workshops, interviews and ethnographic studies and represent both the barriers to transport and solutions which have been attempted to address these.

3. Women in Low-Middle Income Countries

Pakistan ranks 128 out of 182 on Human Development Index (2010), 124 out of 155 on Gender Development Index (2009) and 132 out of 134 on the Global Gender Gap Report (2009). The ILO stated that 'transport remains a neglected area among gender specialists and transport specialists are still reluctant to take on gender issues. Until this is done, the prospects for many women who live in areas characterized by poor physical accessibility and inadequate transport will remain poor'. The network's development is timely given recent initiatives in Pakistan. For example, the PAKSTRAN project looking at sustainable transport policy and mobility in rural access, with a special focus on gender; the 'decent transport project pilot' looking at safer public transport for women by the ILO; the Government of the Punjab's planning department (TPU, established in 2011) has key objectives to develop 'professionally' prepared sustainable transport plans, with key guiding principles of transparency, equity, honesty and integrity. The development of transport master plans for cities such as Sheikhupura, Sahiwal and Karachi and intermodal transport provision has clear resonance with SUMPs being advocated across EU.

Malaysia ranked 111th (out of 145) on the Global Gender Gap Index for 2015, with an especially poor rating in the political arena. Although there has been an increase in women's participation outside the home in which travelling plays an integral part. However, the complex journeys women are required to make in their familial, social and economic roles has not been addressed, whilst recognised as a key question has not been addressed in a concerted manner.

Pakistan

This paper focuses specifically on the data from Pakistan and WeMobile's efforts to apply design research tools to understand and represent issues around gender transport poverty in ways, which will be actionable for transport policy officers and operators. While transport poverty has been conceptualized, measured and made a part of policy-making in many developed countries (Lucas, 2012), there have been no attempts to study it in developing countries such as Pakistan.

To have an overview of population and statistics, according to United Nations, "sixty per cent of the global population lives in Asia (4.4 billion)" (United Nations, n.d.). The 6th Population Housing Census of Pakistan (2017) shows the total population of Pakistan to be 207.7 million, with 106 million (51%) men, 101 million (49%) women, and 10,418 transgender persons. For the province of Punjab, there are approximately 1 million more men than women. For Lahore, where this study takes place, the 2017 census showed that this was the second most populous city, with an 11.1 million population.

In Punjab, the female Labour Force Participation Rate (LFPR) in 2014-15 was 27.8% as compared to the male LFPR of 69.4% (Punjab government, 2018). Hence, men have a higher literacy rate and higher participation in the Labour Force. Moreover, Punjab Gender Parity Report (2018) revealed that the total number of vehicles owned were 1,649,044 vehicles in 2017, out of which only "1% of vehicles were owned by women and 99% were owned by men." The licences situation seems to be bleak as well. "While 5.2% of licences were issued to women, only 1% of women had a vehicle registered in their name". These figures illustrate a gender gap in terms of ability to commute and employment across all sectors and in transportation.

Figure 1: Images from women in the female compartment of a bus and walking on the street

To develop a more nuanced understanding of barriers to women's mobility the WEMOBILE team conducted phenomenological interviews (Bevan, 2014) with multiple stakeholders, combining visual and auto ethnography (Schwartz, 1989; Marcus, 1995;Ellis, Adams and Bochner, 2011), hosted a one-day multi stakeholder world café (Brown, 2010) with transport users, operators and government officials using participatory approaches with participants to understand and characterise women's journeys, and a focus group with representatives from civic, government, and academic sectors in Lahore. To address the shortage of data in Pakistan regarding women's mobility a more quantitative on-line survey was also distributed in Lahore.

Figure 2 Preparing for the Focus group and symposium in Lahore

From the on-line survey in Lahore

The survey contained questions related to modal choices, expenditure, and satisfaction levels with ventilation, cleanliness, experience etc., and issues that might stop them from using transport. In total, 40 women and 7 men from Lahore responded to the survey. Their distribution across mode of transport is shown in Table 1. Most of the respondents were full-time employed 64% while 32% were students.

Table 1: Survey respondents use of transport to and from employment/education

Mode of public transport	% of men using public transport	% of women using public transport
Bus	2.%	11%
Rickshaw	0%	9%
Qingqi	0%	4%

In Lahore, most of the female respondents did not own private vehicles and were therefore either dependent on public transport or other family members. This may explain why 21% women demanded more frequent buses while only 2% commented on this. Women spent 20%-40% of their income on travel, whereas men only spent 10%. There are incidents of sexual harassment that are perpetuated by fellow passengers (19%) and other road users (32%)(see Figure 3). This contributes to the higher level of dissatisfaction towards public transport, expressed by women.

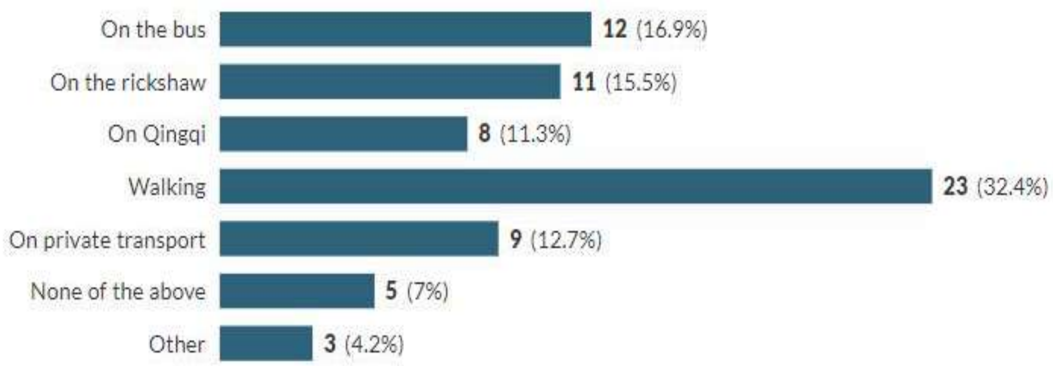


Figure 3: Harassment faced by women on different modes of transport

Harassment typically takes the form of staring and lewd comments. Women also commonly reported touching/groping and being followed by a stranger. About 60% women and 28% men rated highly the importance of safer transport and cities, however 67% women admitted that they simply ignored the harassment while 27% women told their friends or family. The vehicle driver/ conductors were responsible for the harassment in 27.5% of the cases against women. This behaviour results in none of the respondents feeling safe walking to the bus stop after daylight.

A young girl while suggesting improvement in the present transport system, shared;

> *'it's the general sense of respect which should be created, creating more space in buses doesn't makes sense as there is a need of space in brains.'*

Another woman commented,

> *'if I ever have to use public transport which is extremely rare, then the discomfort of the misogyny that surrounds us on the streets and public spaces.'*

Additional comments illustrate that women were not only threatened by the attitudes of men but sometimes the social stigma their mobility created, with comments on '*the narrow-mindedness in the society'* and the '*social opinion of other women'*. The top four worries for women in travelling to work/education were harassment, being late, and travel expense and time constraints. Here, the barriers included 'household responsibilities' and 'wasted time', which was caused by being dependent on others. In contrast, the top worries for men were the condition of roads and noisy traffic. Significantly, they did not mention safety issues or time constraints.

Results from the focus group

Figure 3: Focus group as a moderated panel discussion

A moderated discussion took place between representatives of the Center of Economic Research in Pakistan, Women-on-Wheels initiative, civic sector, Careem (an on-demand taxi service, similar to Uber) and the local government. The focus group discussion included a panel discussion along with a symposium showcasing the projects, research, and efforts by government, various organizations and groups in Pakistan working to improve women's mobility. The conversation in this focus group revolved around sharing individual perspectives coming from different sectors and backgrounds, exploring the different barriers and challenges women face, and evaluating existing and brainstorming possible solutions for improvement in the future.

Highlights from the conversation:

"there is this taboo that women are facing in terms of using these private modes because of which they are 30% more likely than men to be using public transport…." - Program Manager at CERP

"Unfortunately, the fact is that the government has never taken these issues as seriously as they should have, where 48% of our population is women, where we mostly have them as you know, wives or sisters or daughters or mothers but the economic participation and to give them a prominent role in our society and on autonomy, there has never been an initiative…" - Salman Shahid, Director General Chief Minister's Strategic Unit and initiator of Women on Wheels

"Government has taken some initiatives for women mobility such as the Pink buses that they introduced but unfortunately since they were "pink" buses, it didn't turn out to be a very successful initiative. I think the local government and planning department should have female planners in them because the more female planners exist, the more women development would occur." Farhana, Punjab Assembly representative

"My stance has always been that women-only services, women-only buses, women-only bus stops cannot be the only solution to move this society forward. We have this audience here, it's a mixed audience and I hope all women here feel safe and secure and that's how the rest of our country needs to be… Since women are more prone to use public transportation, Careem's 80% base is women." Experience manager, Careem.

Conclusions from the discussion:

1. An agreement on mobility being a significant challenge for women in Pakistan and has to be addressed at governmental, private, not-for-profit, and civic level.
2. Willingness from the different sectors to collaborate and work together to address the issues.
3. Increase in female representation in government and private sector helped bring forward women's perspective. However, there is a dire need to have female representation in urban planning and strategic teams at private, public, and governmental levels.
4. Civic organizations play a crucial role in providing focused and targeted innovation for different communities and need to be supported.
5. All-women buses and only-women transportation modes, though having good intentions have failed to improve mobility.

Results from the discussions at the World Café

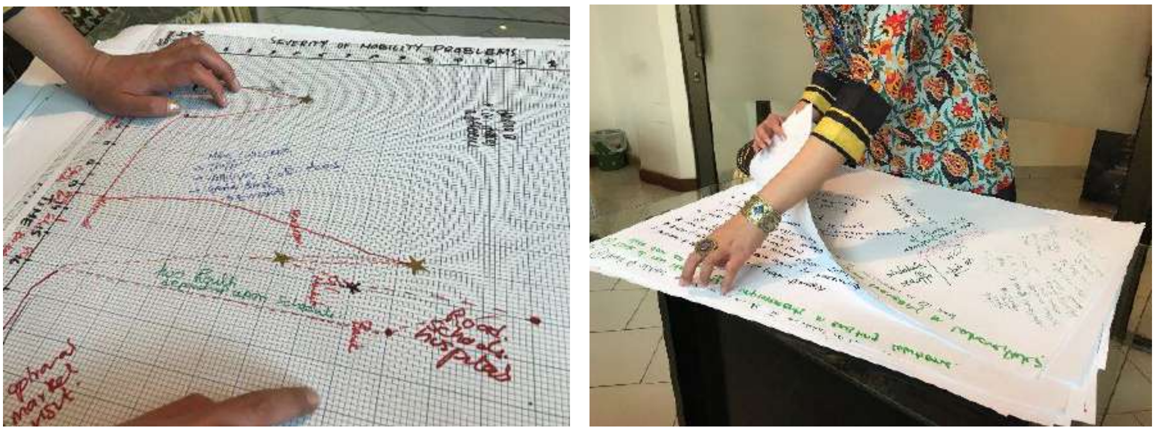


Figure 4. Documenting the results of creative cafe in Lahore

A Creative Café, also known as a World Café, is a collaborative workshop that brings together individuals who have experienced the issue and are well informed about it. By creating an engaging and democratic atmosphere, the Café promotes a space to co-create and co-design solutions for current and future issues, while ensuring the voices of all participants are heard equally (The world Café; Klaiman & Guadarrama, 2016.) A creative café workshop was conducted in Lahore, with 20 participants who were working women, housewives, government representatives, and women rights activists. The discussion was conducted in groups based on four key areas: challenges/issues, their journeys, change over time in mobility, and possible solutions.

Figure 5: Conducting the creative café workshop in Lahore

Figure 6: Sheets from the group discussion tables

Key points which emerged from the conversations:

- Harassment of women on public transport is a major issue as pointed out by most participants.
- Challenges differ for different economic classes and in different geographic and economic regions.
- Middle to upper-middle class women choose to have their own cars because of the many challenges, which is expensive but comparatively safe and reliable
- Women do not feel safe walking on the side of the roads.
- Significant planning for a trip is required, checking availability and financial constraints, which often leads to cancelling plans, leading to travel avoidance.

Synthesis of barriers to women's mobility

Mobility barriers women face in Pakistan - Lower middle to upper middle economic class (family earning Rs 45,000-300,000 per month)

Social/ Societal	Cultural/religious	Economic	Safety	Health	Political/ Govt	Geographic/ Climate	Urban Planning/ Architectural	Transport operation	Transport infrasrcture and design	Regulations
Harassment is one of the biggest issues. It include ogling, staring, following, catcalls, inappropriate touching in public spaces, hitting women through cars or motorbikes among others. "About 82 percent of women commuters report facing harassment at bus stops, with higher rates at LTC bus stops compared to Metro bus stations, and amongst younger women (20–29 years of age) compared to older women. The most common types of sexual harassment at bus stops include staring, stalking,	Reputation/respect and cultural issues for women who stay out of home for long periods of time for work or other needs. Neighbors and family members doubt their character and talk bad about them. This causes restriction for most women.	Urban centres like Lahore have a classism stretching people to present an image which is more than what they can afford. Circumstances and barriers differ in different economic classes, their modes of transportation widely differ as well.	"There are significant safety concerns on buses. About 90 percent of women report experiencing sexual harassment on buses, with a higher ratio on LTC buses. The main types of sexual harassment include passing sexual comments, staring, pushing and inappropriate touching." (1)	Walking is not a natural part of their daily routine due to social and cultural barriers, which is an essential need for a healthy life. For exercise most women have to go to parks or join a gym, which again require a mode of transportation. Therefore, it's expensive and time consuming especially for mothers and married women.	Less or no female representation in policy making. Need for female planners to be part of government teams and projects so that they can empathize with the female perspective and design plans that incorporate that.	Rural areas/villages not easily accessible for public transport	Roads not designed for pedestrians in mind. signal free roads in the main areas of city- walkers find it a huge hassle to go over bridges and walk extra miles to get to a place.	Misconceptions and misinformation about the bus systems. No knowledge of bus routes and timings or the method of payment e.g. speedo bus. Participant in world café said "you can't use it without a card" when in reality you can pay cash as well.	Transport system is not connected for end to end route. To reach the metro, most people have to use rikshaw or qingqi or car because the public transport doesn't connect the routes to areas. Disconnected pathways and walkways. Especially being a woman, it adds more risk and uncertainty when walking on the roads.	Most women are unaware of safety helpline set up by the government. Women also find it useless because of inadequate response
In metro or buses, problems like pushing and pickpocketing	Some upper middle-class women are brought up in liberal families, allowing them to have freedom and liberty, however, they find it difficult to adjust to the relatively conservative culture and society outside, resulting in people judging their character, and slut-shaming them, restricting	Most middle to upper-middle class women choose to have their own cars because of the many challenges, which is expensive.	Exposure to unsafe modes of transportation: harassment, rape, discomfort, kidnapping and human trafficking, murder			Extreme hot weather make it difficult to be outdoors	Accessibility for disabled is a massive issue. Most buildings don't have ramps or accessible entrances and exits. The buses don't have any arangements to facilitate the diabled	Harassment in local vans and bus stops	Bus stops are located far away from residential areas.	**Article 9** *Security of Person* reads: "No person shall be deprived of life or liberty save in accordance with the law."
Constant Fear. Women don't feel safe on roads. Constant fear of purse being snatched or harassment or kidnapping or something bad happening. (participants of world café reported the same as well as personal experiences of team	Most working women have a dual role: earner and home-maker which adds additional stress and workload on women, urging most of them to choose between home and work.	Careem is an expensive mode of transport for lower-middle and middle class and is not an affordable mode on daily or regular basis					No pedestrian signals or walkways in most areas. People don't know what the signals mean in areas where they have been installed		Limited routes of buses and trains e.g. Metrobus travels along Ferozepur Road only	**Article 15** *Freedom of Movement* reads: "Every citizen shall have the right to remain in, and, subject to any reasonable restriction imposed by law in the public interest, enter and move freely throughout Pakistan and to reside and settle in any part thereof."
Lack of empowered female role models in media, popular culture references or social media	In most households if there is one family car, the husband or father/brother gets the priority on its usage since he is the breadwinner.						No footpaths on most roads		poor lighting, maintenance and over crowdedness near bus stops	Article 25 Equality of Citizens states that: "All citizens are equal before law and are entitled to equal protection of law. There shall be no discrimination on the basis of sex alone. Nothing in this Article shall prevent the State from making any special provision for the protection of women and children."
There is no concept of women walking on the roads or cycling to get to places. It used to be acceptable but over time has become a rare sight. Socially and culturally uncomfortable for women to walk or cycle.	Men considered experts in car handling so most women are not given the responsibility of a car. Even when they do get the trust, going to workshops is nearly impossible. The workshops are not considered places for women. They have no places to sit for women, mostly have no women, the men at the workshops ogle									Article 26 Non-discrimination in respect of access to public places states: "....there shall be no discrimination against any citizen on the ground of race, religion, caste, sex...." It adds that nothing in the above clause "shall prevent the State from making any special provision for women and children."
high dependency on others which limits freedom and independence and thus their exposure and growth. Same aged males have a fair amount of independence to walk to destinations, socialize with friends on the streets or play outside the house.	Mother the main caregiver for kids so the ages of children play a huge role in her mobility patterns.									
High dependency on males for travel needs. Are bound to have a trustworthy male for travel- preferably someone from the family	Have to come and leave at an appropriate time due to issues of respectict, virtue and dignity									
	The concept of 'Pardah' in Islam which restricts a lot of women (living in conservative families) from leaving the house (unrelated men are not supposed to see women) and going out of the house without properly covering themselves									

Personas for Pakistan

The results from the various studies were used to create an understanding of mobility systems and structures using the '10 stages of women,' which divides women into ten age groups. For each age group, the factors of mobility, barriers, primary occupations, and roles differ. Figure 1 below shows stages with their primary occupations and social expectations. This is important because it provides a much needed, culturally specific representation of women in Pakistan, which was lacking when we started the research. Moreover, since the mobility differs for women belonging to different economic class and financial backgrounds, this representation is of women belonging to the middle to upper-middle financial stature, which means annual family (not more than 2 kids) income of US$9000 and above. In most research this economic class is ignored and only the lower economic class is studied, however middle and upper middle class is an essential part of the economy of Pakistan. The 36.38% (Pakistan Bureau, 2018) of those who live in urban centres of Pakistan have female literacy ratio of 71% (2014-15) (2017 statistical, 2018).

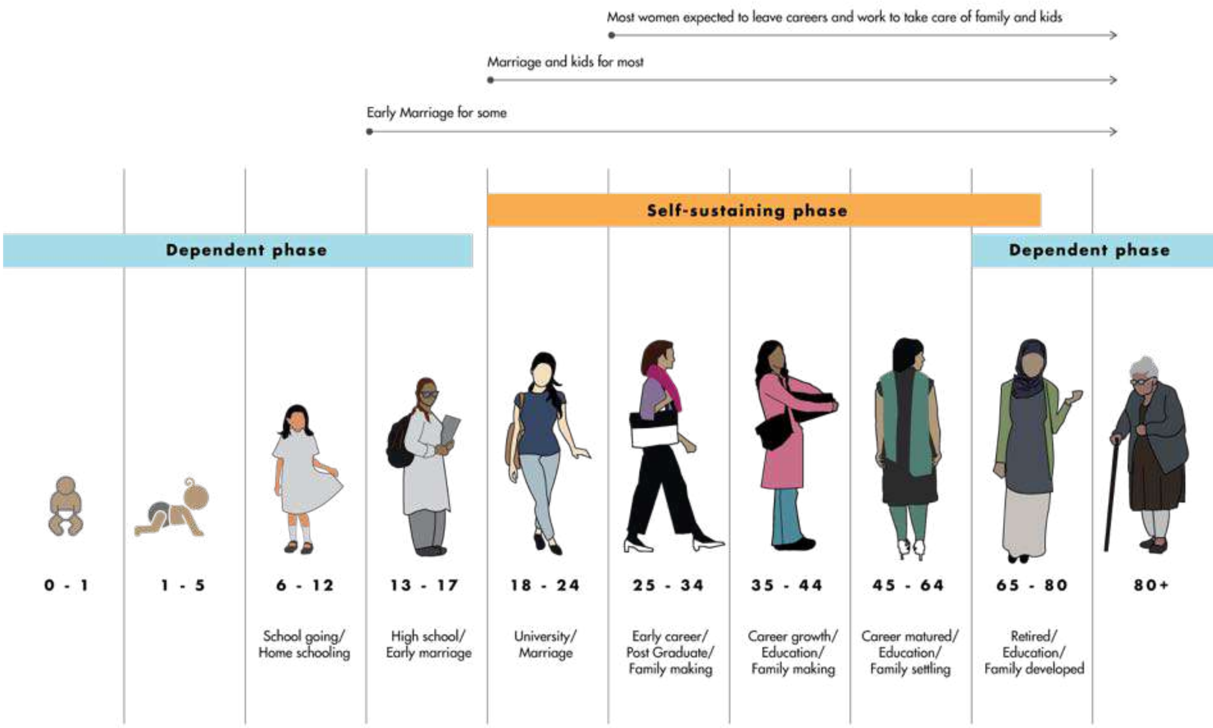


Figure 7. The 10 stages of women in Pakistan

Modes of transportation for all phases are:

- Public transportation: buses primarily (no in-city trains available)
- Rideshare: Careem and Uber
- Private-public transportation: Rikshaw, Chingchi, Taxi
  - Private-personal transportation: Personal/Parent's/Guardian's cars or motorbikes

The stages divide into two main categories: dependant and self-sustaining phases. In the dependent phases, at the beginning of life, journeys are made to school/universities/offices, meet friends and family, and to attend events and gatherings. Toward the end of life, journeys are made for medical needs and to meet family and friends. The dependency falls on fathers, brothers, husbands, sons, and women in the self-sustaining years of their lives.

Mobility barriers for the dependent phase include:

- High dependency on others, which limits freedom and independence and thus their exposure and growth. Same aged males have a fair amount of independence to walk to destinations, socialize with friends on the streets or play outside the house.
- Exposure to unsafe modes of transportation: harassment, rape, discomfort, kidnapping and human trafficking and murder.
- Unable to walk or bicycle on the streets due to cultural and societal norms.

Mobility barriers for self-sustaining phase:

For the self- sustaining phase, it is not implied that women are entirely independent and live a self-sustaining life; instead it means that these women have the choice, and opportunity to do so, accepting the caveats and risks. Women can legally drive and can choose to buy their own cars. They can get a paid job outside home and chose to live independently in a hostel, apartment, or house. However, societal expectation suggests that they get married and preferably move in with their spouse or spouses' families. Those women, who don't own personal vehicles, depend on their fathers, husbands, brothers, sons, and other women who can drive and have a car for mobility.

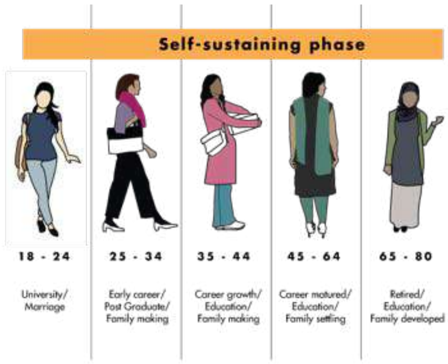
Harassment on buses, bus stops, and while walking on the roads was reported to be the biggest barrier. Tayyaba, a motorcyclist and founder of Rides and Miles (female motorcyclist training academy), who was a part of the focus group shared that

> *"I was riding my bike yesterday and two boys were crossing me and cat-called on me saying, "Darling, where are you going?"… Harassment is a big issue in Pakistan, especially if you are travelling on a bike. In my routine life, if I go out of my home twice or thrice, I face harassment twice or thrice too, whether it's through words or eyes."*

Other challenges include:

- Safety concerns due to cases of kidnapping, theft, acid attacks, and murder.
- Expensive of private vehicle ownership.
- For women with kids, the age of children defines their mobility. Having an infant might make it almost impossible to leave the house unless there is help such as a driver and a car.
- If the family has one car, the preference is often given to the husband or father as they are considered the breadwinners and finance providers.
- Most places are inaccessible to take baby strollers and therefore restricts.

- Influences of the dual role of women in terms of earners and domestic workers. No matter what kind of work they do, they are expected to fulfil all responsibilities of the house.
- Most offices do not have day care centres forcing women to either leave the job or take a leave of absence.
- Inappropriate attitude of male drivers towards female drivers.
- Most car repair workshops are not female friendly and do not have any female representation, thus making female car owners depend on men in their house for car repairs.



	Pre-departure Planning phase	Journey	Arrival/ Plan for return	Return and Arrival
Optoins/ Process	What options available? Depending on whom? Money? TIme consuming & limiting	Stress and anxiety because of on road barriers. Constant feeling of insecurity and fear	Late night stay difficult/impossible. Time dependent mobility. What options available? Needs pre-planning	Constant stress, fear and anxiety. At your own risk. Lack of support if technical problems with car
Barriers	**Public transport, Rikshaws:** Fear, insecurity, unavailability, unreliable **Walking:** Fear, disconnected routes, no walkways, signal free roads without pedestrian crossing **Family Car:** Dependence, availability **Own Car:** Expense, which route safer	**Public transport, Rikshaws:** Unsafe, risk of kidnapping, abduction, harassment, fear **Walking:** Kidnapping, harassmet, abduction, accidents **Car:** Road discrimination, men chasing on bikes/cars, people not following traffic rules	**Public transport, Rikshaws:** No waiting areas, fear, insecurity, unavailability, unreliable **Walking:** Fear, disconnected routes, no walkways, signal free roads without pedestrian crossing **Car:** Late night stay difficult because unsafe. **Careem**: unsafe	**Public transport, Rikshaws:** Unsafe, risk of kidnapping, abduction, harassment, fear **Walking:** Kidnapping, harassmet, abduction, accidents **Car:** Road discrimination, men chasing on bikes/cars, people not following traffic rules, cars stopped
Leverage points	**Careem:** Available, relatively safer option **Own car:** less dependence, safer	**Careem:** Available, relatively safer option, efficient **Own car:** Safer, efficient Safety helplines (esp in Punjab)	**Own car:** Safer, efficient	Safety helplines (especially in Punjab)

→ Time

Figure 8: Characteristics of the self-sustaining phase, broken down across journey stages

Figure 8 shows the characteristics of the self-sustaining phase in terms of transportation options, barriers, and leverage points. In most cases, women require more time to plan for their trip (shown by survey results, focus group, and creative café responses), which causes inconvenience and discourages them to go out at all. It also results in cancelling plans or meetings. Planning includes: making sure the car is not used by anyone else in the house so that they can use it (in the case of one family car); making sure they have money if the option available is rideshare (Careem or Uber); waiting for the rideshare or rikshaw driver to show up to pick them; and ensuring it is not a late night plan because most women do not feel safe travelling in public transport or using rideshare at night. Planning also means making sure they have figured out the mode, time, and route to return home.

4. Systemic Synthesis

The systemic synthesis aids in configuring the interconnections and linkages of the 10 stages of women with the cause and effect cycles they go through, government support, and gaps in the system. It helps policy makers see the narrative from the women's perspective in connection with the solutions they provide and the gaps that exist in meeting the needs. The maps give a brief overview of two to three main gaps; however, they can be expanded to incorporate more elements.

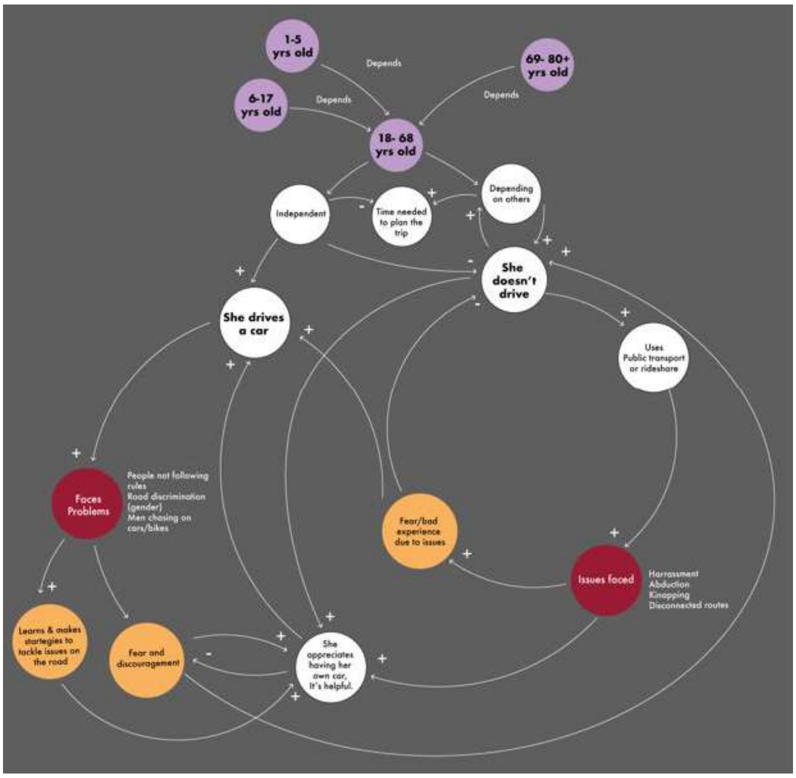


Figure 9. Systems causal loop diagram linking the 10 stages of women and the issues they face

The women in the self-sustaining phase, aged 18-68, are the focus and have two ways of looking at mobility: being dependent on others and external modes of transportations such as buses, Careem, Rikshaw, family car, or can be independent by having their own vehicle. The more dependence they have on other modes, the more time it takes to plan the journeys and ensure availability. The concept of everyone owning their own vehicles is not advisable since it will have a negative impact on the environment; however, this is a synthesis of findings showing a pattern in the existing circumstances.

Women face barriers and challenges whether using their own vehicle or using other modes of transport. In case of buses, rikshaws, family car, or other third-party modes of transportation, as discussed earlier, she faces harassment, time delays, longer wait periods, uncertainty, and fear. In case of her own vehicle, she faces discrimination and harassment on the road (by other drivers on the road especially male), affords higher expenses, and fears vehicle theft and her own safety.

If we look at the 'can't drive' cycle, which is a balancing loop, the more the woman experiences problems and issues with external modes of transportation, the more they begin to appreciate having their own vehicle. At this stage, women who can stretch their finances and afford a vehicle will acquire one. However, some women can never get out of this vicious cycle due to limited financial resources to afford one. Careem and Uber do offer great support in this scenario.

In the case of 'can drive' cycle, when the woman faces challenges and issues, she either learns to tackle them by finding strategies such as not slowing down when driving late night, using window blinds so that others cannot see if it is a female driver; or develops a sense of fear and insecurity. In the latter case, if some women experience traumatic incidents or accidents, they give up driving. Listening about these experiences also might discourage other women from learning how to drive or get their own vehicles.

There is no option of being able to walk or bicycle. Walking on the roads is the most unsafe and uncomfortable options for any woman, therefore, most would avoid it unless walking in marketplaces or malls or highly necessary. Since walking is not a default option for women, unlike in other countries, they cannot leverage the ease or health benefits of it.

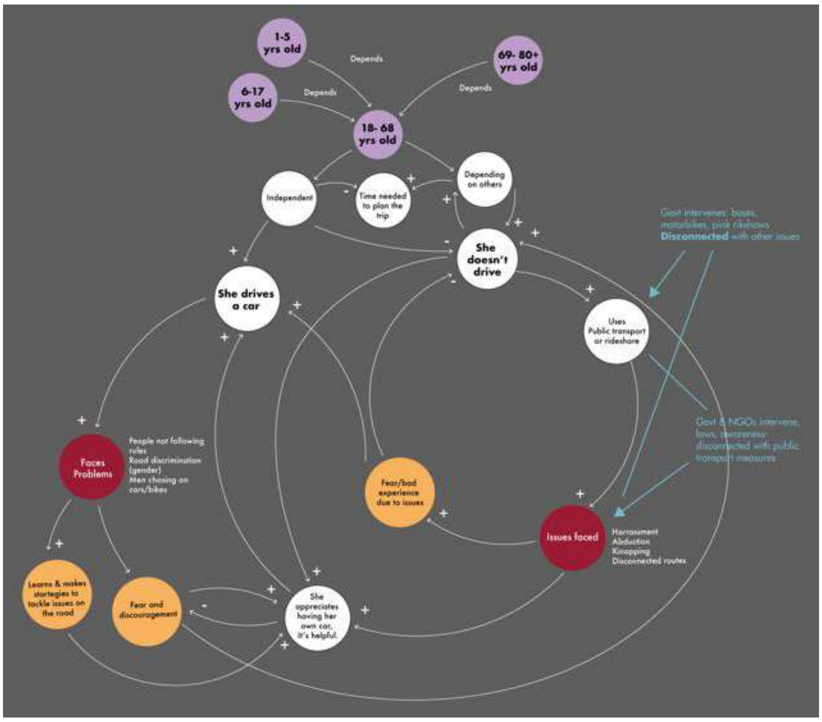


Figure 10. Systems causal loop diagram suggesting 2 main gaps that government and not-for-profit sector needs to address

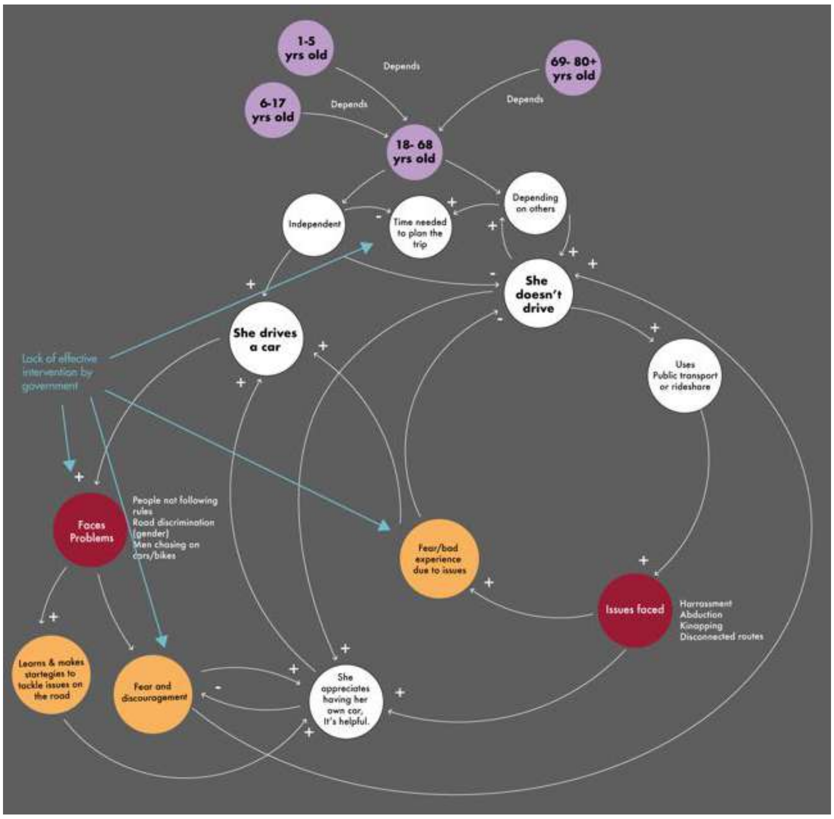


Figure 11: Areas where government intervention lacks

Government interventions are made in the area of public transport facilities as figure 11 shows. The government tried providing pink buses (women only) that failed. To help with enabling women to travel safely they also supported projects such as safe cities, women on wheels, however, the role is limited. The biggest gap in these interventions is the disconnect with other gender related issues associated with mobility as the diagram points out e.g. bus services are improved but harassment issues are not addressed, and more buses are added but the end-to-end routes are not available leading to massive disconnects making public transport unreliable.

There are disconnects in the interventions by the three sectors i.e. private, public, and government due to lack of collaborations and discrediting each other's work instead of building upon it. The not-for-profit sector tries to intervene in the issues of harassment and safety by doing awareness campaigns, research projects, and raising a voice against them. However, it can only be made more effective if the government steps in and incorporates it in their plans and work.

The 'can drive' loop has no significant interventions by the government. There is an established helpline for women in Punjab, which is not highly active and provides with basic help such as connecting with police or support nearby. Government also introduced female traffic police, however, it failed miserably and was stopped.

> *"It was very difficult to stand on the roads and manage the traffic. People wouldn't obey the instructions, also a lot of men on bikes and cars would harass us and would stop their*

> *vehicles to talk for no reason. There were catcalls. There was one time, a guy yelled 'go home! This is not your job."* Female Traffic Warden

Government's women-on-wheels project has been a great success so far. It encourages women to ride bikes, also provides easy instalment packages to buy one, and does advocacy for their safety and freedom. However, the support offered by government is only associated primarily in the provision of public transportation, that too is extremely limited. The other side of this narrative is a blind spot, including policies and infrastructure to encourage pedestrians and providing them safety.

5. Conclusion

To conclude, the system largely lacks a gender sensitive and user-centered approach, data, and holistic strategies which connecting solutions to the resolution of issues across the domain System archetypes such as "shifting the burden", "fixes that fail", and "limits to success" (Braun, 2002) exist causing ideas and plans to fail in achieving the desired impact. To address a systemic design research approach can enable sectors to collaborate in holistic strategies and implementation plans, dividing responsibilities and financial burdens. Stakeholders will have to be involved at every stage, empowering them to participate with not only suggestions but also actions.

References

Bevan, M.T. (2014). A method of phenomenological interviewing. *Qualitative Health Research,* 24(1), 136-144.

Braun, W. (2002). The system archetypes. *System*, 27.

Brown, J. (2010). *The world café: shaping our future through conversations that matter*. ReadHowYouWant.com.

Burns, D. (2007) *Systemic Action Research*, Policy Press.

CiViTAS WIKI Policy Note (n/d). *Gender and equality and mobility: mind the gap*! Retrieved from https://civitas.eu/sites/default/files/civ_pol-an2_m_web.pdf.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. *Design Issues*, 17(3), 49-55.

Dunckel-Graglia, A. (2013). Women-only transportation: How "pink" public transportation changes public perception of women's mobility. *Journal of Public Transportation*, 16(2): 85-105.

Ellis, C., Adams, T.E. and Bochner, A.P. (2011). Autoethnography: An overview. *Historical Social Research,* 36(4), 273-290.

European Parliament: Directorate General for Internal Policies: Policy Department C: Citizens right and Constitutional Affairs (2012). *The role of women in the green economy; The issue of mobility*. Retrieved from http://www.europarl.europa.eu/RegData/etudes/note/join/2012/462453/IPOL-FEMM_NT(2012)462453_EN.pdf.

Gharajedaghi, J. (2011). Systems thinking: Managing chaos and complexity: A platform for designing business architecture. Elsevier.

Gil, N. (2018). *Road rage is sexist and these female drivers know it*. Retrieved from https://www.refinery29.com/en-gb/2018/11/216815/road-rage-sexist-women.

ILO (2019) Retrieved from http://www.ilo.org/wcmsp5/groups/public/@asia/@ro-bangkok/@iloislamabad/documents/publication/wcms_185253.pdf

Jones, P.H. (2014). Systemic design principles for complex social systems. In: Metcalf G. (eds*) Social Systems and Design. Translational Systems Sciences*, 1. Springer, Tokyo.

Klaiman, D., & Guadarrama, G. (2016). World Cafe. SFIN- 6020 Innovation Research Methods Course.

Lucas, K. (2012). Transport and social exclusion: Where are we now? *Transport Policy*, 20, 105-113.

Lucas, K., Mattioli, G., Verlinghieri, E. and Guzman, A. (2016). Transport poverty and its adverse social consequences. *Proceedings of the Institution of Civil Engineers - Transport*, 169 (6), 353-365.

Madan, M. and Nalia, M.K. (2016). Sexual harassment in public spaces: Examining gender Differences in perceived seriousness and victimization. *International Criminal Justice Review*, 26(2), 80-97.

Marcus, G.E. (1995). Ethnography in/of the world system: The emergence of multi-sited ethnography. *Annual Review of Anthropology*, 24, 95-117.

May, A.D. (2015). Encouraging good practice in the development of Sustainable Urban Mobility Plans, *Case Studies on Transport Policy*, 3 (1), 3-11.

McLeod, E.D. (2018). *Pink public transport: A necessary evil?* Senior Projects Spring 2018. 188 Retrieved from https://digitalcommons.bard.edu/senproj_s2018/188.

Osmond, J. and Woodcock, A. (2015, April 13th). Are our streets safe enough for female users? How everyday harassment affects mobility. *International Conference on Ergonomics & Human Factors*, Daventry, United Kingdom, pages 495-502.

Pakistan Bureau of Statistics, Ministry of Statistics, Statistics Division. (2018). Press release on provisional summary results of 6th population and housing census 2017 [Press release]. Retrieved February 12, 2019, from http://www.statistics.gov.pk/assets/publications/Population_Results.pdf

(6^{th}) Population and Housing Census. (2017). Retrieved from http://www.pbs.gov.pk/content/provisional-summary-results-6th-population-and-housing-census-2017-0

Punjab Government Office (2018). *Punjab Gender Parity Report 2018*. Retrieved from https://pcsw.punjab.gov.pk/research_publications.

Rakodi, C. (1999). Cities and people; towards a gender=aware urban planning process. *Public Administration Development*, 11 (6), 541-559.

Rittel, H.W. J. and Webber, M. M. (1973). Dilemmas in a General Theory of Planning. Policy *Sciences*, 4, 155–169.

Sajjad, F., Anjum, G. A., Field, E., and Vyborny, K. (2017). *Overcoming Barriers to Women's Mobility*. Retrieved from http://cdpr.org.pk/images/publications/cities/Overcoming-Barriers-to-Womens-Mobility-Extended-Brief.pdf.

Saul, H. (2017). *The badge designed to tackle sexual harassment on public transport*. Retrieved from https://inews.co.uk/news/badge-designed-tackle-sexual-harassment-public-transport/.

Schwartz, D. (1989). Visual ethnography: Using photography in qualitative research. Qualitative Sociology, 12 (2), 119-154.

The World Café Community Foundation, n.d. Retrieved from http://www.theworldcafe.com/tag/world-cafe-community-foundation/ –

Thompson, D.M. (1993). The 'woman on the street': reclaiming the public space from sexual harassment. *Yale Journal of Law and Feminism*, 6(4). http://digitalcommons.law.yale.edu/yjlf/vol6/iss2/4.

United Nations (n/d), Population. Retrieved from http://www.un.org/en/sections/issues-depth/population/.

Women's Safety Audit in Public Transport in Lahore. (n.d.). Retrieved from http://asiapacific.unwomen.org/en/digital-library/publications/2018/05/womens-safety-audit-in-public-transport-in-lahore

2017 Statistical pocket book of the Punjab (Publication). (2018). Retrieved February 11, 2019, from Bureau of statistics, Government of the Punjab website: http://bos.gop.pk/PocketBook

A Systemic Design Investigation of New Zealand’s Democratic System

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Abstract Addressing systemic problems with long time horizons such as the transition towards sustainability is both a matter of material production and political will. Consequently, systemic design and constitutional design may be seen as interdependent. Taking a systems thinking approach might suggest that taking an incremental approach to constitutional design would be a strength; after all, one might claim that an incremental constitutional system can adapt more easily to suit the changing needs of the society. However, our study of New Zealand’s continually evolving constitutional system suggests that, to the contrary, a rigid constitution has benefits for addressing long term consequences that are intergenerational. We argue that a written superior law constitution better supports the public to hold the government to account.

Keywords: democracy, constitutional design, incrementalism, policy design,

1. Introduction

It is not common to think of democratic regimes as designed objects. The connection between design activity and the stuff people consume is more obvious than the connection between design activity and the system through which a people governs itself. However, it is also clear that implementing the transition towards sustainability is both a matter of material production and political will. Recently Ezio Manzini (2017) identified the connection between design, democracy and sustainability when he argued that since democracy is a resilient system it is the only regime in which we can imagine a sustainable future society. It follows that design for sustainability is interdependent with constitutional design.

Scholars might see the incremental approach to constitutional design as a strength; after all, they might claim that an incremental constitutional system can adapt more easily to suit the changing needs of the society. Similar arguments are found in design research regarding sociotechnical system design, for example Don Norman and JP Stappers (2015) have argued that incrementalism is the best approach for dealing with complex problems such as sustainability. However, almost all countries have some form of written codified constitution. There are only three countries that have an unwritten constitution, namely UK, Israel and New Zealand. New Zealand does not have a written, codified constitution that sets out the basic rules and values under which New Zealand governs itself. Much of New Zealand's constitutional system is in the form of unwritten conventions and norms. Consequently, New Zealand's constitutional arrangements are flexible and constantly evolving.

New Zealand is a sovereign state that includes a territory in the Southwest Pacific Ocean, a nation of 4.9 million people, and a system of government that is a parliamentary constitutional monarchy. By most international standards, New Zealand appears to be stable, well governed, and committed to a climate resilient future. Examining the lessons yielded from the analysis of New Zealand's situation outlines some of the challenges for democracy and sustainability more generally.

This paper takes a constitutional realist theoretical perspective to identify the entities that influence how public power is exercised in New Zealand (Palmer, 2006a, 2006b). Constitutional realists attempt to understand the whole system by examining not only the texts that codify constitutional laws but also the structures, principles, conventions and even culture that form the ways in which public power is exercised. Constitutional realism and systemic design share the commitment to analysing the whole system in context and the aim of synthesising information across disciplines and scales (Jones, 2014).

An unwritten constitution was fine when New Zealand was a smaller country and we agreed on many things. But the New Zealand of today is larger and more diverse than it was 50 years ago. Back then, elections provided adequate security against misrule and there was less need for further checks and balances on public power. Now New Zealand faces big disruptive policy changes, such as the transition towards sustainability, that require a framework of government that can meet the needs of the present without compromising the ability of future generations to meet their own needs.

Although New Zealand is an isolated territory in the Southwest Pacific, it is not immune to international political trends, such as Brexit and Trumpism, that are changing how democracies function. The New Zealand style of government is already authoritarian and the trace of colonialism remains in its constitutional structures. New Zealander's rights and freedoms could wither away without greater controls and oversight on government power. We need a constitutional system that is resilient to the shocks and emergencies that we already know about and those that we cannot foresee.

In this paper I argue that New Zealand has reached the point where it needs a codified constitution that is easy to access and use. We need to be able to increase understanding about how our government actually works and what are the rights and freedoms of individuals in our democracy. Furthermore, these rights should include environmental rights that secure ecologically sustainable development and protect the environment for present and future generations.

2. Design and Constitutionalism

Participatory design and social innovation are domains of design through which values of democracy and designing for social goods have been undertaken. Within the last decade however, designers have also begun to influence policymaking and policy instruments. Design for policy describes a body of literature and practice where design is used to create innovation within the policy process itself (Bason, 2014, 2017; Christiansen & Bunt, 2012). Design for policy concerns doing policy-making differently, rather than viewing design as another tool in the policymakers' toolbox (Bason, 2014, p. 3). Design for policy is an emerging field that is positioning itself as a different model of policy making that is not political decision-making that uses hierarchical control or incrementalism, but one that draws on the approaches of socially responsible design and participatory design. Design for policy is proposed as a different kind of decision-making that will be able to better respond to the new complex challenges that the welfare state faces today. Moreover, the design for policy approach also overlaps with the strategic approach to governance to form a rationale for addressing systemic challenges and large-scale issues termed Strategic Design.

According to Boyer, Cook, and Steinberg (2011, p. 329) strategic design is the adaptation traditional design methods and attitudes to address "big picture" systemic challenges characterized by inconclusive, incomplete or unavailable information. Strategic design is a capability to quickly develop multiple perspectives, to understand people, communities and societies, to redefine how problems are approached, identify opportunities for action, and help deliver more complete and resilient solutions (Boyer et al., 2011, p. 329). A key aspect of the strategic design approach to public sector innovation is the position that the day-to-day organizational structure of government is such that it stifles innovative thinking.

The pressures caused by socio-economic factors suggest that current governance systems are not solving important problems. Furthermore, the crisis of democracy through decreasing participation is affecting the legitimacy of democratic governments. In our view, much of the research concerning design and democracy to date has addressed socio-economic issues that are arguably situated within the neoliberal context of democratizing government expenditure on goods and services. Comparatively less design research has investigated the features of democratic systems. Consequently, the main subject of our research for this paper is the design of the institutions that structure how public power is used within a democratic state. We focus our investigation on New Zealand’s constitutional system.

2.1. Constitutional Systems

A constitution consists of the rules, norms, principles and values that create and structure government power or authority within a state (Waluchow, 2018). A state must have a means to specify and constitute the legislative power to make new laws, the executive power to implement laws, and the judicial power to adjudicate disputes under laws. Most scholars believe that constitutions may either have a written form and be codified in single document, or may have an unwritten form and be a found in a collection of instruments, statutes, norms and conventions. Furthermore, constitutions are either seen as “a stable, neutral framework for the rough and tumble of partisan law and politics” or as “an evolving, living entity which, by its very nature, is capable of responding to changing social circumstances and new (and it is hoped better) moral and political beliefs” (Waluchow, 2018). This characterisation of constitutionalism highlights a key point in the relationship between policy and constitutions, namely while policies may be oriented to short term issues, often within the span of a generation, constitutions often address long term consequences that are intergenerational.

Constitutionalism concerns long term consequences such as the term of a government’s tenure, the credibility of its promises and impartiality of its decisions. First, the fundamental purpose of a written constitution is to prevent a government from indefinitely extending its tenure. Second, without a constitution, governments cannot make credible promises since what assurance is a law if institution that makes can also repeal it?. “A rigid constitution”, Jon Elster (2013) argues, “can enable citizens to engage in long-term economic planning by removing the chilling fear that government might confiscate their gains” (Elster, p. 442) . Third, while an antagonist might argue that no one could know the future of a complex socio-technical system such as a state, the constitutionalist’s counterargument could be that the long-term self-interest of families can mimic impartiality if it has a long time horizon (Elster, 2013, p. 203).

Constitutional systems are interesting because they are not usually seen as designed artefacts. I argue that in fact constitutionalism ties together several important issues in current design research such as democracy, transition to a sustainable society and justice. Investigating constitutions may contribute to design discipline as well as interdisciplinary issues in public management and sustainable transitions.

3. New Zealand’s Constitutional System

A constitution establishes the separation of powers. It prevents any single political actor from concentrating all power in its hands (Elster, 2013, p. 438). In 1688 The Bill of Rights (UK) ended the absolute power of the monarch and this bill granted local legislative authority to the colonial Westminster parliament in New Zealand and continues to establish public power in New Zealand today. New Zealand is a constitutional monarchy, and in theory there are five components to New Zealand's constitutional system and public power is separated between the parliament, the executive and the courts (figure 1).

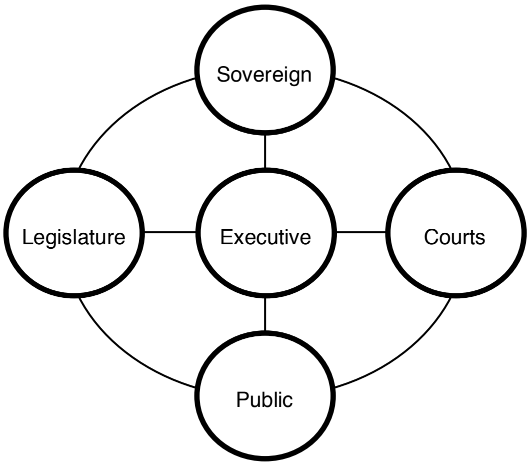

Figure 1. New Zealand's Constitutional System in Theory

However, in reality New Zealand government is rather centralised. A 1991 opinion in the New Zealand Court of Appeal states: "The constitutional position in New Zealand… is clear and unambiguous. Parliament is supreme and the function of the courts is to interpret the law laid down by parliament. The courts do not have power to consider the validity of properly enacted laws" (Geddis, 2016, p. 102, see footnote 11). Therefore, the parliament is supreme and can pass any legislation it sees fit, and there is no supreme law which can override those powers. Consequently, the executive, by enforcing party discipline, holds hegemony over the parliament and can legislate by simple majority without any constraint. This highly centralised governing arrangement, combined with the fact that the parliament is a unicameral legislature, has produced a very streamlined and active form of democracy. New Zealanders expect the government to actively intervene in society and consequently NZ's constitution system is constantly changing.

In the 20th century there have been over 50 new elements added to New Zealand's constitutional system. For example, the upper house was abolished, the Treaty of Waitangi Tribunal was established, New Zealand Bill of Rights Act was passed, the Electoral Act 1993 changed the election procedure from plurality to proportional representation, and in 2003 Supreme Court act established the Supreme Court (NZ) as the highest court rather than the Privy Council (UK). The following timeline (figure 2) shows that New Zealand constitutional system evolves in ways that are difficult to understand.

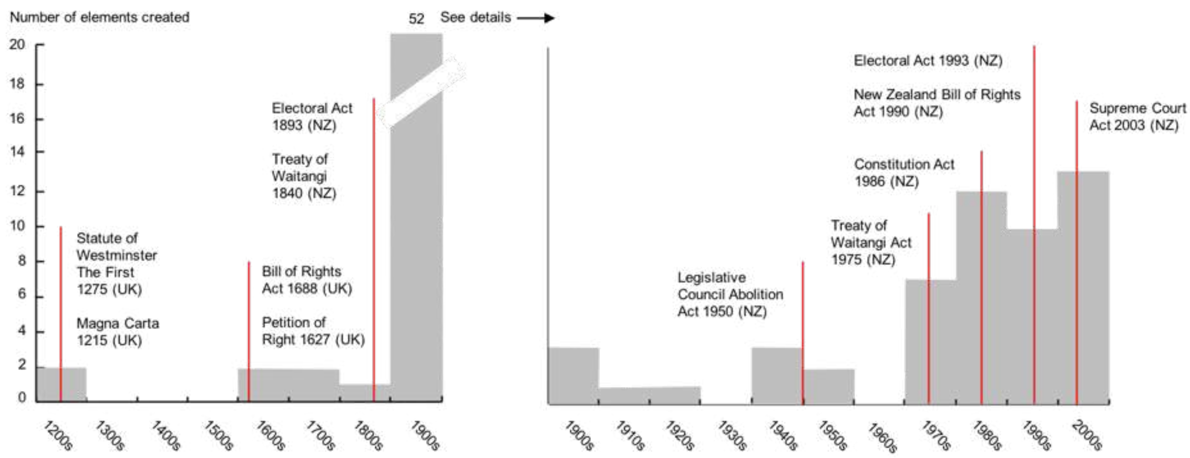

Figure 2. Timeline of New Zealand's Evolving Constitutional System

Figure 3 (right) shows that approximately two thirds of the elements of New Zealand's constitution are made up of legislation which can be changed by simply parliamentary majority (Palmer, 2006b). A quarter is international treaties and New Zealand common law, they are changed according to rules of the ruling bodies. A tenth is constitutional conventions, these are unsaid values and customs that are not formalised in any particular way.

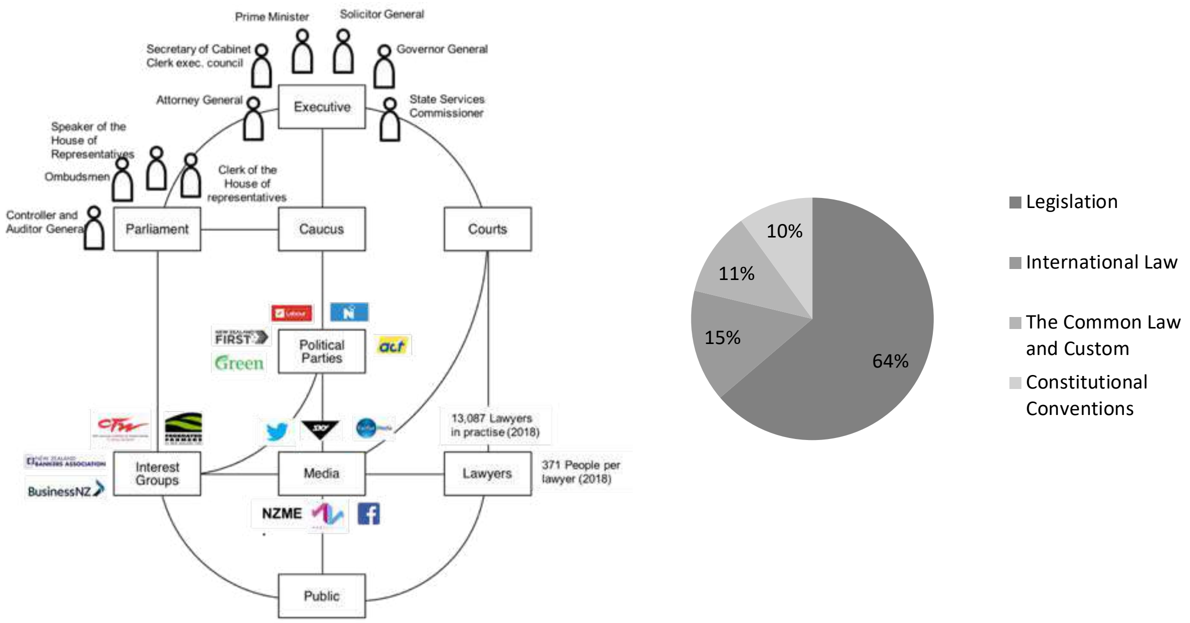

Figure 3. New Zealand's Constitutional System in Reality (left). Elements of New Zealand's Constitutional (right)

Since New Zealand's constitutional system is incrementally evolving, those who are in the position to interpret it authoritatively possess significant power (Palmer, 2006b). Consequently, constitutional issues are interpreted by a few particular office holders (Figure 3, left).

4. From Plurality to Proportional Representation

In the 1990s New Zealand redesigned its democratic system to reduce the strength of the executive. From a systemic design perspective, aim of the redesign was to slow down the executive by reducing its capacity to exclude situational complexity in the public and the legislature. In 1993, New Zealand decided by referendum to change from a plurality based the first-past-the-post (FPP) electoral system to the mixed-member proportional (MMP) system. Plurality voting is an electoral procedure where parties compete and the winner is the one that obtains the majority of the votes. Proportional voting is an electoral system where the complexity of the electorate is reflected in the composition in the legislative body. The first election using the MMP system was held in 1996 (Wikipedia contributors, 2018, December 12). Under MMP, each voter has two votes: the first vote is called the party vote and voters use this vote to express their support for a particular party. The second vote is the electorate vote, which is used to express support for a candidate to represent the voter's electorate in Parliament. MMP uses an electoral threshold which sets the minimum level of support a party needs to gain representation at 5% of the nationwide party vote, or success in an electorate. Parties who meet this threshold are entitled to a share of the seats in Parliament that is about the same as its share of the nationwide vote. Consequently, more small parties were able to enter into legislature. In the 25 years since the first MMP election there has been a change in the composition of the legislature and executive, with more women, Asian, and Maori Members of Parliament (Maoate-Cox & Smith, 2019).

In theory MMP should restrain the executive by forcing different parties to slow the rate of action by making governing messier. Ever since 1996 the executive government has been formed by a coalition of several parties. Coalitions require parties to work together and compromise. Ministers must convince their own parties as well as their supporting coalition partners to pass a bill into law. It is possible for supporting parties to change allegiances, providing minor parties with some leverage over the major parties. Introducing MMP has introduced more flexible governing arrangements, however the basic foundational principles remain the same.

1. Parliament ought to be able to legislate as it sees fit
2. Executive ought to be actively responsive to any and all problems that NZ society faces.

But the change to proportional representation and shift to coalitions of several parties has not changed the fundamental way that power operates in New Zealand’s democratic system. For example, coalitional governments passed the Foreshore and Seabed Act 2004 and the Canterbury Earthquake Recovery Act 2011 with little debate in the legislature or input from the public. This shows that the executive will still make significant constitutional changes or approve significant expenditure in a proportional democratic system. Simply changing the way MPs are chosen has not had significant effect in limit executive power. The public must do more.

5. Constitutional Change Beyond Incrementalism

A written superior law constitution supports the public to hold the government to account. The minimal theory of democracy states that in a democracy parties lose elections (Alvarez, Cheibub, Limongi, & Przeworski, 1996). The fundamental purpose of a written constitution is to prevent a government from indefinitely extending its tenure. This is why written constitutions are made to endure, not indefinitely and not without change, but with a greater lifespan than ordinary legislation. Since what assurance is a law if it lies within the same legislature that can repeal it? It will give no security since the same people may unbuild what they built. If the constitutional law can be changed by majority decision, then there is nothing preventing a government from passing unconstitutional laws. It's a simple two-step process. First, change the element of the constitution preventing the desired law, the pass the law. Your unconstitutional law is now constitutional.

Without a constitution NZ's governments cannot make credible promises (Elster, 2013, p. 442). Any piece of NZ legislation has a life span of three years since that's the term length of a government. A new government can repeal any law with a majority and party discipline. The incremental approach might argue that no one can know what the future of a complex socio-technical system will be so there's no point in making any long-term plans. But the counterargument is that in fact not being able to know the future can facilitate a "veil of ignorance" in decision making (Rawls, 1973). Behind the veil of ignorance, the long-term self-interest of families can mimic impartiality if it has a long enough time horizon (Elster, 2013, p. 203).

A constitution should not only be hard to amend, but also enforceable and credible. How can a constitution acquire causal efficacy? Public opinion can provide enforcement. But this presupposes that the public can easily access and use the constitution. And this is another argument against NZ's unwritten constitution. If someone wanted to find out how NZ's government works you can't do it because it is not written down anywhere.

Since New Zealand's constitutional system is unwritten and incremental, then governments do not address problems with long-time horizons such as the transition to sustainable future. Discontinuous change is needed to address long term consequences that are intergenerational. First, through a superior law constitution, second through fostering the aptitudes in the voters and deputies and preventing the prevention of intelligence. Rather than relying on judicial review by the courts, unconstitutional legislation should also be removed by the influence of the Tribunal of Public Opinion. This point of view proposes that the people are trusted to realise their own interests; we should foster these virtues in all citizens through preventing the prevention of intelligence through education.

References

Alvarez, M., Cheibub, J. A., Limongi, F., & Przeworski, A. (1996). Classifying political regimes. *Studies In Comparative International Development, 31*(2), 3-36. doi:10.1007/bf02719326

Bason, C. (2014). *Design for policy*. Farnham, Surrey; Burlington, VT: Gower.

Bason, C. (2017). *Leading Public Design: Discovering Human-centred Governance*. UK: Bristol University Press.

Boyer, B., Cook, J. W., & Steinberg, M. (2011). *In Studio: Recipes for Systemic Change: Helsinki Design Lab*: Sitra.

Christiansen, J., & Bunt, L. (2012). Innovation in policy: Allowing for creativity, social complexity and uncertainty in public governance. Retrieved from

Elster, J. (2013). *Securities against Misrule: Juries, Assemblies, Elections*. New York: Cambridge University Press.

Geddis, A. (2016). Parliamentary government in New Zealand: Lines of continuity and moments of change. *International Journal of Constitutional Law, 14*(1), 99-118. doi:10.1093/icon/mow001

Jones, P. (2014). Systemic Design Principles for Complex Social Systems. In G. S. Metcalf (Ed.), *Social Systems and Design* (pp. 91-128). Japan: Springer.

Manzini, E. (2017). The politics of everyday life: How to implement a design-based collaborative democracy. Lecture presented at CMU School of Design: CMU School of Design Lecture Series.

Maoate-Cox, D., & Smith, P. (2019). MMP turns 25: more women, Asian, and Maori MPs. Retrieved from https://www.radionz.co.nz/national/programmes/the-house/audio/2018671578/mmp-turns-25-more-women-asian-and-maori-mps

Norman, D. A., & Stappers, P. J. (2015). DesignX: Complex Sociotechnical Systems. *She Ji: The Journal of Design, Economics, and Innovation, 1*(2), 83-106. doi:/10.1016/j.sheji.2016.01.002

Palmer, M. S. R. (2006a). Using Constitutional Realism to Identify the Complete Constitution: Lessons from an Unwritten Constitution. *American Journal of Comparative Law, 54*, 587-636.

Palmer, M. S. R. (2006b). What is New Zealand's constitution and who interprets it? Constitutional realism and the importance of public office-holders. *Public Law Review, 17*, 133-162.

Rawls, J. (1973). *A Theory of Justice*. Oxford: Oxford University Press.

Waluchow, W. (2018). Constitutionalism. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Spring 2018 ed.): Metaphysics Research Lab, Stanford University.

Wikipedia contributors. (2018, December 12). Electoral reform in New Zealand. *Wikipedia, The Free Encyclopedia.* Retrieved from https://en.wikipedia.org/w/index.php?title=Electoral_reform_in_New_Zealand&oldid=873360524

Zines, L. (1991). *Constitutional Change in the Commonwealth*. Cambridge: Cambridge University Press.

Integration of Art of Hosting methodologies and principles into the Social Innovation Lab practice: A case study from a Social and Public Innovation Lab in New Brunswick, Canada

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Abstract In September 2017 the first multi-year standing lab undertaken by NouLAB was launched on the topic of Economic Immigration. Along with more the more traditional Social Innovation Lab methodologies such as design thinking, systemic design and Social Labs structures as defined by Hassan (2014), Jones (2014), and Westley et al. (2015), NouLAB employed the participatory practices of the Art of Hosting and Harvesting Conversations that Matter (AoH) to design and facilitate lab sessions.

The Economic Immigration Lab (EIL) has run for 18 months, and two full cycles. NouLAB has identified the linkages between the AoH approach and the systemic principles of design. Of specific interest is how multi-stakeholder participants' learning and capacity is effectively enabled by the philosophy holding space, encouraging an atmosphere of psychological safety, experimentation, and learning, addressing root causes of problems not merely symptoms.

Keywords: Social Innovation Labs, Art of Hosting, Participatory Practices, Public Sector Innovation, Systemic Design

1. Introduction

Social Innovation Labs (Labs) are inherently transdisciplinary. They borrow methods and tools from design thinking, systems thinking, participatory practice, policy development, human centered design and more (Binder & Brandt, 2008; Bason, 2014; Gryszkiewicz, Lykourentzou & Tuukka, 2016). Sometimes called Public Sector Innovation Labs, i-Labs, or Social Labs — these forums for multi-stakeholder engagement have gained popularity in the public sector worldwide with a burgeoning number of these labs in Canada (Tonurist, Kattel & Lember, 2015, 2017; Westley et al., 2015; McGann, Blomkamp, & Lewis, 2018). The exact approach varies and is highly dependent on the skills and experiences of the individuals running the lab process. This paper is an investigation into the methods of facilitation for Social Innovation Lab processes and specifically, how the suite of participatory practices, the Art of Hosting and Harvesting Conversations that Matter (AoH) played out in a lab on Economic Immigration in the province of New Brunswick, Canada.

As Social Innovation Labs have evolved and progressed over the past decade, there are a few 'must-have' features. As described by Hassan (2014), Social Labs are experimental, multi-sectoral and systemic. Labs are facilitated processes and these three factors are satisfied through designed engagements. There has been work on building a codified practice of facilitation but experience and practice are essential to guiding stakeholders through a meaningful and fruitful co-creation process (Vorberg, Bekkers & Tummers, 2014; Aguirre, Agudelo & Romm, 2017). In the policy realms where Public Sector Innovation Labs are employed, the issues are complex and, according to the Cynefin decision-making framework, the most appropriate response is to probe, sense and then respond (Kurtz & Snowden, 2003). As the tools created to accomplish this task and facilitate increasingly higher orders of complexity have been taken up in policy creation, including Systemic Design practices (Considine, Alexander & Lewis, 2014; Jones, 2014; Ryan, 2014), the question arises of who is equipped to deal with the organisationally emergent qualities of facilitating through this complexity (van Alstyne & Logan, 2007; Lichtenstein, 2014). The work of Quick and Sandfort (2014) identifies that the practice of deliberation in policy creation can be effectively ingrained in facilitators through training in the Art of Hosting and Harvesting Conversations that Matter, a suite of participatory practices that facilitates new ways of working through the complex challenges of our time. The AoH practice shifts the locus of direction from facilitators to participants, more effectively tapping into the innate knowledge and wisdom of the participants, while providing workshop tools to work in collaborative spaces, enabling and enhancing effective creation of system interventions.

The authors of this paper come to the Social Innovation Lab space through careers in nonprofit management, fundraising and a shared experience of a Masters programme in Strategic Leadership towards Sustainability, awarded by the Blekinge Institute of Technology. Their other combined experience is that of the Art of Hosting, being 'hosts', or facilitators of the process, and participants. As such, while planning the Economic Immigration Lab (EIL) processes and practices that come from Art of Hosting were deeply integrated into the all aspects of the workshop experience. At the time of the lab, both authors were employed by NouLAB – New Brunswick's Social and Public Innovation Lab as the Lab Manager and Knowledge Manager.

2. The Economic Immigration Lab: A response to the immigration challenge in New Brunswick

The Economic Immigration Lab began out of an identified need between the New Brunswick Multicultural Council and the New Brunswick Business Council to address a lack of immigration and retention of immigrants in the province. New Brunswick was expected to have the worst economic growth out of the ten provinces in Canada in 2018 (Jones, 2018). Exacerbating this economic trend is the fact that there will be fewer workers to fill the unfilled jobs. According to the New Brunswick government's population growth strategy, there will be 60,000 job openings to be filled between 2018-2023. This, coupled with the expected 110,200 exits from the workforce from now until 2026, has led the province to look to international immigration as a source for ready-to-hire workers (NBjobs.ca, 2017; The Public Policy Forum, 2018). In response to this, and in coordination with the Atlantic Immigration Pilot Program (AIPP), the EIL was launched in September of 2017 as a crucible for ideas on increasing immigration to the province and for sustainable results-oriented action. NouLAB functions as an authorising environment for the work of delving into the root causes of problems and securing support for working in a truly multi-sectoral fashion (Bason, 2013). Looking to Jones and van Patter (2009) the EIL is firmly situated in Design 4.0 with societal transformation as an objective. To achieve this, government policy makers are imbedded on teams with representatives from the private sector, non-profit sector, academia, government and immigrants to New Brunswick, with the purpose of achieving requisite variety for systemic change to occur (Jones, 2014). This has resulted in new and deeper policy interventions that aim at the root of the problem rather than symptomatic responses.

Figure 1. Graphic recording of lab session

3. The Art of Hosting and Harvesting Conversations that Matter

The Art of Hosting and Harvesting Conversations that Matter is a set of participatory practices that enable groups to navigate complex challenges and create spaces for people to come together in different ways (artofhosting.org, 2019). These participatory practices are predicated on the idea that we collectively have the resources and wisdom to solve the complex challenges we face, if we provide the time and space for that wisdom to emerge (Jones 2003; Sandfort, Stuber & Quick, 2012). AoH processes such as Open Space Technology and World Cafe, give space for the self-organisation and participation necessary to enable “increase[d] awareness, incentives and social motivation to accelerate learning behaviors” (Jones, 2014, p. 120). AoH assumes that our knowledge of and about the world is dependent on our position in society, and it places the practitioner within a larger community of practice, supporting collaborative innovation, including multiple sectors in the design process (Bommert, 2010; Torfing, 2019; Sandfort, Stuber & Quick, 2012). AoH fosters a community of practice whereby facilitators actively support and share with one another. This is especially important because “systemic social innovation and transformation processes do not occur due to the activities of only a single leader or ‘hero-preneur’; rather, it is through distributed agency” of stakeholders within the system (Considine, Alexander & Lewis, 2014; Moore, Olsson, Nilsson, Rose, & Westley, 2018, p. 1).

In the lexicon of Art of Hosting, ‘hosts’ play the role of designers/facilitators as they are known in more traditional lab-speak. Hosts legitimise the wisdom of the collective (Quick & Sandfort, 2014) and serve the function of creating a container for dialogue to occur (Isaacs, 1999), pushing participants to their learning edge (Holman, Devane & Cady, 2007) and hold space for emergence to be possible (Senge, 1990) before converging too quickly on solutions without hearing from all participants in the group (Kaner, 2014). The intentionality of design is paramount to the way hosts operate (Ryan, 2014). Hosts sense the needs of the group and are responsive to provide intervention when needed with the aim of empowering people to contribute with their whole selves to the issue at hand. The philosophy behind the hosting concept is very much akin to the philosophy of Christakis & Bausch (2006) that all participants are designers themselves (Jones, 2014).

The Art of Hosting connects deeply to individual values and belief systems as essential elements to work with in order to enact change. Connecting this theory to design literature, Valkenburg & Dorst (1998) also note that the individual or biographical vantage point has as much influence on design as the context or the problem being addressed. Allowing and encouraging products or policy development to align with purpose of individual value systems gives strength and longevity to projects, especially in their nascent stages when long-term commitment and funding has yet to be secured (Jones, 2014).

4. Learning from Eighteen Months in: Change happens at the level of relationships

The Economic Immigration Lab was established as a three-year project. After eighteen months, and two cycles, the following constitute some of our observations. When looking at the change within the immigration system in New Brunswick, our theory of how systems change is deceptively simple – it’s essentially this: Systems change happens at the level of relationships – with the Self and others. Those new relationships, through dialogue, action and reflection, hold emergent potential for change which could not be foreseen. Both the relationships and the byproducts of them (emergent change) ripples out into networks within the system, eventually resulting in a tipping point of systemic change (Lichtenstein, 2014). In other words, our theory of change is some combination of these two aphorisms: "The success of an intervention depends on the interior condition of the intervenor" (Bill O'Brien, quoted in Scharmer & Kauefer, 2010), and "Change happens at the speed of trust" (Covey & Merrill, 2006).

We are not alone in this conclusion. According to Drimie, Hamann, Manderson, & Mlondobozi (2018, p. 2) in *Creating transformative spaces for dialogue and action: reflecting on the experience of the Southern Africa Food Lab*, "social innovations emerge from new ideas supported by new relationships and new commitments emerging from within transformative spaces that lead to action in the system." In systemic design, the principles of self-organization and requisite variety can be fulfilled through the creation of these new relationships amongst groups selected from their diversity in power, age, department, sector and life experience (Jones, 2014). This was the case in the first cycle of the Economic Immigration Lab, where a month long process of interviewing more than 70 applicants led to the selection of 54 participants on the basis of those factors.

The polarisation of factious groups in any complex challenge means that simply applying design thinking will not have the desired impact of creating systemic change. Instead, we need tools that help us to be in conversation with one another, help us to really listen to one another, help us into a co-creative state with one another. Therefore, bringing people into new types of relationship with themselves and one another, encouraging horizontal structures that have inclusion, diversity, equity and access as central pillars, and giving intentional space for people to get in touch with their true Selves and their Work is just as important – if not more important – than the actual tools we use (Newman, Bloom & Knobe, 2014).

'Creating a container' is a term taken from the Art of Hosting, which unsurprisingly, uses the tenets of hosting to reimagine collaborative spaces. Imagine you invited someone over for a meal. You would endeavour to be welcoming, to make them feel safe and comfortable and valued. You might set the scene with beautiful objects or art or candles. You would listen attentively to your guest, you would honour their boundaries, and you would show them respect by behaving authentically and in allegiance with your values. Why then, do we abandon these principles in the workplace?

At NouLAB, creating the container means holding the lab in spaces that are beautiful and accessible. It means checking-in in circle (Baldwin & Linnea, 2010). It means spending a lot of time up front on getting to know one another, as people, apart from the work we are gathered to do. It means listening deeply. It means honouring each person with the opportunity for equal voice. It means acknowledging the expertise, the privilege and the power in the room. It means care for the community and ourselves. It means showing up as facilitators and modelling authenticity, vulnerability, comradeship and failure.

4.1. Results of creating a Container

The impacts of creating a good container can be hard to measure but 100% of lab participants agree or strongly agree that they had the opportunity to meet and work with compelling people (NouLAB, 2018). Policy creators were face to face with stakeholders of the problem they were working on -

sometimes for the first time. Government workers who were in charge of designing policy that impacted immigrants to New Brunswick were in conversation with immigrants to New Brunswick and learning from their experiences in order to design better policy - collaboratively. Immigrants to the province were hearing first-hand about the limitations of the business and political structures and realising that the challenges they had faced when immigrating to New Brunswick were systemic, rather than personal. When interviewed, 93% of lab participants agreed that their understanding of both the newcomer and employer experience had increased and 95% of participants were happy to have been able to analyze opportunities and barriers to immigrant attraction and retention within New Brunswick in order to prototype new paths forward (NouLAB, 2018).

Furthermore, lab participants are rejuvenated by being in the lab and experiencing work in a different way. One participant raved: "I have worked in government for 10 years and needed new wind in my sails, and this lab gave me that". Another participant said: "On a personal level it was a profound experience, and very gratifying". Yet another participant explained that it had helped their entire portfolio, saying, "it allowed my other work to accelerate. I feel satisfied that I have a map and a destination, but still discovering the exact terrain and vehicle" (NouLAB, 2018).

Participants cite the atmosphere created by the hosting team, the encouragement to show up in new ways, the opportunities to engage with people holding different perspectives on the issue, and the space to reflect on how personal values and beliefs impact their vantage point and therefore understanding of the system. Systems change relies on those on either side of power to come into relationship with one another and, in so doing, begin to transform their understanding of the system as a whole, their part in it, and the leverage points for action available to them (Torfing, 2019). It would appear that the most meaningful and revolutionary aspect of the lab in simply bringing folks with different lived experience, different understandings of the challenge and different capacities to interact with the system into conversation with one another. After all, "one cannot expect entire systems to radically shift if one cannot practice and embody a microversion of this in one's conversations with everyday colleagues" (Moore, Olsson, Nilsson, Rose, & Westley, 2018, p. 9).

As evidenced by its name, the Art of Hosting and Harvesting Conversations that Matter is a set of engagement tools to facilitate participatory and democratic *conversation*. It is ultimately an attempt to provide the best circumstances for dialogue to happen. "Dialogue is inherently relational," (Drimie, Hamann, Manderson, & Mlondobozi, 2018, p. 2) and it both deepens and widens over time. At its most basic level, there is knowledge exchange, but methodologies that use dialogue build empathy and connection between participants, which contributes to their desire to find solutions that work for everyone (Senge, Scharmer, Jaworski, & Flowers, 2005).

Art of Hosting practices are designed to be customisable, responsive and emergent instead of being "oriented to a method of set 'best practices'" (Sandfort, Stuber & Quick, 2012, p. 5). As facilitators, we work collaboratively, intuitively and with the expectation that the participants in our programmes will co-create them with us also. This is another principle from the Art of Hosting, where "there are no explicit leaders who command authority; rather [a focus on] creating learning experiences (Sandfort, Stuber & Quick, 2012, p. 3). We check in with participants every day, ask them how they're doing and what they need. And their answers influence our design of the next day – or the next few hours. We've thrown out plans because we have heard that that is not what participants need. Giving participants agency over their experience, invites a new structure of working, where collective intelligence, self-organization, continuous adaptation, and feedback coordination are possible because of the readiness of hosts to make changes and assess situations in real time.

4.2. A Co-created World Café – Tools for Self-organization

In the first cycle of the Economic Immigration Lab, we opened with a World Café that asked: *When we invite people to live and work in NB, what are we inviting them into?* What came out of this World Cafe question was a churning up of some of the deep-seated racism in New Brunswick. It was an opportunity to discuss what it means to be a newcomer in NB, which for some, was shocking. It became very apparent that the time allotted to these conversations wasn't enough, and so the design was altered for the next day to include an Open Space Technology session with the question: What conversations do you need to be having now?

During this session, participants took the opportunity to discuss the experience of being a newcomer through economic, cultural and gendered lenses. Observing the room, the level of attention was palpable. Everyone was leaning in. These conversations were so important for opening up a level of authenticity and vulnerability that influenced the prototypes they tackled and the way they related to one another in the days and weeks to come. Facilitators heard from participants that this session directly impacted how they felt they could show up in the lab and resulted in at least two people choosing prototype topics and teams that they felt called to on a personal level, as opposed to the ones that they might naturally have joined because of an alignment with their work.

It may seem inconsequential – but when the facilitators show up in a different way, it breaks the traditional, hierarchical power dynamic that exists – the one that gives certain people with certain voices more power than others. By sitting in circle to collectively hear and resolve the issue, we invite perspective from everyone – equally.

"The invitation to participate in a community – of co-learners and co-producers of knowledge – also reflects hosting's distinctive and democratizing philosophies about deliberation and design, namely that all people in the room have wisdom, that deliberation enables the sharing of knowledge, that facilitators and others aim to decentre the authority of their position and expertise in the room and that participants coproduce deliberative policy processes as well as decisions" (Quick & Sandfort, 2014, p. 317).

4.3. Disruptive Potential: Understanding the System and Self in New Ways

These practices don't only serve in times of conflict, but throughout the process. By addressing dynamics of identity, power and privilege, we are furthering our disruptive potential towards systems change (Quick & Sandfort, 2014). Furthermore, "at the heart of the disruptive process of social innovation lies a need for a type of institutional reflexivity; that is, the capacity to see, interrogate, and reimagine the taken-for-granted structures that sustain current systems and people–planet relationships" (Moore, Olsson, Nilsson, Rose, & Westley, 2018, p. 3).

Indeed, this is the case for one of the lab teams now prototyping a streamlined process to allow employers and potential employees to navigate the government services they need to meet the requirements for hiring and being hired in New Brunswick. Team members from Immigration, Refugees and Citizenship Canada (IRCC) - the national governing body for immigration in Canada, Post-Secondary Training, Education and Labour, J. D. Irving Ltd. (the province's largest private employer) and Practical Human Resources Services Inc. came together across the national/provincial governmental divide, the public/private sector divide, and with newcomers to the province in order to flesh out the immigration process as it is experienced by immigrants, employers wishing to hire immigrants and the governing institutions for immigration. With this deeper and broader understanding of the system as a whole, the team was able to identify leverage points - or opportunities - for new policy development. Currently, the team, in collaboration with the provincial and federal governments, is prototyping a Concierge Service that will help immigrants and employers navigate the immigration system, as well as track their experiences in order that those learnings be used to inform further policy changes down the line.

The learning from this prototype is scalable throughout New Brunswick, as employers and employees currently have no resource, or are forced to rely on private concierge services to aid their recruitment efforts, which is not an option for many small and medium enterprises in the province. And, with IRCC involved in this prototype the learning could have impact at a national scale.

5. Conclusion

In conclusion, the Economic Immigration Lab turned out to be more than just a space to prototype solutions to the immigration challenges New Brunswick faces. By using Art of Hosting practices, the team at NouLAB managed to: create a container which enabled participants to show up in their work and relationships to one another in new and deeper ways; harness Systemic Design elements, enabling self-organization, feedback coordination, continuous adaptation, requisite variety, appreciating complexity; establish a precedent for co-creation which gave participants agency over their experience and thus over the subsequent work and prototypes that were developed in the lab; encouraged a transformation of identity, relationships, and dynamics of power and privilege, thereby allowing for a reflexivity in the system not otherwise possible.

These features are consistent with Transformative Learning Theory, and “the importance of transforming perspectives by undertaking a critical assessment of epistemic, sociocultural, or psychological assumptions; examining one’s self, including feelings, roles, and competencies; exploring and provisionally trying new roles, relationships, and actions; acquiring new knowledge and skills; and building competence and confidence in new roles and relationships” (Moore, Olsson, Nilsson, Rose, & Westley, 2018, p. 5).

While not explicit in the field of Social Innovation Labs, we contend that the transformative experiences of coming together in conversation in new ways, reorganising traditional hierarchies into distributed horizontal leadership approaches, and co-creating the structure as well as content of the lab in order to increase the self-reflexivity of the system accounts for the performance and success of the lab thus far. The methodologies and principles within the suite of the Art of Hosting and Harvesting Conversations that Matter gave structure and guidance to be able to offer these transformative elements to lab participants.

References

Aguirre, M., Agudelo, N., & Romm, J. (2017). Design Facilitation as Emerging Practice: Analyzing How Designers Support Multi-stakeholder Co-creation. *She Ji: The Journal of Design, Economics, and Innovation*, *3*(3), 198–209. https://doi.org/10.1016/j.sheji.2017.11.003

artofhosting.org. (2019). What is the Art of Hosting? « Art of Hosting. Retrieved February 11, 2019, from http://www.artofhosting.org/what-is-aoh/

Baldwin, C., & Linnea, A. (2010). *The Circle Way: A Leader in Every Chair*. San Francisco, CA: Berrett-Koehler Publishers.

Bason, C. (2014). Public Design in Global Perspective. *Design for Policy*, 23–40.

Binder, T., & Brandt, E. (2008). The Design:Lab as platform in participatory design research. *CoDesign*, *4*(2), 115–129. https://doi.org/10.1080/15710880802117113

Bommert, B. (2010). Collaborative Innovation in the Public Sector. *International Public Management Review*, *11*(1), 15-33–33.

Christakis, A. N., & Bausch, K. C. (2006). *How people harness their collective wisdom and power to construct the future in co-laboratories of democracy*. Greenwich: Information Age.

Considine, M., Alexander, D., & Lewis, J. M. (2014). Policy design as craft: teasing out policy design expertise using a semi-experimental approach. *Policy Sciences*, *47*(3), 209–225. https://doi.org/10.1007/s11077-013-9191-0

Covey, S. M. R., & Merrill, R. R. (2006). *The speed of trust: The one thing that changes everything.* New York, NY: Free Press.

Drimie, S., Hamann, R., Manderson, A., & Mlondobozi, N. (2018). Creating transformative spaces for dialogue and action: reflecting on the experience of the Southern Africa Food Lab. *Ecology and Society*, *23*(3). https://doi.org/10.5751/ES-10177-230302

Gryszkiewicz, L., Lykourentzou, I., & Toivonen, T. (2016). *Innovation Labs: Leveraging Openness for Radical Innovation?* (SSRN Scholarly Paper No. ID 2556692). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2556692

Hassan, Z. (2014). *The social labs revolution: A new approach to solving our most complex challenges.* Berrett-Koehler Publishers.

Holman, P., Devane, T., & Cady, S. (2007). *The Change Handbook: The Definitive Resource on Today's Best Methods for Engaging Whole Systems*.

Isaacs, W. (1999). *Dialogue: The Art of Thinking Together*. New York, NY: Random House.

Jones, B. D. (2003). Bounded Rationality and Political Science: Lessons from Public Administration and Public Policy. *Journal of Public Administration Research and Theory: J-PART*, *13*(4), 395–412.

Jones, P. H., & Van Patter, G. (2009). Design 1.0, 2.0, 3.0, 4.0: The rise of visual sensemaking.

Jones, P. H. (2014). Systemic Design Principles for Complex Social Systems. In G. S. Metcalf (Ed.), *Social Systems and Design* (pp. 91–128). Tokyo: Springer Japan. https://doi.org/10.1007/978-4-431-54478-4_4

Jones, R. (2018, February 12). N.B. economic growth expected to be worst of 10 provinces in 2018 | CBC News. Retrieved April 30, 2018, from http://www.cbc.ca/news/canada/new-brunswick/economic-growth-worst-among-provinces-2018-1.4530882

Kaner, S. (2014). *Facilitator's Guide to Participatory Decision-Making, 3rd Edition [Book]*. San Francisco, CA: Jossy-Bass.

Kurtz, C. F., & Snowden, D. J. (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM Systems Journal; Armonk*, *42*(3), 462.

Lichtenstein, B. B. (2014). *Generative Emergence: A New Discipline of Organizational, Entrepreneurial, and Social Innovation*. Oxford University Press. Retrieved from http://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780199933594.001.0001/acprof-9780199933594

McGann, M., Blomkamp, E., & Lewis, J. M. (2018). The rise of public sector innovation labs: experiments in design thinking for policy. *Policy Sciences*, 1–19. https://doi.org/10.1007/s11077-018-9315-7

Moore, M.-L., Olsson, P., Nilsson, W., Rose, L., & Westley, F. (2018). Navigating emergence and system reflexivity as key transformative capacities: experiences from a Global Fellowship program. *Ecology and Society*, *23*(2). https://doi.org/10.5751/ES-10166-230238

NBjobs.ca. (2017). *New Brunswick Labour Market Outlook 2017-2026*. Retrieved from https://www.nbjobs.ca/sites/default/files/pdf/nblmo-final_e.pdf

Newman, G. E., Bloom, P., & Knobe, J. (2014). Value Judgments and the True Self. *Personality and Social Psychology Bulletin*, *40*(2), 203–216. https://doi.org/10.1177/0146167213508791

NouLAB. (2018). *Economic Immigration Lab: Impact Report and Year in Review*. Retrieved from https://docs.wixstatic.com/ugd/e07719_5433596252a54b178056b8a34dc51231.pdf

Otto Scharmer, C., & Kaeufer, K. (2010). In front of the blank canvas: sensing emerging futures. *Journal of Business Strategy*, *31*(4), 21–29. https://doi.org/10.1108/02756661011055159

Quick, K., & Sandfort, J. (2014). Learning to facilitate deliberation: practicing the art of hosting. *Critical Policy Studies*, *8*(3), 300–322. https://doi.org/10.1080/19460171.2014.912959

Quick, K., Sandfort, J., & Stuber, N. (2012). *Practicing the Art of Hosting: Exploring what Art of Hosting and Harvesting workshop participants understand and do*. https://doi.org/10.13140/2.1.2676.8161

Ryan, A. J. (2014). A Framework for Systemic Design. *FORMakademisk*, *7*(4), 1–14.

Senge, P. M. (1990). *The fifth discipline : the art and practice of the learning organization*. New York : Doubleday/Currency, [1990] ©1990. Retrieved from https://search.library.wisc.edu/catalog/999627139702121

Senge, P. M., Scharmer, C. O., Jaworski, J., & Flowers, B. S. (2005). *Presence: An Exploration of Profound Change in People, Organizations, and Society*. Crown Publishing Group.

The Public Policy Forum. (2018). *The People Imperative: Come From Away and Stay: Strategies to Grow Population and Prosperity in Atlantic Canada*.

Tõnurist, P, Kattel, R., & Lember, V. (2017). Innovation labs in the public sector: What they are and what they do? *Public Management Review*. Retrieved from https://doi.org/10.1080/14719037.2017.1287939

Tõnurist, P., Kattel, R., & Lember, V. (2015). *Discovering Innovation Labs in the Public Sector* (The Other Canon Foundation and Tallinn University of Technology Working Papers in Technology Governance and Economic Dynamics No. 61). TUT Ragnar Nurkse Department of Innovation and Governance. Retrieved from https://ideas.repec.org/p/tth/wpaper/61.html

Torfing, J. (2019). Collaborative innovation in the public sector: the argument. *Public Management Review*, *21*(1), 1–11. https://doi.org/10.1080/14719037.2018.1430248

Valkenburg, R. (1998). The reflective practice of design teams. *Design Studies*, *19*(3), 249–271. https://doi.org/10.1016/s0142-694x(98)00011-8

van Alstyne, G., & Logan, R. K. (2007). Designing for emergence and innovation: Redesigning design. *Soft Artifacts*, *1*(2), 120–129.

Voorberg, W. H., Bekkers, V. J. J. M., & Tummers, L. G. (2015). A Systematic Review of Co-Creation and Co-Production: Embarking on the social innovation journey. *Public Management Review*, *17*(9), 1333–1357. https://doi.org/10.1080/14719037.2014.930505

Westley, F., Laban, S., Rose, C., McGowan, K., Robinson, K., Tjornbo, O., & Tovey, M. (2015). *Social Innovation Lab Guide* (pp. 1–100). Rockefeller Foundation.

Alternative Narratives on Economic Growth: Prototyping Change at the System Level

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Abstract: Increasing inequality, rising social unrest and climate change suggest new approaches to economic growth are needed. Motivated to understand what a human-centered approach might bring to the challenge, this paper explores taking the value of design thinking and a prototyping mindset beyond service delivery to the level of policy research, design and development. Causal Layered Analysis is used to understand and comparatively analyze the current growth-first narrative, an emergent participation narrative and a speculative freedom narrative. This analysis informs a reframe of economy and a participatory experience for stakeholders in the larger economic system to explore how change might happen. Responses to the role play experience show the power of a participatory approach and provide insight into engaging diverse stakeholders as contributors in the future of economy, not just as the passive receivers of policy. Proposals for change are presented based on candidate strategies generated in the role play.

Keywords: growth, economy, narrative, causal layered analysis, role play, reframing, system-level change

1. Introduction

A number of interrelated ideologies prevail within the current growth-oriented economic context. Among them is the notion that growth will 'float all boats'. As economist Joseph Stiglitz (2016) describes, the rising tide hypothesis evolved over time to favour the rich and assumed that improved welfare of citizens and society as a whole would be the outcome of resources received at the top (p. 134). But with growing inequality, as Stiglitz (2016) and other prominent sources on the economy have pointed out, the promise and benefits of economic growth have not trickled down to the greater society (Lin & Tomaskovic-Devey, 2013; Milanovic, 2016a, 2016b; Milanovic & Roemer, 2016; OECD, 2017; Piketty, 2014; Saez, 2018; WEF, 2015, 2017a).

Another prevailing belief is that productivity is everything. Or as economist Paul Krugman describes in *The Age of Diminishing Expectations*, "Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker" (as cited in OECD, 2008, p. 11). Productivity output continues to be a primary indicator of economic growth, but with automated technologies and the rise of fragmented service-based work (Davis, 2016; Lowe and Graves, 2017), the role of the worker and how human labour continues to factor into production is in question.

A closely related third ideology is that innovation is seen as a kind of 'holy grail' of growth. Although innovation is defined in broad terms by the OECD (2005) to cover novelty in products (goods or services), processes, marketing and organizational methods (p. 46), advances in digital and emerging technologies such as artificial intelligence, robotics, 3D printing, blockchain and virtual and augmented realities (World Economic Forum, 2017b, p. 63-64), have come to dominate the discourse around innovation. However, as economist Robert Gordon (2016) argues, although the more recent digital technologies have led to wide-spread access to information and services, they are benefiting far fewer people than the "only once" general purpose innovations of the second industrial revolution during and following what he calls the "special century", from 1870-1970 (p. 1).

These ideologies and the dominant growth focus are what Ivana Milojević and Sohail Inayatullah (2015) might refer to as a "used future", which is one with entrenched thinking and systems based on old assumptions that are out of date with significant changes in the economic, ecological, technological, demographic and cultural environment (2015, p. 155). Growing inequality, rising social unrest and climate change suggest alternative ways of thinking about the economy are needed.

Motivated to understand what a human-centered approach might bring to the challenge, this paper explores taking the value of design thinking and a prototyping mindset beyond service delivery to the level of policy research, design and development and asks: How might reframing growth enable change to a more desirable alternative?

Reframing, as described by American cognitive linguist, George Lakoff (2004), is believed to be necessary for constructing change by enabling people to see a situation through a different conceptual or emotional perspective, and do so through conscious and repeated usage (p. xii-xiii). In

Metaphors We Live By, Lakoff and coauthor Mark Johnson (1980) state that "much of cultural change arises from the introduction of metaphorical concepts and the loss of old ones" (p. 145). These ideas for reframing informed the use of Sohail Inayatullah's (1998) Causal Layered Analysis (CLA), with its inherent inquiry into alternative metaphors and the development of alternative narratives, in combination with role play with diverse stakeholders. A key outcome of the study is that together CLA and role play offer a unique combinatorial means of reframing and iterating toward transformative system-level change.

The scope of interest of the study is Canada, but the topic of economic growth is explored in relation to, and informed by, the larger socioeconomic context of advanced Western economies.

This paper provides an overview of three narratives on economic growth: A growth-first narrative, an inclusive growth narrative and a wellbeing-first narrative. A comparative synopsis is presented as a snapshot of the attributes, values, goals, causes, processes and outcomes across the narratives. Insights from CLA on the emerging mainstream alternative are presented followed by a description of the process and outcomes of using a speculative alternative for exploring change through role play.

2. Methodology

This study was structured in two phases: Understanding the Narratives and Exploring Change.

2.1. Understanding the Narratives

Interviews were conducted with six subject matter experts in the areas of economics and economic policy. The purpose was to understand how people working in these areas think about growth and the economy. CLA was used to analyze the interviews for themes, underlying metaphors and orthodoxies, and alternative ways of framing the economy.

CLA was chosen because it provides a framework for deconstructing perspectives on the current focus with increasing levels of depth (Inayatullah, 1998, 2004, p. 8) and for iteratively reconstructing hopeful alternatives. Figure 1 shows this iterative flow. According to Inayatullah (2004), CLA "is also likely to be useful in developing more effective—deeper, inclusive, longer term—policy" (p. 8). This potential for guiding policy makes CLA a useful methodology for exploring alternative narratives to economic growth and offers a way to comparatively understand them.

Figure 1. Iterative flow of CLA

2.2. Exploring Change

In the second phase, an alternative metaphor and narrative were used to reframe growth and engage two groups of stakeholders in a simulated role play experience addressing how a more inclusive economy might be achieved. The adoption of role play was inspired by the work of George Lakoff and Mark Johnson (1999) on embodied realism. As a form of embodied realism, the hands-on experiential nature of role playing has greater transformational potential for reframing than a using a purely intellectual approach (Chen & Martin, 2015, p. 92; Daniau, 2016, p. 424).

The role play was structured around Roman Krznaric's "Rough guide to how change happens" (2007, p. 30-32). Twelve non-expert participants were engaged in a generative activity exploring:

1. What is the change we wish to explain?
2. Who might be involved in the change?
3. What strategies might be used to bring about the change?
4. What contexts might affect how the change happens?
5. What might be the process or pathway to the change?
6. What are the main elements from above that might lead to change?

Of the ideas generated, five candidate strategies were developed as proposals to encourage policy makers and policy influencers to adopt and evolve a richer set of research and development tools.

Figure 2 shows the overall approach with Phase I: Understanding the Narratives on the left, and Phase II: Exploring Change on the right.

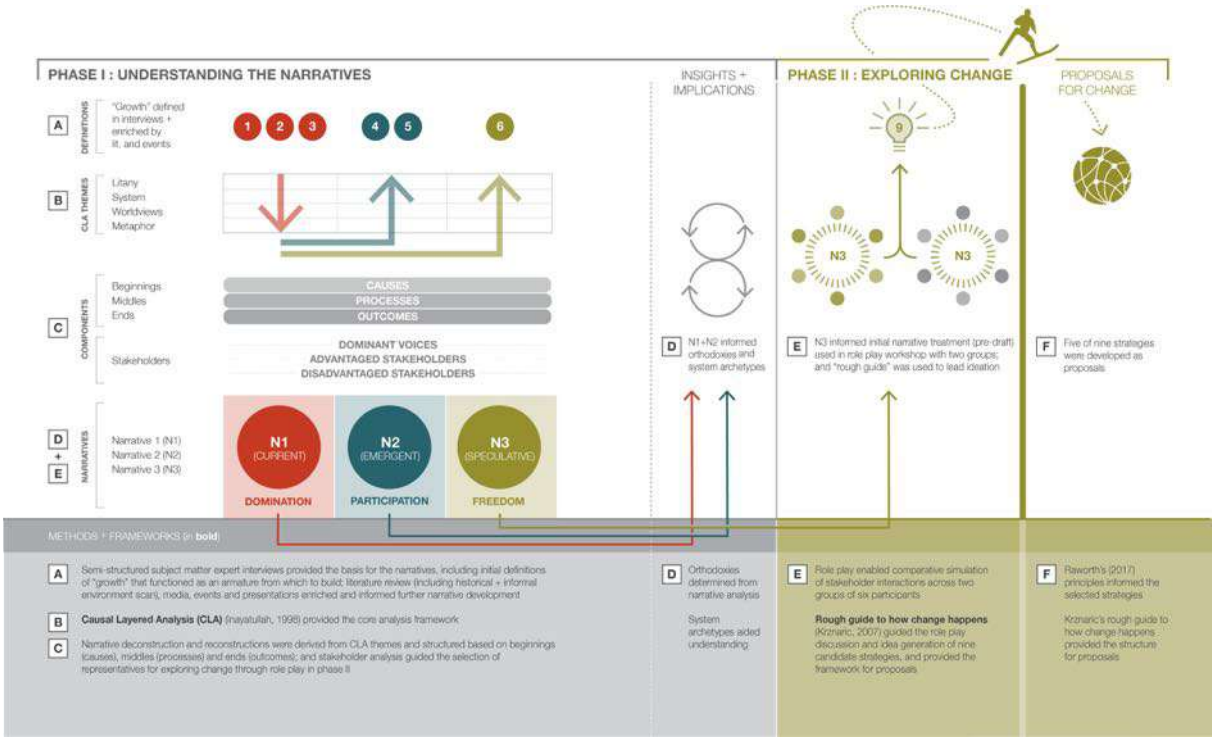


Figure 2. Project Structure & Methodology Overview

3. Understanding the Narratives

The three narratives that emerged through the interviews were the current growth-first narrative, which came to be called 'domination' based on its dominance-based logic and the self-interest that exemplifies market fundamentalism; an emergent narrative, named 'participation' for its orientation toward increased social and economic participation within international and national agendas for inclusive growth; and a speculative narrative, which was given the name of 'freedom' because it embodies notions of independence, self-determination, autonomy and democracy.

As the starting point for the interviews, the first question experts were asked was how they might define growth in a tweet or news headline. These definitions fall along a spectrum and served as an armature on which the three narratives were based.

3.1. Causal Layered Analysis

Key points distilled from the interviews are aggregated within the CLA framework. To contextualize the interviews, participant definitions are accompanied by additional context for each narrative.

Narrative #1: Growth-First (Current) – "Domination"

Definition: (1) Growth is defined by GDP, which is the money value of all products and services in an economy. And, (2) growth is an economy that is growing in its outputs and eventually leads to benefits for society overall (based on interviews).

Context: The fixation on growth and counting the economy in terms of its production was set during the Great Depression with the introduction of Gross National Product (Kuznets, 1934)—later Gross Domestic Product (GDP). Not intended to reflect the long-term welfare of a nation (Abramovitz in 1959, p. 21; Kuznets, 1962, p. 29), GDP has come to be the primary indicator of a country's wealth and is used comparatively for economic ranking in the larger global market. Inherently competitive in nature, the market economy has been entrenched since the early 1980s with the embrace of neoliberal ideology by Margaret Thatcher in the UK and Ronald Reagan in the US (Palley, 2005).

This market orientation values short-term over long-term, wealth over people, self-interest and a dominance-based logic over equality (Klein, 2017, p. 233).

Metaphor: In this narrative, the economy is a *frontier of infinite colonies*—conveying the quest for scale and domination over markets, lands, peoples and, eventually, planets.

Goal: The goal of economic growth, as economist Kate Raworth (2017) describes, is to grow the economy by increasing output of goods and services, regardless of whether or not people thrive (p. 227).

Figure 3 shows the aggregated inputs for the current growth-first narrative. Similar aggregates were developed for the other two narratives but are not shown.

↓	INTERVIEW 1	INTERVIEW 2	INTERVIEW 3	INTERVIEW 4	INTERVIEW 5	INTERVIEW 6	↓
LITANY (continuous)	**Access to social and environmental measures not readily available.** Quantitative sources for government reports primarily from Statistics Canada. Qualitative sources include feedback from consumers, newspaper articles, discussions with regulators and with other countries	**Media reflects government messaging on the economy and fixation with GDP as a measure for how the country is doing**	**GDP is used as a political tool for manipulating public sentiment**. GDP summarizes both good and bad of society but that is not in public conversations. Negative activities show growth but are not good for wellbeing	**People feel a disconnect with growth messaging from government and media, and their own with lack of wage growth and diminishing job prospects.** Traditional economic measurements permeate government reports, which are then conveyed by media	**GDP doesn't reflect what is happening in society and the environment, but it will not change as an indicator.** People are comfortable with it and how it is calculated. But growth for growth's sake is scary. Increases in crime and waste production might correlate with higher GDP but give a false picture of an economy's health	**There is a growing awareness in many countries that growth is not equal to wellbeing.** Economic growth is no longer enough. Countries seek guidance on trends such as issues with inequality, minorities, gender, and environmental degradation	LITANY (continuous)
SYSTEM (years)	**Environmental issues, failed states, population immigration, and people living longer are all converging.** Disruptive technologies are displacing people and threatening incumbents	**GDP indicators bounced back after the financial crash, wellbeing indicators did not.** Living standards and time for leisure and self are diminishing	**National sentiment votes (e.g., Brexit, Trump) show that people are frustrated with the economic situation**	**The Canadian government is struggling for ways to stimulate growth.** We can no longer rely on natural resources. Globalization has given multinationals the upper hand with their ability to move operations and capital, negatively impacting communities. Productivity and innovation are in focus	**Increases in poverty and violent crime suggest economic growth is leaving people behind.** People are feeling downgraded from employed to unemployed. If a society will be judged by how it treats its weakest members, we have to re-evaluate the model. Level of education is a key	**Getting an innovation engine going is key.** Providing the right type of environment for innovation to take place depends on what a country's needs are (developing countries vs. advanced economies)	SYSTEM (years)
WORLDVIEW (decades)	**Technology services, communications and the sharing economy provide opportunities for more people to contribute to growth**	**"It's the economy, stupid". The belief is that the economy matters first and foremost**, and that GDP is a good guide for how a country is doing overall. It will "float all boats"	**It is believed that you either have unemployment or you have economic growth. This is the productivity trap.** Machines contribute to growth by increasing productivity. Because growth and productivity are tied, automation is viewed as a threat to jobs	**There is a belief that there is no societal progress without growth.** Innovation, in particular technological innovation, is seen as the panacea for growth. With that comes the threat to jobs	**Technology is going to take a lot of jobs and displace a lot of people**, particularly aging workers. The future does not hold much hope for young people	**Innovation plays a significant role in contributing to both economic growth and wellbeing**	WORLDVIEW (decades)
METAPHOR & MYTH (societal/civilizational)	The economy is a frontier of **INFINITE COLONIES**, ever growing and expanding to other territories and, eventually, other planets	The economy is a **MACHINE** to be tuned and maintained. Politicians are seen as 'the fixers'	The economy is a **MACHINE, including nature**, to be managed like services	The economy is (traditionally) **ORGANIC**, with a dependency on natural resources Growth traditionally comes from the ground up, based on the natural resources a country is endowed with	The economy is a **DEPENDENT PATIENT** to be diagnosed and treated by the doctor (government) who knows best	The economy is a **PIE** to be made bigger, then shared	METAPHOR & MYTH (societal/civilizational)

Figure 3. Aggregated CLA for current growth-first narrative. Read from top down for a deconstruction of existing context. Read from left to right for a comparative view across the six subject matter experts.

Narrative #2: Inclusive Growth (Emergent) – "Participation"

Definition: (1) Growth is an economy that serves citizens better with more accessible, sustainable, and higher quality goods and services. And, (2) Growth is improvements in a range of social and economic dimensions that contribute ultimately to wellbeing. (Informed by participants.)

Context: Originating from the World Bank (Ianchovina & Lundstrom, 2009), and promoted among OECD countries, this mainstream alternative narrative embodies notions of government-enabled access and participation and, in the Canadian context in particular, a growing and strong middle class (Government of Canada, 2017). Considered by its advocates as the only sustainable path to poverty reduction, inclusive growth is encompassing of all sectors and promises broad-based participation opportunities for people to both contribute to and benefit from economic progress.

Metaphor: In this narrative, the economy is a *pie* to be shared and made bigger together.

Goal: In inclusive growth, according to the World Economic Forum (2015), the goal is an economy that expands social participation in the process and benefits of economic growth (p. 1).

Narrative #3: Wellbeing-First (Speculative) – "Freedom"

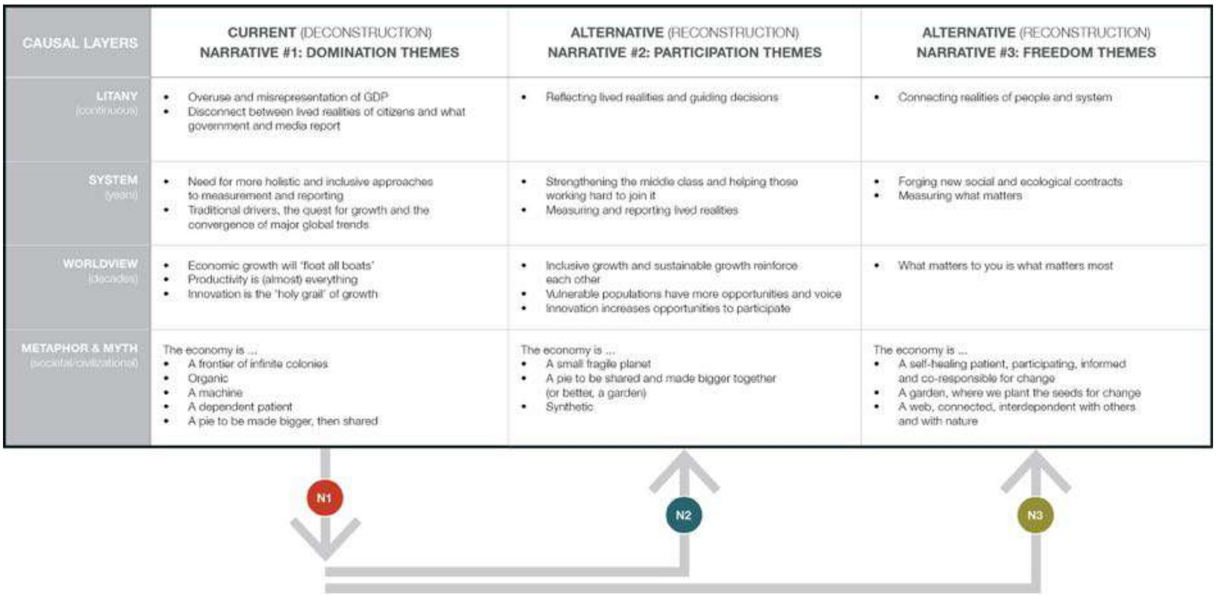
Definition: Growth is evidence that we are striving and achieving the highest possible quality of life and wellbeing for all. (Informed by participants.)

Context: Developed as a composition of signals, this speculative narrative embodies notions of independence, self-determination, autonomy and democracy. It puts choice at the center of economy, giving people the freedom to choose for themselves what the narrative will be or to participate with others in crafting it through both physical and virtual community-level approaches to value exchange.

Metaphor: In this narrative, the economy is a *web*—connected, and interdependent with others and with nature.

Goal: In the wellbeing-first narrative, the goal is an economy in which people are able to thrive, and while growth might be an outcome it is not the goal (Raworth, 2017, p. 227).

Distilled to core themes, interviews are summarized in a comparative view in Figure 4.



CAUSAL LAYERS	**CURRENT** (DECONSTRUCTION) NARRATIVE #1: DOMINATION THEMES	**ALTERNATIVE** (RECONSTRUCTION) NARRATIVE #2: PARTICIPATION THEMES	**ALTERNATIVE** (RECONSTRUCTION) NARRATIVE #3: FREEDOM THEMES
LITANY (continuous)	• Overuse and misrepresentation of GDP • Disconnect between lived realities of citizens and what government and media report	• Reflecting lived realities and guiding decisions	• Connecting realities of people and system
SYSTEM (years)	• Need for more holistic and inclusive approaches to measurement and reporting • Traditional drivers, the quest for growth and the convergence of major global trends	• Strengthening the middle class and helping those working hard to join it • Measuring and reporting lived realities	• Forging new social and ecological contracts • Measuring what matters
WORLDVIEW (decades)	• Economic growth will 'float all boats' • Productivity is (almost) everything • Innovation is the 'holy grail' of growth	• Inclusive growth and sustainable growth reinforce each other • Vulnerable populations have more opportunities and voice • Innovation increases opportunities to participate	• What matters to you is what matters most
METAPHOR & MYTH (societal/civilizational)	The economy is ... • A frontier of infinite colonies • Organic • A machine • A dependent patient • A pie to be made bigger, then shared	The economy is ... • A small fragile planet • A pie to be shared and made bigger together (or better, a garden) • Synthetic	The economy is ... • A self-healing patient, participating, informed and co-responsible for change • A garden, where we plant the seeds for change • A web, connected, interdependent with others and with nature

Figure 4. Comparative view of CLA of interview themes

4. Insights & Implications

In addition to understanding interview themes comparatively, developing a comparative picture of attributes, values, goals, causes, processes and outcomes proved useful for seeing differences between the current and alternative narratives, as well as which of the alternatives to explore as a more hopeful and inclusive representation of the future (see Figure 5).

When these details are considered in close proximity, what is ostensibly a continuum between three narratives—with inclusive growth being the bridge between growth and wellbeing—is more a dualistic choice between growth and wellbeing. The comparative exercise reveals that although inclusive growth feels good and appears to be something different than the current growth orientation, the participation focus is more an economic imperative than a moral one.

System archetypes provide some prospective insight into why inclusive growth may be at risk of achieving its goals for greater inclusion and why it might remain largely aspirational.

NARRATIVE CONTINUUM	N1 **DOMINATION** GROWTH FIRST The economy is a frontier of INFINITE COLONIES, ever growing and expanding to other territories and, eventually, other planets	N2 **PARTICIPATION** INCLUSIVE GROWTH The economy is a PIE, to be shared through participation and made bigger together	N3 **FREEDOM** WELLBEING FIRST The economy is a WEB, connected and interdependent with others and with nature
ATTRIBUTES	Market-led, power at the top, trickle-down guided, competition-oriented	Government-facilitated, centralized, market-informed, participation-oriented	Relationship-driven, decentralized, participatory, community-oriented
VALUES	Wealth over people, short term gain over long term frame and eschews equality in favour of self interest and dominance-based logic	Participation over redistribution and a strong and growing middle class	Community, a shared narrative, purpose and collective wellbeing
GOAL	**An economy that needs to grow, regardless of whether or not people thrive**	**An economy that expands social participation in the process + benefits of economic growth**	**An economy that allows people to thrive, regardless of whether or not it grows**
CAUSES (beginnings)	Market fundamentalism (and financialization)	Low productivity, aging pop., tech disruption, global connectivity, low commodity prices	Diminishing trust in government, business and media; unemployment; tech change, with increased automation
PROCESSES (middles)	Globalization, technological change, capital shifts and financialization	Innovation, training and education, immigration, infrastructure	Increased activism, public and employee ownership and redistribution models, focus on SRI investing, open gov.
OUTCOMES (ends)	Income + wealth disparity, polarization of society, cyber dependency, national sentiment, aging pop. and climate change	Growing economy with stronger middle class. Key metric of success is an additional $15,000 in median household income by 2030	Collective wellbeing, balanced stories through media, embrace of bottom-up approaches to economy

Figure 5. Comparative view of narrative attributes, values, goals, causes, processes, outcomes and voices

4.1. Eroding Goals Archetype

In the Eroding Goals archetype, goals are changed to something more attainable when there are delays in seeing desired outcomes (Braun, 2002, p. 6).

How this archetype applies (see Figure 6 for a visual representation):

Goal: In the participation narrative, the goal is an economy that expands social participation in the process and benefits of economic growth. It is believed that increasing participation will lead to growth and wellbeing for all. These notions have commonality with worldviews of the growth-first narrative, notably that productivity is (almost) everything and economic growth will ‘float all boats’.

Gap: The need to increase workforce participation is due to a gap in productivity performance over several years—in Canada the time period this applies to is ~2011-2016.

Corrective actions: Long-term corrective actions to increase participation include government, businesses and other organizations investing in training and funding opportunities for disadvantaged groups, or exploring alternative models such as reduced workweeks for individuals to increase participation through work-share programs.

Actual rate: Given the delay in seeing the effect of these corrective actions, the actual rate of participation declines through processes like increased numbers of retiring individuals due to an aging population, and time needed to train and integrate new immigrants in the workforce.

Sustained gap: The gap in productivity performance remains open if not widening in the short run.

Pressure to lower goal (short term): When the gap in productivity performance fails to close quickly, pressures to find short-term measures increases. Short-term measures might include firms increasing investment in automating technologies instead of people and decreasing the number of employees to reduce costs or increase profit.

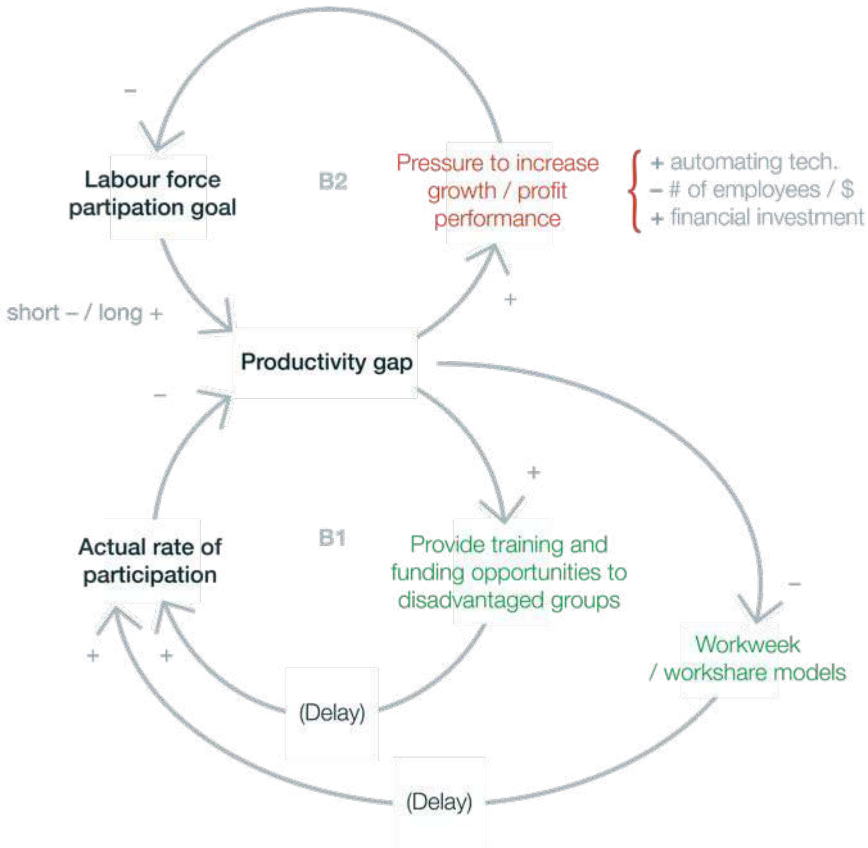


Figure 6. Eroding Goals system archetype example (start with the goal in the upper left)

Countering effects: Government and businesses need to overcompensate to the inclusive side of inclusive growth or growth-first will continue to dominate, along with the widening inequality gap. Although short-term measures might be necessary, ideally they are balanced with long-term corrective actions and the original goal for increasing participation.

4.2. Success to the Successful Archetype

In the Success to the Successful archetype, those who perform well are rewarded with more resources. This is based on demonstrated merit but does not recognize the initial conditions that enabled strong performance by some while hindering performance of others (Braun, 2002, p. 10).

How this archetype applies (see Figure 7 for a visual representation):

At the worldview level, inclusive growth is about social not just economic inclusion, vulnerable populations having more opportunities and voice, and innovation contributing to greater wellbeing by enabling increased participation. Realization of this potential is largely dependent on government to establish the policies and programs that allow for broader participation.

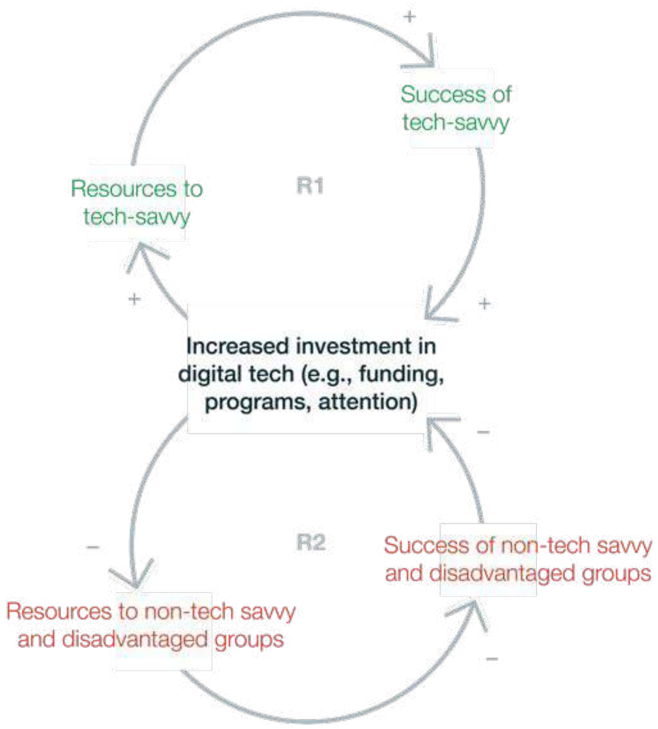


Figure 7. Success to the successful archetype example (start with the goal in the centre)

Examples of Success to the Successful include advantaging:

- Digital technologies and people working in it, reinforcing the digital divide between those who have access to information and communication technologies and those who do not
- Science, technology, engineering and math (STEM) education
- People with means to pay for ongoing education and retraining
- Those included in data collection and reporting, reinforcing data poverty through the omission of populations from data collection and reports used to inform policy

Countering effects: Increased awareness of who is advantaged; promoting and celebrating education beyond STEM to areas that foster creative pursuits and critical thinking (STEAMD – A=Arts and D=Design); and more holistic and inclusive data collection, measurement and reporting.

5. Exploring Change

As context for the role play participants, the economy was reframed as a *web*—connected, interpersonal and interdependent with others and with nature—and presented with an initial treatment of the speculative freedom narrative.

5.1. Stakeholder Representatives

Based on the stakeholders that emerged from interviews and other sources analyzed, six profiles were developed. These included a mix of dominant voices and disadvantaged groups within the Canadian context that were identified in the growth-first and inclusive growth narratives.

Not all stakeholders identified during the first phase were included because of the limited number of available participants, limited time, and the limited depth of research into all representatives suitable for participating. Given these limitations, the role play was considered a prototype that could inform similar future activities using the learning from the initial workshop.

Twelve participants signed up for the workshop and were split into two groups of six. This opened the possibility for more ideas to be generated, as well as comparative data that could be used to iterate on in future role plays.

Figure 8 shows the participants in their stakeholder roles within each of the two groups.

Figure 8. Role play participants in shown as the stakeholders they represented in two parallel groups of six

A profile was developed for each of the six stakeholders that included an overview, name, role, affiliation, interests, challenges and potential relationships (alliances and tensions). See Figure 9.

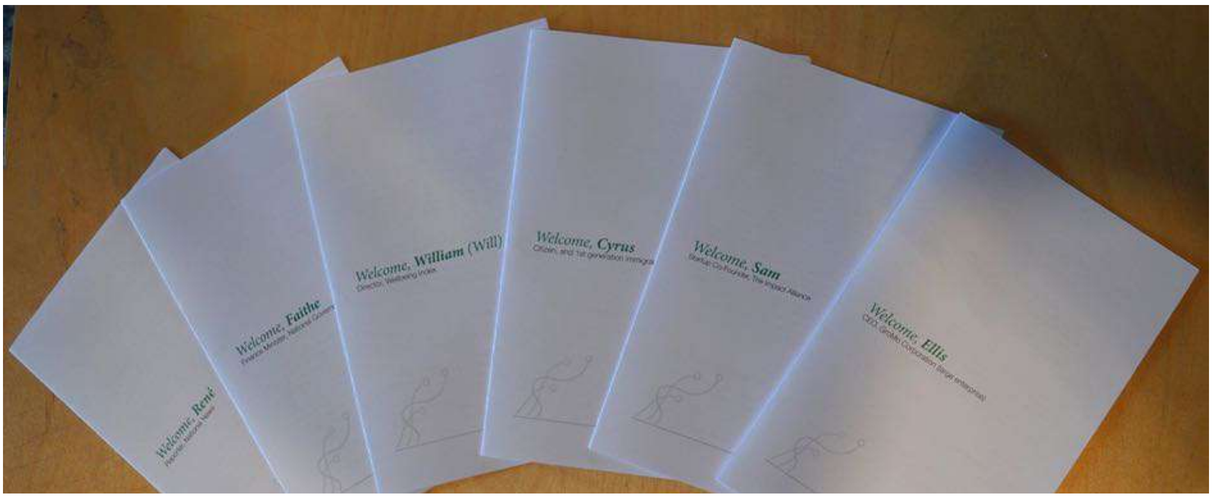


Figure 9. Stakeholder profile cards

5.2. Anticipated Stakeholder Relationships

The potential relationship dynamics presented in each of the profile cards were based on research done in the first phase of the project, but were also hypothetical. The purpose of this information was to provide a starting point for participants to engage, and to use observation to inform future iterations on the role play.

Radial convergence maps, shown in Figure 10, were created to understand anticipated alliances and tensions that might form within the role play, as well as who might be absent from the conversation.

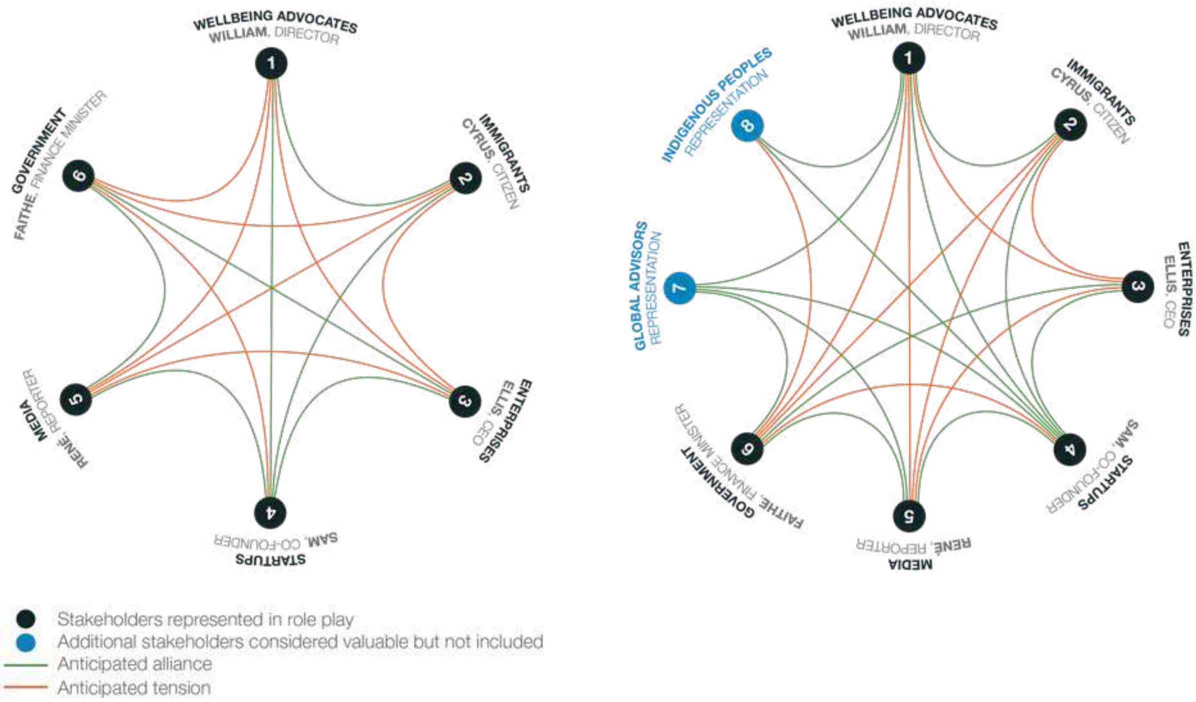


Figure 10. Anticipated relationships *before* the role-play of stakeholders represented (left), and stakeholders identified but not represented in the role play (right)

5.3. Observations & Outcomes

The following results are a summary of inputs and outputs from the activity within five themes:

1. Role play for its transformational potential
2. Role play for empowering non-experts
3. Role play for discovering potential relationships
4. Role play as a generative source for strategies for change
5. Role play as a rehearsal method

These themes provide rationale for the benefit of using role play to explore change at the system level as well as learning for future engagements.

Role play for its transformational potential

The most notable aspect of using role play as a form of embodied realism was the emotional connection of participants to the stakeholders they represented. The degree to which individuals were able to relate to their roles informed how much they were able to productively channel their contributions in the group. On the other side, the more distant participants felt from the values they perceived their stakeholders to have affected how well they were able to represent that voice. At the group level, each experienced different paces to their immersion affecting how quickly and deeply they were able to respond to the guiding questions.

A few enablers were identified through observation and post-workshop reflections that could inform future workshops of this kind:

1. While it is a known challenge in role play for participants to suppress their own viewpoints and interests and represent those of others (Popper, 2008, p. 59), the unexpected emotional response by one of the participants to the stakeholder he was representing allowed for his group to immerse in their roles and the activity more quickly than the other group. This gave rise to the idea of having a ‘plant’ in each group who takes a performative role and uses storytelling to express their interests and bring others in.
2. Another recommendation was to send the narrative and profile cards in advance to allow participants time to immerse in the ideas and roles.

Role play for empowering non-experts

Recognized for its use with, and potential empowerment of, representatives who might be outside typical decision makers, role play can be used as a simulated interaction to elicit novice judgment and as a generative medium for guiding decisions (Armstrong, 2001, p. 26-27; Green, 2002, p. 334; 2005, p. 467). In the context of this study, it was intended to elicit new perspectives on the larger socioeconomic challenges without the constraints of having experts in the room.

A number of the participants expressed a feeling of powerlessness in the role play. The need for change felt real but bigger than what they thought they could affect. In spite of individual discomfort and uncertainty, both groups were able to generate a number of ideas toward enabling change.

Role play for discovering potential relationships

Observation during the role play provided insight into potential participants to involve in a future role play and potential partnerships that could be fostered within the larger system.

Potential future stakeholder participants: Group reflection after the role play indicated that the *youth* voice is not well represented and should be equal among others.

Potential and non-obvious partnerships: Alliances reinforced through the activity, and common to both groups, led to a set of partnerships to explore, notably between:

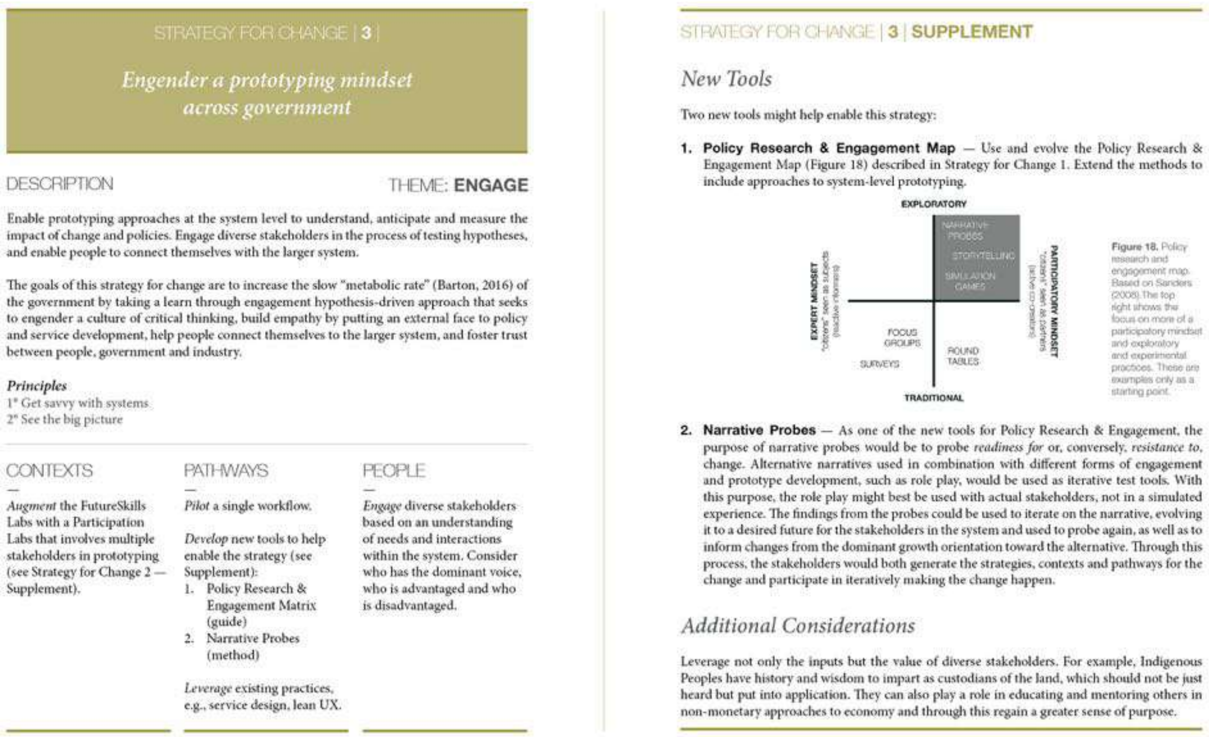
- *Media* and *Wellbeing Advocates*: as a way to address more balanced representation of measurement and reporting.
- *Enterprise* and *Social Impact Startups*: as a way increase investment in social infrastructure and value-creating activities.
- *Social Impact Startups* and *New Canadians*: as a way to support both economic and non-economic immigrants and encourage socially minded new businesses.

Role play as a generative source for strategies for change

Of the ideas generated in the role play, five were distilled into candidate strategies for policy makers and influencers to consider:

1. Build a holistic and inclusive data source
2. Promote a shared narrative that connects people to system
3. Engender a prototyping mindset across government
4. Integrate behavioural approaches into planning and programs
5. Foster positive alternatives to the threat of automation

Each strategy is accompanied by key elements enabling change in Krznaric's rough guide and tagged with guiding principles proposed by Raworth (2017). It is beyond the scope of this paper to provide detail on all proposals. Figure 11 conveys the structure and content of the candidate strategies.



STRATEGY FOR CHANGE | **3** |

Engender a prototyping mindset across government

DESCRIPTION — THEME: **ENGAGE**

Enable prototyping approaches at the system level to understand, anticipate and measure the impact of change and policies. Engage diverse stakeholders in the process of testing hypotheses, and enable people to connect themselves with the larger system.

The goals of this strategy for change are to increase the slow "metabolic rate" (Barton, 2016) of the government by taking a learn through engagement hypothesis-driven approach that seeks to engender a culture of critical thinking, build empathy by putting an external face to policy and service development, help people connect themselves to the larger system, and foster trust between people, government and industry.

Principles
1* Get savvy with systems
2* See the big picture

CONTEXTS
—
Augment the FutureSkills Labs with a Participation Labs that involves multiple stakeholders in prototyping (see Strategy for Change 2 — Supplement).

PATHWAYS
—
Pilot a single workflow.

Develop new tools to help enable the strategy (see Supplement):
1. Policy Research & Engagement Matrix (guide)
2. Narrative Probes (method)

Leverage existing practices, e.g., service design, lean UX.

PEOPLE
—
Engage diverse stakeholders based on an understanding of needs and interactions within the system. Consider who has the dominant voice, who is advantaged and who is disadvantaged.

STRATEGY FOR CHANGE | 3 | **SUPPLEMENT**

New Tools

Two new tools might help enable this strategy:

1. **Policy Research & Engagement Map** — Use and evolve the Policy Research & Engagement Map (Figure 18) described in Strategy for Change 1. Extend the methods to include approaches to system-level prototyping.

Figure 18. Policy research and engagement map. Based on Sanders (2008). The top right shows the focus on more of a participatory mindset and exploratory and experimental practices. These are examples only as a starting point.

2. **Narrative Probes** — As one of the new tools for Policy Research & Engagement, the purpose of narrative probes would be to probe *readiness for* or, conversely, *resistance to*, change. Alternative narratives used in combination with different forms of engagement and prototype development, such as role play, would be used as iterative test tools. With this purpose, the role play might best be used with actual stakeholders, not in a simulated experience. The findings from the probes could be used to iterate on the narrative, evolving it to a desired future for the stakeholders in the system and used to probe again, as well as to inform changes from the dominant growth orientation toward the alternative. Through this process, the stakeholders would both generate the strategies, contexts and pathways for the change and participate in iteratively making the change happen.

Additional Considerations

Leverage not only the inputs but the value of diverse stakeholders. For example, Indigenous Peoples have history and wisdom to impart as custodians of the land, which should not be just heard but put into application. They can also play a role in educating and mentoring others in non-monetary approaches to economy and through this regain a greater sense of purpose.

Figure 11 Example candidate strategy for change distilled from the role play

Role play as a rehearsal method

As a participatory research method, role play provided a safe and low-stakes way to explore how interactions between stakeholders might play out in the actual system, identify potential partnerships and generate candidate strategies toward change.

The notion of rehearsal also applies to exploration of narratives. More specifically, although an initial speculative narrative was useful as an input to the role play, outputs from the activity can be used to evolve future iterations of the narrative.

Building on the use of role as a way to iterate on the narrative, the more powerful outcome, which arose through group reflection following the workshop, is that alternative narratives have the potential to be used as ongoing probes for readiness for, or resistance to, change. This suggests that narrative probes be developed in a simulated context, as in this study, and tested when possible with actual stakeholders. In this way, narratives can be used as both representatives of the change desired as well as probes for change and, through simulated enactment of an alternative, stakeholders in the system might them selves begin to enact the change in the world.

6. Conclusion

Motivated to understand why the current economic system appears to be failing us and what a human-centered approach might bring to the challenge, this study investigated both current and alternative narratives on economic growth and how reframing might enable change to a more desirable alternative.

This paper described the two phases of primary research—Understanding the Narratives and Exploring Change—and the outcomes of each phase. Through comparative analysis of subject matter expert interviews and the current, emergent and speculative narratives, the first phase revealed that the mainstream alternative ‘participation’ narrative on inclusive growth shares the same underlying growth focus as the current ‘domination’ narrative. Although the goal of inclusive growth to increase social and economic participation is positive, participation is motivated more by an economic imperative than a moral one. Because the wellbeing-oriented ‘freedom’ narrative provides a more significant departure from growth-first, it was selected as the hopeful alternative around which to explore change in the second phase.

Role play with Krznaric’s rough guide proved powerful for use with non-experts as a generative method for exploring change and probing potential relationships for future engagements. For those able to ‘get into character’, role play provided greater transformational potential for reframing than a purely intellectual approach. Participants reinforced it as a tool for building empathy and suggested it be used with actual stakeholders where they would play the role of others.

A key outcome of the study is that CLA and role play in combination offer a unique approach to reframing, probing readiness for change and enabling stakeholders to iterate on both the reconstructed hopeful narratives and the realization of change in the world.

If the growth orientation continues to dominate, there might be significant work with government, business and the public to co-create strategies that guide transition and foster adaptation to more hopeful alternatives for all. The participatory approaches discussed in this paper provide input to this future learning.

References

Abramovitz, M. (1959). The Welfare Interpretation of Secular Trends In National Income and Product. In *The Allocation of Economic Resources* (pp. 1–22). Stanford University Press.

Armstrong, J. S. (2001). Role Playing: A Method to Forecast Decisions. In *Principles of Forecasting: A Handbook for Researchers and Practitioners* (pp. 15–30), J. S. Armstrong (Ed.). Norwell, MA: Kluwer Academic Publishers. https://doi.org/10.1007/978-0-306-47630-3_2

Braun, W. (2002). The system archetypes. *System*, *2002*, 27. Retrieved from http://www.albany.edu/faculty/gpr/PAD724/724WebArticles/sys_archetypes.pdf

Canada 2020. (2017). The Open Government Data Explosion. Ottawa: *Canada 2020*. Retrieved from https://www.youtube.com/watch?v=IZGobhDoBCg

Chen, J., & Martin, A. (2015). Role-play simulations as a transformative methodology in environmental education. *Journal of Transformative Education*, 13(1), 85–102. https://doi.org/10.1177/1541344614560196

Daniau, S. (2016). The Transformative Potential of Role-Playing Games: From Play Skills to Human Skills. *Simulation & Gaming*, 47(4), 423–444. https://doi.org/10.1177/1046878116650765

Gordon, R. J. (2016). *The Rise and Fall of American Growth: The US Standard of Living Since the Civil War.* Princeton, NJ: Princeton University Press.

Government of Canada. (2017). *Budget 2017: Building a Strong Middle Class*. Ottawa. Retrieved from http://www.budget.gc.ca/2017/home-accueil-en.html

Green, K. C. (2002). Forecasting decisions in conflict situations: A comparison of game theory, role-playing, and unaided judgment. *International Journal of Forecasting*, 18(3), 321–344. https://doi.org/10.1016/S0169-2070(02)00025-0

Green, K. C. (2005). Game theory, simulated interaction, and unaided judgment for forecasting decisions in conflicts: Further evidence. *International Journal of Forecasting,* 21(3), 463–472. https://doi.org/10.1016/j.ijforecast.2005.02.006

Ianchovina, E., & Lundstrom, S. (2009). Inclusive Growth Analytics: Framework and Application (World Bank Policy Research Working Paper No. 4851). Retrieved from https://ssrn.com/abstract=1410472

Inayatullah, S. (1998). Causal layered analysis: poststructuralism as method. *Futures*, 30(8), 815–829. https://doi.org/10.1016/S0016-3287(98)00086-X

Inayatullah, S. (2004). *The Causal Layered Analysis (CLA) Reader: Theory and Case Studies of an Integrative and Transformative Methodology.* (S. Inayatullah, Ed.). 8-49. Retrieved from http://www.metafuture.org/library1/causal_layered_analysis_intro_chapter_reader_2004.pdf

Klein, N. (2017). *No is Not Enough: Resisting the New Shock Politics and Winning the World We Need.* Alfred A. Knopf Canada.

Krugman, P. (1997). *The Age of Diminishing Expectations: U. S. Economic policy in the 1990s* (3rd ed.). Cambridge, MA: MIT Press.

Krznaric, R. (2007). How Change Happens: Interdisciplinary Perspectives for Human Development. *Oxfam Research Report*, 31(2–4), 1–59. https://doi.org/10.1080/02703140802146233

Kuznets, S. (1934). National Income, 1929-32, 73rd US Congress, 2nd Session, Senate Document No. 124. Retrieved from https://fraser.stlouisfed.org/scribd/?title_id=971&filepath=/files/docs/publications/natincome_1934/19340104_nationalinc.pdf

Kuznets, S. (1962). How To Judge Quality. In Croly H. (ed.). *The New Republic*, 147(16), 29–31.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought.* Basic Books.

Lakoff, G. (2004, 2014). *Don't Think of an Elephant: Know Your Values and Frame the Debate.* White River Junction, Vermont: Chelsea Green Publishing.

Lin, K.-H., & Tomaskovic-Devey, D. (2013). Financialization and U.S. Income Inequality, 1970-2008. *American Journal of Sociology*, 118(5), 1284–1329. https://doi.org/10.1177/0002716206296734

Lowe, G., & Graves, F. (2017). *Redesigning Work: A Blueprint for Canada's Future Well-Being and Prosperity.* Toronto: University of Toronto Press.

Milanovic, B. (2016a). The greatest reshuffle of individual incomes since the Industrial Revolution. Retrieved from http://voxeu.org/article/greatest-reshuffle-individual-incomes-industrial-revolution

Milanovic, B. (2016b). *Global Inequality: A New Approach for the Age of Globalization.* Cambridge, Massachusetts: Harvard University Press.

Milanovic, B., & Roemer, J. E. (2016). Interaction of Global and National Income Inequalities. *Journal of Globalization and Development*, 7(1), 109–115. https://doi.org/https://doi.org/10.1515/jgd-2016-0023

Milojević, I., & Inayatullah, S. (2015). Narrative foresight. *Futures*, 73, 151–162. https://doi.org/10.1016/j.futures.2015.08.007

OECD. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data* (3rd ed.). Paris: OECD Publishing. https://doi.org/10.1787/9789264013100-en

OECD. (2008). OECD Compendium of Productivity Indicators 2008. *Directorate for Science, Technology and Innovation*. Retrieved from http://www.oecd.org/std/productivity-stats/40605524.pdf

OECD. (2017). Global Interim Economic Outlook, March 2017: Financial vulnerabilities and policy risks. Retrieved from http://www.oecd.org/eco/outlook/Will-risks-derail-the-modest-recovery-OECD-Interim-Economic-Outlook-March-2017.pdf

Palley, T. (2005). From Keynesianism to Neoliberalism: Shifting Paradigms in Economics. In Saad-Filho A. & Johnston D. (Eds.), *Neoliberalism: A Critical Reader* (pp. 20-29). LONDON; ANN ARBOR, MI: Pluto Press. doi:10.2307/j.ctt18fs4hp.6

Piketty, T., & Saez, E. (2006). The Evolution of Top Incomes: A Historical and International Perspective. *American Economic Review,* 96(2), 200–205. Retrieved from http://www.aeaweb.org/articles.php?doi=10.1257/000282806777212116

Piketty, T. (2014). *Capital in the Twenty-First Century.* Cambridge, Massachusetts: The Belknap Press of Harvard University Press.

Popper, R. (2008). Foresight Methodology. In L. Georghiou, J. Cassingena Harper, M. Keenan, I. Miles, & R. Popper (Eds.), *The Handbook of Technology Foresight: Concepts and Practice* (pp. 44–88). Edward Elgin Publishing Limited.

Raworth, K. (2017a). *Doughnut Economics: Seven Ways to Think Like a 21st Century Economist.* White River Junction, Vermont: Chelsea Green Publishing.

Saez, E. (2018). Striking It Richer: The Evolution of Top Incomes in the United States. In D. B. Grusky & J. Hill (Eds.), *Inequality in the 21st Century: A Reader* (1st ed.). New York, NY: Routledge. https://doi.org/10.4324/9780429499821

Stiglitz, J. E. (2016). 8. Inequality and Economic Growth. *The Political Quarterly*, 86(S1), 134–155. https://doi.org/10.1111/1467-923X.12237

World Economic Forum. (2015). *The Inclusive Growth and Development Report 2015*. Geneva, Switzerland. Retrieved from http://www3.weforum.org/docs/Media/WEF_Inclusive_Growth.pdf

World Economic Forum. (2017a). *The Inclusive Growth and Development Report 2017*. Geneva, Switzerland. Retrieved from https://www.weforum.org/reports/the-inclusive-growth-and-development-report-2017

World Economic Forum. (2017b). The Global Risks Report 2017. 12th Edition. Geneva, Switzerland. Retrieved from http://wef.ch/risks2017

Design logics for relations: A methodology of mapping-and-designing (in) the city as open complex system

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Abstract

The city, beyond its physicality, is an open dynamic complex system, composed of relations among heterogeneous things. Questioning analysis and design in the city through this point of view, the paper presents an under-construction methodology of a generative mapping which negotiates logics of designing. The methodology develops through three levels of actions: 1. data gathering, 2. investigation of relations among data; 3. tests the methodology through case-studies. The paper examines the methodology through the combination of two tests, the public space of Athens center and in a park (Pedion Areos). Through this exploration, the paper concentrates on how such a relational-thinking methodology affects design logics by the following capacities: generative analysis; simultaneous decompositions and re-compositions of (new) relations in the city; defining and proposing relational fields for strategic interventions; augmenting the physical dimension; a briefing and decision making oriented design. Broadly, this methodology permits an intentional triggering, emergence and abstracting of complexity/ies.

Keywords: methodology of urban design, methodology of relational design, generative analysis, relational territorialities, relationally generated complexity

1. Introduction

The city is an open complex system, composed by dynamic relations among heterogeneous things: things defined by diverse (both material and immaterial) parameters (i.e. subjects, meanings, socio-economic conditions, information). These relations are generative, when they become interactions and intra-actions[1]: this way, new relations emerge. Therefore, the city as an open system with a interdependent dynamic 'environment' is under constant change.

The paper approaches city's complexity attached to its relationality process. It presents a phase of the author's ongoing PhD[2] research, which focuses on the construction of a methodology of describing and designing things from a relational-thinking point of view. The methodology is developed through the dialogue of a theoretical and a practice-oriented part: its logic evolves through testing applications. The paper looks at the research by examining how two testing case-studies in the city give feedback to the methodology and to its aims towards potential applications into design processes.

The paper's outline: after this introductory part, central points of the framework are added. Next, the methodology's scheme is described, while its capacities through the testing case-studies begin to unfold. The paper closes by discussing how these capacities can be translated from the specific level of the case-studies into more generalised perspectives towards logic(s) of relational urban design.

2. Framework

2.1. Conceptual – Theoretical framework

Central idea is the condition of relationality: relations are prerequisites of complexity. This argument is founded on Batty's (2013) focus on the dynamics and especially on the behaviour of the interactions' parameters of a system. These interactions, as supported by Cilliers (1998) too, evolve non-linearly, simultaneously and in different scales. They are observable depending on the relations among the system, the environment and the observer's intentional actions. Thrift (1999) highlights the spatial-and-temporal substance of complex systems as well as the combination of qualities-and-quantities.

Space and place constitute conditions perceived accordingly as emergent situations in time, through intra-actions' processes: intra-actions include subjects-and-objects, which are mutually composed following broadly theories that deny object-subject dichotomy (i.e. Barad 2007, Thrift 1999). Place conceived as a specified, by attributed meanings, field in time. The meanings are given through semiosis actions. Semiosis is comprehended in terms of the triadic relational model of C. S. Peirce (1931): a sign/ semiosis is composed by the relations of three terms. The first is a representation

[1] 'Intra-action' (Barad 2007) refers to cases of interaction where its elements emerge and are mutually composed through their interaction: "the neo-logism intra-action signifies the mutual constitution of entangled agencies" (Barad 2007: 33).

[2] The PhD entitled "The Relationally Composed Object: Description and Design" is supported by a scholarship from the General Secretariat for Research and Technology (GSRT) and the Hellenic Foundation for Research and Innovation (HFRI).

(representamen) of a second term (referent/ object) to which this is referred in a way that becomes capable to define a third term, the interpretant. This process of generating third term(s) is potentially infinite; a point enforcing the openness of the semantic level of a system and at the same time integrating memory and organic transformability.

2.2 Research

The research is fed by the question of how analysis and design in the city can integrate the conditions of relationality - complexity and constant changing. The research hypothesis responds to this question by setting mapping as a key starting point. Mapping, as an action of broader analysis, is a process, that can be both analytical and generative (Corner 1999). Mapping refers to the whole process of signifying actions producing any kind of recorded description of a thing. It is intentional and made by a specific subject within a specific context.

Great attention is given to the parameter of the subject. The subject-object mutual emergence through intra-actions integrates the relation between an open complex system and its environment, referring to its boundaries. Cilliers (2001) notes that boundaries don't "limit possibilities", they are "enabling constraints". Setting boundaries is analogous to framing: a system is framed during its description in a specific way and for a particular reason by its subject. Furthermore, the diversity of subjects amplifies the semantic spectrum of the system, triggering more potentialities of interactions. This inter-subjectivity triggers an inter-objectivity, which through intra-actions becomes a complex of intra-object/subjectivity, involving agency.

The object of research concentrates on the construction of a methodology for describing and designing in complex relational fields, such as the city. The methodology is expected to be developed into a digital tool (i.e. software - digital application) in the future. Current aim of the methodology's capacities is to create a 'tool' - way of a generative analysis linked to design actions; a tool capable of analysing an object (i.e. city) in regard to its parameters of relationality. This kind of analysis enables to decompose and recompose an object and, thus, multiple new re-organisations of it. The generative aspect is not promoted towards a direction of an increasing complexity. It aims at revealing it, at understanding, exploring it and at the same time to managing it through abstractions, always depending on its intentionally shaped context.

2.3 Relations with the scientific community

Theories and research practices closely related to the methodology developed are Space Syntax as well as the theory and the work of Michael Batty, both linked to the broader thought of Christopher Alexander. Space Syntax is a methodology for analysing space through its relations with social life, but it does this in the material field, without integrating the sphere of the different meanings (Hillier and Hanson 1984). The current methodology prioritizes the semantic-generated interactions and their relations with territoriality. This difference cultivates an opportunity of complementarity: in next research phases synergies between the two approaches could be investigated, in order to strengthen the actions of evaluating design decisions for material interventions. The same applies with Batty's (2007, 2013) models, but differently. Adapting the semantic data to his models and comparing them with the current enhances the evaluation of the design decisions through comparisons. Regarding digital maps and platforms (i.e. Google Maps, G.I.S) they offer spatial information: on the one side, there is the spatial information and on the other, there are desires, intentions and agencies, manifested through different actions, such as discourse. The role of the methodology lies in-between these fields: it relates them, enabling the expression of their negotiations and interactions. Its value is the translation of these expressions into design proposals.

3. Description of the methodology

3.1 Methodology's logic scheme & Visualisation into an Interactive Open Map

The methodology is composed of three levels of actions.

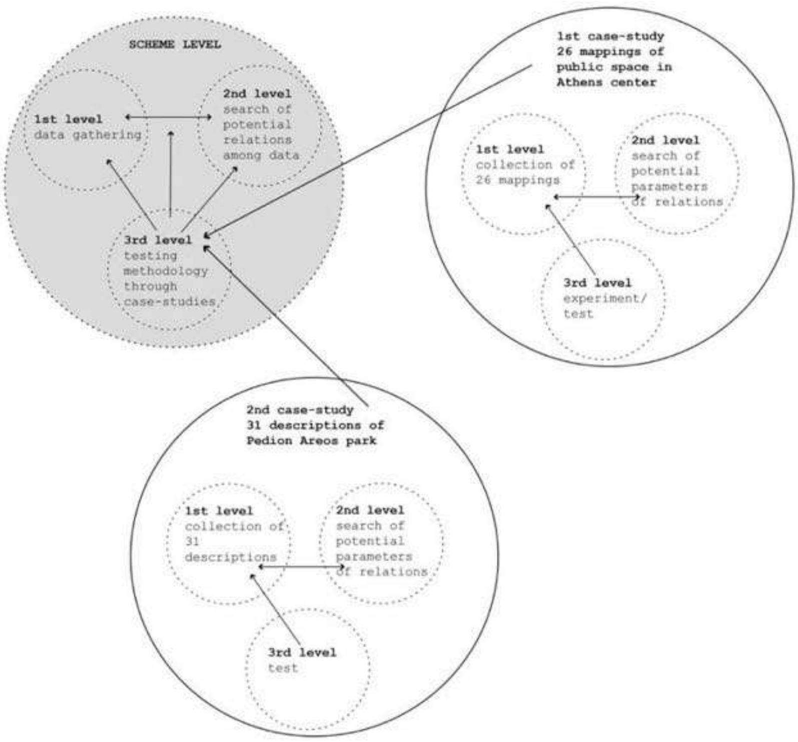


Figure 1. Methodology's scheme, integrating the testing case-studies' contribution.

In the first, data are gathered: mappings or descriptions of the city, made by different subjects, following a sampling logic under the criterion of achieving heterogeneity. The second level concerns the data organisation, in order to define communication parameters among them. Communication refers to relations, potential interactions and intra-actions. This way, the system becomes open to new connections; hence, to the emergence of new meanings or broadly new information. These expand, densify and "complexify" its semantic networks, affecting other sub-systems. In the third level, the methodology is tested through different case-studies: the current paper assesses the methodology through a combinatory consideration of the selected two tests. Inspired by the spirit of the research by design and the attitude of system-thinking, this level is crucial. It enables back-and-forth transitions between generalisations and specifications. It makes the logic adaptable to different processes and contexts. It keeps the scheme open to feedback loops.

The organisation of the data and their relations can be visualised through an "Interactive Open Map" (IOM)[3], composed of the system of a data-base, a table and a map (figure 2).

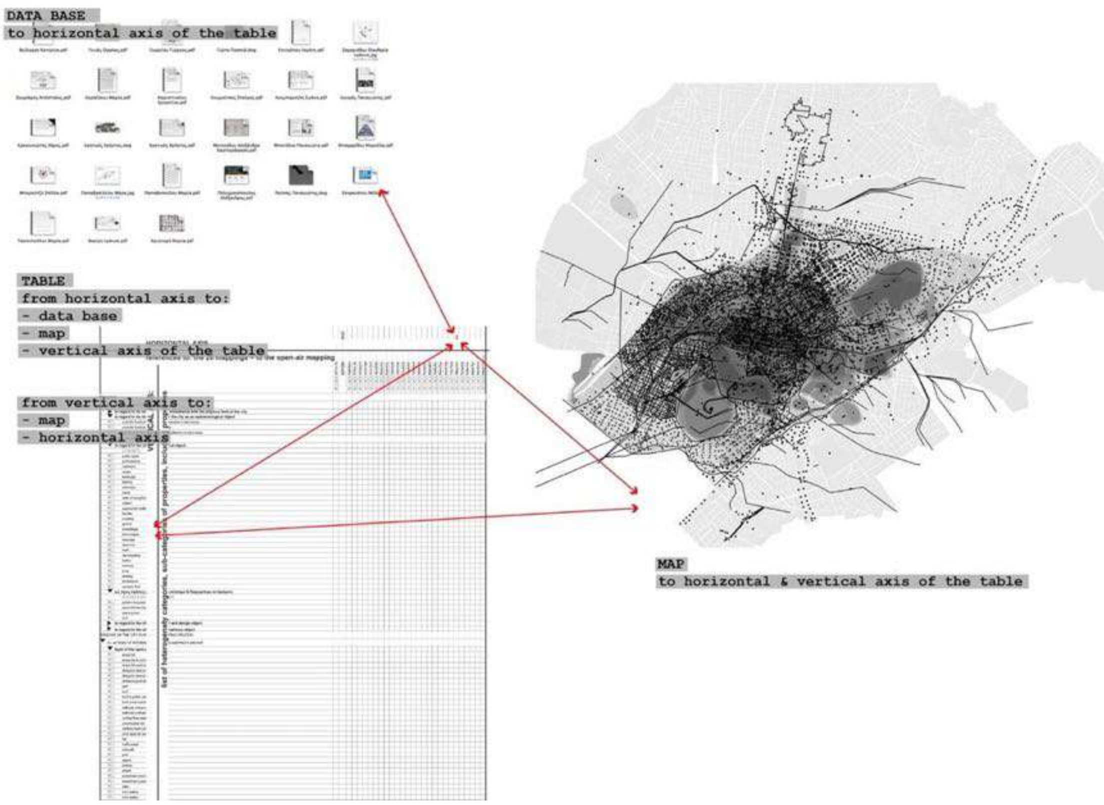


Figure 2. Selection options in IOM.

The data-base contains the mappings - descriptions in their original form. The horizontal axis of the table integrates references to the gathered data and the vertical axis the properties list as organised in categories. The organization and the classification of properties, depends on the logic of city's parametrization set by its context. What is significant is the existence of such a list/ table: the parameters and their potential relations define the networks that can be created and revealed beyond the physical connections. On the map, the references to physical locations are codified and

[3] In the current phase of the research this is developed in a level of describing how it might operate. No software is used. The codification, the noting of the data, the formation of the maps and the tables is done manually.

noted: each dot corresponds to a reference to a specific location, each line to paths and the irregular schemes to abstract references to areas. In IOM, the data-base, the table and the map are interconnected through options of selections (red lines in figure 2).

The map-table relations are central, being inspired by the logic of the diagram and this of the abstract machine, as introduced by Deleuze and Guattari (1988). The diagram sets a base for a logic capable of organising and triggering the emergence of “new realities”. As Stan Allen (1999) puts it, a diagram is a “description of potential relationships among elements, not only an abstract model of the way things behave in the world, but a map of possible worlds”. The selections made between the map and the table are capable of creating maps of possible worlds, multiplying and densifying the city.

3.2 The methodology through the case-studies

The first case-study is an experiment of 26 mappings of public space in Athens center, carried out in the context of a postgraduate course in 2015: each subject was asked to map public space in regard to its research interests. Mappings’ subjects have converging backgrounds in terms of scientific discipline, but due to this the heterogeneity of the mappings’ properties appears wider, in regard their methodologies.

Although the parameters’ list is something decided according each process intentions, in order to proceed to the test, a scenario was built: every mapping is a semiosis process that is framed by its subject and whatever frames it, but which also frames the city. Two general interdependent properties’ categories resulted from this (figure 3).

Figure 3. Properties classification for the first case-study.

In figure 4, some of the mappings of the first case are shown in their original form. In figure 5, each map presents the references of each mapping to the city in a codified form. In the map of figure 6, the 26 mappings appear overlapped.

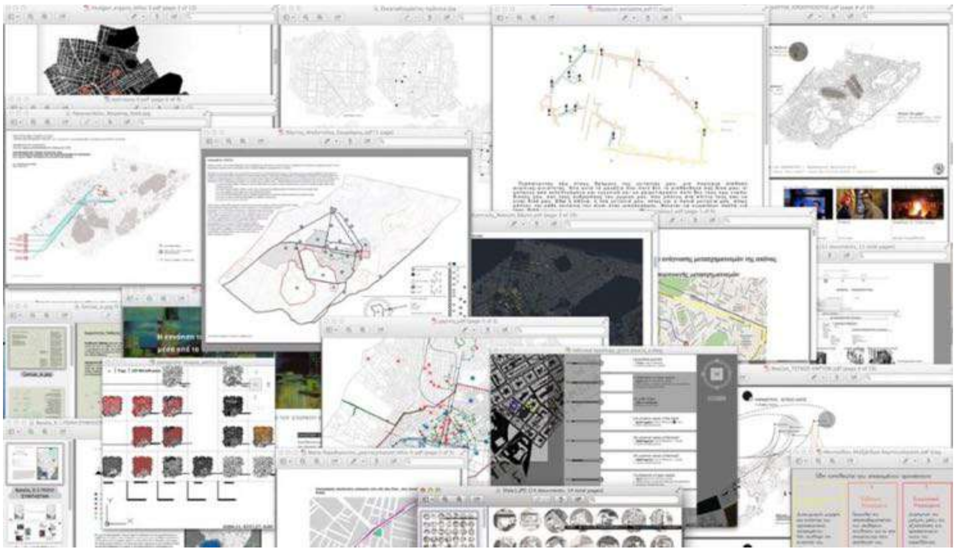


Figure 4. Sample of the 26 mappings in their original form.

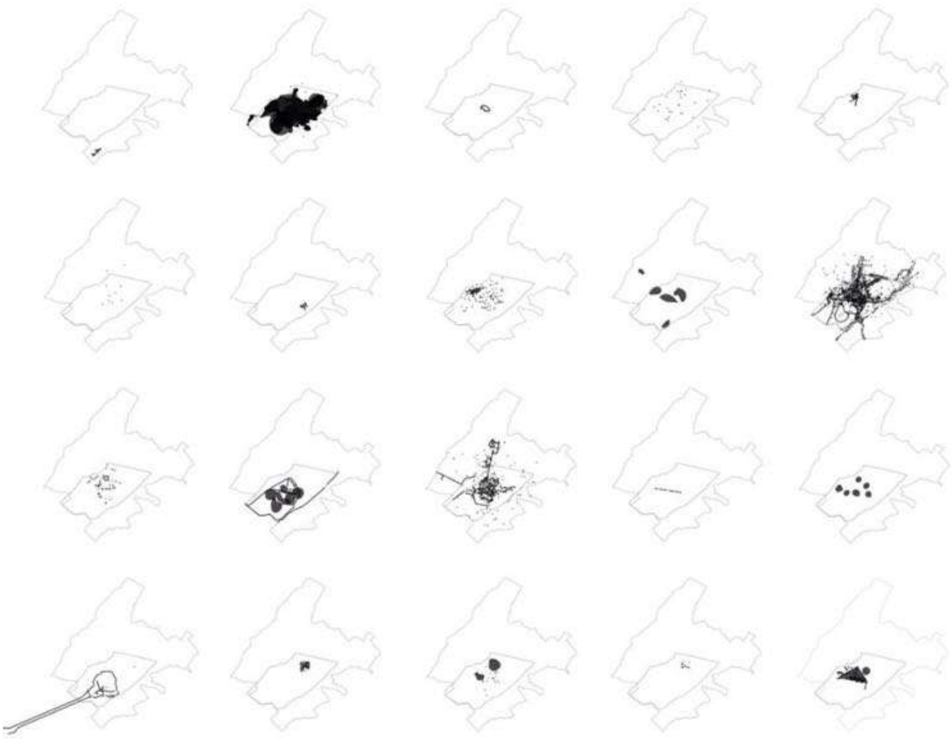


Figure 5. The codified 26 mappings. Outer shape is Attica and inner the area of the initial base-map.

Figure 6. The 26 mappings overlapping.

The second case-study, is more recent and ongoing test. The descriptions gathered cover (in a sampling logic) a wider timespan and subjects' diversity, which corresponds to different stakeholders.

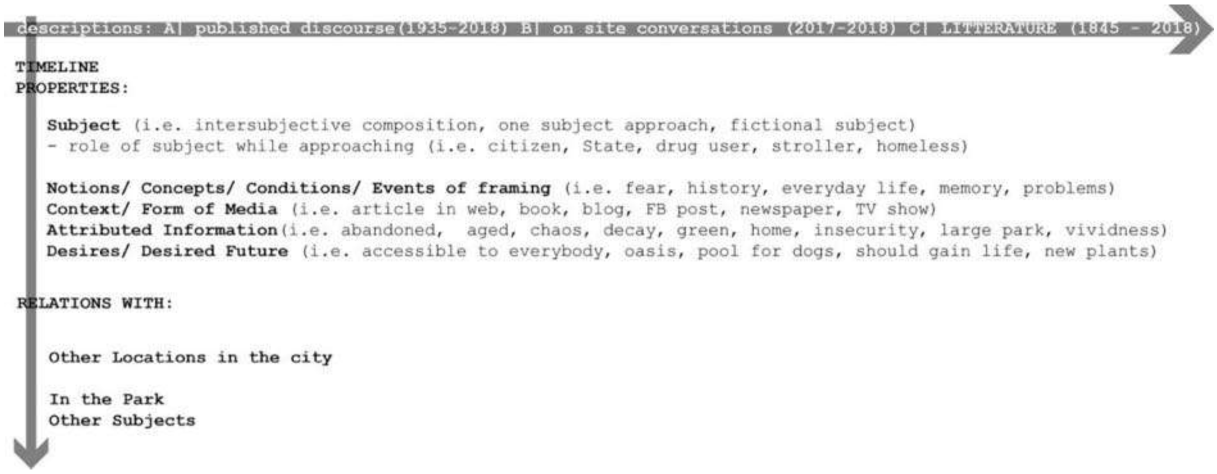


Figure 7. The scheme of the main parameters for the organisation of the 31 descriptions into a table.

The extraction of properties focuses on the conceptual and semiotic parameters that can reveal new relational-generated geographies of the park and the complexity triggered by the information created through discourse actions. References to other locations or other subjects are part of the parametrisation, in order to enhance the inter-subjective relations that form it and the systemic approach of the park as integral part of a system.

Another difference is the different scales of the cases: the scale of the first is a large area of Athens center, while the second concentrates on a park. These are different scales of complexity, which challenge the methodology on how it deals with the transitions between them.

3.2.1 Athens center public space case-study

The selection of properties activates references on the map and, thus, implied relations among them. In figure 8, the property 'open editable file' is selected, so that the mappings having this property are highlighted and their references to the city are activated. This way, the spatial expression of one or more properties is revealed. Considering that through these actions all the relevant references to the city are getting connected, what one sees on the map is a potential network, that has been created through its interaction with the IOM. The value of such actions is not the creation of connections; but the capability of seeing how these interrelations, decompose and at the same time recompose the "city".

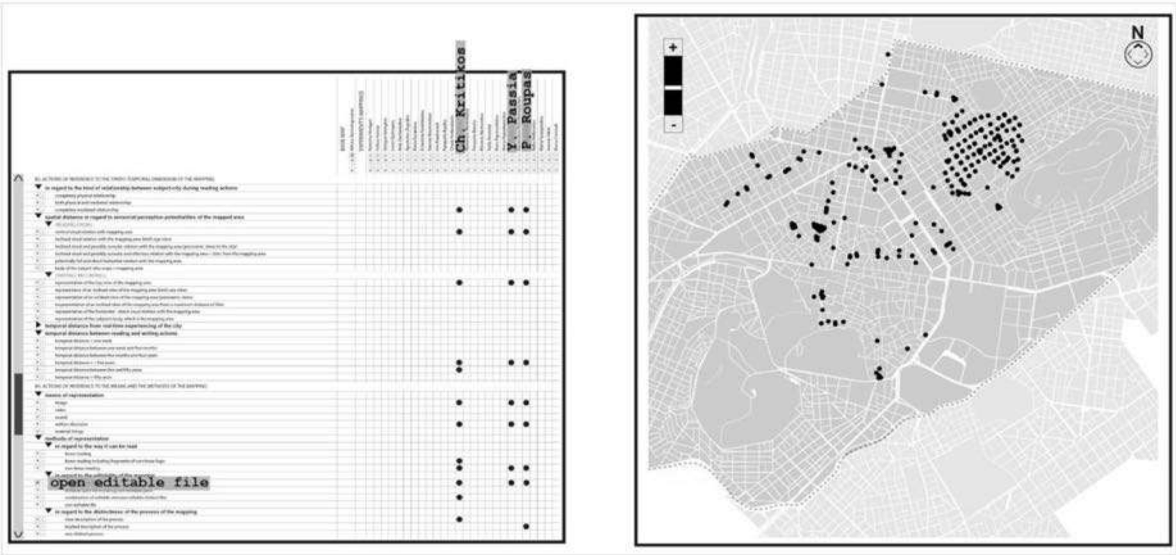


Figure 8. Sample snapshot of selection of a property in the vertical axis of the table, which indicates the mappings including this property and activates their references on the map.

In the figure 9, the location Syntagma square is selected and the mappings including reference to it and their properties are shown. This way, properties attached to any physical location can be detected on the map. From these options, it is shown how locations and information are related, but also how information affects the relations of locations, and vice versa: how relations of locations reveal relations of information.

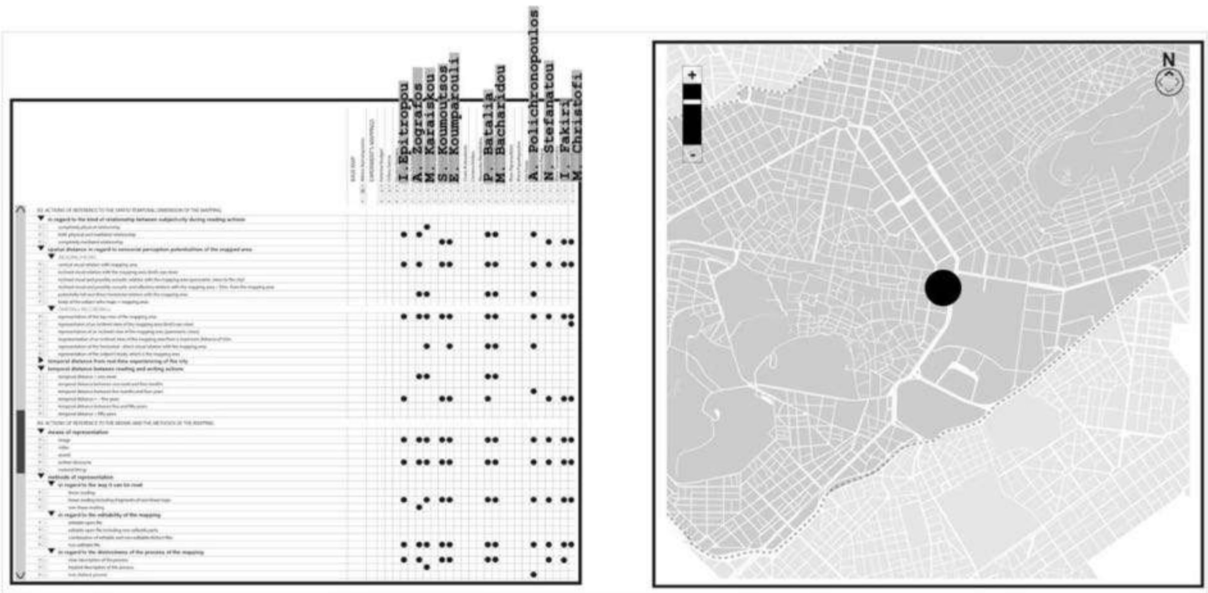


Figure 9. Sample snapshot of selecting a location on the map, which highlights the mappings including reference to it, along with their matched properties on the table.

3.2.2 Pedion Areos park case-study

The ‘node’ of a location, such as Syntagma square, can be further analysed. The second case, which is a park, can reveal it, as a zoom-in action. Every node/ dot on the map of the Athens center, is another network - system, revealing more details about its relational field. Every node incorporates further networks and vice versa. By zooming-out, every network looks like a ‘node’ and so on. Here, a perspective is opening: one can reveal but also combine simultaneously multiple networks and scales of complexities. The descriptions of the Pedion Areos were organized in a similar to the first case-study way, although the organization of properties is developed and adapted to the different type of gathered data.

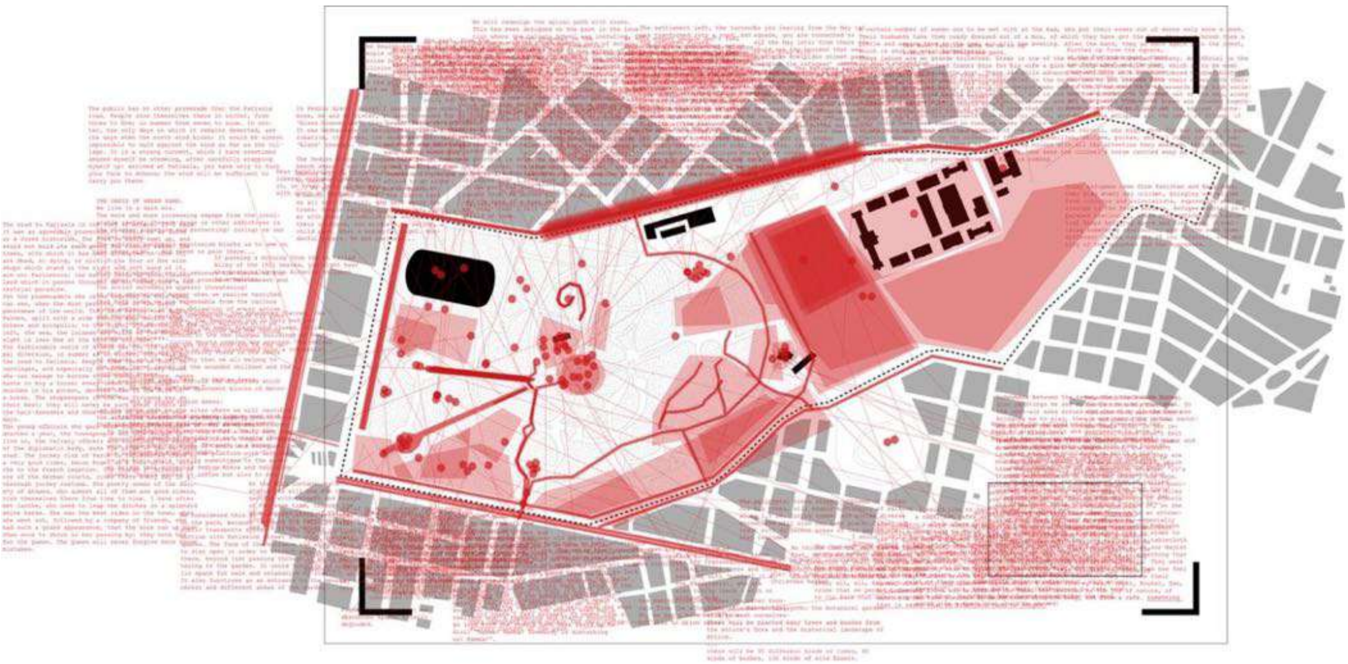


Figure 10. Map of all the references of the 31 descriptions to Pedion Areos.

4. Perspectives of design logics

The sequences of actions already presented show in very simple ways how this methodology becomes a tool of revealing and triggering multi-scalar complexities and making abstractions. This section explores how the aforementioned capacities of the methodology could be adapted and evolve, in order to discuss about design processes through the terms of relationality and complexity over the broader context of system-thinking.

4.1 Design as generative analysis

Firstly, the IOM can produce intentional urban design and strategy proposals attached to the analysis actions. This is linked to the aim of the methodology to promote a logic of a generative analysis of a thing. The analysis comes close to synthesis' actions in two ways. First, because it is selective and second, due to its generative capacities. Regarding the first one, the analysis of the city is based on its intra-subjective perception, as expressed through intentional actions of mapping and description. When dealing with conceptual and the semantic complexity, analysis is selective, through decisions related to which kind and which level and scale of complexity it activates or more simply it sees. It sets the frame in which further actions will take place. The parametrization actions in both case-studies function as this process of intentional selections.

The methodology, but also the IOM, by embedding the diagrammatic logic of Deleuze and Guattari (1988), make analysis generative, by connecting it with synthesis actions. Through the interaction of the data, new information about relations reveal. This is a kind of what Deleuze and Guattari mention as a "new reality". Actions among the levels of the methodology's scheme as well as actions among the components of the system of IOM are non-linear; especially in the latter, a back-and-forth movement is encouraged. Through both ways, one can de-assemble and re-assemble the city; thus, create multiple new re-organisations of it, as set in the aims of the methodology.

Therefore, either by selecting parameters or by non-linear decomposing and recomposing of relations, design can be perceived as the design of the framework through which new relations or new realities may emerge. This is the design of the rules and the parameters for the emergence of a relational field.

4.2 Design as defining & proposing relational fields for strategic interventions

Through actions in the IOM, one can detect, define and propose, locations, areas or networks for further interventions. Definition and proposal is not limited to the locations and the limits of the intervention(s) field, but it also integrates the terms, the briefing, since relationality is connected with the territoriality. Such terms could be the concepts and the meanings, intentions, other properties or even the relations with other locations. Therefore, this is a logic of promoting an approach of a relational territoriality, where design assembles physical and non-physical relations as a system. The field is approached along with the information and the memory it carries, depending the selections made by whoever manages the IOM.

Figure 11. Map of all the references of the 26 mappings in Athens center.

For instance, in the map of figure 11 the references are denser in this area around the Syntagma square. The intensity of density can be linked to a hierarchy that a location or a node has in the context of the system it is approached. In this density and hierarchy, the connections of a node with other locations should be also considered, since hierarchies have to do with communication routes (Cilliers 2001). Here, hierarchy is not taken for-granted or static; it is transformable (Cilliers 2001), revealed within its approach context and the selections causing it. This density and hierarchy is in coexistence and potential relation with other densities and hierarchies, evoking the thinking of overlapping hierarchies (Batty 2018; Alexander 1965).

Observing the density on the map is not enough to understand the described hierarchy. By making the respective selections on the table, one can go deeper on the parameters and the reasons leading to this result. Second, a zoom-in into the Syntagma square, would unveil further networks and relations as well as more information about overlapping behavior.

Given that one is aware of the non-statistical character of this, such densities might give directions to decisions about the description of a design proposal. These can take the form: of spreading and connecting this density to other areas; of turning the focus only to locations related to it; of loosening the density and the related to it hierarchy by intervening to connections or to parameters of the location; of experimenting with the relations among overlapping hierarchies. These scenarios may evolve into different intentions of strategies to manage the relational density of a location. In this logic, the intervention has to do with design actions to the whole system - environment relation, taking into account its expansion, its spatial behavior and its content.

4.3 Design as augmenting the relationally the of the physical

Another option of intervention, could be the revealing of Syntagma square's properties or Pedion Areos: the designer concentrates on the mappings - descriptions that include it and relate it to other locations. For instance, considering that the Syntagma square is related with other referred locations in each mapping, then the following actions are made on figure 12: the location is chosen on the map, then the 11 mappings containing reference to it get highlighted on the table along with their matched properties. Next, the references of the 11 mappings to the city are activated on the map and the overlapping of the 11 different networks in which Syntagma square is part of are revealed. If a place is among else its relations with other places (as these are made here by the 11 mappings), then it can be argued that the Syntagma square expands to everywhere it is colored in black on the map. These are non-physical relations, which influence the physical connections.

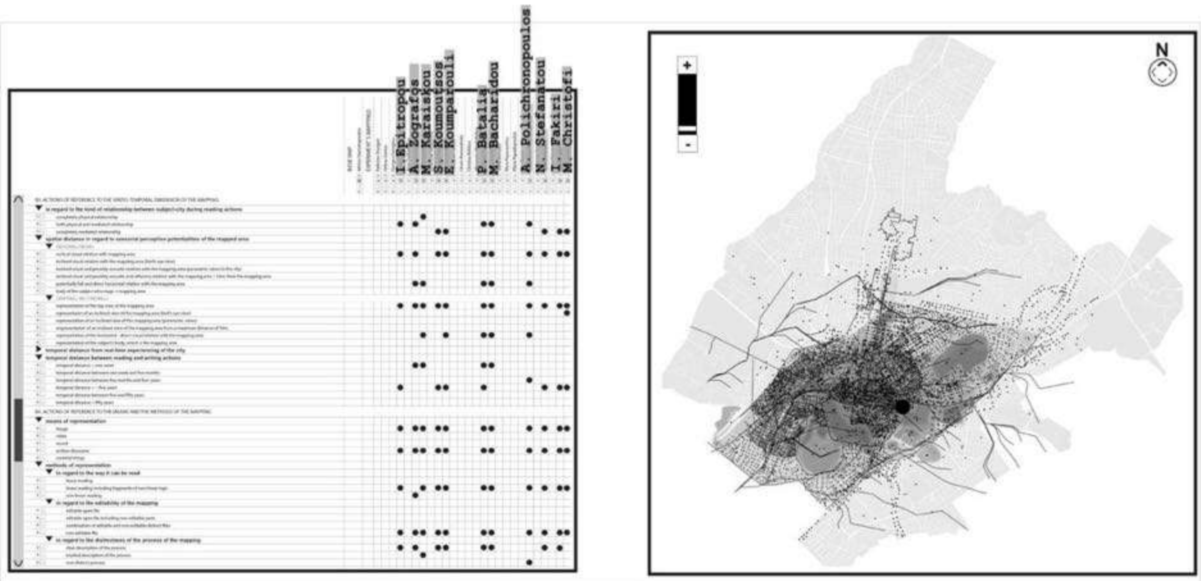
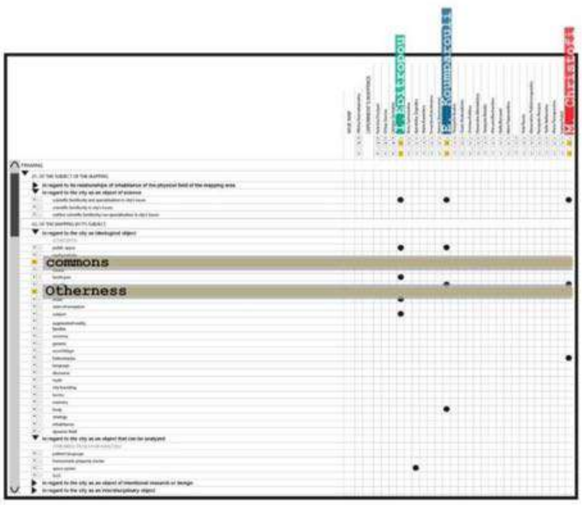


Figure 12. Sample snapshot of activating a location's complexity.

This is an approach of any location, through the lens of other, related to it, places. From a system-thinking point of view, considering that a designed intervention is capable of affecting other nodes or relations (networks), it opens the following option: to intervene to a place without doing something directly to it, but to its relations and its effects to the whole system that it is part of. This logic is also close to the idea of a more strategic form of design, which gives emphasis on the effects of the decisions and their actualisation as well as on the processes of the interactions that are estimated to cause the intended result. Therefore, this perspective of designing focuses in a more intense way on the design of processes, which share features with the logic of the acupuncture.

4.4 Briefing, decision and abstraction making oriented design

By making different selections, going back-and-forth the map and the table, one can zoom-in the Syntagma square and proceed to a more concrete proposal by setting intentionally hierarchies on information of the table in order to control what it can be seen on the map. For instance a scenario towards a proposal for the Syntagma square in regard to the combination of the concepts of the commons and of the Otherness: among the 11 mappings that refer to it, only 3 of them do it through these two concepts. Thus, in figure 13, it is abstracted which mappings and, thus, networks refer to the Syntagma square in regard to these two concepts. Additionally, one can detect on the map other areas of encounters among the different networks and at the same time complementary or conflicting properties on the table.



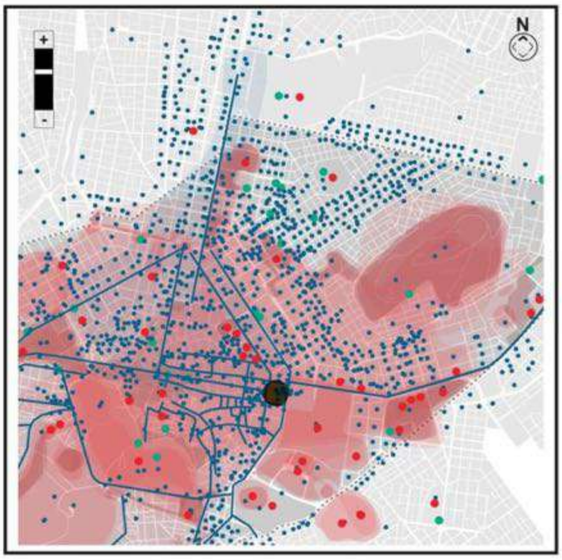


Figure 13. Sample snapshot of making abstractions.

This can be done through extra sequences of actions in IOM. In this perspective, the briefing begins with a specific 'node' and two concepts. It can proceed to more abstractions by being more selective on the information shown on the map and the table.

4.5 Design as classifying relations as forces

Similar actions can be applied in the Pedion Areos park. By clicking to the property "problems" (figure 14), it becomes clearer that the red networks (figure 15) are composed of diverse types of networks in terms of forces: some relations implied among the references to the physical territory might be conflicting, while others trigger attractions.

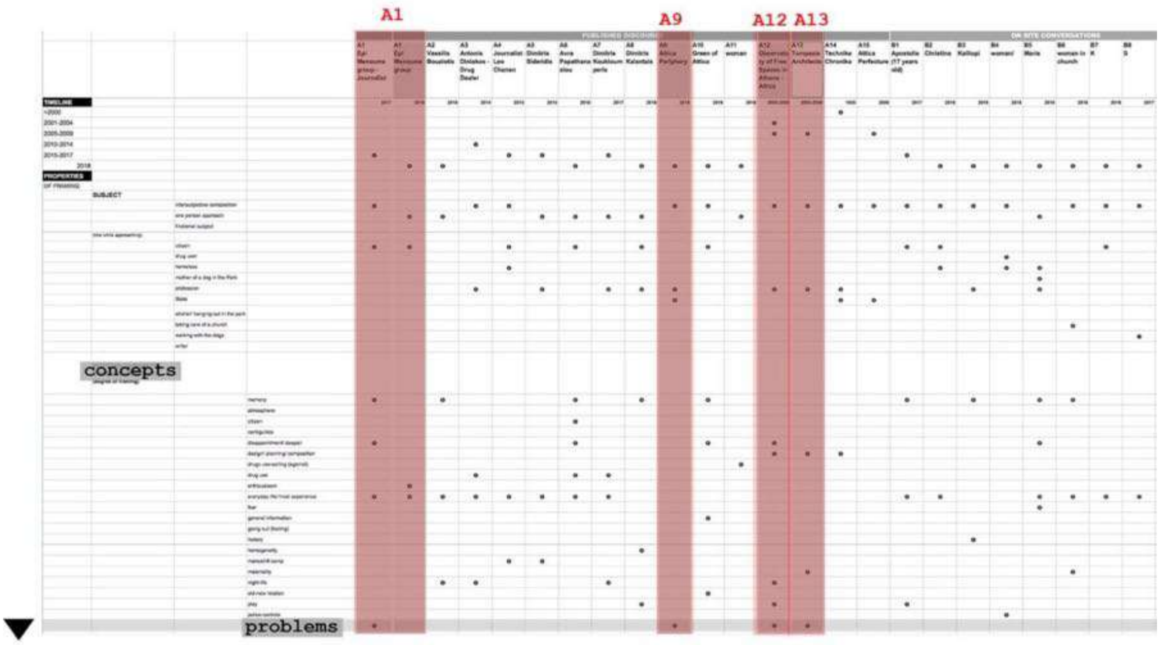


Figure 14. Sample snapshot of selection of a property on the table (part of the list is shown in this snapshot) and the consequent highlighting of the descriptions having this property.

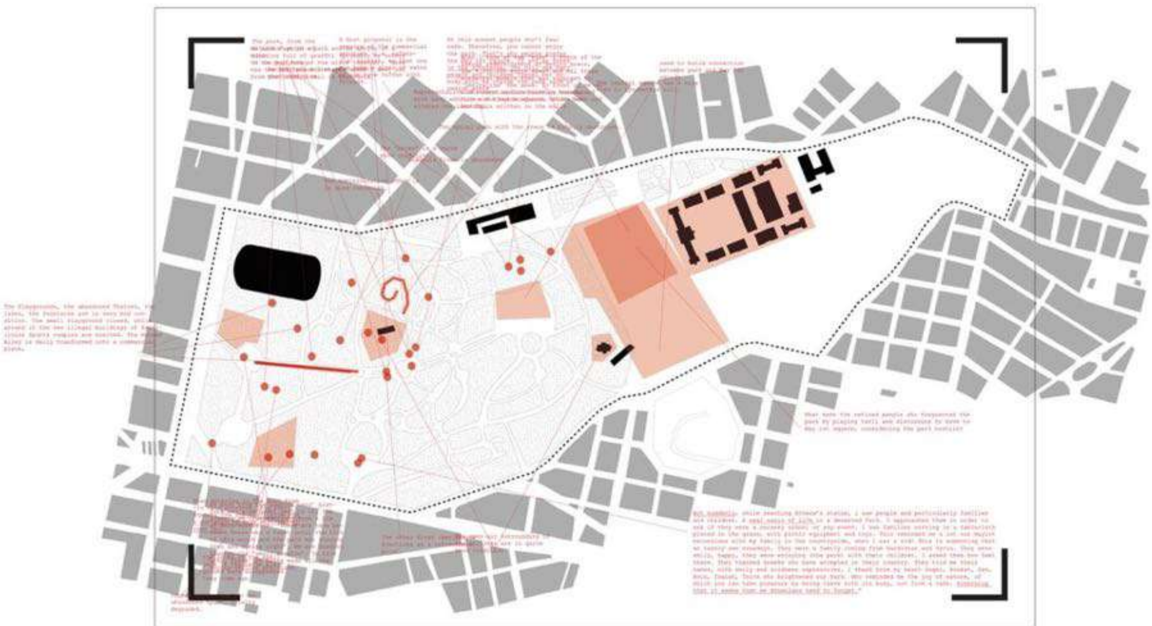


Figure 15. References of the 4 mappings approaching Pedion Areos through its problems.

A way to reveal conflicting relations is through information attributing negative properties. These (noted in dashed lines on the maps) make the physical distances feel-like larger; they function as immaterial boundaries, borders and gaps in the field. Accordingly, relations (noted in solid bold lines on the maps) of complementarity and consistency bring locations closer. In order to understand this better, the references made by the four descriptions are noted in 4 colors. Each description is cited in different map in its codified form (figure 16–19). All their references have been translated in positive and negative, according to the attributed properties, as set by their subjects. By connecting all the negatives and accordingly all the positives, two types of fields of forces reveal. One of attractions and one of repulsions.

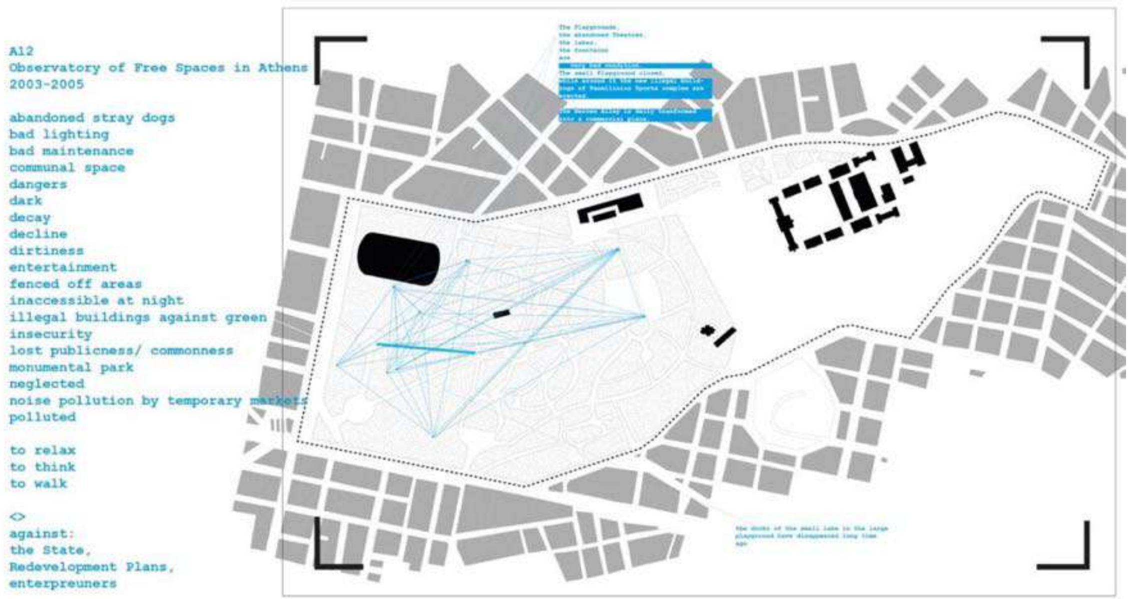


Figure 16. References of the description A12.

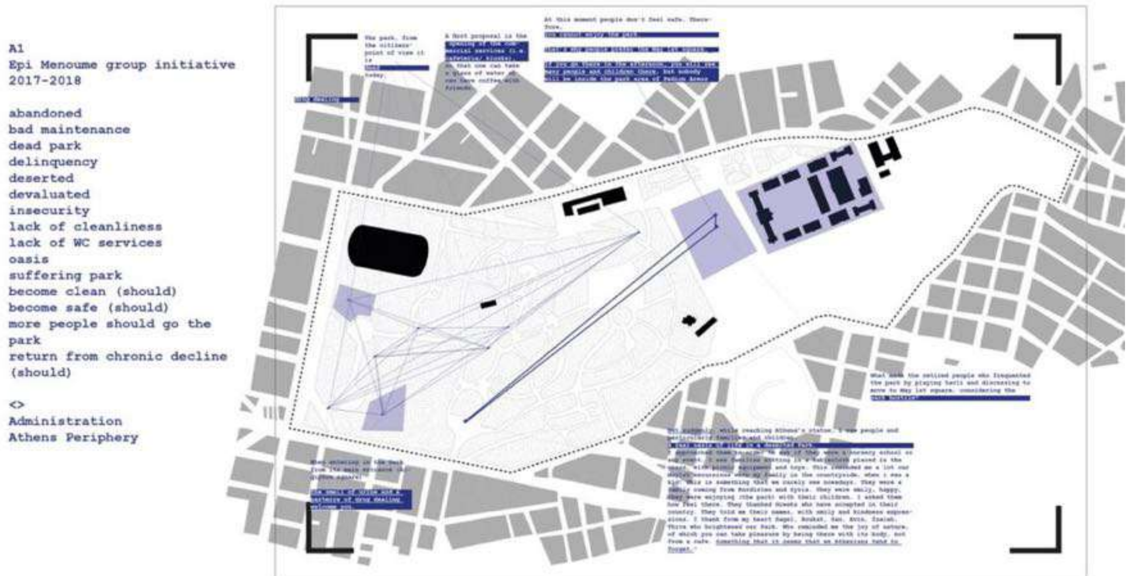


Figure 17. References of the description A13.

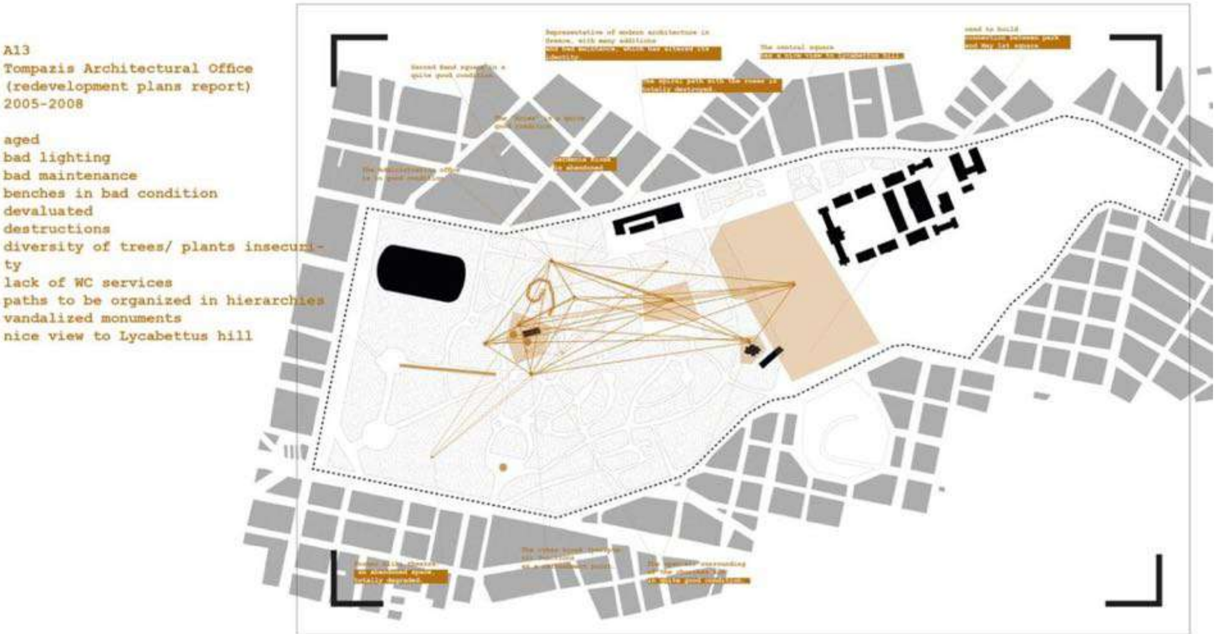


Figure 18. References of the description A1.

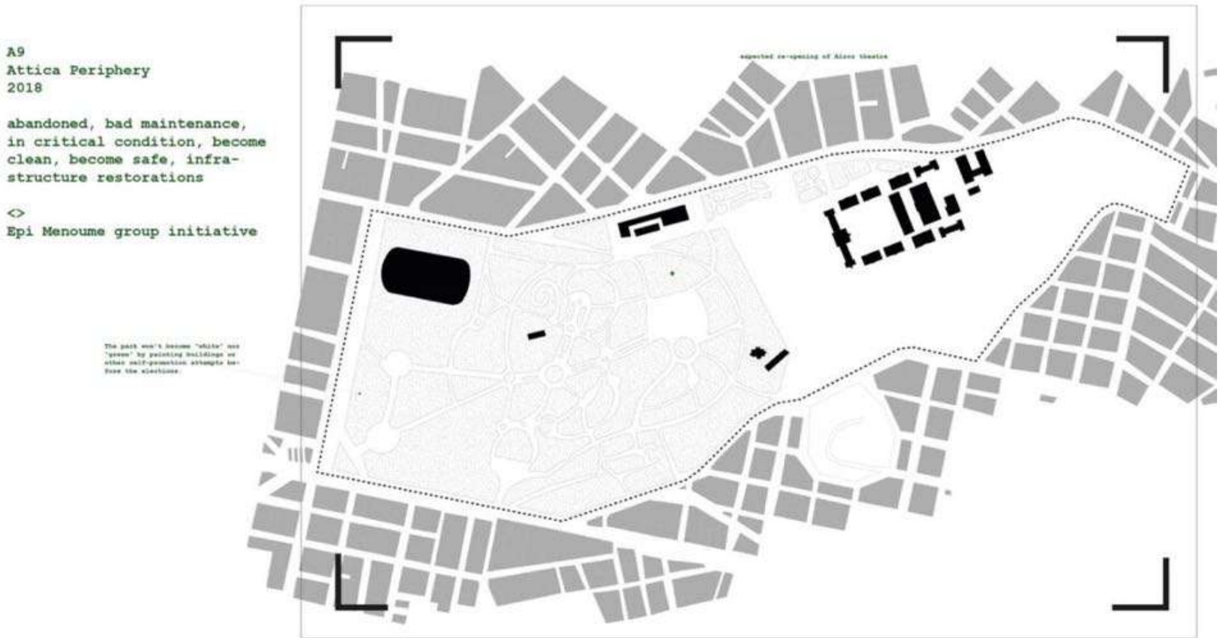


Figure 19. References of the description A9.

Through this step, more perspectives of back-and-forth actions among relationality and territoriality are opened. Additionally, one can go deeper on the issue of the park’s “problems” by activating further information, as the properties noted on the left of every map. These by implying or mentioning problems related to them (accessible through the table) enrich the description of the problems of the park, contributing to more targeted proposals.

In figure 20, the overlapping of the diverse networks is depicted. The chronological sequence of their positioning before or their overlapping reveals how this field of forces changes: it changes in regard to the different point of view, to different intentions and agencies.

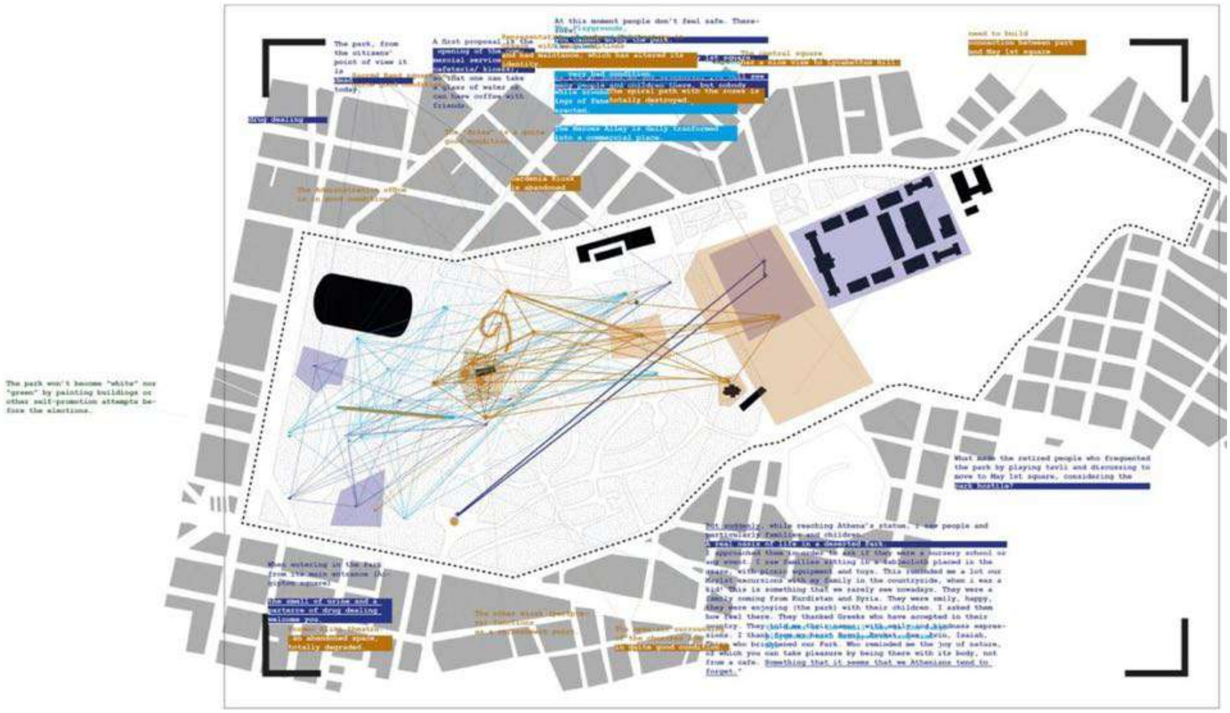


Figure 20. Overlapping of the 4 (or 8) different networks of forces.

5. Conclusion

The comparative consideration of the two cases contributed to the maturation and the enrichment of the transitions from data to design. At the same time, the whole process of comparing presented in this paper put under rethinking the first testing case-study - and through it the methodology -, in terms of revisiting and reviewing it. The different scales of territories, relationalities and complexities is the main triggering reason, because it challenges the object of urban design and its relations with architectural design and urban planning. Such a negotiation can be tested through the larger scale of the first case-study. The next test is planned to focus on Syntagma square: which is not considered any more considered as a node, but a relational field overlapping with other relational fields. It is a case through which more back-and-forth as well as zoom-in and zoom-out experiments can be carried out. Another intention for the next test is to enlarge the timespan (in order to experiment with transformations in time) of the data as well as the subjects, which means that new data will be added. In this rethinking, the idea of attracting and repulsing forces shaping relational fields constitutes another significant idea to be integrated and further developed, since relations, interactions and potential intra-actions depend on them.

References

Allen, S. (1999). Diagrams Matter. ANY, 23 (Diagram Works).

Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: University Press, 2007.

Batty, M. (2007) *Cities and Complexity*, Boston Massachusetts: The MIT Press. 2007.

Batty, M. (2013) *The New Science of Cities*. London and Cambridge Massachusetts: The MIT Press.

Cilliers, P. (1998)*. Complexity and Postmodernism*. London: Routledge.

Cilliers, P. (2001) 'Boundaries, Hierarchies and Networks in Complex System', International Journal Of Innovation Management 5(2): 135-47.

Corner, J. (1999) 'The Agency of Mapping' in D. Cosgrove (ed.), *Mappings*. (pp. 213-252). London: Reaktion Books.

Deleuze, G. & Guattari, F. 1988. A Thousand Plateaus. Translated by B. Massumi. London, New Delhi, New York, Sydney: Bloomsbury.

Hillier, B. Hanson, J. 1984. *The Social Logic of Space*. Cambridge: Cambridge University Press.

Peirce, C.S. (1931). *Collected papers of Charles Sanders Peirce. 6 Volumes*. Ch. Hartstone and P. Weiss (Eds.). Cambridge MA and London: The Belknap Press.

Thrift, N. (1999) 'The Place of Complexity', Theory Culture & Society 16(3): 31-69.

2 | INDUSTRIAL PROCESSES AND AGRI-FOOD SYSTEMS

Systemic Design in Food Security and Resilience: Building A Holon

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Abstract

This paper concerns Food Security and the capturing and understanding of the potential usefulness of the notion of Resilience in that context. An important representative research project working on the complex problem space of Food Security and Resilience is the I KNOW FOOD (IKF) project. Work with the researchers engaged on this project is used here to demonstrate the approach presented. This approach is based on Systems Thinking and the capturing and building of a Holon of the problem space in order to discover, understand and evaluate the far-reaching effects of the role of resilience in Food Security. This approach also underscores the need for grounding the 'acknowledging' and use of holistic views of the problem space of such complex problems. By doing this, it moves forward from simply adopting a holistic stance, that of-introducing and including more people, components and issues,-to offering ways to examine the resulting interrelationships.

Keywords: Systemic Design, Resilience, Food Security, Holon

1. Introduction

In a previous paper (Darzentas et al., 2017), the IKnowFood (IKF) project, its composition and objectives were introduced. As its name suggests, an overall aim is to integrate knowledge about food systems, in the context of Food Security. Food Security is defined as existing "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization of the United Nations, 1996). In particular, the project examines Food Security in the light of food systems resilience. The IKF project defines food systems resilience as "the ability to learn, adapt and transform to cope with external and internal stresses and shocks in order to maintain stable levels of nutritious food supply" (Doherty et al, 2019).

The word 'systems' is used in food studies very frequently, as the food research literature recognises the interconnectivity of various elements and talks about "food systems", but it is more common to find research that deals with parts of food systems independently, for instance concentrating on food production, or on food supply systems. This has been changing, with more Food Security researchers trying to find ways to study food systems more holistically. Such research (e.g. Bland and Bell, 2007; Ericksen, 2008; Horton, 2017) on Food Security is working to draw in sources of multiple interactions, to identify key processes, drivers, multiple feedbacks and outcomes. This then leads to some thought-provoking perspectives on how components are interlinked and could potentially lead to "actionable improvements". This wider, more holistic, agenda for Food Security research may include many different factors not apparently directly influencing Food Security, such as over-consumption of 'bad' food and obesity, to be studied along with more traditional foci such as increasing food production and improving food value chains. The IKF project belongs to this newer tradition of taking a wider, more holistic, perspective, and has a main objective to integrate many different types of knowledge about food.

However, a major difference between these more holistic approaches found in the literature and that presented here, is that these researchers conceptualise the interconnected food systems as well-defined entities, pre-existing and agreed upon, and assume that their interactions with one another form patterns that can, with study, be revealed. Indeed Ericksen (2008) advocates for compiling a 'database' of such interactions, once they have been studied, and that such case studies, can be abstracted away into typologies, to be referenced by other researchers when faced with similar situations. The aim is that this database will guide those in charge of managing Food Security policies. Similarly, Horton (2017) is interested in modelling the whole of the agro-food economy in such a way as to apply quantitative methods to analyse and manage it. It is important to acknowledge the significance of these approaches that move from reductionistic models of food systems and embrace more holistically based viewpoints.

The approach of this paper questions these fixed conceptualisations, in spite of them being used and accepted in the literature generally and proposes looking afresh at the components such as people, elements, issues. This is because interactions between these components that are recognised by those studying such complex problem spaces, are essentially dynamic, and subject to change.

Therefore, although they can be recorded, they are not necessarily constant. Allowing fresh views onto the problem space, deliberately avoiding fixed 'pre-defined' conceptualisations, can open up richer and more realistic contemporary interpretations, and hence more appropriate and relevant paths to interventions.

Support for such openness is evident, for instance, in the conclusions derived by Bizkova et al. (2016). In their work with 20 local communities in central America (Honduras and Nicaragua), they adopted a systems perspective that enabled them to include a wide range of stakeholders, from households and local food production, scaling up to those involved in the management of natural resources, and those involved at institutional level in critical infrastructures such as sanitation and transport as well as governance and policy making. They created a framework and envisaged this for clarity as a pin wheel with 5 concentric layers going from the local and scaling up. However, in essence, when working with the communities at local level and scaling up, they realised that, in fact, interrelationships crossed these artificial boundaries. Relaxing these boundaries helped them to identify potentially critical points for building resilience at policy levels, through institutional changes and their role in improving local and other systems, such as production and market systems that are well beyond the local livelihood-environment-food production nexus.

2. The Concept of Resilience

Resilience has been conceptualised in at least three ways; as absorbing shocks, as preventing shocks, or as adapting to shocks whether in socio-ecological systems (Béné et al., 2016) or socio-technical systems (Taysom and Crilly, 2017), and in some cases more than one of these forms of resilience are apparent. For instance, an aid agency may provide first aid to help absorb the shock from an emergency, but also try to put in place preventive measures to resist unwanted changes, or even a development project to transform the current food production/consumption processes so that it is not vulnerable in the future to the type of shock caused by the emergency.

In most current discourse, both general and academic, resilience is generally mostly considered as a positive attribute. Situations that are resistant to change are resilient and endure and are stable. But resistance to change can mean that undesirable states remain (e.g. resistance to changing known 'bad' dietary habits). Moreover, resilience of one part of a system may cause the destabilisation of another part. For example, creating desirable resilience by converting to the production of a different type of crop that is not susceptible to extreme climatic changes, may mean that the storage and transportation demands of that new crop are more resource intensive, putting pressure and vulnerability to that part of the system.

IKF proposes the use of the lens of resilience to examine Food Security. Researchers from the project, define the food system as series of "structures, institutions and information that connect or divide food system stakeholders" (Doherty, 2016, p.20). When stakeholder goals are not aligned to those stuctures, (the spatial and organisational complexity of the food system), or to those institutions (the complex systems of governance that constitutes the food system) or when the information exchanges between stakeholders is not clear, then there are threats to resilience (Doherty et al, 2019). Appreciating this position, our approach extends to the need to capture and understand the elusive interconnectedness of the classes of obstacles they distinguish.

3. Systemic Design Approach

Our approach is grounded in Systems Thinking and Design to capture, learn about and develop deep and shared understandings of complex problem spaces, such as that of Food Security. Such understandings are *a priori* necessary in order to move towards appropriate and robust design interventions. A critical step in this approach is to build a Holon (Darzentas et al., 2017).

The term 'Holon' has had a strong influence in the evolution of Systems Thinking. It was first used by Koestler (1967) to explain that a whole of any sort is essentially at the same time a sub-whole. Researchers (Bland and Bell, 2007) working in agroecology, found this a useful term, because of their problematique with boundaries, when everything could be a system, that is part of another system, then the notion of 'flickering', i.e. keeping these differing contexts in mind was important. Checkland and Scholes (1990) suggested that the Holons could denote "the activity of systems thinkers who formulate some Holons relevant to the perceived reality they are interested in" (p22), in order to understand that perceived reality more fully, and having done that, perhaps design interventions to make things better. They further state that the use of Holons "is to enquire into, or interrogate the real world in order to articulate a dialogue, discourse or debate aimed at defining changes deemed desirable and feasible" (Checkland and Scholes, 1990, p287). It is in this sense that it is used here.

We adopt the meaning of the Greek word 'ὅλον' which means 'whole' or 'everything', in relation to the problem space. The Holon is not a systemic representation of a complex problem space. Rather, it forms a way to capture and record understandings about the problem space. The emerging Holon consists of stakeholders' issues and the components and interrelationships considered relevant. Systemic designers have a particular role to play in building the Holons, because they can draw upon a range of design methods such as those informed by ethnographic tools, as well as participatory activities. In this process, a Holon may be refined many times, as the learning and understandings deepen. These refinements can also come about in response to the application of a range of different design methods that help to make emerge different features of the situation under study. The Holon when 'translated' into a systemic language makes use of known tenets and principles of Systems Thinking (Darzentas and Darzentas, 2016). In this way, notions such as resilience can be examined using the Holon to situate them in the problem space.

This paper presents work initially bringing researchers together into a shared space to develop understandings of the IKF objectives. A first step was to move from the 'given' system definitions (e.g. 'supply chain system', 'healthcare system', as well as 'stock' definitions of actors and roles (e.g. farmer produces food) to develop fresh understandings and reveal emergent properties. Although these researchers are just one group amongst the stakeholders engaged in IKF project, they are each working in partnership with the main groups of stakeholders. For example, researchers working with food producers meet with farmers' groups. These pre-existing groups are made up of farmers whose motivation is exchange of information between themselves, on various subjects such as the role of technology, of governance, of safety, etc. The role of the IKF researchers is to engage in social learning and immerse themselves in their world. In doing so, they bring a richer understanding of the motivations and values, the limitations and outside constraints that come into play in the farmers' spheres of activity. Bringing these richer understandings to the building of a Holon allows for differentiated emphases from the more commonly accepted food systems' actors allowing possible re-orientations.

Figure 1 below shows a Holon created by the group of the researchers over the course of 3 workshop sessions. Each session lasted on average 2 hours and 30 minutes, and the researchers represented different groups of Food Security stakeholder interests (e.g. farmers, consumers, value chains of food processors and distributors, retailers etc.) as well as environmental concerns, (effects of climate change, etc.). In addition, as consumers of food, or as activists in initiatives to alleviate food poverty, they are also able to represent other interests.

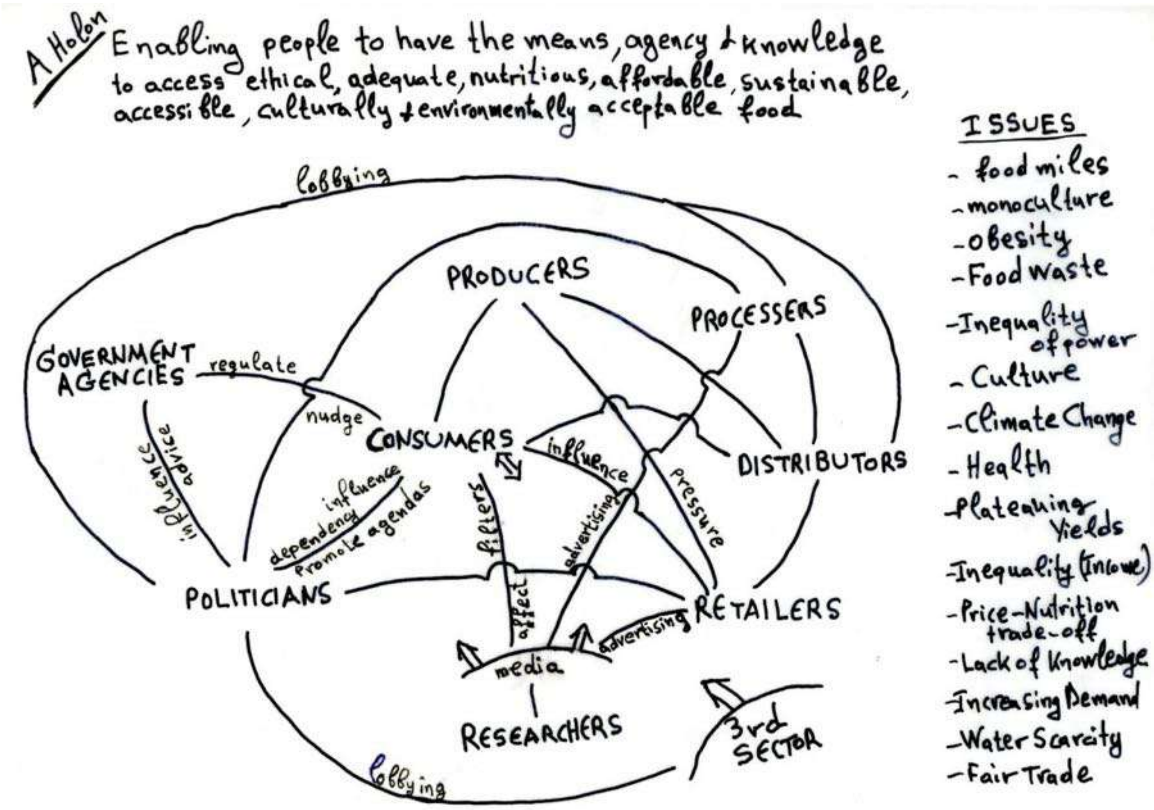

Fig.1. A captured Holon on Food Security

3.1. Preliminary Observations

Already, some very promising preliminary observations emerged that demonstrate the usefulness of the systemic design approach, which is based on initially capturing a Holon of the problem space for the grounding of resilience in the project. Some of these are described in the paragraphs that follow:

Refining the definition of Food Security: A description of the situation of concern elaborated during the workshops shows interesting differentiations when contrasted with the official definition of Food Insecurity from the Food and Agriculture Organization. Their carefully crafted definition, which is periodically reviewed, states that Food Security is: “A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO-2001).

In contrast, the workshop elaboration paid attention to human self-sufficiency, introducing the concepts of *means, agency and knowledge* as necessary to access food, in contrast to the ‘physical social and economic’ of the official definition. It qualifies food as being *ethical*, as well as nutritious, and affordable, and finally, they introduced the notions of *care for the environment* as well as the *cultural acceptability of food*, that do not exist in the FAO definition. Their final elaboration was: “Enabling people to have the means, agency and knowledge to access ethical, adequate, nutritious, affordable, culturally and environmentally acceptable food”.

The role of Communicators: Acknowledgement of the influential role played by the stakeholder group termed ‘communicators’. This group includes people such as food journalists. Although the academic world recognises the importance of communicators, with whole journals dedicated to them and their research, (e.g. the Journal of Environmental Communication), within the Food Security literature they do not seem to feature as a stakeholder group. Yet, evidence of their activity abounds, whether it is exerting influence on consumers via advertising; or their key role in informing and educating consumers about safe and nutritious food practices; or as conduits to filter and popularise scientific results to consumers with practical recommendations regarding dietary information. Of course, as everywhere, the role of information and communication as a powerful and influential tool is well recognised, but when dispersed into makers and writers of documentaries, newspaper articles, and commissioned reports, they are not easily recognisable as stakeholder group.

The importance of the Third Sector Organisations. This is a term used to describe the range of organisations that are neither public sector nor private sector. It includes voluntary and community organisations (such as associations, self-help groups and community groups), social enterprises, and co-operatives. Generally speaking, these organisations are independent of government and state. This means they are motivated by the desire to achieve social goals (for example, improving public welfare, the environment or economic well-being) rather than the desire to distribute profit; and they reinvest any surpluses generated in the pursuit of their goals so as to be financially sustainable. These organisations are often to be found operating at the forefront of difficult, perhaps emergency, situations, and therefore have first-hand knowledge of the conditions. Often it is they who are actively engaged in implementing resilience (whether trying to absorb shocks carrying out first aid in emergencies, or whether engaged, perhaps after a disaster, in trying to build resistance or to transform).

Potential of stakeholders to influence a situation. Finally, an observation was that of understanding the range and spheres of influence of stakeholders or the nature of the potential of stakeholders. Notwithstanding the many inequalities that are present, each stakeholder appears to have some mechanisms, to influence, affect, change, or even disrupt flows of material and of information within the Holon. Further refinement to explore these mechanisms, to understand how they operate and the range of their influence would enable better understanding the nature of this potential, and what consequences activating it can have.

4. Working with the notion of resilience

The richness of a Holon such as the one in Figure 1 offers an opportunity to identify some of the effects that an external stress, for instance, might have within the captured Holon. This may also then allow for some useful speculation on the type of resilience required to deal with the outcomes, whether to adapt or to absorb or both. Of course, it must be noted that any capturing and understanding of the problem space is evolving iteratively, so that the Holon may be refined repeatedly

Figures 2 and 3 give examples of the potential effects of external 'prodding'' such as that of an awareness campaign aimed at the consumers of food might have on some stakeholders (Fig.2), and the introduction of legislation regarding the living conditions and transportation of livestock (Fig.3).

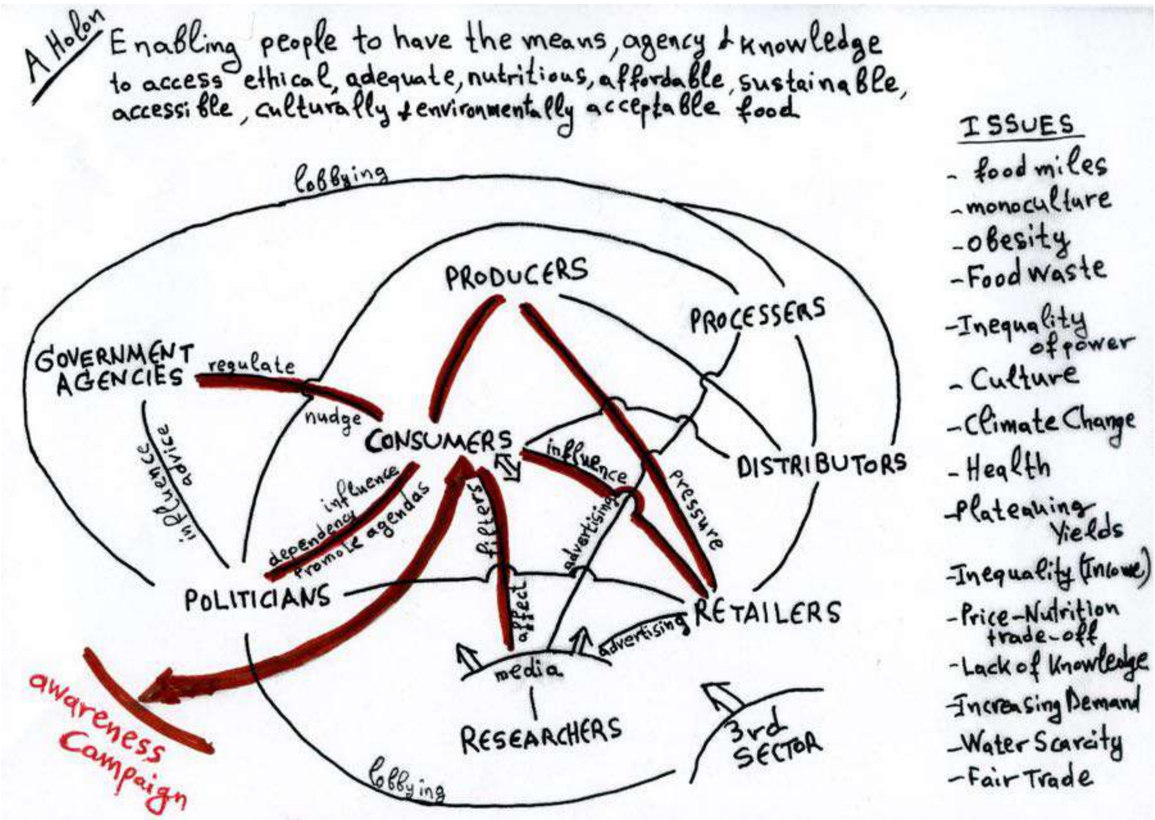

Fig.2. Potential stakeholders affected by the external ''prodding'' of an awareness campaign

By stressing or 'prodding' the system, it is possible to see where the potential 'shockwaves' hit. For example, in Figure 2 above, the awareness campaign aimed at consumers, may also affect others, such as retailers, and this may have a knock-on effect to the link between retailers and producers. The Holons allow for creating understandings of what types of resilience might be needed by the various stakeholders either to resist being affected by the shockwaves, or to have mechanisms in place to adapt to the shockwave, or to reform.

In other words, identifying such pathways allows for understanding the possible forms that resilience, if required, could take. Translating into systems language provides a platform to move towards creating interventions where tried and tested design methods can be used. Again, it is emphasised that a very important benefit of the systemic design approach is that, because of the way the 'paths' to emerging subsystems are generated, the stakeholders involved in each one of those, can 'meet' again, when necessary, back at the 'system' (or translated Holon), or even at the Holon itself. That may be necessary because of the iterative nature of the evolving understanding and learning, as well as the dynamic nature of systems' characteristics such as borders and environment which change continuously.

Similarly Figure 3 shows as an example the possible effects the 'stress' a piece of legislation on the rearing conditions of livestock might have on 'food systems' using the Holon of Fig.1. As an example, an organisation championing farm animal welfare, Compassion in World Farming noted that in the UK, it is a legal requirement for all eggs to be labelled by producers and retailers, stating the farming system in which the hens live. Eggs are labelled as 'eggs from caged hens', 'barn eggs', 'free range' or 'organic'. The mandatory labelling scheme for eggs was introduced in 2004, and by 2016, UK production of cage-free eggs had increased from 31% in 2003 to over 60%. The organisation claims that as a result of labelling, consumers finally had the full picture, and could make purchase choices about the type of farming conditions it wanted to endorse. Examples such as these can aid the capturing of emerging relevant interconnectedness amongst stakeholders, issues etc. which will or might be affected and decisions that will have to be taken by and for the stakeholders involved about what kind of resilience will have to be adopted and exercised.

In this example, such legislation will affect 'producers' directly and indirectly 'processers' and of course the 'distributors'. The emerging form of the problem space calls for the consideration of potential interventions to deal with the upcoming required changes. In other words, learning about and understanding what type of resilience should be introduced. For instance, in the case of 'producers' they may have to 'adopt' as well as 'absorb' while 'processers' and 'distributors' will have to 'absorb'.

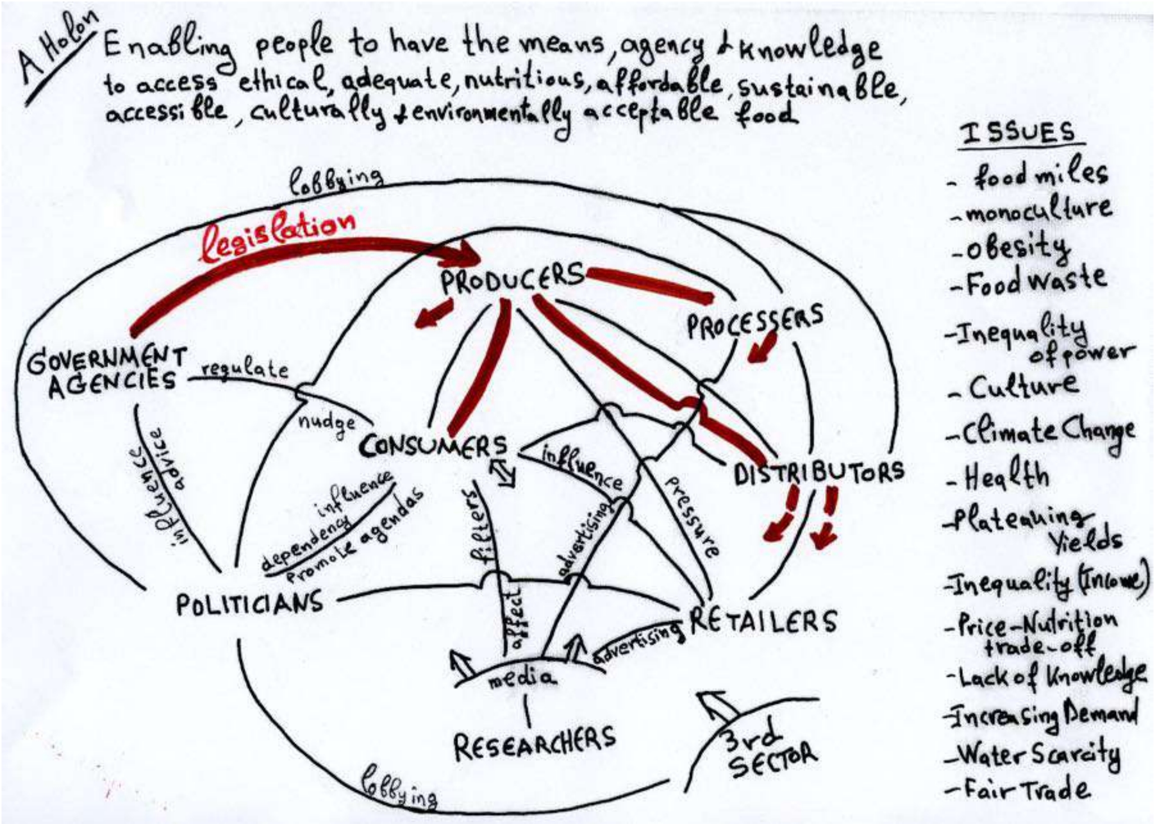

Fig.3. Possible effects of the 'stress' of a legislation on the growing and transporting live stock

5. Summary and Conclusions

This paper has attempted to show the contribution that systemic designers can bring to the debates about meeting important 21st century challenges (Sustainable Development Goals, 2015) such as that of Food Security. Acknowledgement that this is a complex situation requiring multi and interdisciplinary perspectives and moving away from silo and reductionist thinking and methods is well-recognised in this arena. However, multiple viewpoints each with their own traditions of communication are hard to integrate, and even harder to make sense of, when the brief is to try to plan and take decisions affecting humanity and the environment on a global scale. The continually changing dynamic nature of the interconnections is a further compounding feature of this endeavour. However, this is not to say that seeking to understand is a futile exercise, rather it is helpful to demonstrate that it is not only permissible to keep the dialogic nature of interconnections in mind, but that it is a requirement to continually examine and question pre-defined groupings and supposed relationships.

Understanding the interconnectedness of various components is emerging as a concern in the literature on Food Security. For instance, previously, public health issues and the availability of food were areas of distinct study, but now connections are established (e.g. obesity and availability of cheap calorie-laden food). However, methodologies to identify appropriate interventions are lacking, and as a result work sometimes halts once the connection is established. With the aid of Holons, the emphasis on interconnectedness will reveal other linkages susceptible to being affected by decisions on interventions aimed at tackling the problems caused by obesity issues.

Systemic designers, by leading enquiry and moving away from given definitions within the Food Security literature, can help to explore and give voice to interconnections that may be 'known' at some level, perhaps from being encountered in everyday life, or instinctively felt, but which are not often openly acknowledged. This may be because scientists are trained to justify statements about such interconnections with evidence. Furthermore, using Holons and studying interconnections, these can make use both of 'zooming in' to examine what happens at a local or regional scale, and 'zooming out' to understand working on the larger scale. Thus, the enquiry can explore what works at the micro and at the macro level, bringing in knowledge from one scale to see how it looks at another.At present, in the face of intense impacts from the realisation of globalisation enabled by technological advances in transport and communications, there has been much research examining the effects on local communities, and what these can do to be resilient and maintain or adapt their ways of living and working. However, it is now becoming apparent that the local must be linked to the global and acknowledge that interventions that work at local cannot always work at larger scales.

The IKF is a project funded by the UK, and although it ostensibly is about Food Security for the UK, this cannot be studied, nor can improvements be suggested, without taking into account a wider picture. The work with the group of researchers within that project served to complement the work in the project as a whole, both in the sense that researchers assigned to various workpackages within the project structure were able to meet and work together on a common platform, but also in the sense that the overall nature of the project was debated and new interpretations formed.

References

Béné, C., Headey,D., Haddad, L. & von Grebner, K. (2016) Is resilience a useful concept in the context of Food Security and nutrition programmes? Some conceptual and practical considerations *Food Security* 8:123–138

Bland, W.L. & M. M. Bell (2007) A Holon approach to agroecology *International Journal of Agricultural Sustainability* 5(4) 284-294

Bizikova, L., Tyler, S., Moench, M., Keller, M. & Echeverria, D. (2016) Climate resilience and Food Security in Central America: a practical framework *Climate and Development*, 8:5, 397-412

Checkland, P. Scholes, J. (1990) *Soft Systems Methodology in Action* Chichester, Wiley, Compassion in World Farming (2019)retrieved from https://www.ciwf.org.uk/our-campaigns/honest-labelling/

Compassion in World Farming Retrieved from https://www.ciwf.org.uk/our-campaigns/end-the-cage-age/

Darzentas, J. & Darzentas J.S. (2016, Jun 27-30th) Product-Service Systems or Service Design 'By-Products'? A Systems Thinking Approach in: P. Lloyd & E. Bohemia, eds., Proceedings of DRS2016: Design + Research + Society - Future-Focused Thinking, 10, 3771-3784

Darzentas, J. Petrie, H. & Darzentas, J.S. (2017, Oct 18-20th) Employing Systems Thinking Approaches and the Service Design paradigm as tools to support collaboration across a multi-stakeholder initiative: the responsible food consumption exemplar in Sevaldson, B. (Ed) Relating Systems Thinking and Design 6 (RSD6 Working Paper) Retrieved from https://www.systemic-design.net

Doherty B: (2016) Resilience and Fair Trade. *Journal of the Institute of Food Science and Technology*. 30(3).

Doherty B, Ensor J, Heron T and Prado P. (2019) Food Systems Resilience: Towards an Interdisciplinary Research Agenda [version 1; referees: 3 approved]. Sustainable Food Systems, 1:4

Ericksen, P. (2008) Conceptualizing food systems for global environmental change research *Global Environmental Change* 18(1), 234-245

Food and Agriculture Organization FAO (1996). Rome Declaration on Food Security and World Food Summit Plan of Action. Retrieved from: http://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf

Food and Agriculture Organization FAO (2001) State of Food and Agriculture, Chapter 2. Food Security: concepts and measurement Retrieved from http://www.fao.org/3/y4671e/y4671e06.htm

Horton, P., Banwart, S.A., Brockington, D., Brown, G.W., Bruce, R., Cameron, D., Holdsworth, M., Lenny Koh, S.C., Ton, J. & Jackson, P. (2017) An agenda for integrated system-wide interdisciplinary agri-food research *Food Security* 9:195–210

IKnowFood (IKF) Integrating Knowledge for Food Systems Resilience Project. retrieved from https://iknowfood.org/

Koestler, A. (1967) *The Ghost in the Machine* London, Hutchinson

Sustainable Development Goals of the United Nations (2015) Retrieved from https://sustainabledevelopment.un.org/?menu=1300

Taysom, E. Crilly, N. (2017) Resilience in Sociotechnical Systems: The Perspectives of Multiple Stakeholders, *She Ji: The Journal of Design, Economics, and Innovation*, (3) 3, 165-182

Building the fashion's future.
How turn textiles' wastes into ecological building products

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Abstract. The textile system is one of the most influential production activities at a global level from an environmental point of view, both in relation to the processes that characterize the supply chain and in relation to pre and post-consumer waste. It produces million tons of global greenhouse gas emissions per year and it consumes millions of litres of water; it uses million tons of chemical products. Furthermore, millions of tones of special textile wastes are yearly landfilled in upstream process as well as in downstream process. Less of 1% of materials used to produce clothes becomes part of a closed-loop recycling and less of 2% are recycled in other industrial activities. Changing the textile industrial linear model in a circular one according to Systemic Design principles is advisable, starting from wastes and by-products. As proved in the working paper wastes, due to their properties, can assumed as inputs of new production systems. Particularly the scientific contribution deals with some research activities carried out within a project titled EDILTEX - Innovation for reusing in textile companies. The achievements are described, showing that construction and fashion are fields only apparently far from each other. They can - on the contrary - developing powerful synergies and products with interesting technological and physical performances.

Keywords: recycling and reusing textile wastes, Secondary Raw Materials, ecological building products, textile recycling scenarios.

1. Introduction

The textile plays a crucial role in the third economic sector in several European Countries. The fashion industry is considered as a benchmark of excellence in Italy and Italian fashion revenues are remarkable (Crivelli, 2017). But at the same time the textile system is one of the most influential production activities at a global level from an environmental point of view, both in relation to the processes that characterize the supply chain and in relation to pre and post-consumer waste. The textile sector produces about 3.4 million tons of global greenhouse gas emissions per year and, due to the dyeing, printing and fixing processes, it consumes an average of 7.5 million litres of water and it uses 6 million tons of chemical products (Sistema Moda Italia, 2016). Special wastes are landfilled (Wicker, 2016) both in upstream process (afterwards the production and the delivering) as well as in downstream process (once the textile is used). Less of 1% of materials used to produce clothes becomes part of a closed-loop recycling and less of 2% are recycled in other industrial activities. This is likely due to the currently manufacturing system that operates through an almost linear way (MacArthur, 2017).

Although the framework highlighted, some good practices have been already carried out, showing how it’s possible use textile wastes in several sectors, including the building one. Building sector is only apparently far away from the fashion industry. An example of open loop recycling of fashion wastes used in construction is the California Academy of Sciences in Golden Gate Park in San Francisco designed by Renzo Piano Building Workshop. The thermal insulation materials have been made with over 200.000 pairs of discarded jeans.

Transforming the textile industry according to Systemic Design principles is therefore thinkable, proposing a well-known but fundamentally change: wastes and by-products due their properties might be assumed as inputs of new production systems. Such methodological approach makes it possible to meet the circular economy goals set out in current European Directive (EU Directive 2018/851).

2. EDILTEX – Innovation for reusing in textile companies

The project titled EDILTEX (Carbonaro et al, 2018) – Innovation for reusing in textile companies – is a research aimed at meeting needs to reducing environmental impacts of Small Medium Enterprises, in two textile and fashion districts (Tuscany and Lombardy). DAD’s research team of Politecnico di Torino was partner of the project dealing with some aspects related to reuse and recycling processes. The research was developed with the economic support of *Fondimpresa* inter-professional fund. On the whole commitment and collaboration were implemented sharing knowledge, analysing the production systems and defining different waste disposal opportunities.

The main normative framework aimed at defining objectives, methodology and activities was the Communication "Towards a Circular Economy: Programme for a Zero Waste Europe" [COM(2015)

614] (European Commission, 2015). The European Commission, by introducing the Circular Economy issue into the European public debate, establishes the importance and priority of identifying methods, tools and solutions to recycling by-products and wastes into Secondary Raw Materials (SRM). Besides, it plans an approach to the development of products and processes fully coherent to Systemic Design.

Therefore, bearing in mind the Systemic Design as methodological reference the research was split-up into stages: *Needs finding; Ideation and Prototyping; Monitoring; Business Strategy* (see figure 1).

Each of the items listed above is described in the following paragraphs.

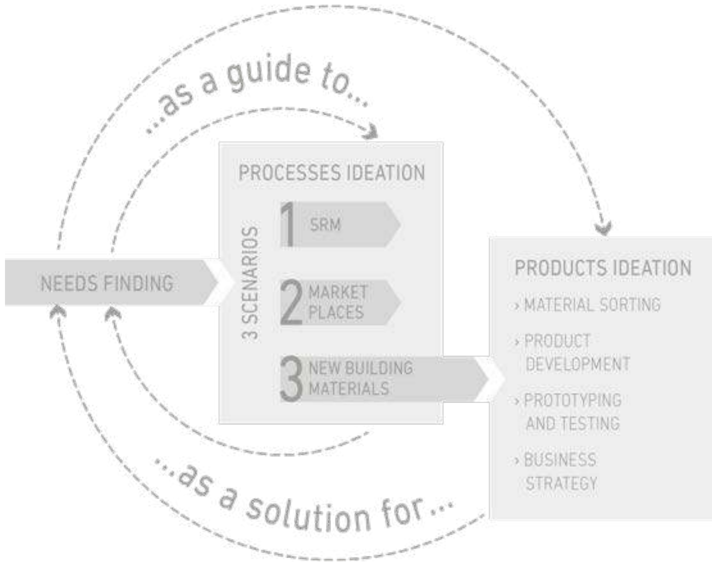

Figure 1. Ediltex project at a glance.

2.1. Needs finding

Needs were pursued through environmental audits in order to point out the most important manufacturing findings and in order to characterise the wastes proprieties and how they could be reused and recycled. Based on the wastes characterisation, some applications for the building sector were identified starting from a study on some international database and several scientific achievements.

For instance, the international MATREC database (matrec, 2019) - allows the search for circular, sustainable and advanced materials for the building and eco-design sectors and covers environmental and technical information. The database includes 21 products from the recycling of textile waste and 37 from leather waste. With regards to building sector, they are mainly used for thermal insulation and acoustic panels and to a lesser extent for wall and floor coverings.

Some interesting studies were found in the international scientific literature. Textile waste was used in addition as thermal insulation blanket (Briga-Sa et al, 2013); researches also include the use of waste fibrous materials in reinforced mortars (Gonilho-Pereira, 2013; Bendjillali et al, 2011; Fantilli, Sicardi, & Dotti, 2017). Scientific paper points out the potentiality of recycling cotton waste as addictive in brick manufacturing in order to improve its thermal performance (Rajput et al, 2012). With regard to leather waste, there are interesting applications concerning the utilization as fine aggregate in concrete (Sathish & Vijayaravind, 2015), or eventually in the production of bricks (Aguiar et al, 2001).

Furthermore, on the basis of the territorial analysis carried out, particularly at a local scale, it was made possible to identify stakeholders (private and public) such as: enterprises interested in recovering and recycling processes (e.g. Maiano); enterprises enable to building-up machinery to recycle textile wastes and to transform them into Secondary Raw Materials (e.g. Cormatex); research bodies focused on innovation in the textile sector (e.g. Next Technology, Material Recycling); public consortia engaged in textile collection and recovery; chambers of commerce in order to develop business opportunities.

2.2. Ideation and prototyping

Matching the information collected, in the *ideation* stage three scenarios were outlined. The first scenario was focused to enhancing textile wastes as Secondary Raw Materials and/or by-products in existing recycling companies. Some opportunities were investigated such as existing enterprises that manufacturing floor mat materials from recycled textile wastes.

The second scenario was addressed to the valorisation of textile wastes in on-line markets (market places). Within such the reuse or recycling chances are not predetermined. They depend on the supply-demand balance.

Finally, the third scenario was aimed at developing new building materials, basically through two activities: the *material sorting* process and afterward the *product development*.

In particular, the research was focused on waste used mainly in wadding manufacturing. These are polyester fibres (PET) and polyurethane foams PUR. PET and PUR were chosen in relation to:

- chemical-physical characteristics of wastes, both obtained from non-renewable raw materials with a high environmental impact, as consequence it is priority to develop reusing and recycling strategies;
- absence – for the time taken into account (year 2017 and 18) - of a recovery chain;
- quantities to be disposed by the companies, on average higher than other types of waste.

As is well known, a building product in order to be used in construction must be able to fulfil a large number of requirements. This occurs both in the case of new raw materials and in the case of Secondary Raw Materials. Crucial in the material sorting is the comparison among properties of wastes and by-products with similar products made up with raw materials (e.g. wool was assumed as benchmark since its properties and since it is usually classified as an ecological material). A correlation was then made (through database and software) between the density value, used as a constant reference parameter (kg/m^3), with the following properties: mechanical; chemical; environmental; physical; thermal; acoustic.

Particularly, the correlation between the density of wastes made with PUR and PET with the absorption coefficient (see figure 2) shows that both wastes - although featured by different specific weights - are characterized by excellent performances to be used as sound absorbing materials.

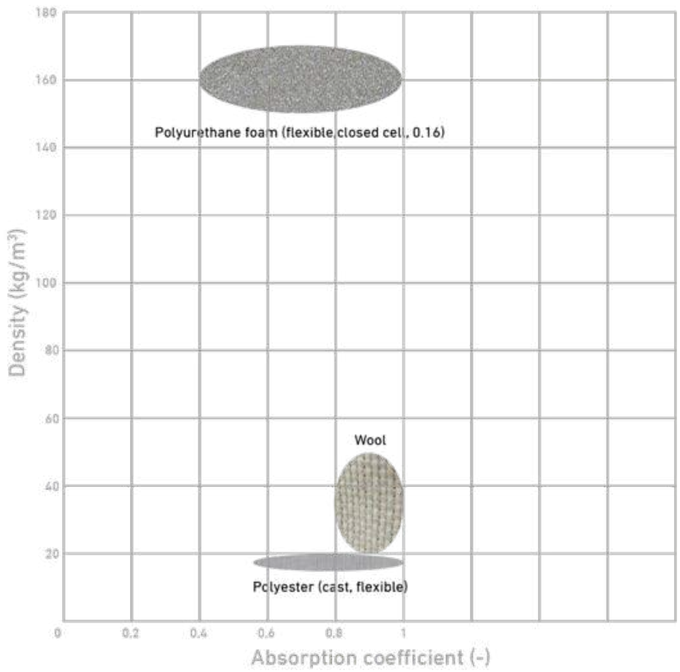

Figure 2. Correlation between density [kg/m^3] and absorption coefficient [-] of PUR and PET in comparison with wool (benchmark material).

The absorption coefficient was ranked between 0.6 and 1, according to PUR or PET chemical-physical compound. Such outcome has influenced the subsequent activities. The research was thus addressed towards the design and developing a product that can improve the indoor acoustic comfort.

As already mentioned, a product to be classified as a building product has to meet different kinds of requirements. The product development was therefore influenced by the current regulatory framework for acoustic comfort. In particular, a technical standard (UNI 11532-1:2018) was taken into account, which states guidelines for the acoustic design of offices, schools and restaurants.

Figure 3 shows the conceptual proposal. In accordance with the acoustic technical standard guide lines, it was decided to *develop a product* featured by overlapped layers. According to absorption coefficient expected, its inner part was made up mostly with PET wastes. The use of such waste is due to the fact that was decided to give firstly priority to waste at a lower mass. A Medium Density

Fireboard (MDF) framework was designed to stiffen the product. However, other scenarios were considered, e.g. by combining the PET and PUR wadding wastes with thermo-formable materials (for instance in case of furniture solutions). An outer fabric, made of leatherwork waste was proposed since leather is an easy maintaining material and overall it has self fire extinguishing characteristics. The product development was completed with the proposal of assembling the layers and sewing them together. As highlighted in figure 4 the product might be implemented both as an internal finishing and as a furnishing element.

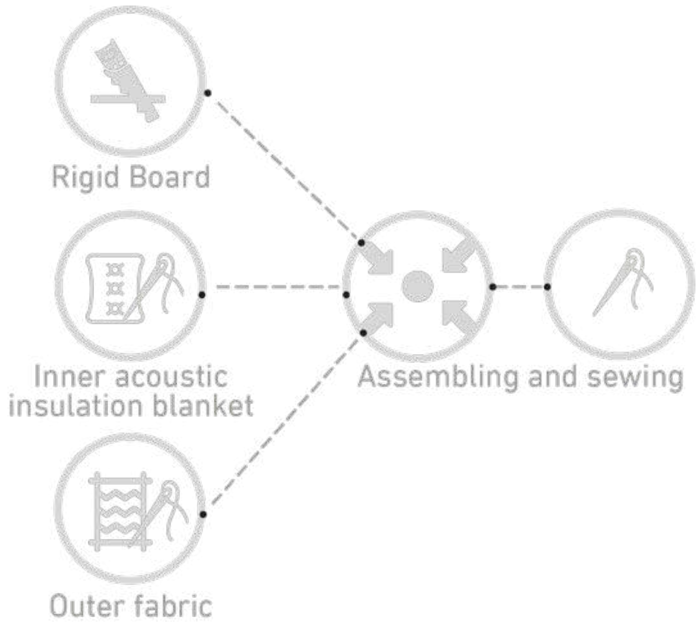

Figure 3. The insulation acoustic product. The proposed materials and assembling.

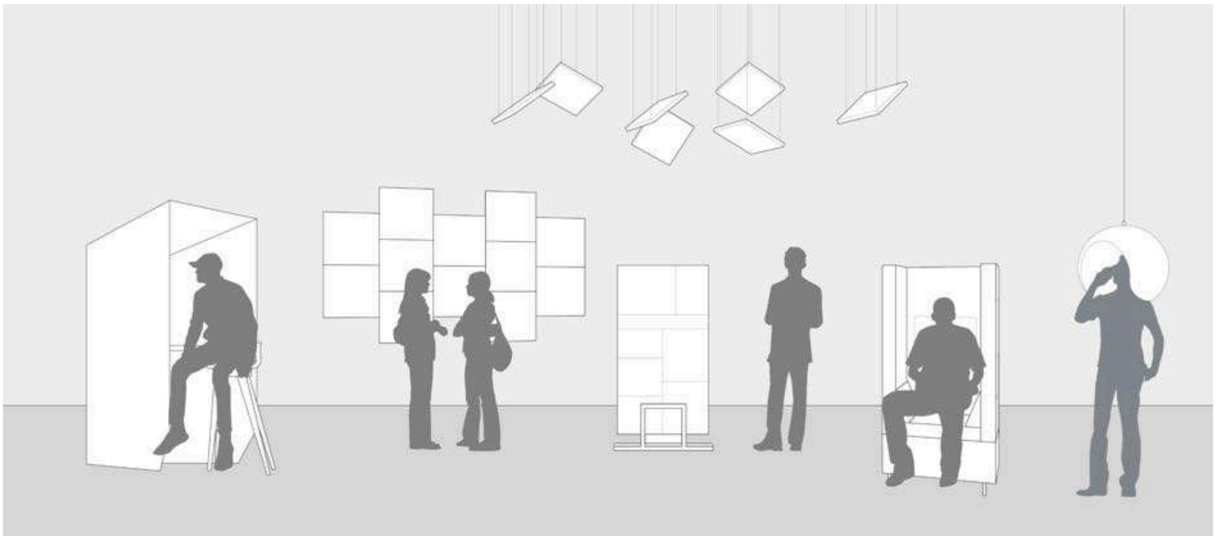

Figure 4. Potential scenarios use of the acoustic insulation product. From left to right: 1) focus area 2) panels; 3) mobile partitioning; 4) think-tank armchair; 5) phone-boot.

During the *prototyping* several experiments were carried out and some interesting achievements were reached. Among the scenarios outlined the activities were focused on manufacturing samples, sized as flat square panels. The wastes were processed at the LASTIN (Laboratory for Innovative Systems) of the Politecnico di Torino as well as the afterward cutting-off and forming of PET wastes samples. Some PET and PUR wadding wastes were tested and they were chosen those more suitable for shaping modular acoustic screens. The external surface was featured both with leather and textile surpluses. The reuse of different trimmings gave a unique pattern in term of size and colour (see figure 5).

Figure 5. On the left, one of the prototype of insulation acoustic screen manufactured within EDILTEX project. On the right, a list of available textile and leather waste samples.

2.3. Monitoring

The *monitoring* stage was involved mainly the evaluation among technique for measuring sound absorption performance. Generally speaking, it is possible to carry out a sound absorption test in three ways:

1) measurement of resistivity to the flow of single materials;
2) measurement of the sound absorption coefficient from normal incidence (sound wave orthogonal to the surface), through the use of Kundt's pipe;
3) measurement of the sound absorption coefficient by random incidence (acoustic wave from all directions) in reverberation chamber.

With regards to the specific characteristics of the prototype, with the support and the scientific collaboration of INRIM (National Institute of Metrological Research), it was recognized that the measurement in reverberation chamber was the most appropriate. The reverberation chamber is an “environment” specifically designed to have no parallel surfaces and it is built-up from hard and reflective materials. Inside, a diffuse field is generated in which the incidence of the sound wave produced by a source is totally random. This type of measurement is the one that allows to have a sound absorption coefficient closer to the real conditions of use. Furthermore, the reverberation chamber test allows to verify the actual acoustic behaviour of the prototype and to outline the absorption curve at different frequencies.

The first monitoring carried out show that some acoustic requirements were met, demonstrating that the characteristics of the selected materials since the pores size and pores disposition are suitable as acoustic screen. This shows the potentiality to develop a building product from a certain quantity of PET and PUR wastes promoting a systemic and symbiotic processes between only apparently disparate industrial sectors.

2.4. Business strategy

Finally, the *business strategy* definition was focused on two main activities: on the one hand side, activities aimed at analysing the technical feasibility; on the one other, activities aimed at assessing the economic viability. Both are still in progress.

The technical feasibility is addressed to developing, prototyping and experimenting the other mentioned scenarios (focus area; mobile partitioning; think-tank armchair; phone-boot) in term of: shapes and sizes; connections and fastening; performances, depending on the intended use. Furthermore, it is planned to install and test the solutions in some pilot sites and monitor their efficacy *in situ*.

At the same time, activities focused on the economic viability has been developing in order to: explore the market, in particular perform primary and secondary research to identify market volumes, areas, trends, segments, barriers; identify the best technological proposition for the market; define the value proposition(s); define a go-to-market strategy.

3. Conclusion

The transition from a linear production process to a circular one entails the implementation of current wastes collection and processing systems. As mentioned designing the supply chain is a crucial part of the business strategy shared with the Small Medium Enterprises, thus their wastes can be effectively exploited as Secondary Raw Materials in an other manufacturing systems.

On the whole the outcomes show that new perspectives in textile production are actionable. They are based on the principles of circular economy and in accordance to a systemic approach matching together sectors such as fashion and building. Despite it is required to managing properly situations of complexity and uncertainty - in which there are no simple answers and lot of efforts are still necessary - a systemic addition is however possible: building and fashion makes “building the fashion future”.

4. Acknowledgments

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References

Aguiar, J. L., Valente, A. R., Pires, M. J., Tavares, M. T. (2001). Incorporation feasibility of leather residues in bricks. 7th Conference of the European Ceramic Society. Euro Ceramics VII, Brugges (Belgium).

Bendjillali, K., Goual, M. S., Chemrouk, M., Damene, Z. (2011). Study of the reinforcement of limestone mortars by polypropylene fibers waste. Physics Procedia, vol. 21, pp. 42-46.

Briga-Sa, A., Nascimento, D., Teixeira, N., Pinto, J., Caldeira, F., Varum, H., Paiva, A. (2013). Textile waste as an alternative thermal insulation building material solution. Construction and Building Materials, 38, 155-160.

Carbonaro C., Giordano R., Montacchini E., Muñoz M., Tedesco S. (2018, June). EDILTEX; new building materials from textile wastes. An experience of industrial symbiosis practices. 24th International Sustainable Development Research Society Conference action for a sustainable world: from theory to practice, Messina (Italy).

Crivelli, G. (2017 May). Textile and fashion industry generates half of Italy’s trade surplus, Il Sole 24 ore digital edition, http://www.italy24.ilsole24ore.com

Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste

European Commission COM (2015) 614. Closing the loop - An EU action plan for the Circular Economy.

Fantilli, A. P., Sicardi, S., Dotti, F. (2017). The use of wool as fiber-reinforcement in cement-based mortar. Construction and Building Materials, vol. 139, pp. 562-569.

Gonilho-Pereira, C., Faria, P., Fangueiro, R., Martins, A., Vinagre, P., Ratão, S. (2013). Performance assessment of waste fiber-reinforced mortar. Materials Science Forum, vol. 730, pp. 617-622. Trans Tech Publications,

MacArthur, F. E. (2017). A new textiles economy: redesigning fashion's future. Retrieved from https://www.ellenmacarthurfoundation.org/

Matrec (2019). Retrieved from: www.matrec.com

Rajput, D., Bhagade, S. S., Raut, S. P., Ralegaonkar, R. V., Mandavgane, S. A. (2012). Reuse of cotton and recycle paper mill waste as building material. Construction and Building Materials, vol. 34, pp. 470-475.

Sathish Kumar, V., & Vijayaravind, S. (2015). Utilization of Tannery Shredded Waste as Fine Aggregate. Concrete. International Journal of Engineering Research & Technology, vol. 4(04), pp. 484-486.

Sistema Moda Italia. (2016). Sostenibilità nell'industria Tessile-Abbigliamento-Moda. Retrieved from https://www.sistemamodaitalia.com/it/sostenibilita

UNI 11532-1:2018 - Caratteristiche acustiche interne di ambienti confinati – Metodi di progettazione e tecniche di valutazione – Parte 1: Requisiti generali

Wicker, A. (2016). Fast fashion is creating an environmental crisis. Retrieved February, 13, 2017.

Natural Fibers Insulation Panels: An adaptive production

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Abstract The research team recently developed an innovative system with low environmental impact for the production of semi-rigid panels for thermal and acoustic insulation, obtained from recycled sheep's wool from Piemonte region. Starting from the previous work, a new semi-rigid panel has been produced, combining sheep wool with hemp technical fibers. Both sheep wool and hemp comes from agri-food systems and are considered as a wastes from existing production chains. Panels show low environmental impact and stiffness as main innovative features, if compared with other similar products on the market. A further experimentation phase allowed to improve the production process adaptability degree to the availability of natural by-products from local agri-food systems, with the aim to develop an "open recipe" able to answer to the building market different requests. The contribution presents the methodology adopted for the research in progress, the "open" technology assessment adopted for panels production and results of preliminary thermal tests.

Keywords: Sheep wool, Insulation panels, Agri-food by-products, Corn bracts, Almond shells, Dry bean pods.

1. Introduction

In Italy the building market is currently characterized by a drastic decrease in new constructions and a increasing importance of existing building stock refurbishment, thanks also to specific public incentives. In public procurement it has been mandatory from 2016 to apply the Minimum Environmental Criteria – CAMs (Decreto Legislativo 19 aprile 2017, n. 56). CAMs are aimed at identifying design solution, product or services, offering the better possible environmental performances along the whole life cycle, taking into account market availability. In the future, their application will probably lead to deep changes in the demand-supply system of the building market, expecting an increasing availability of low environmental impact products, designed within a circular economy perspective. Research in eco-building field is more and more focusing on circular economy issues: starting from a systemic analysis of existing production chains, waste products, currently not recycled, are often analysed in order to find new uses or applications. Circular economy topic were also one of the main pillar of *Cartonlana* research project, born from the opportunity to face the so called sheep wool issue. In Italy, and in Piedmont region, sheep farming is a traditional activity now aimed only at meat and milk production. Sheep wool has become an economic weakness in the production supply-chain due to a double cost: the final disposal and the shearing costs (Bosia et al. 2011). Because of its low quality, Italian sheep wool hardly find use in the textile industry. On the other hand, due to its excellent thermal insulating features, and low environmental impact, sheep wool have been finding increasing use as a raw material for building components production, with an evident paradox: local wool is usually wasted, buried or landfilled, while imported wool, particularly from New Zeland, is used for insulation panels production (Figure 1). In *Cartonlana* (Bosia 2011) research project wasted sheared wool from Piedmont region was collected and used for insulation panels production, defining not only a production process, but also a "systemic" concept for building products design, which follows the main principles of CAMs. After *Cartonlana*, *FITNESs* project have been developed, mixing sheep wool and wasted hemp fibres and testing how the panel performance were influenced changing the original 100% wool composition. In this paper the research team try to further enlarge the research field, working on other wasted material coming from existing agro-industrial productions chains localized preferably in the Piedmont region context or in other Italian regions where sheep wool breeding has an interesting widespread.

As Italian sheep wool, natural waste materials explored for the new research steps, have no use for the farmers and are generally buried, landfilled or disposed otherwise, often generating additional costs, while not finally disposed, using them as a biomass. The aforementioned approach is intended, as in the previous works, to keep new panels with a low environmental impact while, at the same time to recognize economic value to local agri-food by-products, that could help to lower breeders and farmers activities economic management cost.

The research main aim is to develop an "open recipe" based on the previous researches *Cartonlana* and *FITNESs* production process and adapting it to the specific features of the new raw materials, proposed to be used in combination with sheep wool fibers, for new panels production.

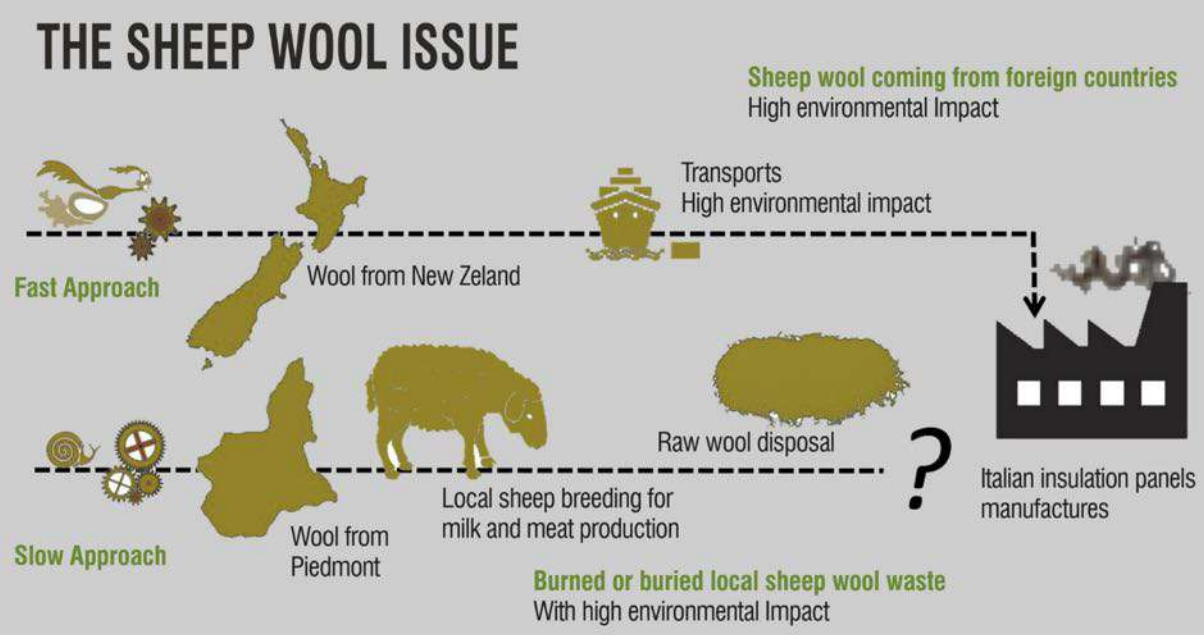

Figure 1. The Sheep wool issue, in Italian market raw wool from sheep breeding is generally disposed as a waste while sheep wool for building insulation products is imported from foreign countries.

2. "Open recipe" – an adaptive production method

2.1. Cartonlana and FITNESs

The multidisciplinary research team, composed by Biella *CNR ISMAC* and *Department of Architecture of Politecnico di Torino* members, in collaboration with the textile company *Davifil* and *Assocanapa*, recently developed an innovative system for the production of low environmental impact semi-rigid panels, *Cartonlana*, for thermal and acoustic insulation, obtained from recycled sheep's wool coming from Piedmont region breeding. Starting from that first work, the production system was implemented, combining in equal measure sheep wool with hemp technical fibers, leading to *FITNESs* panels production.

Both two panels have two main innovative features: unlike the already existing hemp and wool insulation mats, they are semi-rigid products, which allows a wider range of uses in architecture, and they has low environmental impact, as shown by the Life Cycle Assessment (Pennacchio et al. 2017). Panels stiffness was obtained through a production process peculiar feature; the keratin contained in the wool fibers works as a binding matrix and, when drying, constitutes a rigid structure, conferring stiffness to the product. The panels have been tested, both in laboratory and in real use conditions, in order to measure their thermal conductivity and transmittance and their acoustic absorption, demonstrating excellent performance, in line with similar natural products currently on the market. Laboratory measurements showed a thermal conductivity of 0,041 W/mK for *Cartonlana* and 0,040 W/mK for *FITNESs*. As for sound absorption performance, particularly *FITNESs* panels, shown a really competitive sound absorption coefficient value, measured in α_w=0,75 MH, slightly improved if compared to *Cartonlana*'s α_w=0,55 MH (Pennacchio et al. 2017).

Figure 2. *Cartonlana* and *FITNESs* panels composition

2.2. The "charge", an adaptive selection method based on low environmental impact requirements

Starting from *Cartonlana* and *FITNESs* experiences, a further research phase regarding the feasibility to use other natural waste materials or by products, coming from local agri-food systems, to be aggregated to sheep wool fibers in the panels production process is being implemented. The research main aim is to define an "open recipe" for insulation panels production, able to adapt to the real availability of local resources, keeping unaltered the panel main innovative features.

New panels, as those already developed by the research group, consist of two main components:

- a "matrix" based on sheep's wool chemically treated, according to a process patented by the research group able of constituting the rigid keratin structure of the insulating panel;
- a "charge", made up of waste from agri-food chains; natural fibers with no use on the market.

In the "open recipe" the binding matrix is mixed with a "charge" in different proportions fixing the appropriate rules and variables to keep panels thermal and acoustic performances suitable for the building sector.

The research group defined a Technology Assessment to be adopted for the selection of products to be eventually used as a charge. Some principles were fixed, in order to keep as low as possible the environmental impact of the insulation panel. The selection process was oriented to:

- waste materials, without any specific use, from production chains already existing and sufficiently widespread in sheep breeding areas, where sheep wool is available, but currently discarded as a waste too;
- natural waste materials, in order to facilitate the end-of-life disposal, assuming, ultimately, a thermo-valorization as biomass scenario;
- preferably fibrous materials, or however easily to be combined with wool fibers, in order to produce panels with an homogeneous composition.

Considering these requirements, the research group selected the following materials as possible alternatives: wood sawdust, chestnut bark, corn bracts, dry bean plant residual - referring to the Piedmont region territory - and almonds shells - referring to Puglia and eventually Sicily region. After a preliminary analysis of products availability, a local production-chain study (Figure 3) have been developed for corn bracts, dry bean plant residuals and almond shells, while panels specimens have been also produced in laboratory.

2.3. Selected by-products: Corn bracts, Almond shells, Dry bean pods.

Corn bracts are considered a by-product of corn cultivation harvesting; the bracts are single sheath leaves, protecting the corn female inflorescence, an ear that grows sideways to the stem, at the height of the 6-7th node below the male inflorescence, a panicle at the top of the stem (Agraria - Istruzione agraria online 01/10/2018, Dipartimento di Agraria – Università di Sassari (12/09/2018). Corn plants generally present a single ear 10 – 20 long, but occasionally can reach 42 cm length, and 3 – 5 cm large (Assomais, Baldoni 2018), carrying about 1000 dry one-seeded fruit, the caryopsis, each. The female inflorescence is supported by a peduncle generating the bracts, generally in number of 5-6 each flower and representing about 7% by weight of a mature whole corn plant (CRAB 2004). Corn is highly widespread in North Italy, while Piedmont is one of the four regions with the highest corn production in Italy, with a production area of about 140000 ha and about 1.350.000 tons harvested production (ISTAT 2019), despite suffering a sensible decrease of cultivation area of about 33%, after 2014. In Italy, corn harvesting is usually planned in September-October, and it is generally made using a combine harvester machine (Bertolino 2005). A square meter corn plantation area is likely to make about 6-8 corn ears, about 30 – 48 bracts, 40 – 65 t/ha of chopped plant, in north Italy. As a corn plantation by-product, bracts have quite no use, excepting, as biomass and boilers fuel, together with other corn residuals, they are also used in craftsmanship to weave baskets or bags. Otherwise corn harvesting residuals are generally shredded and used as litters in stables or sold on the market as a by-product. Moreover, the large widespread on the regional area, its fibrous nature and low protein content, make it a potentially interesting product to be tested as a “charge” for the panels open-recipe.

Almond shells are considered a by-product of the almond fruits harvesting; the shells are the non-edible parts of the fruits of the almond trees. The almond (*Prunus dulcis*) is a deciduous tree, belonging to *rosaceae* family, genus *prunus*, species *amygdalus*. It is characterized by medium height (from 5 to 7 metres in its adulthood) and slow rate of growth but very long-lived. It generally goes into production around the age of 5 and achieves maximum productivity no earlier than 20 years of age. It well tolerates drought and high temperatures in summer and adapts to dry and poor soils. Its fruit is an ovoid and elongated drupe, with a fleshy, light green coloured and hairy (sometimes also glabrous) exocarp (hull), which detaches when ripe. The endocarp (shell) is woody, whose consistency can be hard or brittle. Inside the shell are contained seeds (almonds). The harvesting period goes from the end of August to the end of September, depending on pedoclimatic conditions and cultivar, when the hull is completely open and almost detached from the shell. The edible parts are separated and collected for commercial uses. Almonds are mainly used by the confectionery industry and, partly, consumed as dried fruits. Currently, more than 93% of national production comes from two regions: Sicily (60%) and Puglia (33%). The total amount of the national production of shell fruits is about 79,600 tons (ISTAT 06/02/2019). Given a yield of 25-30%, remain about 55,000-60,000 tons of non-edible parts (shells) that are merely used in cosmetic industry or become fuel that could be employed, instead, as "charge" for making panels. Moreover, as in Sicily and in Puglia both sheep breeding and almonds cultivation are largely widespread (ISTAT 09/02/2019), there could be the opportunity to build a local sustainable production chain for almonds shells and sheep wool fibers panels.

The opportunity of using the dry bean plant residuals as a "charge" for the insulation panels comes from:

- great material availability in Piedmont region, where 23% of the whole Italian beans cultivation area is concentrated (ISTAT 06/02/2019);

- the expected of thermal conductivity performance, due to the dried plant physical similitude to other kind of straws, already used in building components for thermal insulation for their physical features.

The province of Cuneo could be considered as the most suitable scenario for setting up a panels production because of both sheep breeding and beans cultivation widespread and because of the local beans production identification by the IGP (Protected Geographical Identification) denomination as "Fagiolo di Cuneo". Moreover, another research group from Department of Architecture and Design has recently developed a local beans production-chain and valorization scenario, referred to the IGP denomination, as part of to the EN.FA.SI.2 project (Barbero et al. 2012), funded by Piedmont Region.

The beans are harvested by hand or through threshing in different phases during the autumn season. In the threshing-harvest, the thresher collects the beans, leaving the rest of the plant (stem, leaves pods) in the field, where it completes its drying process. The plant is rarely harvested, more often it is turned in the field, with the risk of soil contamination by parasites. In few cases is used as cattle litter (with lower yield than straw) or burned as biomass to produce energy. On the base of the EN.FA.SI.2 research outcomes, the research group propose to use the entire dry plant for the production of the panels as aggregate "charge" to combine with the sheep's wool "matrix".

Figure 3. Selected by-products features

3. Sample production and thermal conductivity tests

3.1. Sample production

As already mentioned, the production of Fitness panels consists in mixing the fibrous materials (sheep's wool and hemp) and treating them with a chemical bath, which partially turn wool into a keratin glue. The glue sticks the fibres and gives stiffness to the panel. After the chemical treatment the panels are dried, getting enough rigidity to be considered self-supporting, but flexible enough to be easily assembled into building components such as walls or roofs. Compared to Fitness, the introduction of new "charges", needed production process to be adapted to new materials features. In fact, while the in field-macerated hemp presents long and well separated fibres, ready to be easy aggregated with sheep wool (with long fibres, very separated each other) the new charges requested to be processed in advance, before mixing.

In order to define the production process, adapting the Fitness one, different specimens were produced, using the selected products:

- 3 specimens with corn bracts and sheep wool, changing some variables like the two material percentage and the chemical bath composition;
- 1 specimen mixing corn bracts, bean dry plant, wood sawdust and sheep wool;
- 1 specimen with bean dry plant residual and sheep wool;
- 1 specimen composed with almond shells and sheep wool.

During the chemical bath, keratin "glue" produced by sheep wool fibers needs to spread and distribute as homogeneously as possible, in order to provide stiffness equally to the whole panel volume. Both corn bracts and beans dry plant combines less homogeneously than hemp with wool fibers; moreover, since they have not undergone maceration processes, they must be divided into smaller parts, separating the fibres so as to properly mix them with wool.

Corn bracts and beans dry plant samples were produced separating fibres manually, which took quite a time; an hypothetical production scale-up, would require the use of a specific tool or machinery in order to keep the whole process within a reasonable duration.

Despite. Almond-shells haven't a fibrous structure, can were considered an interesting possible "charge" for the insulation panel because of their "quarry" section, which in nature has exactly the purpose of insulating and protecting the almond seed inside. However, during the sample production their aggregation abilities with the wool before entering the chemical bath proved to be limited. So, in order to achieve a proper cohesion between the matrix and the charge, the chemical treatment was prolonged, with a greater production of keratin glue. The result is a sample showing limited thickness high density and low flexibility. Compared to the other samples, the almond shells one proved to be more fragile and less workable then the others, so was not considered suitable for thermal insulation purposes, while other kind of uses in building components could be considered anyway.

Figure 4. Samples produced in laboratory, combining sheep wool with different selected agri-food by products.

3.2. Thermal conductivity measurements

Thermal Tests took place in the laboratory of the *Department of Energy (DENERG)* of *Politecnico di Torino*, on the 300 x 300 mm and 32 mm thick, sheep wool and dry bean pods specimen. In order to be able to better compare resulting performances, measurements were carried out applying the same methodology followed for the previous works *Cartonlana* and *FITNESs*. The thermal tests were conducted according with the heat flow meter method and the EN ISO 12667 (EN 2011) regulation for the evaluation of the thermal conductivity of building products with high and medium thermal resistance, by means of a *Lasercomp FOX600* Guarded Heat Flux Meter apparatus.

The apparatus is provided with two plates generating a temperature difference of 20°C, inducing a heat flow through the thickness of the specimen, placed in the middle. Steady state thermal measurements were carried out at two different average temperature setpoints, respectively of 25°C and 40°C, while the sample was previously dried in oven during 2 days, at a constant 60.5 °C temperature.

Test were held over 24h allowing to define the specimen thermal conductivity λ; according to measurements result, the sample shown an average thermal conductivity of 0.05 W/mK, which is a little higher than Cartonlana and FITNESs', but can be considered quite an interesting result to be improved.

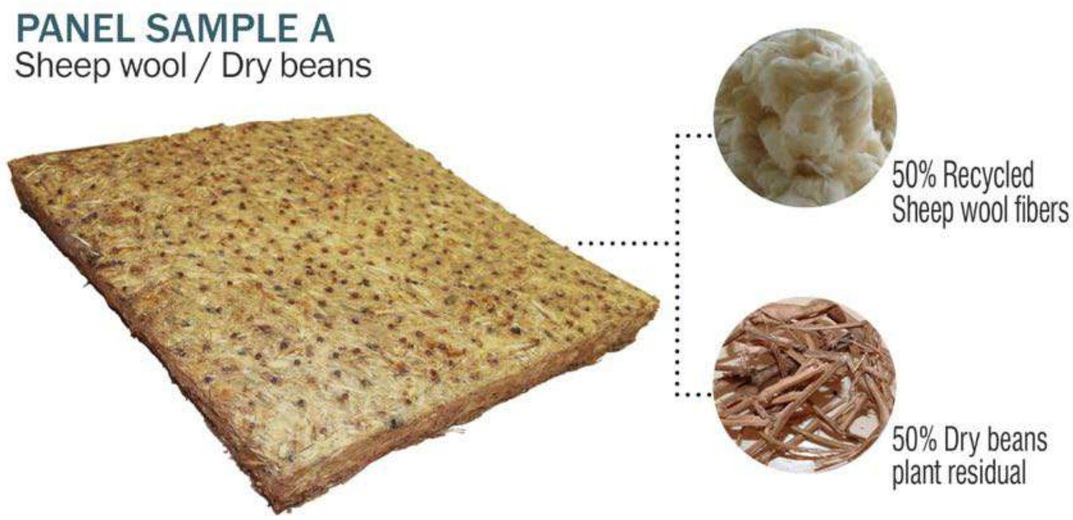

Figure 5. Sheep wool/Dry beans plant residual sample produced in laboratory composition.

4. Discussion

Almond shell have been considered as a possible “charge” for panels production due to its porous section, interesting in terms of thermal insulation features and its large cultivation in Italian regions where also sheep breeding is particularly widespread. Nevertheless because of its non-fibrous shape, chemical treatment during sample production needed to be extended, resulting in a high density, low flexibility and fragile sample. The production of the sheep wool and dried bean plant panel specimen gave a positive result, with qualitative features similar to the already tested *Cartonlana* and *FITNESs* panels, highlighting, however, some difficulties in separating the dried plant fibers in order to improve the workability pf the mixture and the homogeneous distribution of the two different fibrous materials.

Corn Bracts and beans dry plants showed a low homogeneity degree and needed additional work to separate fibers manually and chop them in smaller parts, in order to obtain a proper mix with wool fibers. In a future production scale-up a suitable specific tool would be required. Nevertheless both of them have been considered suitable for thermal insulation panels. Particularly corn bracts, due to their entirely fibrous nature, showed quite a high compatibility with wool fibers and the panels production process oriented at keratin dissolution. However, corn bracts yield cannot be considered particularly interesting with respect to the corresponding corn plants growing surfaces, so dry beans plants residual was chosen for a further implementation of the panel to be thermally tested.

Thermal measurements showed how dry-beans plant residual could be potentially considered as a suitable material to combine with sheep wool fibers for insulation panel production (Savio 2018). Matrix and charge mixing proportions, as chemical bath duration, need further research anyway, in order to improve panel sample thermal conductivity, to bring its thermal performance as closer as possible to *Cartonlana* and *FITNESs*, as to similar products still existing on the market.

5. Conclusion

Sample production tests realized during the research allowed to assess the feasibility of combining sheep wool fibers with other Piedmont region agro-industrial chains by-products or wastes, as a charge for insulation panels production, in accordance to the production method assessed during previous researches.

The encouraging thermal performances shown by sheep wool fibers and dry-beans plant residual sample, also open the research field to not entirely fibrous agro-industrial by-products, to be used in combination with sheep wool fibers for insulating panel production. As a result, also full corn plant field cut residual, containing already tested corn bracts, acquire further additional interest as a possible charge to be used in panels production, due to its high production yield and to large corn production areas in Piedmont.

References

Agraria - Istruzione agraria online (01/10/2018). *Mais o Granoturco - Zea mays L., Atlante delle coltivazioni erbacee – Cereali*. Retrived from http://www.agraria.org/coltivazionierbacee/mais.htm

Assomais (13/09/2018). *Caratteristiche del mais*. Retrived from http://www.assomais.it/caratteristiche-del-mais/

Barbero S., Tamborrini P. (2012). Systemic Design in AgroFood Sector: EN.FA.SI project. In: International Conference on Designing Food and Designing For Food, Londra, 28-29/06/2012. pp. 285-296, London Metropolitan University (http://porto.polito.it/2498253/ since: July 2012 Publisher)

Baldoni, G. (12/09/2018). Coltivazioni erbacee*: Il mais*. Retrived from http://www.ducabruzzi.gov.it/materialididattici/Molari/mais/DIAPOMais.pdf

Bertolino, M., Franchi, R., Frisanco, F. (2005). *Il mais: una storia anche trentina*. Istituto Agrario di San Michele all'Adige.
ISBN: 88-7843-003-X

Bosia, D., Giordano, R. & Savio, L. (2011). Progetto locale ecocompatibile di filiera di prodotto: pannelli isolanti innovativi in lana di pecora. Techne, Journal of Technology for Architecture and Environment, 01, 110-115.
https://doi.org/10.1400/186306

CRAB (a cura di) (2004). *Gli antichi mais del Piemonte*. Borgone di Susa: Provincia di Torino.

CREA – Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria (20/09/2018). *Giornata del Mais 2018: Bergamo 26 gennaio*. Retrived from http://www.ruminantia.it/wp-content/uploads/2018/03/CREA-MAIS-2018.pdf

Dipartimento di Agraria – Università di Sassari (12/09/2018). *Mais – Zea Mays L.* Retrived from https://studylibit.com/doc/5668192/diapositiva-1---associazione-studenti-di-agraria-iaas-sas...

EN 12667: 2001, Thermal Performance of Building Materials and Products – Determination of Thermal Resistance by Means of Guarded Hot Plate and Heat Flow Meter Methods – Products of High and Medium Thermal Resistance, 2001.

ISTAT (12/10/2018). *Istat, Agricoltura e zootecnia*. Retrived from http://agri.istat.it/sag_is_pdwout/jsp/dawinci.jsp?q=plC190000010000012000&an=2017&ig=1&ct=270&id=15A|21A|30A

ISTAT (06/02/2019). *Istat, Agricoltura, Coltivazioni, superficie e produzione – dati in complesso*. Retrived from
http://dati.istat.it/Index.aspx?QueryId=33654

ISTAT (09/02/2019). *Istat, Agricoltura e zootecnia*. Retrived from http://agri.istat.it/sag_is_pdwout/jsp/dawinci.jsp?q=plB040000010000012000&an=2017&ig=1&ct=204&id=8A|9A

Pennacchio, R., Savio, L., Bosia, D., Thiebat, F., Piccablotto, G., Patrucco, A., & Fantucci, S. (2017). Fitness: sheep-wool and hemp sustainable insulation panels. *Energy Procedia*, 111, 287-297. https://doi.org/10.1016/j.egypro.2017.03.030

Savio, L., Bosia, D., Pennacchio, R. & Thiebat, F. (2018). Applications of Building Insulation Products Based on Natural Wool and Hemp Fibers. In R. Fangueiro and S. Rana (eds.), *Advances in Natural Fibre Composites, Raw Materials, Processing and Analysis*. (237-247). Springer International Publishing. ISBN: 978-3-319-64640-4. https://doi.org/10.1007/978-3-319-64641-1_20

3 SOCIO-TECHNICAL SYSTEMS IN THE DIGITAL AGE

New strategies for the refrigerator in the transition towards a circular economy

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Abstract In the last decade, the values of the traditional economy have been strongly challenged, considering the concept of development of the last century as the leading cause of many environmental issues we are facing today. Recently, new strategies have been introduced to provide a renewed concept of development, to achieve a transition towards a circular economy such as the development new revenue models, the importance of intangible value, the merging of products and services as opposed to the strategies of the linear economy. This study carried out a case study on the refrigerator in order to assess which strategies can bring this traditional home appliance towards a circular economy. It has been evaluated every step of its life cycle hypothesising some strategies, following the R-list edited by PBL (Potting et al., 2017) and eventually discussing the need for more strategies on the usage phase and a greater focus on the user as an active part of this necessary change.

Keywords: circular strategies, design strategies, circular economy, predictive maintenance, refrigerator

1. Introduction

In the last decade, the values of the traditional economy have been strongly challenged, considering the concept of development of the last century as the primary cause of many environmental issues that we are facing today. Recently, new strategies have been introduced to provide a renewed concept of development, including some strategies to achieve a transition towards a circular economy that consist for example in the development new revenue models (Potting et al., 2017), a greater importance given to intangible value, the merging of products and services (de Arruda Torresa, 2017) opposed to those of the linear economy.

Another step forward is the introduction of shared responsibility between the consumer, the producer and the recycler, especially for Waste Electrical and Electronic Equipment (WEEE). The European legislation on WEEE, indeed, requires producers and importers to collect and recycle the discarded items from households (Potting et al., 2017), taking care of the end-of-life (EoL) of such products, and the user should dispose of those products in the right way. Consumers can leave electrical and electronic items in the shop where they buy new equipment or take them to municipal recycling centres or second-hand shops (Potting et al., 2017). However, in less regulated fields, many companies continue to pay scant attention to their products after the sale, once the warranty has been expired.

About household appliances, such as large devices and refrigerators and freezers, table 1 provides an overview of the volumes of their collection and recycling in the Netherlands. Discarded equipment could be (i) exported, conferred to Wecycle & ICT Milieu (i.e. two Dutch organisations in charge for the WEEE recycling process) that collect about 30% of large devices discarded and 51% of refrigerators & freezers discarded, (ii) disposed of in other documented ways, (iii) disposed of in not documented ways or (iv) incinerated. The latter option is not practised, although we are aware that in Italy, some parts of the refrigerators (polyurethane foam and other expanded materials) are separated, compacted, extruded in briquettes and then used as solid fuels in the construction sector. However,

the recycling rate in the two Dutch facilities is estimated about 85% (table 2), compared to the recovery rate of 57% (Center for Sustainable Systems, 2016) of home appliances in the U.S.

Table 1. Collection and recycling of discarded electric and electronic equipment, Source Potting et al., 2017

Collection in kiloton in 2012			
	Large devices	Refrigerators & freezers	Total
Dutch market	131	64	175
Discarded equipment	106	49	155

- Export	4	10	14
- Wecycle & ICT Milieu	31	25	56
- Documented otherwise	46	6	52
- Not documented	24	7	31
- Incineration	0	0	0

Table 2. Recycling in percentages of collected equipment in 2014. Source Potting et al., 2017

Collection in kiloton in 2012		
Via Wecycle & ICT Milieu	Large devices	Refrigerators & freezers
- Regulatory aim	75	75
- Realised	85	85

Table 3 shows the refrigerator's material recovery.

Table 3. Composition of output flow of WEE recovery of refrigerators, according to industry take-back scheme, based on real performance recyclers. Assumption of Mt collected by industry across EU (Magalini et al., 2018

EU collection - refrigerator materials		
Material	**Mt**	**Percentage**
Aluminium	0,02	3,3
Copper	0,01	2,2
Glass	0,01	1,3
Plastics	0,08	15,5
Polyurethane foam	0,01	1,5
Steel	0,34	63,4
Other	0,01	1,2
Material to Energy Recovery	0,06	11,7

Strategies focused on the end of life could increase the efficiency of material recovery. However, to progress from 85% to 100% is still a long way to go.

If we want to achieve the 100%, manufacturers should rethink all the materials that currently do not have a profitable recovery, in particular, the ones that lose value and cannot be exploited for a second use (i.e. material to energy recovery, polyurethane foam and some types of plastics). Moreover, considering that recycling, especially the low-grade one is relegated to a linear economy, a more ambitious CE transition towards substantially, lower resource and material consumption and less generation of waste will preferably be based on high-circularity strategies (Potting at al., 2017) that we will see in the methodology section. For this reason, in this study, we focus only on some strategies indicated in Fig. 1 as "extend lifespan of product and its parts", avoiding considering “useful application of materials”.

The tendency to think that the environmental responsibility should fall on government, policymakers and manufacturers, is a reductive vision of the shared responsibility. If we think about the mediatic echo of the recent Plastic-free movement, it has been encouraged by the European Parliament and the Council of the European Union that have reached a provisional political agreement on the ambitious new measures proposed by the Commission to tackle marine litter at its source, targeting plastic products (single-use plastics). From there onwards, the big players are all looking for a strategy to tackle the challenge. However, little attention is paid to possible strategies that companies can perpetrate to give the user an active role, as a prosumer, in environmental challenges, or to inform and change some wrong consumer behaviours, that maybe are given for granted with the use of new technologies/digital systems able to facilitate the communication.

In this study, we take into consideration the use of fuzzy products to reduce the environmental impact of the products in which they are embedded. In the case of home appliances, they can achieve a reduction a decrease of energy use and resource consumption, in the case of the fridge it may also addressing the food waste, in addition to energy consumption. While, over the years, refrigerators have reached technological improvements able to halve their energy consumption (manufacturer's side), all the tests that characterise both energy labels[1] and LCA analyses refer to a refrigerator empty, closed, without any interaction with the user.

Therefore, the indicated energy consumption (expressed in KWh/y) is not only underestimated, but it fails to consider the number of variables that change the real energy consumption once the refrigerator is placed in the real context of use and is affected by the householders' dynamics.

Products, people, environment are three variables that affect each other and determine the real impact of a product during its life cycle. For this reason, the LCA, unbalanced on production and EoL cannot work as an indicator for assessing the real impact of products. Moreover, we cannot refer to a product that is more sustainable than another, if we do not consider usage dynamics and the context in which it is placed. Approximations on these aspects risk overshadowing the benefits of a circular economy if we refer exclusively to measurable indicators. We do know that the usage phase impacts more in products such as the refrigerator, which is characterised by a long lifespan (according to

[1] EU Directive 92/75/EC established a mandatory labelling scheme called EU Energy Label. The directive was implemented by several other directives. The energy efficiency of the appliance is rated in classes from A to G on the label, A being the most energy efficient, G the least efficient. The labels also provide other pieces of information to the customer to compare and choose among different products.

Bakker at al., 2014 the ‘optimal lifespan’ of new purchases is now estimated around 20 years) and a continuous use (400-1100 KWh/y according to the related energy class).

In this paper, we take into consideration how products could continuously evolve after their implementation (Hansen et al., 2008) and how manufacturers could benefit from them throughout their life cycle, delivering new services while changing their revenue models. This approach leaves room for addressing every step of the traditional life-cycle in a more circular way, shifting the focus on a more complex vision about the product. This scenario could radically change by introducing new business strategies such as reducing product ownership through sharing, remanufacturing activities and so forth, while extending the product lifespan, without the need to rely on linear strategies such as planned obsolescence, company downsizing, delocalisation or the push on the purchase of more goods.

2. Methodology

Various approaches, known as R-strategies, have been developed to achieve less resource and material consumption in product chains and make the economy more circular. Several R-lists exist (Potting et al., 2017, CE and MVO, 2015; EMF, 2013; RLI, 2015; Vermeulen et al., 2014) in order to give an identity to these strategies and to share them with policymakers and manufacturers. In this study, we refer to the R-list represented in Figure 1.

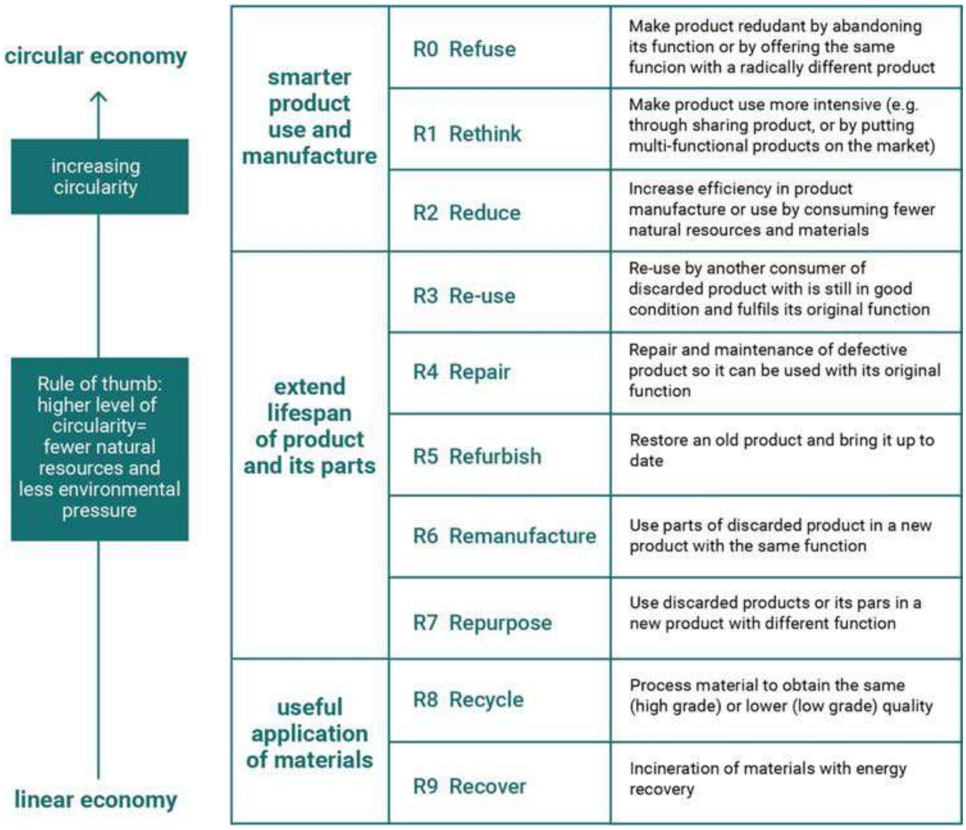

Figure 1. Circularity strategies and the role of actors within the production chain (Source: Potting et al., 2017)

These types of list all elaborate on the *Ladder van Lansink* which establishes a priority order for waste treatment methods on a Dutch level, similar to the influence of the waste hierarchy on an international level (Potting et al., 2017; EC, 2010).

They differ mainly in the number of circularity strategies they indicate and they typically present a range of strategies ordered from high circularity (low R-number) to low circularity (high R-number). Nevertheless, when Circular Economy best practices are analysed, they often fall back on efficient ways of recycling, thus remaining low in the R-list (R8- high R-number). A few examples are able to satisfy high circularity strategies, among which the most well-known are referred to the sharing economy (R1 - Rethink), which apparently has some benefits on the decrease of the ownership of material goods, the full exploitation of products, real-time maintenance, but can also lead to undesired effect (rebound effect), well-explained by Potting et al. (2017). However, these strategies lack the user's active involvement and little or no attention has been paid on the usage phase that for some products is the phase that impacts the most. It is the case of large appliances such as the refrigerator that are characterised by high durability and a high cost to operate.

Moreover, observing both Figure 1 and 2, we can notice how these strategies mainly involve EoL scenarios, without addressing both the usage and partially the design phase.

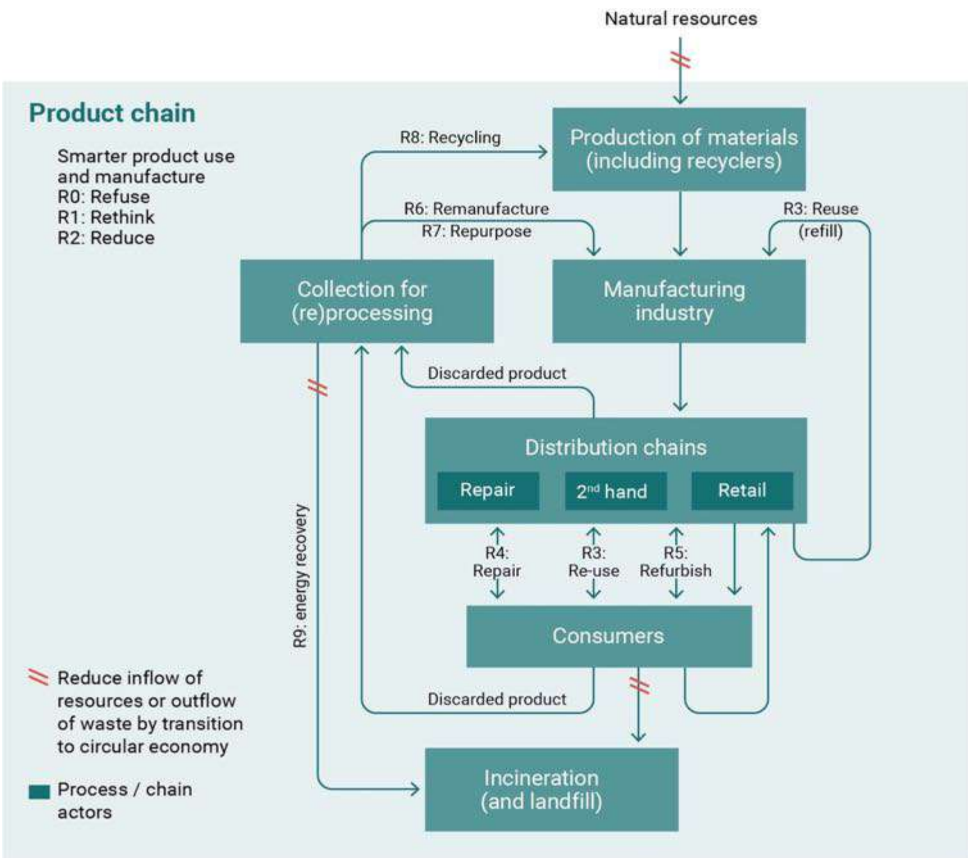

Figure 2. Circular strategies and the role of actors within the production chain (Source: Potting et al., 2017)

In figure 2, indeed, consumer represents the use phase and the box related does not have any outcome. About the manufacturing block, instead, some strategies (R0, R1 e R2) are shown on the left side. We can consider the design phase included in the manufacturing phase, although we prefer to keep them separate later in this paper. The same work seems to indicate that the sole responsibility attributable to the user is related to the correct disposal of the product, relegating the user to a rather marginal and not very active role.

In this paper, however, both the design phase and the use phase play a fundamental role in reducing environmental impacts and should be addressed and innovated with new strategies. For the household appliances' value chain, the design phase impacts the EoL direction the product will follow after discarded, while the usage phase weighs heavily on the energy of the housing sector.

In their type 2 CE transition, Potting et al. (2017 p.17) stated that:

> *"It is possible to design [..] a washing machine that lasts longer, is easier to repair and can be readily disassembled at the end of its lifespan. This is technologically far less invasive than developing a radically new technology, leading to a fundamentally different product grounded in a fundamentally new knowledge base and within a new innovation system. CE transitions around incremental technological innovation lead to adaptations to an existing product within an existing innovation system. Consequently, this* ***makes the adapted products less easy to distinguish from their previous versions. After all, there is little technological difference between the old and the new product, and no new innovation system has had to be built.*** *Here, to keep track of progress, the subtle changes in existing innovation systems need to be monitored, rather than the development of distinct new innovation systems."*

However, innovation can be related to product design instead of technology. This kind of innovation does not imply that the product cannot be distinguished from previous products. Indeed, it could be more distinguishable for functional and, by consequence, formal changes.

3. Results

We adapted some of the strategies of the circular economy listed by Kirchherr et al. (2017) within the standard life cycle of the product (Figure 3), by facing the gap of a certain lack of circular strategies related to the use phase. Hence seven strategies have emerged, two of which are based on the early design stage, three strategies are suitable for exploring new scenarios based on the concept of flexibility, and two strategies are based on the idea of predictive maintenance.

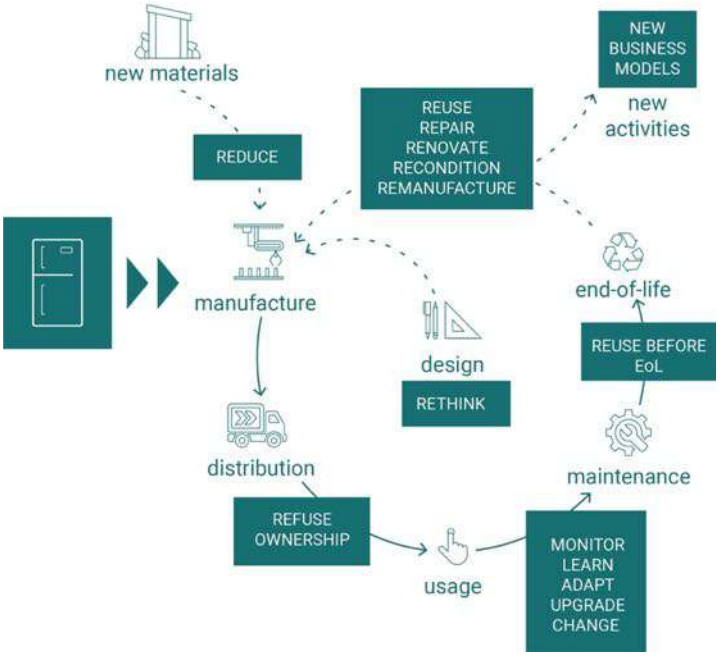

Figure 3. Introduction of circular economy strategies within the standard life cycle of the product

3.1. Design Strategies

This first section provides two examples of investigating design strategies for pursuing product innovation or its optimisation (Figure 4).

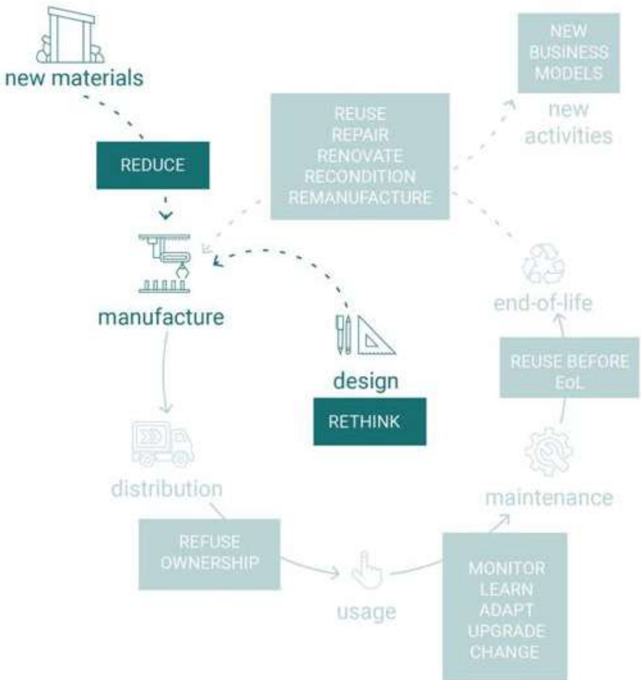

Figure 4. Design phase - rethinking and material reduction

Rethink (R1)

Improving the environmental sustainability of a home appliance does not mean just replacing parts, changing materials and designing for disassembling, but it could also mean rethinking functionalities and aesthetics to adapt to the user's renewed need and better respond to the functions that are expected to be delivered. Moreover, by changing the functions, we can obtain a reduction in environmental impacts introducing new processes that are not even comparable with the original ones (e.g. using the last rinse of the dishwasher and the washing machine for the next cycle reduces the use of water, even if the whole process does not use less water). If we consider the design strategy “design by components” (Bistagnino, 2008), the shape of each part should reflect the function it performs. If we consider the washing machine, the current form is dictated by the standardised space dedicated to this appliance within the bathroom furniture (60x60cm). Therefore, the washing machine has the shape of a box, almost empty inside. According to the Design by Components, the washing machine should have the shape of its functional components, showing the pipes and the parts to be maintained. This is what we mean to completely rethink a product (R1) and its functions and the reason why we need to give value to the design phase to obtain product innovation.

Optimise and reduce materials (R2)

Regarding the optimisation of the product, both designers and manufacturers could rely on one of the Design for X (DfX) strategies (Fiore 2018). Otherwise, they could carefully consider the materials to be used to reduce the impact of its components, i.e. using materials from renewable sources, take full advantage of the mechanical, chemical and performance characteristics of each material chosen, use materials according to the expected duration. For long-lasting product, one option could be choosing materials that age gracefully, easy to clean and which do not change characteristics over time. In general, reducing materials and lighten the weight of components can lower the impact on production and transport. Choosing additive manufacturing strategies, where possible, could lead to completely change the aspect of components if we choose “design for additive manufacturing” (DfAM) as a design strategy.

3.2. Product Flexibility

This second section provides three non-inclusive examples of exploring new scenarios based on flexibility, empower the user to personalise the object and develop new behaviours of purchase, use and consumption.

Refuse ownership (R0):

The first scenario in this section could be the integration of sharing or pay-per-use strategies, that leads the user to reduce the ownership of goods (Figure 5), by paying for the actual product use, saving money when the product is used in a virtuous way. In this paper, an in-depth analysis of scenarios is carried out, based on the literature which considers ownership and planned obsolescence as two obsolete strategies.

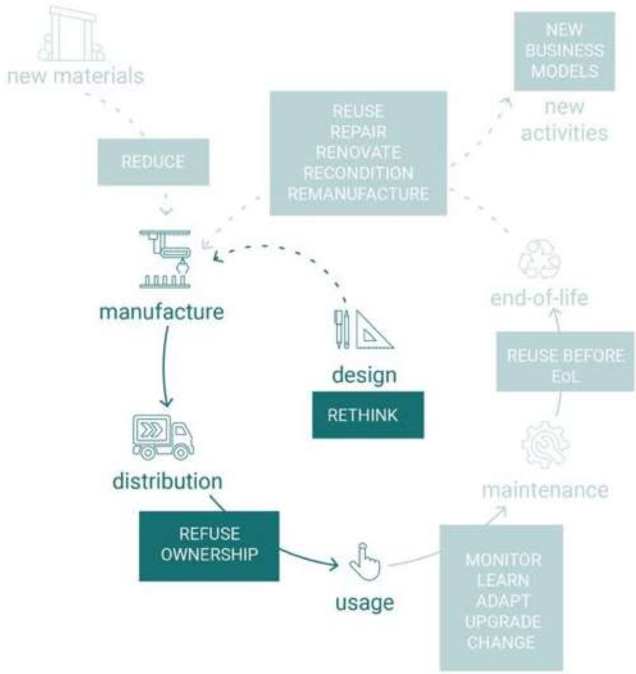

Figure 5. Refuse ownership

However, Italian households are accustomed to having their own appliances, and thus, they are not inclined to sharing household appliances. In other northern and western European countries, however, residents of flat complexes typically use centralised laundry facilities for example (R1a). In those cases, the costs for maintenance, repair and renewal are factored into the rent or contributions to the owners' association (Potting et al., 2017). This kind of services could be implemented with digital systems to facilitate booking a machine and paying for its use. In this regard, sharing refrigerators and freezers with other households seems less obvious. However, in some countries, refrigerators and freezers are already often included in the rental of flats and houses. Regarding the refrigerator, how suggested by PBL (Potting et al., 2017) homeowners or landlord (on behalf of all tenants) could refrain from buying a product and instead go for a service&use contract with the manufacturer (R1b). This encourages manufacturers to continuously improve their equipment, for example, by designing them to be easy to repair and refurbish by replacing components (R4 and R5).

Product evolution (Rethink R0)

Focusing on the usage phase, the software update is just an example of a product that evolves over time, changing and adapting to external changes (e.g. technological). What if the same concept would be extended to every part of the product and every step of the life cycle? In this scenario, the user purchases/rent a product and then he/she could transform it and shape it according to his/her needs with components and functions that can be integrated or updated. However, the user alone is not enough to put this strategy into practice, but he/she need to be supported by a careful design of how this product service system (PSS) works. Therefore, updates must be planned and provided by the manufacturers, as well as possible integration in functionalities and components should be foreseen in the early design stage.

Product adaptability (Rethink R0)

About the user's relationship with the product and vice versa, what if the product could change its behaviour according to contextual factors, usage information and the habits of those who use it? In this scenario, the user purchases/rents a product, he/she starts using and providing feedback to the product and after a while his/her expectations will be delivered, because the product evolves to meet user's requirements and expectations. Equipping products with intelligence makes them adapt and respond to change and remain fit-for-purpose over more extended periods (McAloone and Pigosso, 2017; Ellen MacArthur Foundation 2015). In this perspective, IoT data can be used to improve current products, but also for developing virtual services and sharing economy platforms to support the technical lifetime. The introduction of learning systems can transform the product into a fuzzy logic product (Lanzavecchia et al., 2012) which pursues environmental goals such as the reduction of impacts, the correction of wrong user behaviour and so forth, according to the actual use of the product by the user.

The latter two strategies are shown in Figure 6.

Figure 5. Refuse ownership

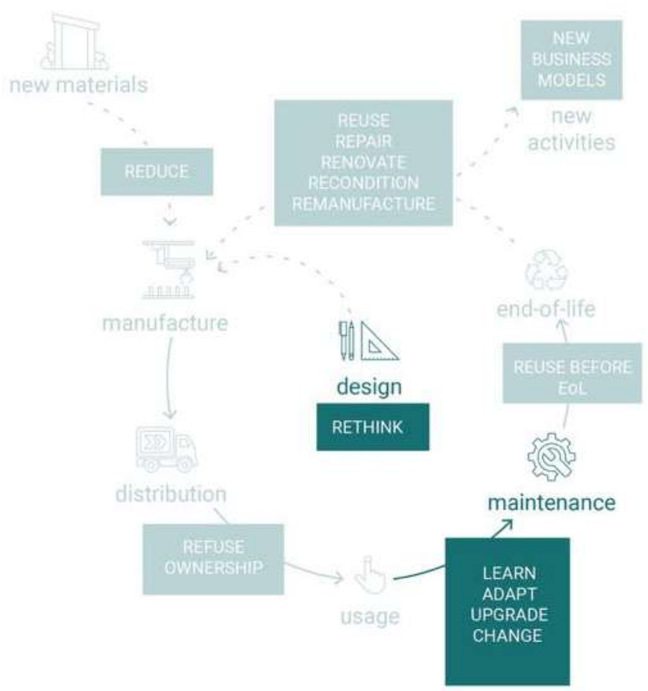

Figure 6. Product evolution and adaptability

3.3. Predictive Maintenance

This third section of the result, instead, investigates how to combine IoT data with the design of new products, suitable for addressing the usage phase and the following phases of the life-cycle. McAloone and Pigosso (2016) suggested that combining IoT data with participatory tools IoT could be one driver for the success of the circular economy, together with sustainable design/eco-design and Business model innovation. The circular economy can benefit from this intelligence for up-cycling processes, monitoring the condition of individual components or whole product systems. Data about the real use of a product can be collected for a short time, with an object instrumented ad hoc for the experiment or alternatively on the marketable products.

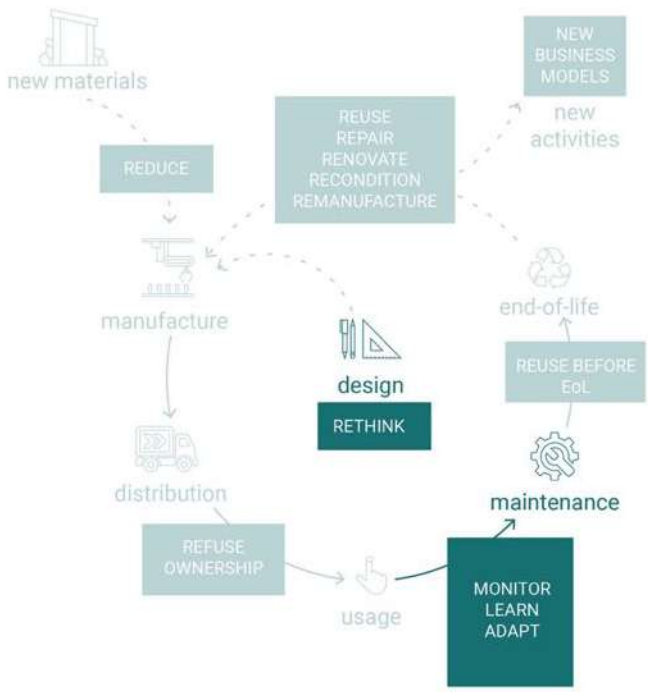

Figure 7. Monitoring strategies

Monitoring experimental products

In the first case, the product or its components can be monitored with experiments, to make their recovery suitable for a second valuable use. The R&D or design team, indeed, could study a prototype and then make projections over time of the expected use to determine when the object should be replaced or updated to obtain the maximum value from it. This could be the case of the following three examples, considering:

- Functional groups of components, i.e. a system of parts grouped by a specific function;
- Essential components, whose breakup will compromise the whole product functioning, eventually leading to replace it;

- Wearing parts, which can be easily replaced. Some relevant indicators should be defined and verified by measuring them through ad hoc experiments on these components, providing a more precise knowledge of the system.

Monitoring the final product

Monitoring some parameters of the refrigerator as a form of predictive maintenance could also be performed on real products, to provide added value services throughout the lifecycle. It could be done by introducing a few sensors on the final product that will be delivered to the user, to allow continuous data transmission of the most important indicators. Among the possible outcome, detect failures in advance, notify, inform, communicate are only a few possibilities, and it raises the need for learning systems able to recognise patterns, together with a platform on which to share and communicate directly with the user.

In this paper, we decided not to go through the end of life strategies, since many works already addressed them.

4. Discussion and conclusions

In this study, we focus on a specific product chain, the one that refers to the refrigerator. CE transitions based on higher circularity strategies call for more radical change throughout the whole product chain than transitions based on lower circularity strategies. For this reason, this paper refers to circular strategies that range from R0 to R6. Potting et al. (2017) proposed innovation in enabling technology, product design and revenue models as important strategies to facilitate changes.

In the first section related to the **design strategy**, we focused on the role of designing for reaching a deeper change in new products, for pursuing product innovation or its optimisation. We considered rethink strategies such as “design by components” in order to obtain a reduction in environmental impacts introducing new processes that are not even comparable with the original ones. We also considered general strategies for optimising and reducing the materials (R2) drawing from “Design for X” strategies, including strategies to extend the product lifetime (choosing materials that age gracefully, easy to clean and which do not change characteristics over time) and “design for additive manufacturing”.

In the **product flexibility** section, we addressed the introduction of sharing services which poorly addressed the refrigerator, but they adapt better to other appliances. This approach would require a change in the mind-set of residents since, at present, the market is dominated by privately owned appliances. We have seen the introduction of different revenue models in which home appliances remains the property of the manufacturers and is returned to them at the end of the equipment’s service life, giving both manufacturers and consumers a more active role in product management (Potting et al., 2017). In this section, we also highlighted the need for smarter manufacturing and use of products (Potting et al., 2017) using fuzzy logic products. Focusing on the usage phase, we highlighted the need to design functions that can be integrated or updated after the product has been delivered and the need for carefully designing new product service systems (PSSs). We also investigated the need for a feedback system to allow an exchange of information between the user and the product. Collecting and elaborating feedback could be a strategy to deliver new functions of the product and make them evolve over time.

The two scenarios provided in the section **predictive maintenance** have different purposes. The first deal with instrumented objects used for testing and monitoring objects to intercept the product when is suitable for a second use (R1, R3), before it reaches its end of life, avoiding the product disassembly by preserving its integrity.

The second aims to reconfigure the product through repairing, refurbishing and so forth (R4-R5-R6) to obtain real-time data and intervene promptly, shaping the object behaviour on the user habits and behaviour. This could be possible by interacting with the user, facilitating the predictive maintenance (R1, R4), upgrading or replacing parts (R4), improving the product or eventually allowing the product to adapt to changed conditions (R1) and learn from users' usage (R1). Both scenarios would require analytics to measure and combine data inputs over time (Henne, 2015). The proposed strategies are suitable for both current product-centred economy and a future service-centred one, providing directions for further studies that want to address the extension of the product life cycle while promoting efficient use of the product itself. IoT data open a variety of possibilities in monitoring, accessing more precise knowledge of both home appliances and households, useful for design purposes.

In conclusion, to achieve such a transition toward a circular economy, we should challenge existing ways of consuming, producing and doing business.

References

Bistagnino L. (2008) Il guscio esterno visto dall'interno. CEA, Milano.

Bakker, C. A., Wang, F., Huisman J., and den Hollander M. C. (2014). Products that go round: Exploring product life extension through design. Journal of Cleaner Production 69: 10–16.

CE and MVO Nederland (2015). The potential for high value reuse in a circular economy. Online publications (Consulted May 2016.

Center for Sustainable Systems (2016) Municipal Solid Waste Factsheet. Retrieved April 2017, from http://css.umich.edu/

de Arruda Torresa P.M. (2017) Design for Socio-technical Innovation: A Proposed Model to Design the Change, The Design Journal, 20:sup1, S3035-S3046

Ellen MacArthur Foundation (2016) Intelligent Assets: Unlocking the circular economy potential, Report of the Ellen MacArthur Foundation, February 2016.

EMF (2013). Towards the circular economy. Economic and business rationale for an accelerated transition. Online publication. Ellen MacArthur Foundation (EMF).

Fiore E. (2018) Integrare i dati nella progettazione di prodotti complessi. Un approccio sistemico e multidisciplinare applicato al caso studio di un frigorifero, In: FRID 2017 Sul metodo/Sui metodi. Esplorazioni per le identità del design. pp. 371-384

Hansen, S., Berente, N., Lyytinen, K. (2009) Requirements in the 21st century: current practice and emerging trends. In: Lyytinen, K., Loucopoulos, P., Mylopoulos, J., Robinson, B. (eds.) Design Requirements Engineering. LNBIP, vol. 14, pp. 44–87. Springer, Heidelberg

Henne, B. (2015) How IoT Data Becomes Valuable Intelligence. Retrieved June 20, 2017 from http://blogs.ptc.com/

Kirchherr, J., Reike, D., Hekkert, M. (2017). Conceptualizing the circular economy: an analysis of 114 definitions. Resources, Conservation and Recycling 127, 221-232

Lanzavecchia, Barbero S. and Tamborrini P. (2012) Il Fare Ecologico. Il prodotto industriale e i suoi requisiti ambientali. Edizione Ambiente, Milan

Magalini, F., Kuehr, R., Huisman, J., Deubzer O. And Sinha Khetriwal D. (2018) Material Flows of the Home Appliance Industry - CECED Retrieved January 2018, from www.unu.edu

McAloone, T.C. and Pigosso, D.C.A. (2017) From ecodesign to sustainable product/service-systems: a journey through research contributions over recent decades. In Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives (ed. R. Stark, G. Seliger and J. Bonvoisin), pp. 99–111. Springer International Publishing.

Potting, J., Hekkert, M., Worrell, E., Hanemaaijer, A. (2017) Circular economy: measuring innovation in the product chain. Policy report. The Hague: PBL Netherlands Environmental Assessment Agency.

Rli (2015). Circular economy. From intention to implementation. Council for the Environment and Infrastructure (Rli), The Hague.

Vermeulen WJV, Witjes S and Reike D. (2014). Advice about a framework for measuring the impact of circular procurement. Faculty of Earth Sciences, Utrecht University, Utrecht.

Cleaning & Facility. A co-design process to create systemic relations from services to products.

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Abstract

The paper illustrates a service project performed with a co-design approach by the stakeholders of a cleaning system Consortium for the contract market sector, with the scope of all the different user's inclusion and creation of a systemic relations toward a participatory economics. This new service aspires to get more effective and efficient the offered performances of the Consortium, combining the cleaning service with some facilities management activities, as the space's control in order to little maintenances. The Consortium who commissioned the research, in particular, has requested to the University Design team, skilled in the development of ICT based services, HCD and ID, to identify and valorise, through the new service, virtuous relationships among actors, processes and tools of the complex supply chain of cleaning and facility activities.

Keywords: co-design, system design, service design, user experience design, cleaning and facility

1. The Cleaning & Facility management sectors: which contributions from Design?

The Consortium that commissioned this research provides services for the professional cleaning sector at different levels, both for the civil sector - from the condominium to the school - and for the sanitation sector - from the hospital to the food company - in this case with hygiene standard much more severe. It includes the entire B to B supply chain (business to business) and consists of a manufacturer of trolleys, manual equipment and cleaning textiles, a research center for the sustainable production of chemical detergents, as well as product distributors and service providers to cleaning companies in terms of technical information, security and training.
Founded in 2014, the Consortium represents an interesting model of support for the activities of cleaning companies and stands out for its high level of sustainability and innovation, both technically and socially.
Just from the activity of support to cleaning companies that participate in demanding public contracts, the Consortium observed how today the professional cleaning sector often find hybridization just with that facility, aimed at managing and maintaining spaces and buildings together with their systems and services connected.

Inside of this flourishing sector, the sub-cleaning sector is therefore a very important component: on average with other European countries, the cleaning sector in Italy represents 2018, a quarter of that of maintenance, both in terms of employees (240,700 part of 1 million) that of turnover (15 billion euros part of 62 billion). This estimate is quite easy to understand, if we take into consideration that the facility system and in particular the cleaning system, recognize the remuneration of the employees as the first item of the financial statement.
In this scenario, therefore, there are many cases of synergy between the Cleaning and Facility sectors, for two reasons:

- the synergy brings with it an economy of scale in the management of each individual site, where in relation to the increase in the quantity of services offered and therefore of man-hours required, the general expenses and management of the construction site decrease. This, in general, translates into a benefit for both the company and the customer;
- the offer, not of a single competence but of more integrated skills, favours the demand for innovation, both of a technical nature both managerial. The introduction of the Facility Manager, for example, is a demonstration of management innovation that acts through an open mind figure formed to provide advice and updated skills on the subject of the organization of corporate services in an inter-related and integrated form, able to relieve the company from the continuous updating required at the legislative, social security, but also for ethical progress.

Acting in this scenario, the Consortium built its own vision based on the sharing of relationships between the various actors of the system, supported by a selection of objectives in terms of innovation. He also embraced the Design Thinking approach, which presupposes defining objectives with limited actions over time and the resources used, and has called Research Design as a consultant, engine and director of personalized innovation processes (Celaschi, 2008).

Processes in which, in the wake of nature, other knowledge is called to participate: cognitive ergonomics and psychology as regards evaluation methods in the UX context; management engineering for the development and strategic/economic evaluation of co-design processes;

project Design for the conscious and creative development of new product and service activities; while the technical aspects remain the responsibility of the Consortium's know-how.
The priority was given to "co-design processes", addressed in two phases (Figure 1):

- in the first phase they found application, for the first time in the experience of the Consortium, the HCD and UXD assessment methods for the quality measurement of leading consortium products (trolley and related equipment), through the direct involvement, as evaluators, of the site operators in the workforce cleaning;
- in a second phase, the most illustrated in this article is still underway, has come to life a new "digital platform", with the aim of improving the management of the cleaning service on site, the measurement of the performances offered by materials and equipment for cleaning and the integration to the cleaning activity of some tasks related to logistics (small maintenance).

It is therefore a digital service that provides a participatory approach (co-design), from all the actors in the supply chain, able to trigger shared relationships between: the consumer, the site operator, the site coordinator, the cleaning company, the supplier/manufacturer.

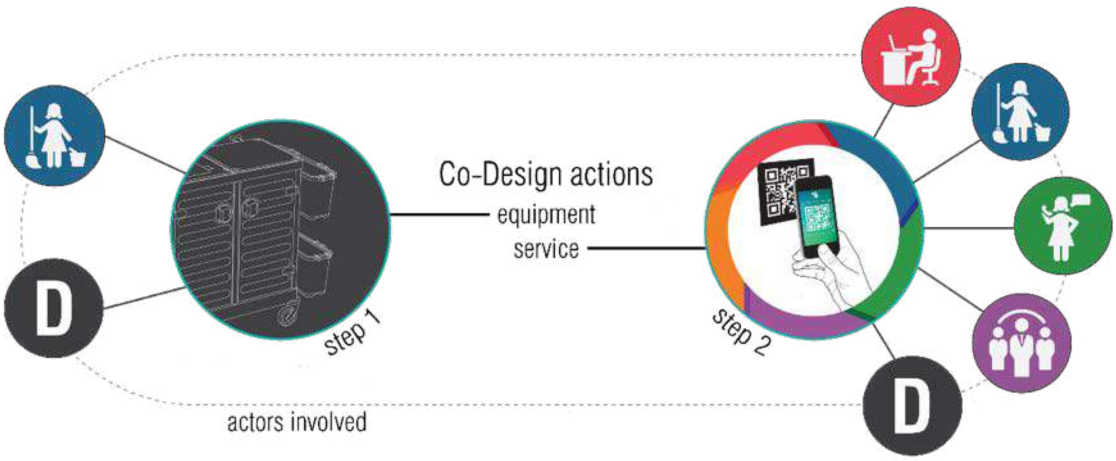

Figure 1. Co-design actions and related actors involved in the project.

2. The question changes: from the "how" to the "what"

The two phases of action show how the Consortium has immediately formulated, in line with the instinct of the company, a first question about "how" products could be innovated, especially those already considered leaders. The Design has responded to this first solicitation of the product by introducing inedited evaluation methods that see the participation of the cleaners as evaluators and suggestions for improvements (co-design), then shifting their gaze to the "what" between the objectives innovation was more attractive and not expressed either as a customer requirement or as a market offer (Germak & Bozzola, 2010).

The strategic objectives of innovation presented by the Consortium are divided into 5 points (fig.2):
1 - Ergonomics: development of equipment with ergonomic and technically performing solutions;
2 - Hygiene: development of innovative and efficient cleaning processes;
3 - Sustainability: product certification, welfare and worker participation;

4 - Speed: accelerate and optimize cleaning operations for greater economy and profit;
5 - Management: computerization and integration between cleaning and logistics services;

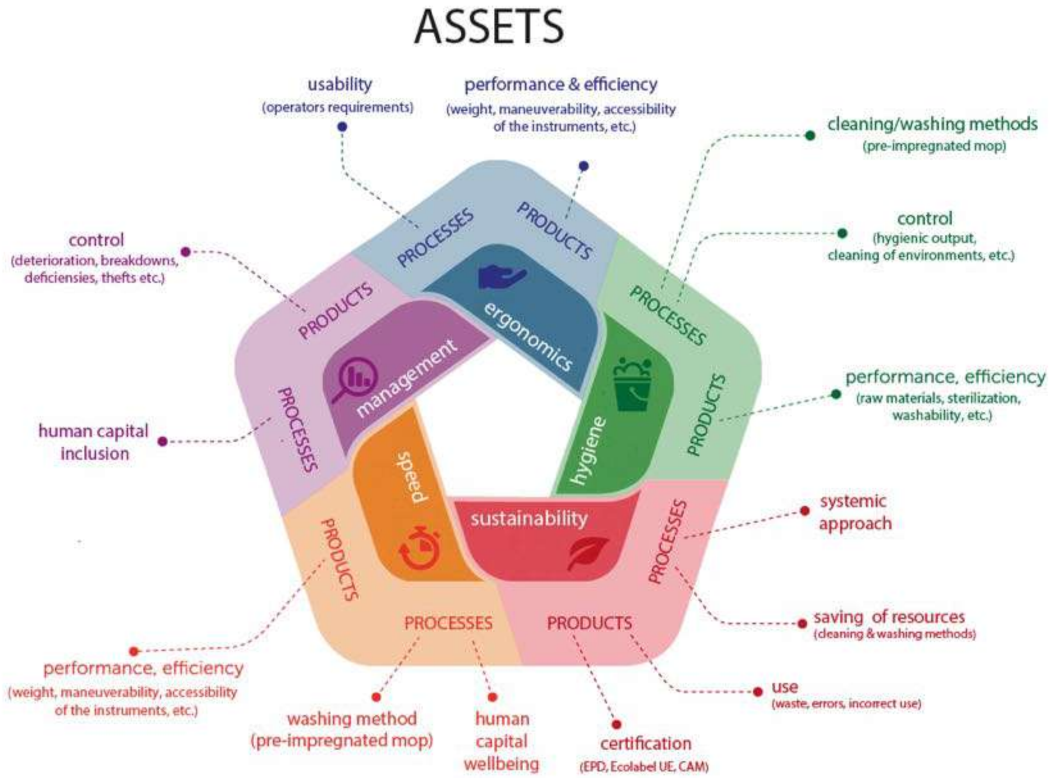

Figure 2. The 5 innovation directions identified by the Consortium. In a clockwise direction, the first 4 relate to the product, the fifth to the cleaning service.

In the first phase, "how", the UXD (User Experience Design) team considered that the new collection of cleaning trolleys is of value, a perception confirmed also by the operators in the role of evaluators, because it introduces the method of cleaning floors with pre-impregnated polyester strips, instead of washing with water. This method is not new, but it certainly deserves for the high level of sustainability, efficiency and practicality of use, to be promoted at the cleaning companies.

This because, as says Norman the "User experience" encompasses all aspects of the end-user's interaction with the company, its services, and its products. The basic requirement for an exemplary user experience is to meet the exact needs of the customer, without fuss or bother. (Norman & Nielsen, 2007)
The clinical investigation carried out on the new family of trolleys has highlighted many strong points and some weaknesses at an ergonomic/functional level, but not the need to rethink a new product today. While the co-design method with which confirmations and/or new needs have been identified represents a real innovation for the Consortium.

Therefore, since the margins of innovation on the trolley product are reduced, the interest has shifted to the strategic efficiency of the "process" that regulates the cleaning service and has led reflection on the evaluation of effectiveness and efficiency of the relationships that could be established between the different "subjects" involved in the activity, if these links were seen as systemic elements.

The activity in question, called Cleaning Design Process, therefore represents the second phase of the research/project carried out in collaboration with the Consortium and is aimed at developing an innovative design solution for the service, aimed at integrating the role of cleaning with that of the facilities.

3. The cleaning trolley. Product's performance evaluation techniques in co-design.

The method of co-design based on evaluation processes shared with users was presented to the Consortium as an element of innovation in the approach to the 4 objective parameters listed in fig.2, i.e. Ergonomics, Hygiene, Sustainability, Speed.
The evaluative analyzes conducted by the UXD interdisciplinary team, made up of designers and psychologists, focused on measuring the performances offered by the prototypes of the new collection of "trolleys".
They contributed to the evaluation of the total quality of the prototype, an analysis of "benchmarking with multicriteria indexes", from which the trolley was a highly evolved product compared to the competition, as well as the only European model with EPD sustainability certification referring to materials and components, both for the Ergonomics and Operability speed parameters, through tests and surveys on the prototype conducted with the participation of the cleaning operators themselves.
In fact, it is known that "The good practice of a co-design approach results from the union of the skills of designers and researchers together with those of people whose work will be influenced by change: a project approach based on experience and personal skills of workers" (Bødker, 1996).

The methodological objective of this phase is the detection of "explicit" and "tacit" needs, but also of "latent" ones, emerging from sessions of ethnographic interviews and repeated tests of operability, where operators can freely express themselves, denounce and suggest (Rizzo, 2009).
In addition to the "explicit" ones, the first to be highlighted, the tests are able to detect the "tacit" needs, i.e. those that are not explicitly expressed but easily understood by various indications, as for example the result of the question addressed to users to put the cleaning operations in hierarchy in relation to the fatigue required by them.
We knew that some cleaning operations were tiring and that they had repercussions on the health of the worker, as already expressed in the literature for example in the report for Expo Milan 2015 written by ASL (Local Health Authority) with the title "Safety in cleaning companies" (Cattaneo, Borello & Cassinelli, 2015), in which the indications to construct biomechanical validation tests in cleaning operations on large sites are very useful.

But we did not know how to organize them in the hierarchy, which the operators first conducted individually, then collectively returning a shared list of strenuous activities, to which the Consortium is following up with improvements in feedback.
As an example, we report the most difficult activity by operators, especially female: squeeze in the appropriate lever container, about 60 times during its turn, the Mop, the stick with soft fringes used to wash with water the floors.
From here the search for alternatives for the operation, from which emerged pedal systems, with opposed rollers, also electric.

But perhaps it is precisely the difficulty of using the Mop that has led the cleaning operators to point out that the use of pre-impregnated strips for a washing without water, is far more effective and easy, so applying the Mop to retirement.

Finally, the survey, perhaps the most interesting, relating to the "latent" needs: those that can only derive from the spontaneity and creativity of the witnesses, who in this case not having an object to be evaluated, change the role of evaluator with that of co-designer.
In some cases only latent needs have emerged, in others the co-designer, urged by the UXD team, has suggested and discussed possible solutions (fig.3).
A condition, well described in the literature: "Users can become members of the design team as "experts in their experiences", but in order to take on this role they must receive the appropriate tools to express themselves" (Sanders & Stappers, 2008).

Operators_TUT Trolleys Usability Prototyping Test		
Operator's Attitudes	**Definition of Attitudes**	**Detected Attitudes by the Cleaning Trolleys test**
DOING	Being aware to do an experience	The desire to tell once's own experience
CUSTOMING	You can do things by yourself	The ability to customize your work
MAKING	Creating with your own hands	Problem solver with own hands
CREATING	Feeling inventor	The desire to suggest solutions

Figure 3. The measure of experience through the attitude detected by the tests on the prototype cleaning trolley.

As an example there is an anecdote told by the Consortium. The idea of the pre-impregnated strip that has revolutionized the field of professional cleaning, was actually born from the intuition of a female cleaning lady who had wrapped the fringe of her broom with a light cloth, just moistened, fixed with two strips of velcro. What enabled her to wash the floor without water and sliding the broom smoothly.

Also in our case, the evaluators coming from medium-sized cleaning companies are predominantly middle-aged women, without a real specialization if not the experience gained over the years carrying out this task. The women took turns, inside the laboratory yard (a university campus), in the guide of the trolley, carrying out all the cleaning operations known to them, evaluating and bringing out:
- weight and fatigue during the push in a linear way and in change of direction;
- accessibility to the various sectors in which the trolley is organized;
- ergonomics of use of the main components;
- spaces available for personal effects (smartphone, water, cigarettes, personal gloves, etc.);

- safety for the person in relation to the parts in use;
- strength and durability of the components;
- expressiveness and significance of shapes and colors.

The test with the trolley was repeated 3 times by 40 operators and some site managers, in order to achieve credible results that depend on the knowledge of the tool or machine by the person. A knowledge that gradually matures with a learning process in which the user can encounter more or less large difficulties, depending on the complexity of the instrument (Polillo R., 2010).
Overall, the trolley, characterized by closed compartments for order and safety against accidental contact with cleaning products considered dangerous and dirty tools, proved to be a very convincing product, obtaining results of total quality evaluation more than positive by of the evaluators, respectively: excellent 20%, great 60%, good 15%, discrete 5%, sufficient 0%, mediocre 0%, poor 0%, seriously insufficient 0%. On the other hand, limited usability gaps have emerged that are already undergoing revision by the manufacturing company, including: the control and protection against impacts against walls and passages, the placement in an inaccessible place of detergents for the purpose of security against third parties, the guide with a horizontal handlebar and the need for spaces to devote to the recovery of the personal effects of the operator.

4. Data collection. An inclusive service to data management of cleaning and facility maintenance.

The second phase, whose object of innovation is the creation of a data collection service to check the efficiency of the building site where the cleaning takes place, opens access to the "latent" needs of user and awareness of having an active role, with the ability to take or suggest decisions.
Redirecting the supply chain process, to understand all the relationships that are established between the various subjects involved in the "cleaning" activity, also extended to some operations that today compete in the maintenance service of the large collective spaces (facilities), given life to a virtuous "systemic cycle" that has effects of return as well as service also on the product.
It is important to organize and optimize all the parts within a system so that they evolve coherently with each other and to accompany and manage, at all stages of service development, mutual dialogue between the various actors in this field (Bistagnino, 2011).

The products, designed and constructed, will therefore not only be the object of an isolated activity conducted by the Designer and the Producer, but the result of an activity directed by new relationships based on the sharing of experience. In which way? By recording the perception that different users have of the activity and planning the possibility to signal and organize "data":
- the collected data serve to improve the service in real time;
- the collected data, object of a reading by competent subjects and with responsibility on each specific phase, are used for the improvement of the product.

A further innovation is represented by the inclusion in the customer satisfaction and data collection process, for the first time in these service areas, of the end user, who lives in the spaces.

It is thus created a process of sharing the activity on the part of all the subjects who live and share that activity; subjects that previously positioned themselves, according to a linear chain of relationships, downstream of the activities of conception and realization of the product.

4.1. A digital service 4.0

The cleaning operator is a professional figure with a low specialization, subject to migratory phenomena in the past as recently, with a massive entrance today of foreigners; has a high incidence of female labor (65%), also demonstrated by the fact that for 70% it is still held in part-time regime, sometimes also as a double job: one of the motivations is that it takes place (75%) in anomalous hours, outside the opening hours to the public. It is a profession that seems to have flexibility because of the aforementioned characteristics and probably, according to the experts, it will be subject to considerable changes in the future. It is our opinion that it could also be an opportunity for those who have lost their jobs in middle age and who have entered here, perhaps temporarily, could guarantee a higher cultural level; even greater knowledge and familiarity with digital technologies.

This was a conviction of the opportunity to design a service based on relationships and the exchange of data, also focusing on obvious economies of scale deriving from the synergy between "cleaning" and "structures" operations. Specifically, it involves using the "cleaning" activity aimed at spaces as a complementary activity to the "maintenance" one, detecting faults, defects and improvements to the service in order to have a return on the operation of the service and on the design of the products.
The cleaning/facilities 4.0 therefore wants to put the person in the spotlight: both the operator responsible for cleaning the space and to which a more active participation will be required, and the client, who can thus take advantage of a more efficient and quality service, in which "to count". But the new systemic process will also involve the employer in terms of increasing productivity and staff satisfaction.

The new digital approach has a structure designed in such a way as to make the staff work better, with greater efficiency and professionalism. The operator will already know where to go and how to equip his trolley. No more empty trips and no more overloaded trolleys. In this way work will be less stressful and more rewarding. The time that will be saved, will allow to focus more attention on the controls, raising in this way the quality of work and stimulating the motivation of the operator. The collected data will then be used to check the performance and performance of the service provided.

In relation to the state of the art and the future it is therefore important to understand how this new activity configures as a Smart Service, i.e. "a new generation of IT and technical infrastructures that help manage and monitor systems, exploiting the logic maximum integration between all the players in the supply chain, including customers" (Agrawal, Mani & Minsok, 2001). In the years to come, companies will have to take courage and direct their planning and economic attention towards the efficiency of services. While it appears that in these two sectors, especially in small and medium-sized businesses, the potential associated with the digitalization of services is almost completely unexplored, and the advantage linked to faster and simpler data sharing, especially at the supply chain level, is not yet understood.

4.2 The digital service architecture

The service is the result of a systemic approach to the relationships between the players that are highlighted within the cleaning yard (end user, cleaning operator, site manager) and, outside of this, expanding the circularity of information, the data, to the subjects that make up the entire supply chain (cleaning company, supplier, producer).
From this perspective, the HCD and in this particular case the HCI provides for the design, implementation and evaluation of interactive systems in the context of the task and work of users (Dix, Finlay, Abowd & Beale, 2003)
The possibility of having "information and data" will allow both to positively affect the management dimension of the cleaning yard, encouraging greater efficiency and effectiveness from the point of view of processes and economy of resources, both on the activities of the actors in the supply chain positioned outside the work sites, in terms of managerial management for cleaning companies and product innovation for suppliers/producers.

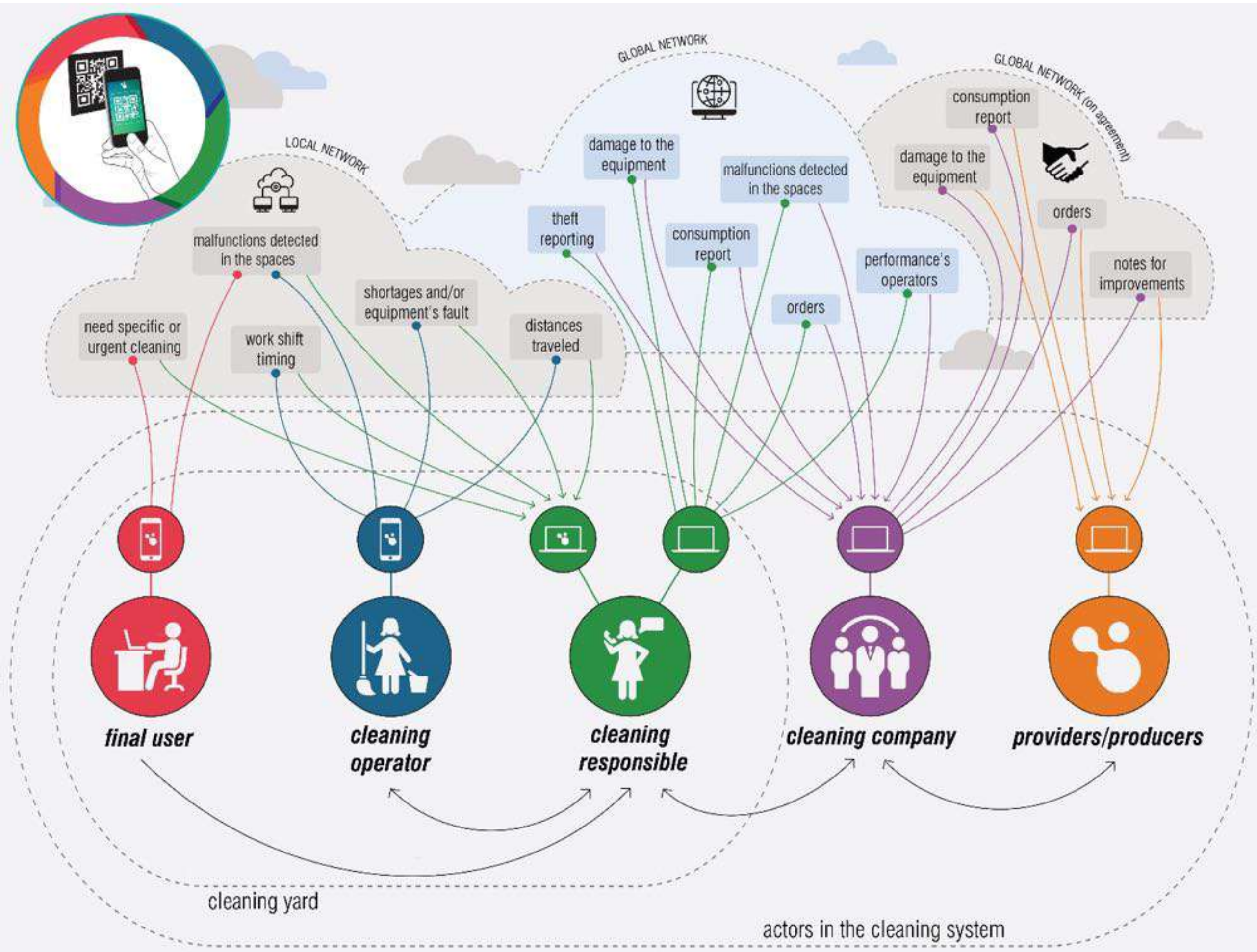

Figure 4. The actors involved in the cleaning system and the relationships that are created at the network level

The QR-Code is the key to accessing the functionalities of the service. Chosen for its simplicity of access, as well as easy and economic planning, this key can open both the entrance to the environments that make up the site (the rooms) and equipment (trolley, equipment, supplies).

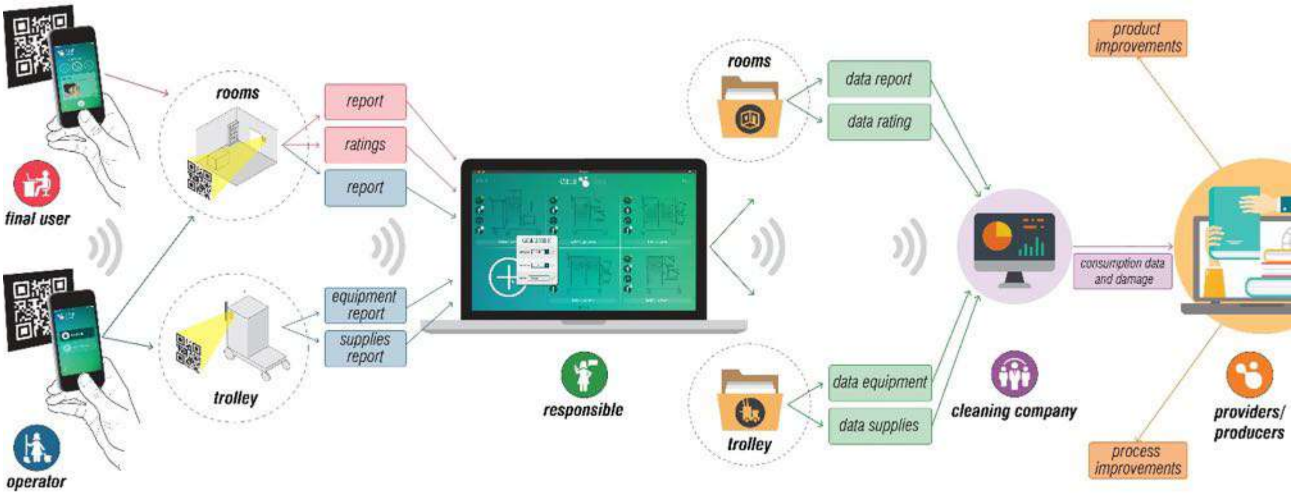

Figure 5. The various types of access to the service and the features it offer

It is accessed with tools for both personal and professional communication. The end user and the cleaning operator, within the construction site, will use their smartphone (even if the issue is still under discussion for the operators) to access a series of interactive screens where the contents will refer to the room or trolley in question.
On the other hand, the site manager will have at his disposal a tablet, configured to receive and send simple data with the operator and the end user, subsequently processed in a more complex form for sending to the company.
The data and the information that in passing in passing are extended, are managed by a digital platform with controlled access, for the sole exercise of the responsible of yard. This figure therefore assumes a crucial responsibility within the system: it can improve in real time the efficiency of the cleaning service, including the speed of service, the level of hygiene, sustainability and customer satisfaction, with regard to building site environment; has the task of collecting and cataloging, in the first instance, the data collected from communications with the end user and operator, sending them to the company.
The company is the fourth subject involved in the system: it has the task of analysing the data collected by the responsible of yard, distinguishing between those that can be used for the improvement of their service and those concerning malfunctions of components or products, together with new potential needs to be sent to suppliers/producers.
Obviously, the feasibility of the system provides for forms of alliance in terms of agreements between the company and the supplier/producer.

The User, i.e. the inhabitant, accesses the "communication platform" connected to the site manager only, to request urgent interventions, to indicate additional needs for cleaning, furniture and system malfunctions. But it can also provide evaluative feedback regarding the cleanliness of the room in which it is located, both in the form of a "text" note and a "photographic image", to date the most direct and easy tool for orientation and reference.
The cleaning Operator has the possibility to access the application in two different ways, one for the rooms and one for the trolleys. Accesses the room interface to communicate to the site manager the presence of any faults within the room and, by selecting the "feedback" item, check for readings and/or requests made by the final user.
Instead, it accesses the trolley's interface, by selecting the item "equipment" and "supplies", pages through which it can report failures to the equipment or components of the cart,

qualitative or quantitative deficiencies, already present or coming, referring to consumer products supplied.
For easier accessibility, even multi-ethnic, the pages in question have simplified lists of icons, captions selectable in different languages, in addition to the usual textual spaces and photographic images.
The responsible of yard can access the "trolley" page where he can update the service status of the trucks, monitor the reports provided by the operators regarding the equipment and supplies, keep an inventory of the daily-equipped consumer products and implement the yard fleet trolley. In a similar way, access the "room" interface, where it is inserted in an interactive site plan to verify the effective passage of the operators inside each room, monitor the reports from these and the users, checking the periodic trend of the assessments received.
The third and last mode of access for the cleaning responsible is that relating to the item "data collection". From the contents on this page the manager can perform, by selecting one or more filters, archive searches of the received messages, view infographics reports related to the chosen time interval, organize the data transaction, upstream, towards the cleaning Company.

5. Conclusion and future developments

On the basis of what has been tested, it is presumed that within a period of 6 months it will be possible to verify the feasibility of punctual proposals by evaluating the dimensions between "local" and "global" networks.
It is probable that the end user, interfacing with the cleaning operator, aspires above all to enrich himself through the proposed activities as "local network", in addition to possible contacts. Meanwhile, the cleaning company operates in what is referred to as its "global network".

References

Agrawal, Mani, K. & Minsok, & H. Pak. (2001). Getting smart about supply chain management. *The McKinsey Quarterly,* 22.

Bistagnino, L. (2011). *Systemic design. Designing the productive and environmental sustainability*. Slow Food Editore.

Bødker, S. (1996). Creating Conditions for Participation: Conflicts and Resources in System Design, *Human Computer Interaction,* 11(3), pp. 215-236.

Cattaneo G., Borello F., & Cassinelli V. (2015). La sicurezza nelle imprese di pulizia, *Quaderno tecnico per datori di lavoro Cantieri Expo Milano 2015.* https://www.puntosicuro.it/view-pdf/uso-delle-attrezzature-rischi-ergonomici-nelle-imprese-di-pulizia-AR-15434/

Celaschi, F. (2008). Il design come mediatore tra bisogni. In Germak, C. (a cura di) *Uomo al centro del progetto*. Torino. Umberto Allemandi & C., pp. 19-31.

Dix, A., Finlay, J. E., Abowd, G., & Beale, R. (2003). *Human-Computer Interaction.* Pearsons.

Federazione nazionale delle imprese di pulizia, di disinfestazione, di servizi e multiservizi*, Il mercato italiano delle pulizie professionali*, 2017.

Germak, C., & Bozzola, M. (2010). A design training model in Italy. *Strategic Design Research Journal,* 3, pp. 13-19.

King, S., Conley, M., Latimer, B., & Ferrari, D. (1989). *Co-design: A process of design participations.* Van Nostrand Reinhold Company.

Norman D., & Nielsen, J. (2007). *The Definition of User Experience (UX).* Retrieved December 27, 2007, from http://www.nngroup.com/about/userexperience.html (27.12.2007).

Polillo R. (2010). *Facile da usare, una moderna introduzione all'ingnegneria dell'usabilità*. Apogeo, Milano.

Rizzo, F. (2009). *Strategie di co-design. Teorie, metodi e strumenti per progettare con gli utenti*, Franco Angeli Edizioni, Roma.

Sanders E.B., & Stappers, P.J. (2008). Co-creation and the new landscapes of design, *CoDesign*, 4, pp. 5-18.

Zanotti A. (2014). La crisi e la "rivoluzione" dei servizi. In Schmidt, Rainer, et. al. *Industry 4.0 – Potentials for creating smart products: empirical research results.* Paper presented at International Conference on Business Information System, Cham, 2015. Springer.

Data, Fashion Systems and Systemic Design approach: an information flow strategy to enhance sustainability

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Abstract Nowadays, the role played by fashion industry in contributing to degradation of natural systems is increasingly acknowledged. Acting in terms of information flow from a systemic perspective does not represent a parametric adjustment, nor a reinforcement or a weakening of an existing cycle. It is the generation of a new cycle, that of information, in a place where it was not previously given, therefore inducing a different behavior in people. The structure of information flows can be an effective leverage point in the fashion system, if information is delivered where it was not before, causing people to change behavior. Adding or restoring information, in a fashion system where the information circulating is sometimes not linked to an ethical and social value, can therefore represent a powerful intervention, usually easier and cheaper than reconstructing physical infrastructures. The ambition of this paper is to offer a perspective that faces this complexity and align fashion with sustainability values through insights gained from data.

Keywords: Data, Systemic Design, Information Flow, Sustainable Fashion, System Thinking

1. Introduction

Nowadays, the role played by fashion industry in contributing to degradation of natural systems is increasingly acknowledged. The impacts on the environment are mainly linked to the use of non-renewable raw materials, water pollution and waste generated. In addition to these socio-cultural implications deriving from the use of cheap labour and undignified working conditions resulted from 'fast' fashion business model, where economies of scale deliver standardized fashion at high volume and low price. Overlaps to all this a significant lack of information and communication between stakeholders make the interpolations of the system difficult to enodate.
In this context therefore characterized by complexity, intricate interdependencies and flux, and a wide span, geographically, epistemologically and in term of disciplines and discourses it draws together since was first introduced to the realm of fashion (Fletcher, 2008) system and design thinking, has provided a helpful viewpoint on the area.
A preliminary literature review reveals in fact that acting in terms of information flow from a systemic perspective does not represent a parametric adjustment, nor a reinforcement or a weakening of an existing cycle. It is the generation of a new cycle, that of information, in a place where it was not previously given, therefore inducing a different behavior in people. According to Meadows the structure of information flows can be an effective leverage point in the fashion system, if information is delivered where it was not before, causing people to change behavior. Adding or restoring information, in a fashion system where the information circulating is sometimes not linked to an ethical and social value, can therefore represent a powerful intervention, usually easier and cheaper than reconstructing physical infrastructures.
The ambition of this paper is to offer a perspective that faces this complexity and align fashion with sustainability values through insights gained from data.

2. Fashion as a complex system

Fashion is a powerful cultural lever, capable of influencing the consumerist economic model based on mass production that characterises us today.
The fashion system is "composed of interconnected elements that produce their own pattern of behavior over time". (Meadows, 2009, p.2)
In her latest book, published for the first time in Italian, Fletcher not only defines it as a system rich in complexity but also associates in a precise way the adjectives *stratified* and *multidimensional* as well as multidisciplinary.
The papers analysed during the research in the literature review phase highlight the coexistence and the indissoluble integrity of four areas when we talk about fashion and sustainability - the technical, the political, the aesthetic and finally the psychological and behavioural.
In fact, looking at sustainability is impossible if you do not keep in mind technical problems related to the traceability of the production chain; the efficient use of energy sources, water and chemicals; if you do not ensure the safety of the working environment; if you do not care about innovation in the choice and production of materials, if you do not improve recycling practices; if a fair wage system related to the future impact that the fourth industrial revolution will have in automated production processes.
Similarly, sustainability issues cannot include solutions that do not take into account institutional policies that are national or international or that do not affect the business choices of individual brands. Fashion implies and is conditioned by systems of control and power at the highest levels of modern society and which in turn frames a system where the free choices of citizens sometimes do not change the games of big names.
Addressing in a correct way any phenomenon related to fashion can no longer be done ignoring the challenges to sustainability that the aesthetic variable brings with it: the fashion industry, more than any other, has perfected the cycle of invention, acceptance and rejection of a series, aligning itself with the ever-changing but constant ways of exhibiting its image, almost definitively releasing a cycle of change that was inspired by physical necessity with a series of variations dictated only by the aesthetic function.
Looking at the fashion system as a complex system means being able to direct the outcome effectiveness of a series of changes and approaches in a broader perspective that make the designer ready to predict and prevent objectives, time frames and scales of application.
Each of these areas, like every complex system, is then regulated by strict rules or flexible interdependencies with direct or indirect repercussions on consumers and ecosystems from the smallest to the largest scale.
In the same way, a sustainable fashion system that is as complex as the non-sustainable one remains an interconnected flexible process that does not stop taking into consideration any of the four areas, giving it equal weight and importance in undertaking strategies aimed at change.

3. Data as a strategic tool for sustainability

The intersection of fashion and new technologies is a rich and expansive space that capture simultaneously elusive aspects of being human and fashion experience, the purpose for this approaches that use data with an holistic point of view, is not just about describing businesses and brands how to include big data into their daily practices, but to help every stakeholder to add this resources to their toolkits to increase sustainable policies.

Fashion, therefore, introduces a complex system made up of different components and actors that interact with each other in countless possible ways, and its overall behaviour is not given by the pure definition of behaviours but by the objectives of individuals and their interactions. The ability to understand such a system with the aim of leading it towards a more sustainable fashion system is not limited to strategies oriented to the knowledge of the individual parts, but above all to the ability to recognise and structure a vision of sustainability able to relate the various long term procedures.

The Systemic Design approach defined and tested in different fields of design such as the food supply chains focuses on the design of relationships between people, activities and contextual characteristics to improve the knowledge of complex systems.

The use of data together with a systemic approach aims to generate a unified understanding of sustainability strategies in the system and to disseminate all the information that can produce a significant change influencing the behaviour of the system.

Also, using data aimed at holistic relief guides the designer in a deep understanding of the issue, outlining the real role of all actors involved in their field of application, their development and their relationships in their operational context.

As far as data, fashion and sustainability, on a broader discourse, are part of the potential already mentioned above, such as transparency and traceability of the supply chain, in-depth knowledge of territorial dynamics and last but not least, the creation of a direct relationship between the company and consumers based on real needs rather than on trend forecasting guided by consumerism and profit.

Data represent a quantitative input that analysed, understood and used in a systemic perspective produces a qualitative output of high value in terms of awareness for companies and consumers.

4. Systemic Innovation Design methodology applied to fashion data

Specifically using systemic design as a catalyst of change, this research looks through data generated inside fashion system in a holistic way, defining all the process, service and actor as a dynamic whole and not as a fragmented sum of its part.
Contrary to what happens with the sustainability strategies currently in use, that are focused on symptoms, and endorse methods that try to solve single problems not caring about existing relationships, systemic design approach can be an effective tool to restore the lack of information that concern the whole process and all actor.
This approach, which looks at the larger picture, focuses on the transition from a linear vision, where individual environmental issues are addressed, to a systemic approach, where an improvement of the individual components, if put in relation, corresponds to improvements for the whole industry. Through the systemic use of information, however, fashion can act constructively to stimulate positive practices and quality development in the direction of sustainability.
Data can be involved with an innovative approach in the phases of fashion creation and at the same time can implement processes and applications in a more sustainable direction.

4.1 Methodology

Complex systems are inherently unpredictable because we can not explain a high percentage of variance that affects results. Under these circumstances, Editd's chief executive Geoff Watts observes that "minor disturbances in one part of the system can be amplified to produce larger effects somewhere else." Moreover, this is precisely what happens in the fashion system: where the purchase of a garment in a highly fragmented chain with high social impact causes devastating consequences for the environment and the entire system.

The multitude of social and economic activities that are understood and constitute the fashion system is therefore necessarily complex.

To navigate the complexity of a system so strongly interconnected and based on an apparent win-win model that hides its real inability to be transparent and communicative is necessary for our work applies an information flow strategy, based on data and all of that technological tools which could reveal any information.

Starting from the analysis and the recognition of fashion as a complex system the research aims to identify the relationship between components and different elements. Integrating data become possible to inspect and understand in detail not only business and organisational needs but also human being and behaviour pattern of choice, use and consume the fashion product.

From an operational point of view, the research is based on the intention to highlight the capacity of interconnecting people, process, and environment with fashion: we apply the Systemic Innovation Design Methodology to enhance knowledge and understanding about the system, to produce functions, objects, and process for the wellbeing both the individual and the collectivity. With this approach that combines systems thinking skills with design thinking in order to address fashion system complexity a collection of data become useful for generating new awareness and identify patterns of behaviour.

Data are no longer considered a static asset whose use ends when the purpose for which they were collected has been accomplished; hence a raw material, a vital input, used to create new forms of value as well as a source of innovation and new services (Gaiardo, Tamborrini, 2015).

This kind of study starts with a holistic analysis of the current situation, clearly outlining all the life cycle step of garment production and all the actor and the actions undertaken or undergone by the context in question.

Since fashion is more than the materials that garments are made of, data give us the opportunities to go beyond the lack of information that concerns the whole process and all the actors involved.

A technology-enabled sustainable fashion system operates similarly to an ecosystem where there is a conscious evaluation of the impact and both inputs and outputs, how they depend upon and influence one another, and the environment as well as the economic cost of each decision.

The outcome of this research aims to give to a million data collected a sort of structure capable of capture context underlying connection, drive insight through design and organisation and last but not less critical create value identifying and defining sustainable strategies.

4.2 Stages of research

The need for a systemic change dictated by the environmental crisis means that different choices will be made by consumers and companies, related not only to material supplies but also to the habits in our lives and the way we express ourselves through fashion.

For this reason, can only be necessary a series of structured activities that manage the collaborative and participatory processes that are developed above the data.

Within this contribution are illustrated the preliminary phases of the research before the information collection, nevertheless for the comprehensiveness of the purpose are listed the following stages, which are expected to develop in the future according to the methodology of systemic innovation design.

4.2.1 Mapping the current fashion system and identify the information gap

The first stages of the research consist in mapping and analysing every step of the customer journey in order to find any information gaps and selecting on the context-rich, real-time and *in situ* pool of data that will be collected in the following steps. This preliminary focus on the customer experience takes from the customer's perspective right from the start and aims to understand a customer's behaviour, feelings, motivations and attitudes before, during and after the shopping experience. The customer journey includes all activities and events and in this emotional and physical journey are included all the activities between the customer and his garments in order to examine the relationship in between.

This step is essential also to identify the other actors involved, the nature of their relationship, the knowledge and the technologies that are available and which can be useful in the subsequent collection and analysis phases.

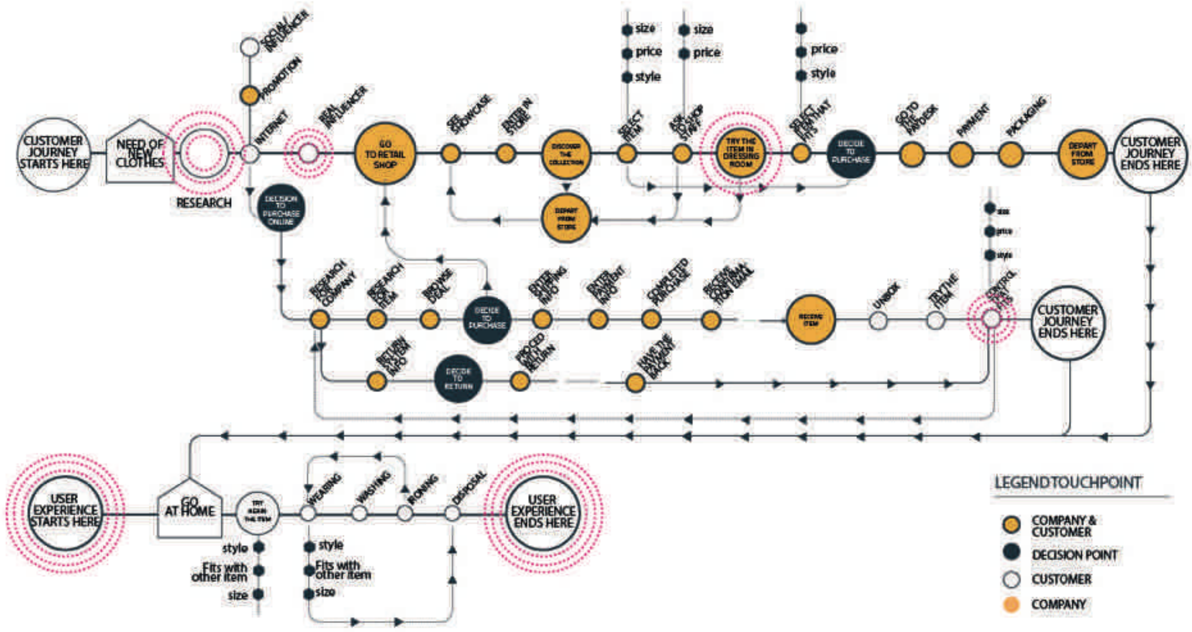


Fig. 1_Customer journey map – information gap

4.2.2 Planning data collection

The result of the first step is the quite clear overall picture of the system from the customer point of view: after that is crucial to structure the data collection in detail. The transformation from data into useful information at all levels of the design process requires a continuous process in which data are collected, classified and appropriately contextualised in a specific analysis context.

In this phase, the structuring of the collectable dataset involves the evaluation of qualitative and quantitative data that will be integrated into the research in order to understand many aspects as possible.

In this phase, three datasets have been identified: (1) customer information, (2) product information, and (3) the information flow.

The nature of the customer-based data set is not intended to draft consumer needs to produce perfect deals for companies, which would have nothing to do with sustainability goals, but instead have the final objective to generate an even more close relationship between consumer and product in order to lengthen its life cycle.

For this reason, part of the information research aims to obtain the data related to the product. A recent report edited by the Fashion Revolution movement, in fact, dealt with understanding what information customers would like or should receive from brands about the environmental impact of their products and what kind of information influences the purchase of certain products. The results of the survey reveal that consumers would like to receive more information about the origin of raw materials, the impact on the environment and workers' rights, and not least the social and environmental conditions of their entire supply chain. With the same objectives, the research for information in the product dataset is structured.

Future research could concern developing the following step:

a. Collection of information

b. Information analysis

c. Validation of information

d. Detailed guidelines

e. Definition of concept

f. Experimentation and project development

4.3 Research outcomes

The content of this research returns four levels of results that complement each other to solve in a complex way the criticalities previously highlighted in the fashion system.

1. Research Level such as consumer behaviour, consumption as everyday practice, unconventional user behaviour, systems of use, measuring sustainable consumption e mapping ecological footprints etc…;

2. Service Level for both company and consumer with the aim of development strategies for increase consumers awareness and companies sustainable impact;

3. Product-level by which enhance product sustainability;

4. Organisational level in order to redefine the process and spread transparency and circular economy policies.

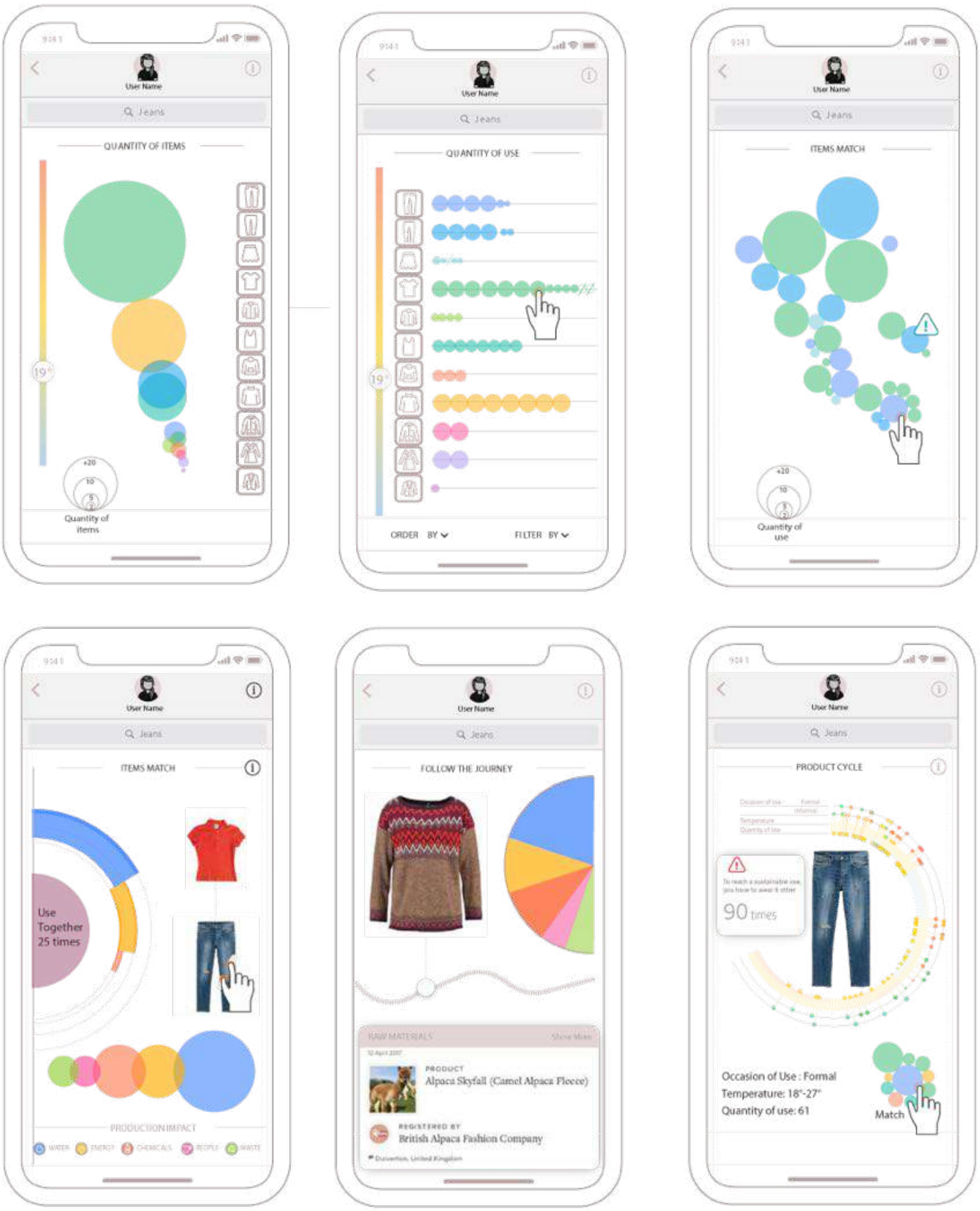
In conclusion, Big Data in fashion industry has the potentiality to unlock interesting areas for design disciplines such as consumer behavioural data or unconventional use behaviour capable to generate value within the system but also to make visible the intrinsic one becoming a fertile territory for the most indicated innovative intervention (the better decision).

It is clear that big data will contribute to the optimization of the supply chain and to the development of sustainable product and service, but is important to evidentiate how it is possible to generate a unitary and coherent understanding of the whole system that allows a sustainable development also in all systems connected with the fashion one.

The combination of quantitative data and qualitative ones helps the system to understand where to focus and how providing meaningful insights to ensure that the weakness of one is balanced by the other.

The following figure shows an example study of how having access to personal information could vary the level of awareness of sustainability in choices related to clothing.
In the first screen, each circle corresponds to a category of clothing: the size of the individual circle communicates the amount of clothing owned for a given category.
The second screen displays the amount of garments used in the wardrobe: each circle corresponds to a single garment. The size of a single circle indicates the number of times the garment has been worn. Crossed-out circles identify garments owned but not used because of the chosen temperature.
By selecting a certain circle with a click, it is possible to obtain the set of combinations that the user generally chooses to wear, in the third screen. The colour of each circle identifies the category of garments. The proximity of the circles identifies possible combinations; the distance of some circles highlights isolated combinations: the disintegration of the garments inside the wardrobe is an indication of poor sustainability.
The three final screens highlight the overall impact (production and use) of the wardrobe. The impact

is given for the number of garments owned and their life cycle. A small number of combinations within the wardrobe indicate poor sustainability.



5. Conclusion

Forecasting consumer demand for fashion is a complex subject. Big data will help to predict customer behaviour to steer fashion industry in the right direction, however having access to millions of data is not enough for a system like fashion to be more efficient to deal with the reality of biophysical limits and their incompatibility with the logic of growth.

This research wants to underline the importance of collecting interaction and relationship in a significant dataset. Systemic design could represent an approach that enables a holistic view of the whole fashion system, allowing a complete elaboration of the complexity of the users' behaviors and of that of the upstream processes, keeping in mind the centricity of the individual involved and the context within which sustainable projects can be developed; thus, generating a comprehensive view of the entire fashion system.

Innovation and change, combined thus with the enormous potential of data, can start, as we demonstrate, from any different stages of the supply chain and produce significant results for the environmental responsibility of fashion companies.

Future research will provide the collection of data and the holistic relief starting from companies and supplier perspective.

References

Bistagnino, L., (2011) Design Sistemico. Progettare la sostenibilità produttiva e ambientale, 2ª ed. Bra (Cn), Slow Food Editore

Chapman, J., (2005). Emotionally Durable Design: Objects, Experiences and Empathy. London: Earthscan.

Fletcher, K., (2018). Moda, design e sostenibilità - Postmedia Books, Milano

Fletcher, K. (2008) Sustainable Fashion and Textiles: Design Journeys. London, UK: Earthscan.

Fletcher, K. and Grose, L. (2012) Fashion & Sustainability: Design for Change. London, UK: Laurence King Publishing Ltd

Meadows, D.H. (2009). Thinking in Systems: A Primer. Chelsea Green Publishing, White River Junction, VT, pp. 222.

Gaiardo A., Tamborrini P., Bardone L. and Buriano L., (2013) Playing with Data: an Experience in Creative Infovis, In: Communicating Complexity, Edizioni Nuova Cultura

Rissanen, T. (2013) Zero-waste Fashion Design: A Study at the Intersection of Cloth, Fashion Design and Pattern Cutting. PhD thesis. Sydney, Australia: University of Technology

Siraj, D. (2014). The data store: on big data. Retrieved from https://www.theguardian.com/technology/2014/jan/30/fashion-data-tool-editd-helps-asos-push-revenues-up-37

Tamborrini, P., Remondino C. L., and Marino, C., (2018) Fashion Industry as a Big Data Enterprise for Sustainability. Curr Trends Fashion Technol Textile Eng; 3(4): 555616. DOI: 10.19080/CTFTTE.2018.03.555616

Beyond Participatory Design for Service Robotics

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Abstract

The spread of technologies as Cloud and Distributed Computing, the Internet of Things (IoT) and Machine Learning techniques comes with highly disruptive innovation potential and consequent design imperatives. High connectivity of devices and machines is shaping not only sensing and monitoring capabilities, but also describing ever more ubiquitous and diffuse computing capabilities, affecting decision-making with a wide range of assisting tools and methods. With the scaling potential of moving beyond its contemporary application such as industrial facilities monitoring, precision farming and agriculture, healthcare and risk management scenarios, RaaS is bound to involve an increasingly fluid and diverse range of users, shaping new socio-technical systems where practices, habits and relationships will evolve in respect to its adoption. On these premises, applied research at Polytechnic Interdepartmental Centre for Service Robotics in Turin, Italy, focuses on the development of a service robotics platform able to operate on the local scale and capable of adapting to evolving scenarios.

Keywords: service robotics, socio-technical, complex systems, making use, design

1. Introduction

Service Robotics is an emerging field in engineering design research and practice, that deals with recent advancements of technologies such *cloud services* and low-cost sensors, as enablers of the *automation* of activities beyond industrial applications. In consistency with Richard Normann's view of *service* (Normann, 2001)as value-creating systems with us inside, its progress is shaped by people's desire to augment human intellect, unlocking new levels of *productivity* and *creativity* by automating activities and evolving better programming paradigms.
Normann's description of services puts emphasis on the strong relationship that ties technology to its environment, as it influences habits and lifestyles in a perpetual process. Within this frame, anthropologist Tim Ingold's definition of *taskscape* is particularly useful to address the complementarity of the bond that ties human activity to the landscape (Ingold, T.,1993).

As described by Goodwin, the concept of landscape emphasizes form, as that the concept of *body* put emphasis on the form rather than on the function of a living system (Goodwin, B., 1988). Like organism and environment, body and landscape imply each other, alternately as figure and ground, generated and supported in and through the process of carrying out a total field of relationships that crosses the emerging interface between organism and environment.
Ingold proceeds in the description of this processual complementarity introducing the concept of *embodiment* as a "movement of incorporation" of the organism, in which its bodily form *emerges* from the life-cycle process, as being also pertinent in the description of the environment. To do so, the concept of *temporality* as experience of those who carry forward the process of social life in their activities, is introduced in his argument. He calls this ensemble of activities the '*taskscape'.*
Within this context 'tasks' are defined practical operations, carried out by skilled agents in their environment, as part of his or her normal business of life. In other words, tasks can be identified as the unit of dwelling activities. Tasks then take their meaning from their positions within an ensemble performed by many people working together in series or in parallel. Taking these considerations into account it becomes impossible to separate the technical dimension of a system from the social act of inhabiting a place, as every technological practice is embedded in the current of sociality, as people *attend to one another* when performing their tasks. Temporality is then intrinsic of a taskscape, emerging from the network of interrelationships between the multiple rhythms of the activities constituting it, lying the foundations of *sociality* in the resonance of movement and feeling deriving from the reciprocal and attentive commitment of people in a *context* of shared activities.

This anthropological framing of technological development is used in the following case studies analysis to include the social dimension in the development of Service Robotics applications, such as Precision Farming. By social dimension we then refer to the mutual engagement of organisms as sentient agents carrying out their activities in an environment. This definition helps us understand human as well as non-human (other animal and plant life forms) relationships between organisms themselves and their dwelling in the environment.
As Richard Tapper argues, farming activities shaped the notion of *domestication*, as involving a 'kind of mastery and control' similar of that entailed in slavery (Tapper R., 1988). By slavery, Ingold

describes a situation where the autonomy of the agent to act according to his own volition is compromised through the application of force with the specific intent to overwhelm his resistance. In the sense by which the use of force is based on the assumption that the slave is a being with the ability to act and suffer, and in that sense a person, domination and domestication are distinguished, starting from the assumption that one is a form of social control exercised over subject-people, and the other a form of mechanical control exercised over object-things.
Based on these premises, the domain in which human beings are involved as social beings with one another cannot be rigidly distinguished from the domain of their involvement with the non-human components of the environment. Therefore, any qualitative transformation in environmental relations manifests itself in a similar way both in the relations that man extends towards animals and in those that are established between them in society. It was, in fact, only with the advent of *industrial breeding and livestock management* that animals were reduced, in practice and not only in theory, to mere "objects" that the theorists of Western tradition had always assumed to be (Tapper 1988).Technical advances in adaptation strategies, such as those that led the advent of the agro-pastoral industry, marked the transition from a principle of *trust* towards the environment to one of *domination*, that extends beyond non-human relationships, directly into human social sphere.

In recent research, service robots have been described as a combination of a mobile platform and a manipulator which main function is to carry objects between locations. This kind of operation requires abilities such object detection, navigation, positioning and object manipulation (Kaloyan Y. et.al, 2016). The development of modular, more connected and versatile ‘robots’ enables the automation of more complex tasks that cannot be split into simple actions.
The recent broad diffusion of Internet of Things (IoT) paradigm in industrial development enables the use of automation well beyond production lines and well-structured and controllable manufacturing activities. High connectivity of devices and machines is shaping not only sensing and monitoring capabilities of different application fields, but also describing ever more ubiquitous and diffuse computing capabilities, affecting decision-making with a wide range of assisting tools and methods, like context-aware AI fuelled by a yet unmatched data flow. Digital Abundance is a shorthand that introduces us to the economy of information as a non-depletable resource, as it can be continuously copied, while exponentially increased due to “cheap and small” sensor technology. The high degree of connectivity that is going to characterize places irrorated with objects capable of ‘talking’ is bound to remove many physical constraints for social interaction.
These capabilities make fields of application such agriculture as favourable as industry, giving raise to new fields of research and development such Precision Agriculture (PA). Also known as Precision Farming, PA aims to manage spatial and temporal variability associated with all aspects of agricultural production, with the main goal of improving both *environmental quality* and *crop performance*.

2. Methodology

2.1. Beyond Participatory Design

As theorized in recent empirical studies of technology, philosophically recognized theoretical perspectives claim that the distinction between "designers" and "users" is symptomatic of culturally perpetuated social roles, as both designers and users perform inventive, creative and transformative acts in the same way. (Vardouli, 2015). From this argument, function theorist Beth Preston states that function is independent from isolated agents' purposes but grows from 'historical patterns of actual use and reproduction for that use' (Preston, 2016). Studying the phenomenon of use dissociated from design helps to correct some of the shortcomings of design-centric and communicative attitudes, which are based on the need to establish causal links between how an artefact was created and how it is used or between the human actor who created it and the one who uses it. Following Ingold's ecological approach, where the boundaries between subjects and objects do not exist before an active process, but emerge through the process itself and can only be recognized retrospectively, design theorist Theodora Vardouli argues that throwing these boundaries, in this case between users and artefacts, in advance is like reading the process backwards rather than forwards (Vardouli, 2015).

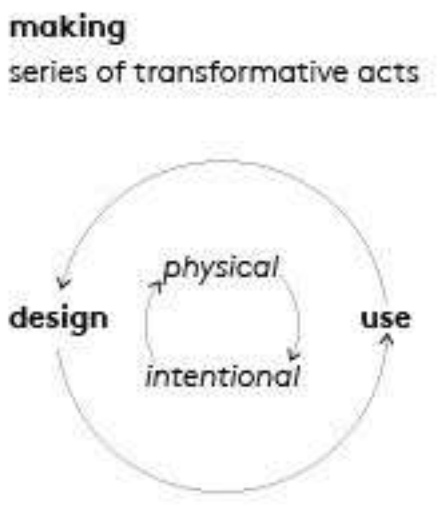

Figure 1. Transformations that occur when humans engage with things.

As Ingold's notion of 'taskscape' has been beforehand introduced as an ensemble of *tasks,* both as physical operations and acts of dwelling, it describes them a continuous, qualitative and heterogeneous, in opposition to isolated and quantifiable activities. They are driven by their own temporality, which causes the experience of the past and the perspective of the future to collapse into acts of present improvisation. Ingold's position shows visible traces of phenomenological philosophy, especially in his focus on the embodiment and construction of temporality as lived duration rather than quantifiable time. This shift from the intentions of a single human actor to a dynamic context of action, interwoven with material, social and cultural forces, is solidified in the

keyword "making". 'Making', for this definition, shifts temporality and emergency to the centre of the scene by conceptualising the production and use of artefacts, opening new critical and productive possibilities for design research. The performative approach of man's engagement with artefacts, promoted by the conceptualizing of use as a sort of making, encourages designers to take a new perspective towards the products of their projects, not as a continuation of their author's intentions, but as constitutive parts of other people's niches. Consequently, users are no longer passive recipients of design activity, but active performers of improvisational, open-ended tasks as *makers of use* (Vardouli, 2015). The grammar of 'making' replaces the "identity operation" (application of rules on fixed entities) with an "embodying operation" (application of rules on any part of an entity that offers an opportunity for action to a subject)(Stiny, G., 2006), allowing emerging results.
In this sense *embedding* refers to the possibility in a particular situation that a subject recognizes for action, resulting in a concrete analogy with the initially proposed ecological meaning of *affordance* by American psychologist J.J. Gibson (1977)

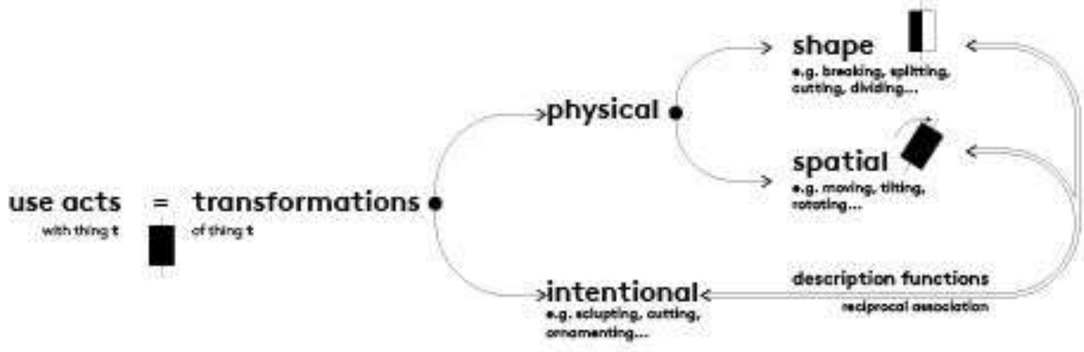

Figure 2. Vardouli's Sketch diagram of Use acts viewed as transformations (rules), which are divided into physical and intentional transformations, linked by reciprocal yet not necessarily deterministic relationship 'description functions' that occur in a human-artefact engagement.

3. Case Studies

To support heterogeneity of solutions fitting diverse use cases and even different application fields we investigate service robotics case studies looking for *modular* technological solution in relation to actors involved as users and more generally as stakeholders.

3.1. Modular Cloud Robotics Architecture

The management of agricultural activities requires intense and broad monitoring of multiple entities, such plants' health or soil humidity, resulting in the collection of large maps, images, video, real-time networks and financial transactions. The term "big data" is used in this context to describe amounts exceeding the processing capacity of a conventional database system. This condition makes it impossible to process the required information for an on-board memory of a single robot.

The main innovative technological feature of this project is a 'cloud approach' to data processing (collection and computation), which provides service robots with *access* to vast resources of data necessary to manage complex tasks. The working team proposes a high-level cloud platform to manage several unmanned robots, both aerial and terrestrial (UAVs, UGVs) with the goal of providing support through remote connection to the end users, both expert technicians and related to the application field. (Silvagni, et.al, 2016). In spite of the high degree of automation, this configuration requires a lot of interaction with diverse end users to carry out its tasks, from mission supervision to data management. End users are in fact required to produce mission requests to provide the constraints for automatic UAV/UGV path generation and other database and backup functions necessary to obtain a fully autonomous mission execution. Expert users have access to decentralize analysis capability thanks to real-time video deployment to control missions, while a more general data collection is used for *knowledge sharing* among robots, field agents and end users. The whole system is also built to adapt to local navigation authority rules through high-precision real-time localization features, guarantying safety avoiding costly systems such those used on commercial airplanes.
Further interaction is provided through APIs basic function blocks that can be used to build new services on top of the more open-ended "remote brain" that contains the main specific applications, opening the possibility of custom service applications, involving developer users.

3.2. RHEA project

A recent example of service robotics deployment in precision agriculture is the RHEA (Robot Fleets for Highly Effective Agricultural and Forestry Management) Project (Gonzalez-de-Santos P, Ribeiro A, Fernandez-Quintanilla C, Lopez-Granados F, Brandstoetter M, Tomic S, et al., 2016), concluded on 31 July 2014. The project was conducted under a work program of the European Commission that focused on the design, development and testing of robotic systems for physical and chemical management of weed in agriculture and forestry. In order to contrast the growth of the pest that subtracts vital nutrients form its surroundings, farmer usually apply pesticides with traditional sprayers, distributing them uniformly over the fields. The aim of this project was to provide support to the farmers to reduce the amount of applied pesticides without reducing the effectiveness of the treatment, by targeting local area of intervention such as wide row crops (processing tomato, maize among others), close row crops (winter wheat and winter barley) and forestry woody perennials (walnut trees, almond trees, olive groves and multi-purpose open woodland). with ground robots equipped with three different manipulators, once identified with high-quality cameras mounted on-board of flying robots hovering over the fields. To allow the control system to accurately steer the robots to work on wide-row crops (with 0.75 m-spaced rows) and ensure autonomous outdoor navigation, a high precision Global Navigation Satellite System (GNSS) was used. A graphical User Interface (GUI) on a ground station was provided to the farmers, allowing them to create and launch the missions. The interaction required the definition of the area by entering the limiting point of the field of action.

4. Conclusions and Discussion

The systematic design methods assist researchers in design choices, whereas the economic analysis considers allowable cost of a system. Only a few authors report design processes based in requirement engineering. For this product-service system we propose a *Socio-Technical Innovation* framework to balance the efficiency of simple stable technological systems with the capacity for resilience and adaptability of more complex, unstable social systems that surround them. A wider network of stakeholders, reaching out to growing community of users and producers, allows organizations to see more opportunities than those dependent on previous choices. Local decision-making made by a variety of actors with shared interests, is likely to be the most successful: though the larger system is complex and difficult to predict, its subunits are less so.

In order to increase cognitive ergonomics and affordance for the end user, each subsystem (component) shall have a self-sustaining life cycle, with explicit functions that make its purpose recognizable. A wheeled or winged structure will be regarded as responding to 'locomotion' functions, while a camera or a condensation hygrometer will cover 'sensory' functionalities and a robotic arm is responsible for 'grasping'. A great advantage given by this modularity is that improvements in the structure of a function can be integrated in the whole system without having to lose every other part.

To be part of a larger system, these components also need to be connected, which means they must interface with each other. This is made easily possible by standards of data transferring via wireless connection to internet services. Complex systems high connectivity leads to difficulties in centralized control and predicting causes and effects, driving the need of localizing decision-making when possible. Chances of identifying a single 'optimal' solution for the whole system width are low; great part of current information and implementation happen on a local scale, necessitating a decentralized approach. While in simple and stable systems homogeneity of input is favoured over a more problematic diversity, in complex social systems heterogeneity is incredibly more valuable, both increasing the range of current information and of solutions generated. The possibility to configure sequence or arrays of function to manage complex tasks in different and evolving scenario, along with the feedback provided by monitoring the conditions of the environment, gives users a much greater capability of engagement.
Faced with an ecological crisis that has its roots in this disengagement, in the separation of the human agency and social responsibility from the sphere of our direct involvement with the non-human environment, it is certainly necessary to reverse this order of priority.

A designed system of product components and services follows the purpose finding principle (Jones 2016). As Jones further explains in his paper on Systemic Design Principles, the purpose principle provides a whole-to-part view of problem space. The diversity of solutions provided by a modular configuration of functionalities, delivered in the form of services, guarantees a balance between fixed purposes and what Jones refers to as creative framing.
Useful to this purpose is Robotics-as-a-Service framework, a cloud computing service model that allows to seamlessly integrate robots and embedded devices into Web and cloud computing

environment. As a service-oriented architecture for robotic applications, a RaaS unit has the environmental potential of decoupling the production of economic value from energy and resources consumption. It includes services for performing functionalities, a service directory for discovery and publishing, and service clients for user's direct access. This platform allows to manage robotics components both as an increasingly granular integration of control over automated tasks and as part of a largely aware whole emerging from their connectivity.

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References

Baek, J. S., Kim, S., Pahk, Y., & Manzini, E. (2018). A sociotechnical framework for the design of collaborative services. Design Studies. https://doi.org/10.1016/j.destud.2017.01.001

Baek, J. S., Meroni, A., & Manzini, E. (2015). A socio-technical approach to design for community resilience: A framework for analysis and design goal forming. Design Studies, 40. https://doi.org/10.1016/j.destud.2015.06.004

Bouras, A., Eynard, B., Foufou, S., & Thoben, K.-D. (n.d.). Product Lifecycle Management in the Era of Internet of Things. Retrieved from http://www.springer.com/series/6102

Carayon, P. (2006). Human factors of complex sociotechnical systems. Applied Ergonomics, 37(4 SPEC. ISS.), 525–535. https://doi.org/10.1016/j.apergo.2006.04.011

Carvalho, L., & Goodyear, P. (2018). Design, learning networks and service innovation. Design Studies. https://doi.org/10.1016/j.destud.2017.09.003

Gonzalez-de-Santos P, Ribeiro A, Fernandez-Quintanilla C, Lopez-Granados F, Brandstoetter M, Tomic S, et al. Fleets of robots for environmentally-safe pest control in agriculture. Precision Agriculture. 2016;1-41

Gibson, J. J. (1977). The theory of affordances. In R. Shaw, & J. Bransford (Eds.), Perceiving, acting, and knowing: Toward an ecological psychology. Hillsdale, NJ; New York, NY: Lawrence Erlbaum Associates; distributed by the Halsted Press Division, Wiley.

Goodwin, B. 1988. Organisms and minds: the dialectics of the animal-human interface in biology. In What is an Animal? (ed. T. Ingold). London: Unwin Hyman, pp. 100-9.

Ingold, T. (1993). The temporality of the landscape. World Archaeology, 25(2), 152e174. http://dx.doi.org/10.1080/00438243.1993.9980235.

Jones, P. H. (2016). Systemic Design Principles for Complex Social Systems. https://doi.org/10.1007/978-4-431-54478-4

Kaloyan Yovchev, Denis Chikurtev, Nayden Chivarov, and Nedko Shivarov; Precise Positioning of a Robotic Arm Manipulator Using Stereo Computer Vision and Iterative Learning Control; Advances in Service and Industrial Robotics, Mechanisms and Machine Science 49, DOI 10.1007/978-3-319-61276-8_32

Mario Silvagni, Marcello Chiaberge, Claudio Sanguedolce, and Gianluca Dara. A Modular Cloud Robotics Architecture for Data Management and Mission Handling of Unmanned Robotic Services; Ferraresi and G. Quaglia (eds.), Springer; Advances in Service and Industrial Robotics, Mechanisms and Machine Science 49, DOI 10.1007/978-3-319-61276-8_55

Richard Normann. Reframing Business: When the Map Changes the Landscape. Wiley, 2001.

Preston, B. (2013). A philosophy of material culture: Action, function, and mind. New York, NY: Routledge

Stiny, G. (2006). Shape: Talking about seeing and doing. Cambridge, MA; London: MIT Press

Tapper, R. 1988. Animality, humanity, morality, society. In What is an animal?, ed. T Ingold. London: Unwin Hyman, pp. 47–62.

Vardouli, T. (2015). Making use: Attitudes to human-artifact engagements. Design Studies. https://doi.org/10.1016/j.destud.2015.08.002

4 | TERRITORIAL METABOLISM AND FLOURISHING ECONOMIES

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WORKING PAPER

Systemic design for sustainable territorial development: ecosystem definition to support autopoietic local economies

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Abstract To meet the current challenges to fight global and interconnected problems as waste production, systemic thinking is needed to provide a new cultural paradigm to create Sustainable, Circular and Blue Economies. One action can be done spotlighting the local territory in which we are living every day enhancing cultural and natural resources, indeed of considering it as a place where the products are manufactured, travel everywhere and leave only waste. Systemic Design can provide an answer creating eco-innovation and environmental, social and economic sustainability, especially at the local level. A multiple case-study analysis on previous projects on Systemic Design has conducted to understand the principal barriers in their implementation and their outcomes to reach sustainable territorial development. After the identification of the new opportunities created at the entrepreneurial level, finally, it is designing the entrepreneurial ecosystem of innovation to foster Systemic sustainable projects framed in a specific context of reference.

Keywords: systemic design, ecosystem, manufacturing sector, eco-innovation, sustainable local development.

1. Introduction

Nowadays, the production models should be reconsidered and redesign to meet future challenges and the current need of sustainability at economic, social and environmental level (Garetti and Taisch, 2012). In the current situation made of fast changes and interconnected problems with effects at the global level, holistic thinking is needed to provide a new approach and a cultural paradigm (Capra, 2014) as it has represented a 'turning point' for many disciplines (Capra, 1982). This new point of view should contaminate the linear economy, many times pointed by scholars as one of the enemies of the current society (Gast, 2017; Littig and Grießler, 2005), to produce a shift in production models and creation of economic models to reach a Blue and Circular economy (Pauli, 2010; EU, 2015). This shift can be produced spotlighting the attention on the local territory in which we are living every day enhancing its cultural and natural resources, indeed of considering it as a place where the products are manufactured, travel everywhere and leave only waste.

Systemic Design (SD) demonstrates with many projects to be an approach able to connect the territory, design and environmental issues to create a local sustainable development (Bistagnino, 2011). This research investigates the intersection between systemic design, environmental sustainability and entrepreneurship, and wants to demonstrate the need of the creation of an ecosystem to support the implementation of projects born from SD to overcome the complex implementation of this type of projects in practical terms which threat their success. It is vital to produce eco-innovation and a shift in production models.

To demonstrate the principal thesis firstly was framed the current scientific literature on topic correlated to Systemic thinking, Design, Business Ecosystem and Innovation models. Secondly, was performed a multiple case-study analysis on previous SD projects applied to the manufacturing sectors developed by SD research group to understand the principal barriers in their implementation and their outcomes. This process was facilitated thanks to the direct involvement of authors in these projects. Afterwards, the typologies of new activities born from the application of SD approach to the manufacturing sector in a specific territory are defined. Finally, the ecosystem is designed (ECO-SD) able to stimulate and foster the born and the implementation of eco-innovative systemic projects with the goal to create and support autopoietic local economies.

This research work is complementary to the work presented in Battistoni, Barbero (2019, in press).

2. Literature review

2.1. Systemic Design: innovation, sustainability and territory

The design discipline with its methodology and approaches has confirmed through different applications to be a strategic approach for innovation creation (Bertola, 2003; Celaschi, 2007; Brown, 2009; Franzato, 2011). At the same time, design shows potentialities in increasing the value of a particular geographical area, as the valorisation of the material culture and natural resources represented in many works as De Giorgi and Germak (2008); Bozzola and De Giorgi (2016); Catania (2011).

Some design approaches also represent a solution to reach sustainability (Ceschin and Gaziulusoy, 2016). Between them, SD, as a discipline which include systemic thinking in the design practice, enlarges the borders of the traditional discipline producing a step forward the eco-design (Jones and Kijima, 2018).

SD applied to anthropic production process was mainly defined by Bistagnino (2011) (Battistoni and Barbero, 2017). This approach is mainly developed around five principal guide-lines, in collaboration with Zeri foundation and Fritjof Capra (Bistagnino, 2011). SD intends to create relationship(2°) based on “an output become an input” (1°) for another system as happens in Nature. These links are created acting locally (3°) and connecting the human being with the context of reference(5°). In addition, the systems created are auto-generating (4°) in terms that they are self-reproducing systems. Indeed, SD applied to single productive activities permits to change their core business, transforming the production models in an open system in relations to the other ones. Considering waste as resources, their incomes are improved and increased. Moreover, it permits the creation of new products that can let the born of new economic realities (fig. 1), generating the autopoiesis phenomenon typical of the natural systems (Capra, 2014). All these opportunities can boost sustainable territorial development, creating a local circular economy. To perform this, they required the intersection between the economic, social and environmental aspects involving different

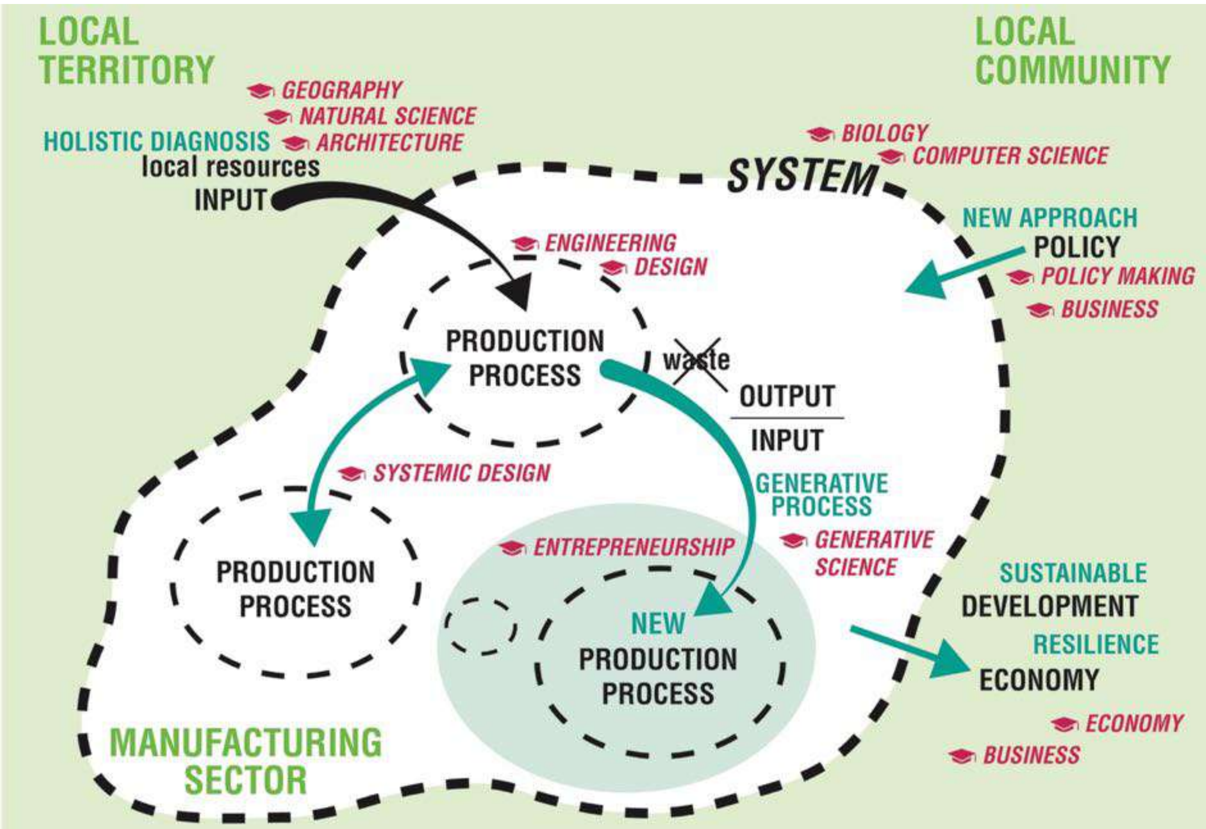

Figura 1 graphic representation on the SD applied to the manufacturing sector and the competences involved in this approach

competences: from technical to humanistic competences (fig. 1.).

2.1. Ecosystem, innovation and territory

As stated by Bassis and Armellini in 2018, Moore (1993, 1996) with his works coined the term Business Ecosystem (BE) defining it as "an economic community supported by a foundation of interacting organizations and individuals" (Bassis, Armellini, 2018, pg. xx) and introducing the concept in the management field. Moore used the biological ecology as a metaphor claims for interactions between existing business in search of innovation (Scaringella and Radziwon, 2018). Moore identified the evolution, adaptability and community as key characteristics of BE, however his Innovation Ecosystem (IE) theory was focused on the firm itself, to help managerial challenges, and the boundaries of the ecosystem ware globally seen (Bassis, Armellini, 2018). Trying to define the differences between IE and System innovation (SI) which both have the theoretical basis in System Thinking, Bassis and Armellini (2018) define the focus of SI in the location (region or country) to which a firm belong, referencing the work of Patel (1994).

Others studies confirm that the concept of the complex adaptive system that comes from biology was starting to be used in the business environment. As stated by Reeves et al. (2016), company, as complex adaptive systems, continues to evolve through cycles of interactions, emergence and feedbacks and they are nested in different systems, from business to societal.

For the multifaceted nature of the concept BE, subsequently in the paper we will use the word of Ecosystem as a metaphor for the way of the Nature act, and not referring to Moore's theory.

During the years the concept of BE is evolved in more concept as "industrial ecosystem", "innovation ecosystem", "digital business ecosystem" and "entrepreneurship ecosystem" (Bassis and Armellini, 2018; Scaringella and Radziwon, 2018), some of which link the ecosystem concept with territorial approaches (Scaringella and Radziwon, 2018), but none of them has links to Moore's theory of IE (Bassis and Armellini, 2018).

For the scope of our research, we are focusing on the Industrial Ecosystem (IE) and Entrepreneurial ecosystem (EE). IEs are identified in the eco-industrial parks created following the industrial ecology where the industrial ecosystems are examined as complex systems (Costa, xx; Chertow, 1999, 2000). Instead, EE is defined as a "systemic view of entrepreneurship" following a recent review on EE by Cavallo et al. (2018). Many studies had focused on the definition on the components of the EE (Cohen, 2006; Neck et al., 2004; Stam, 2015; World Economic Forum, 2013; Feld, 2012; Spiegel, 2015; Isenberg, 2010). About the relation between EE and the territory, Cohen (2006) have contributed to highlight the attention on how the territorial context have impact on entrepreneurship and that entrepreneurship takes place in a precise geographical area with the coordination of multiple actors (Cavallo et al., 2018), and Audretsch et al. (2012) pointed the focus on the relationship between regional characteristics and entrepreneurial activities.

The scientific literature has many times focus on the role of Business Incubators (BI) and their role in EE. A previous work by authors has stated the BIs phenomenon (Battistoni and Barbero, in press). Along the discussion on the meaning, there is the one on understanding the typology of existing BI, their goal and services. Along with different typologies, many authors identified the regional incubators archetype (Barbero J. L. et al., 2012; Aernoudt, 2002; Von Zedtwitz and Grimaldi, 2006).

More recent studies, like the one of van Weele et al. (2018), call for the fourth generation of BIs: "the 'systemic' incubators that aim to transform or create institutions to strengthen the entrepreneurial ecosystem (DiMaggio 1988). Lately in our study, referring to a 'Systemic Incubator' we will not only refer to this definition but mainly to an incubator that can foster the creation of start-ups from systemic design projects.

The intersection between entrepreneurship, environmental and social responsibility is identified in 'ecopreneurship' (Battistoni and Barbero, 2019 in press). The benefits for sustainable-driven business models are starting to be investigated by researchers as Kiron et. al (2013) however their research is focused on profits raised by companies and a Systemic Thinking should be applied to the design of sustainable enterprises to consider sustainable and social factors in business models (Jones and Upward, 2014).

According to, Scaringella and Radziwon (2018) EE emerges through the interactions of various actor and stakeholders creating intersections between different systems considered in the triple helix model of innovation (industry, university and government level to create the knowledge society and innovation and economic development) leading to the quadruple helix model which consider the civil society (Scaringella and Radziwon, 2018). The helix models of innovation had evolved during the years (fig. 2). Very interesting for our study is especially the Triple Helix Systems of Innovation in which the triad is acting as a system with systemic and non-linear interactions between actors (Stanford University website).

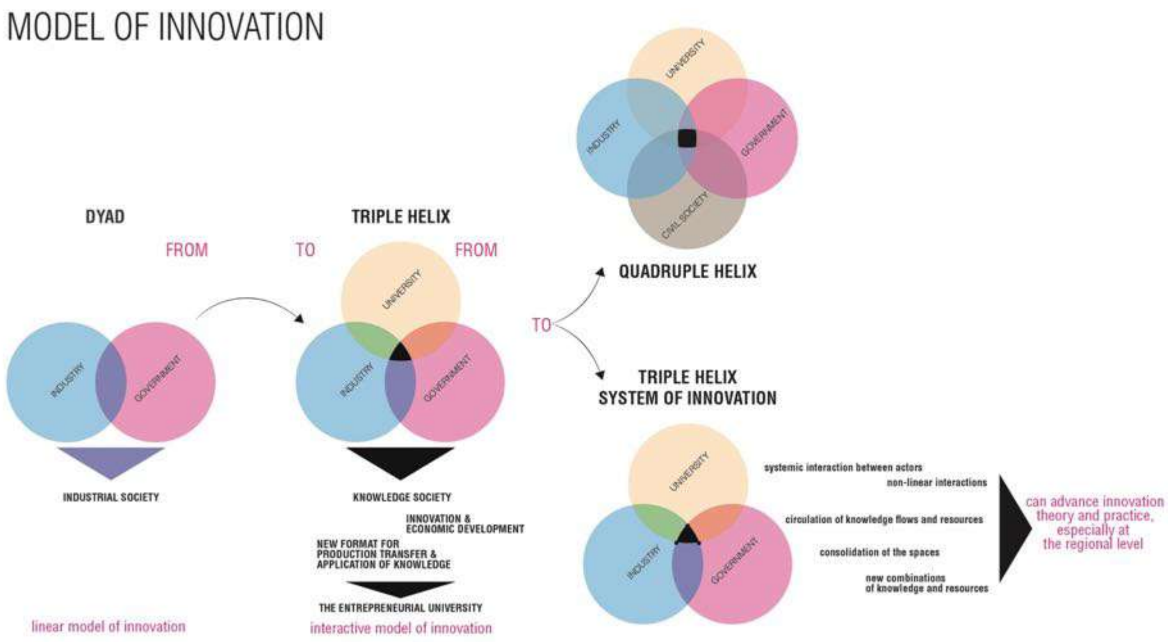

Figura 2 graphic representation of the evolution from the Dyad, to the triple helix and quadruple helix

Literature has also focused on the relationship between BIs and governments and their roles (Kautonen et al., 2017; Cavallo et al., 2018; Stam, 2015; Scaringella and Radziwon, 2018)..

3. Case-studies on SD for territorial development

Although the literature has highlighted important characteristics of SD projects to reach a sustainable development (Bistagnino, 2011; 2016) at the same time, they can represent the barriers to their success and implementation. We will focus on two SD projects which fit in two categories for their high level of complexity which didn't permit their implementation: (1) project for a particular territory; (2) project for a particular production process based in a particular territory. We performed a multiple case-study research (Yin, 2014) highlighting for each case the main pros and cons to understand the main barriers reasons.

3.1. SD project for a particular territory

In this project, the SD approach has been applied in a mountain Valley in Piedmont Region, Italy (Battistoni & Daghero 2013; 2016). The project design new sustainable production model for every 24 typologies of enterprise taken in consideration, creating at the end a complex system able to generate territorial development not only at economic level but also at environmental and social one. The project demonstrates to be able to create: (1) 26 typologies of new activities as shown in fig. 3); (2) several environmental benefits as the reduction of the use of the drinkable water of 80%; (3) a substantial economic profit. After a considerable consensus by the local policymakers, the project wasn't implemented.

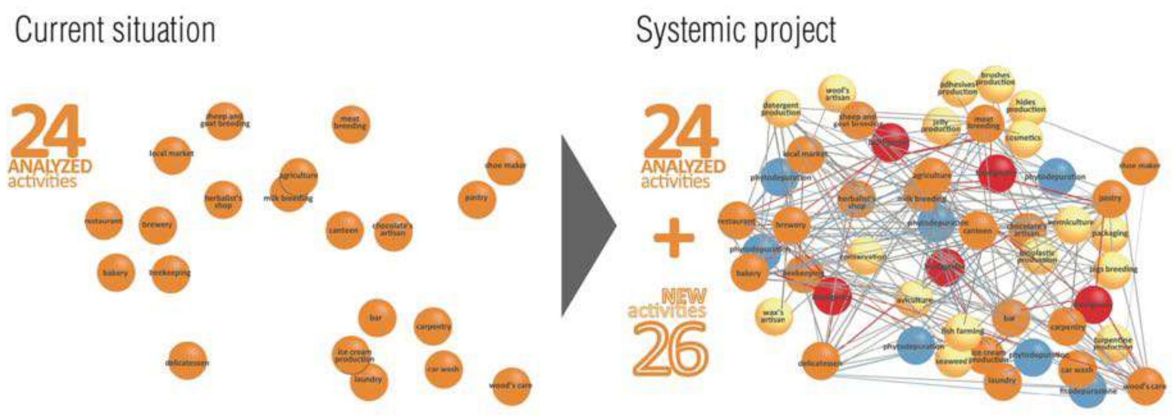

Figure 3 development and design of the complex system. In the visual representation are present only the principal relationships between the components. In orange are represented the current activities, in yellow the new one.

In table 1 is presented an analysis of the pros and cons of the project for its implementation.

Tab. 1. Pros and cons of the project implementation

BENEFITs (pros)	Initial support from city major
	An alpine Valley plenty of natural resources
	High sense of community between citizens
	Presence of only micro-small enterprise
	Close valley (at geographical level)
	Rich Valley

	Strong relation between nature and inhabitants
PROBLEMs (cons) related to the project (internal):	Lack of commitment by the activities' owner along all the project
	Most the activities involved are from the 1° sector (agriculture and breeding), owned by old people and with no inclination to investments
	Close valley (at social level) and reduce openness to innovation
	Difficulties in understanding the importance of the project
	Sleeping Valley: most of the people who live there, work out from the Valley
	Lack of external founding, despite the major commitment
	The city major changed few months after the project
	Difficulties in understanding the complexity of project
	Lack of awareness on the importance to change (no Valley in crisis)
	Lack of strong commitment by the entrepreneurs
	Top-down approach (not coming from the citizens or enterprises)
	Lack of a feasibility study of the project, only economic forecast

3.2. SD project for a particular production process based in a particular territory

In this case study, the SD approach was applied to a particular production process, food factory (Barbero & Battistoni, 2016). The project, done in collaboration with the industry and the Systemic Design research group, guide the enterprise towards a systemic production model. The project worked on the re-connection of the food production with local resources and know-how acting on the change of ingredients, re-designing a typical traditional product which can become a symbol of the region and the cares about the consumer's health. Involving local products in the new recipe, the factory starts acting as a re-activator of the local agriculture and manufacturing sector, increasing relationships which can have cascade impact for all the region and starting up also other business (fig. 4), creating sustainable territorial development.

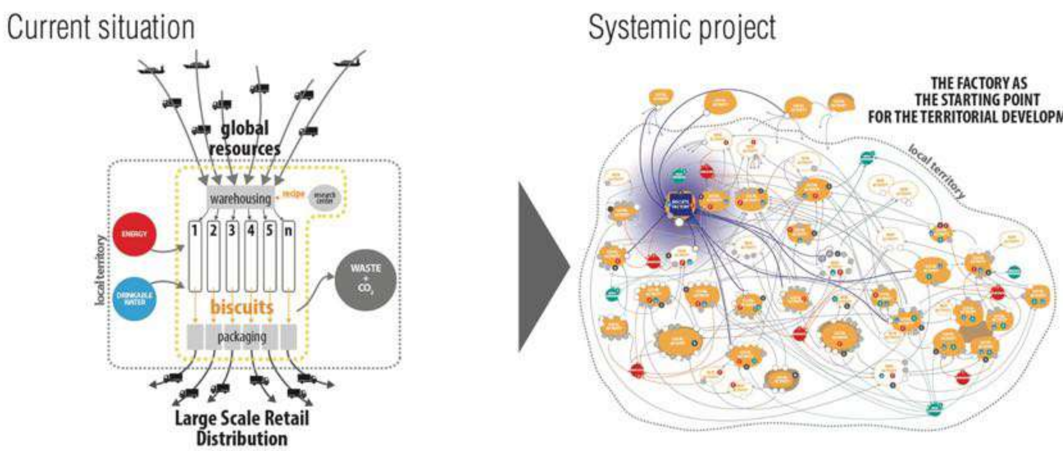

Figura 4 visual representation of the shift proposed by the Systemic Design project. Graphic review of the picture published in Battistoni, Barbero 2016

In table 2 is presented an analysis of the pros and cons of the project for its implementation.

Tab. 2 pros and cons of the project implementation

BENEFITs (pros)	No problem in economic investments
	Interest for innovation projects
	Internal research centre
	Industry which in the past started as a little biscuit maker in the same location (has a recognisable role in the area)
	Thanks to innovation in management, the employees are listened by the CEO, and their ideas are taken into consideration
PROBLEMs (cons) related to the industry (internal):	Lack of commitment by the industry along with all the project duration (or at least by the CEO along the project duration) - Change of CEO during the project
	Sharing of internal data to external people (even researchers involved in the project)
	Lack of data on the specific quantity of the different input and output
	Difficulties to understand the importance of the project over the economic benefit
	Large industry which must preserve many job places, it acts with caution
	Reduced openness to collaboration with other industries
	Lack of awareness by the CEO on the area where they are located (better situation among employees)
	Focus on its own production and lack of awareness on what is happening outside (especially on agriculture topic)
	Lack of awareness on the implications of their actions on the environment and consumer’s health
	Lack of future visions on the environmental situation
	Difficulties in managing the complexity of the projects
	Resistant to change

4. Results

Thanks to the precedent case studies analysis, is possible to draw many results: from the state-of-the-art of territories to the major implementation barriers faced by SD projects to the definition of the many opportunities created by SD project for a new kind of entrepreneurship, to the draft of the ecosystem requires to ease the implementation of the new typologies of enterprises.

4.1. Territory: state-of-the-art

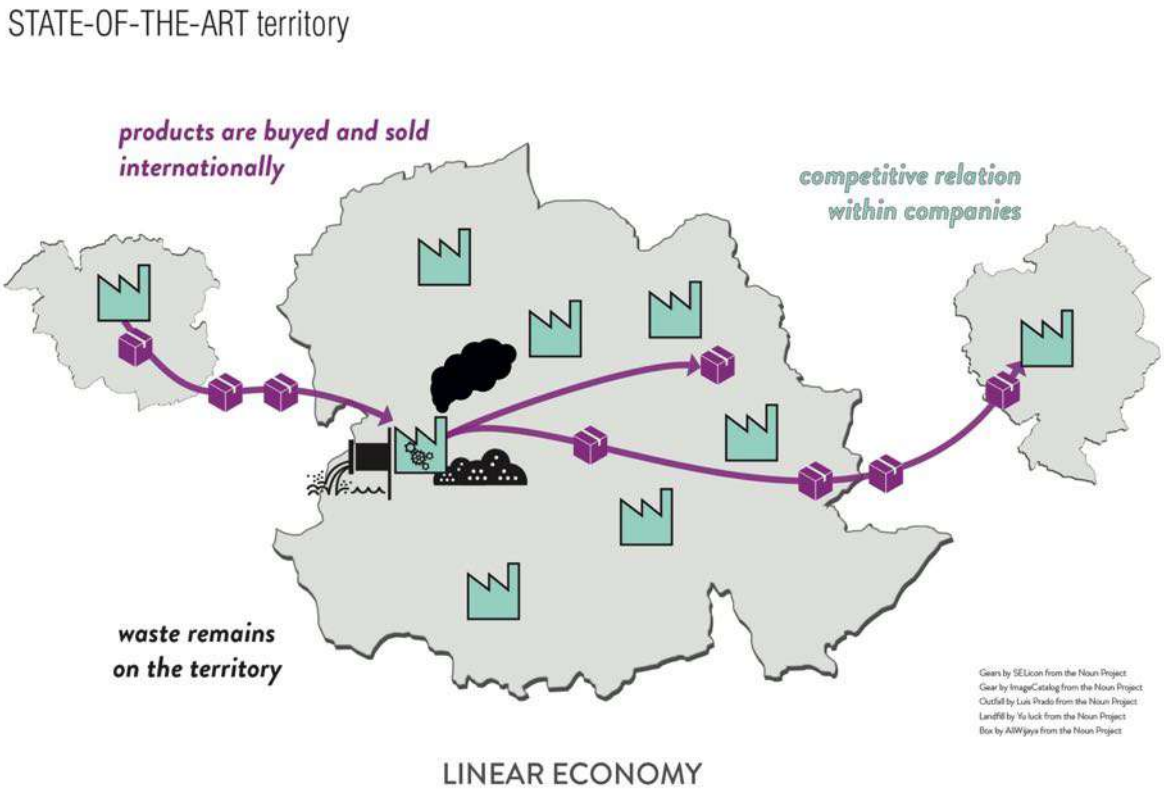

Figura 5 grapic representation of the state-of-the-art of territories, considering the behaviour of the productive sectors

From the analysis of the current situation performed in every projects, it is possible to frame the state-of-the-art of our territories based on the behaviour of the productive companies located in them, as shown in fig. 5. Usually, the companies are processing different typology of matters which comes from many different territories and sell their products at the global level in a competitive ecosystem. Under this behaviour, there is a lack of awareness about the implications of our action on the environment. Indeed, there is an exploitation of the of the energy and the human capital needed for the manufacturing process and on the territory where the company is settled remains only waste and pollution (in water, soil and air).

4.2. SD projects implementation barriers

Another result that is possible to obtain for the case-study analysis is the barriers to SD projects implementation (tab 3). At the basis, SD projects require a cultural paradigm shift (Barbero,2016), from the linear to the systemic thinking, from competition to collaboration, identified by Capra (1982) “the turning point”. Besides, complexity resulted to be one of the SD projects fundamental characteristic as they focus on the relationships between components instead of the single entities and on the resources which go in and out of a production process. Complexity can represent an obstacle to overcome for the human linear way of thinking developed with the industrial revolution.

Moreover, talking about input/output and not resources/waste they need a complete change on the cultural paradigm and point the focus more on qualitative aspects than quantitative ones. The current legislation on waste is limiting the relationships made by flow of matters. Another consideration is that SD projects are community-oriented, territorial-oriented and environment-oriented more than profit-oriented and producing sustainability they require the competences of different disciplines, multiple actors and stakeholders, both in the design phase than in their implementation, being multidisciplinary and interdisciplinary projects. Finally, they require financial support, human resources and project management as all the projects. Luckily, the current emphasis on the Circular Economy from the European Union is helping to bridge the cultural gap since 2015 (EU, 2015).

4.3. Identification of the typology of new activities that can potentially born

The application of SD approach to the manufacturing sectors can support the creation of new opportunities to obtain a sustainable local development that can be turned in new enterprises. These opportunities are defined as:

- Action on the entire production model to produce a shift from the linear one to a circular and systemic one;
- Spin-off creation by:
    a. new opportunities discovered inside one production model;
    b. the opportunity given by a single output well-known by research community - depending on output quantity it can born from the collaboration of similar industries or just by one;
- Start-ups/new enterprise, created by:
    a. Systemic designer which become eco-entrepreneurs which idea come from different past experiences;
    b. eco-entrepreneurs after a training on SD approach, which idea come from the scan of regional opportunities (HD) for:
        i. business profit (e.g. production of a new kind of product from something that now is considered waste;
        ii. non-profit business (e.g. biodiversity and biological ecosystem protection and restoration);
        iii. business profit with the goal of community involvement increasing awareness through the creation of activities as workshops (e.g. working on waste perception);
        iv. business profit with the goal of citizens and awareness improvement (e.g. buying group for local products)
        v. benefits for the entire territories (e.g. creation of a fab-lab for the recovery of local know-how);

   c. collaboration of different industries and systemic designers to manage one of the companies' problems (e.g. to manage the sharing of technical instruments or machines);
- new clusters: association of industries with close collaboration in the same area (same goal with eco-industrial park concept (Chertow, 2000).
- Research projects:
   a. on particular local output not well-known by scientific community, to advance the scientific knowledge and with possible new business opportunities creation;
   b. to provide the redesign of products following 'ecodesign' (Lanzavecchia, 2012) and 'design by components' (Bistagnino, 2008) approach, thanks to the competences of systemic designer involved.

4.4. Ecosystem definition

Missing contributions by the scientific literature on the definition of the ecosystem which can sustain SD projects, the design of a systemic entrepreneurial ecosystem is necessary (ECO-SD). Its goal is to stimulate and foster the born and the implementation of eco-innovative systemic projects to obtain a sustainable regional development. It is represented in fig. 6. This definition represents a step over the one presented in a previous conference paper (Battistoni and Barbero, in press).

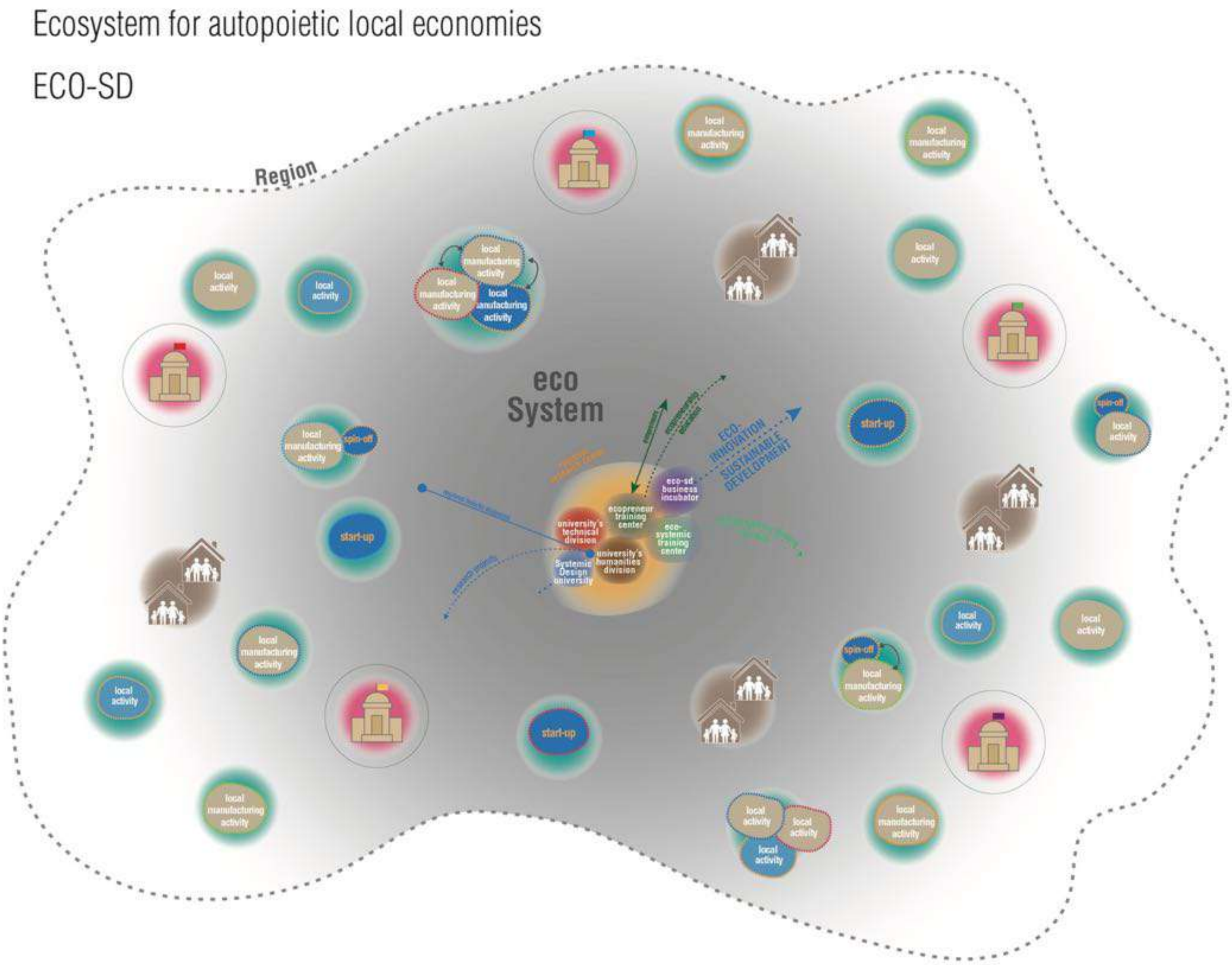

Figura 6 graphic representation of the ECO-SD

Looking at the territory and its productive sectors with a systemic approach, shifting the attention from the single actors to the relationships that are possible to create among them, is possible to obtain different results. As the theory of system suggests "the whole is *greater* than the sum of its parts" (Aristotle), or better "the whole is *other* than the sum of its parts" from Gestalt theory (Koffka). This shift can let emerge several new opportunities and potentialities linked to a development which is far away from the current economic evidence, centred exclusively to the increase of the GDP. Acting in this way is possible to answer to the real needs of a specific area, with the final goal to act on the cultural paradigm, obtaining a real sustainable development.

ECO-SD incorporates the characteristics of the EE and the different models of innovation, the triple helix system of innovation and the quadruple helix, cited before. A graphic representation of the actor involved in ECO-SD is present in fig. 7. The university level is represented by the technical and humanities division and also includes the university on SD which include technical and humanities skills. The government is represented by the different levels (from city to regional and national) which act on a specific territory. The industry is represented by the three typologies of enterprises (micro and small, medium and large). The civil society is present not as a single entity but in relation with all the others, being everyone represented by human beings that act as a civil society once that their work end.

The heart of ECO-SD cannot be identified only in the current BIs which are concentrated mainly on the economic sustainability of the projects and the training of the future entrepreneurs within linear economy benchmarks. Instead, it is represented by the Regional Research Center (RRC) (fig. 8) which present the intersection between the universities, the training centre on ecopreneurship and systemic approach. RRC acts as a guide: starting from the execution of the HD (Battistoni and Giraldo, 2017), it can identify the current significant problems and the sectors where projects are needed. Opening the way to the innovation of process, production models, products and services, they are therefore designed by multidisciplinary groups where the designers collaborate with other scholars and experts coming from the natural, social and economic science, acting as "mediator" (Celaschi, 2008), fostering the dialogue and the contamination. Working together for the implementation of the new projects, they should maintain the link with the local actors, not exclusively coming from the productive sector but also from the decision-making, to assure a local sustainable development.

In close relationships with RRC works the ECO-SD incubators, a systemic incubator with the goal to foster the born and the reproduction of productive processes and act as an open system. In here, also the economists should think in another way as Raworth suggested (Raworth, 2017) and work in close relationship with the Ecopreneur Training Center. In the ECO-SD incubators, the attention is on the flow of information, matter, energy and people which create relationship both inside every single process and within them, and within the context of reference where it is placed as shown in fig. 9.

All the opportunities created in the ECO-SD can lead to the creation of different typologies in the same territory as the one represented in fig. 10. Along the one which are created thanks to the ECO-

SD inc there are the one which has been affected by the ECO-SD RRC only by trainings or the one that has not received any supports.

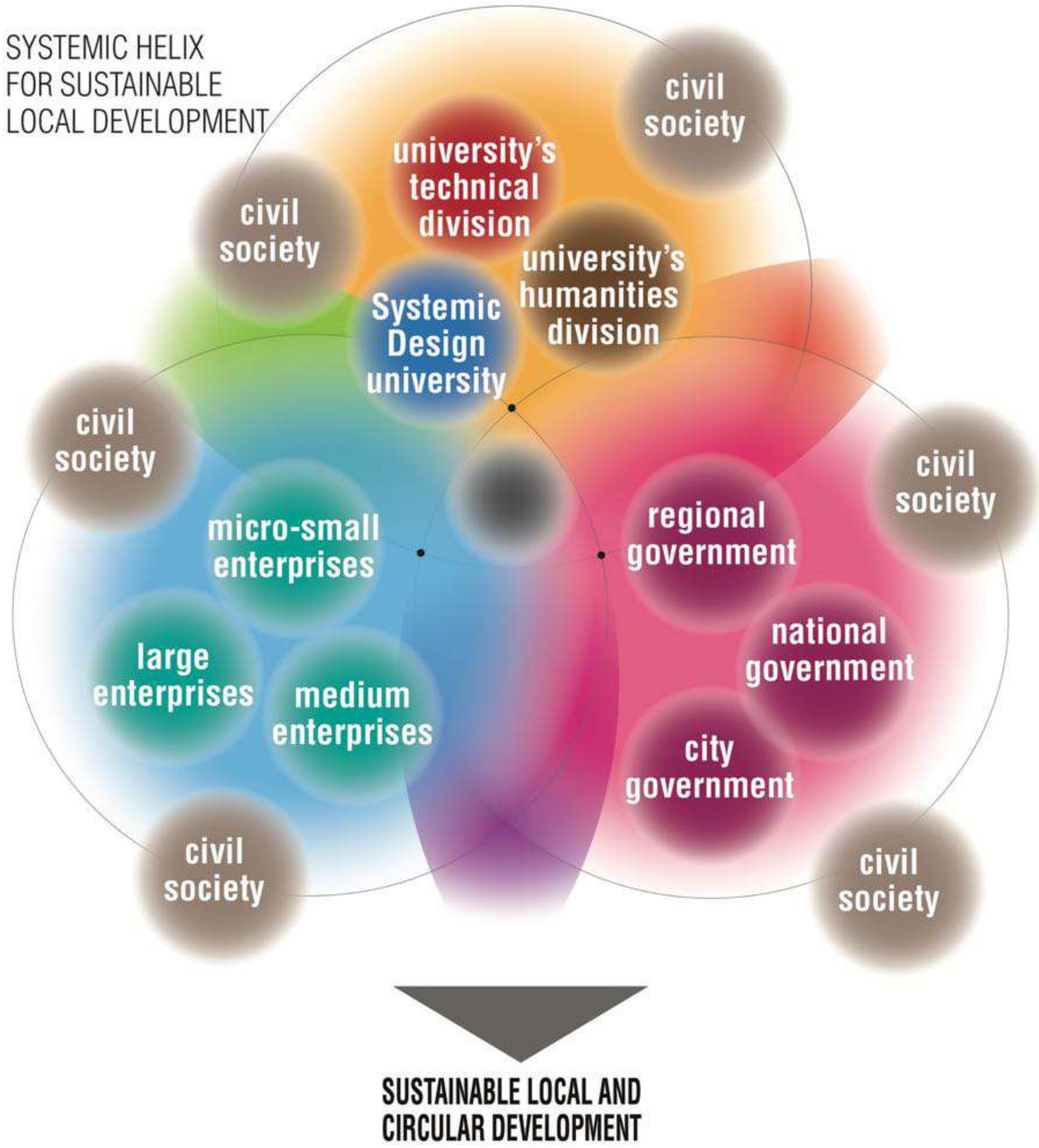

Figura 7 graphic representation of ECO-SD

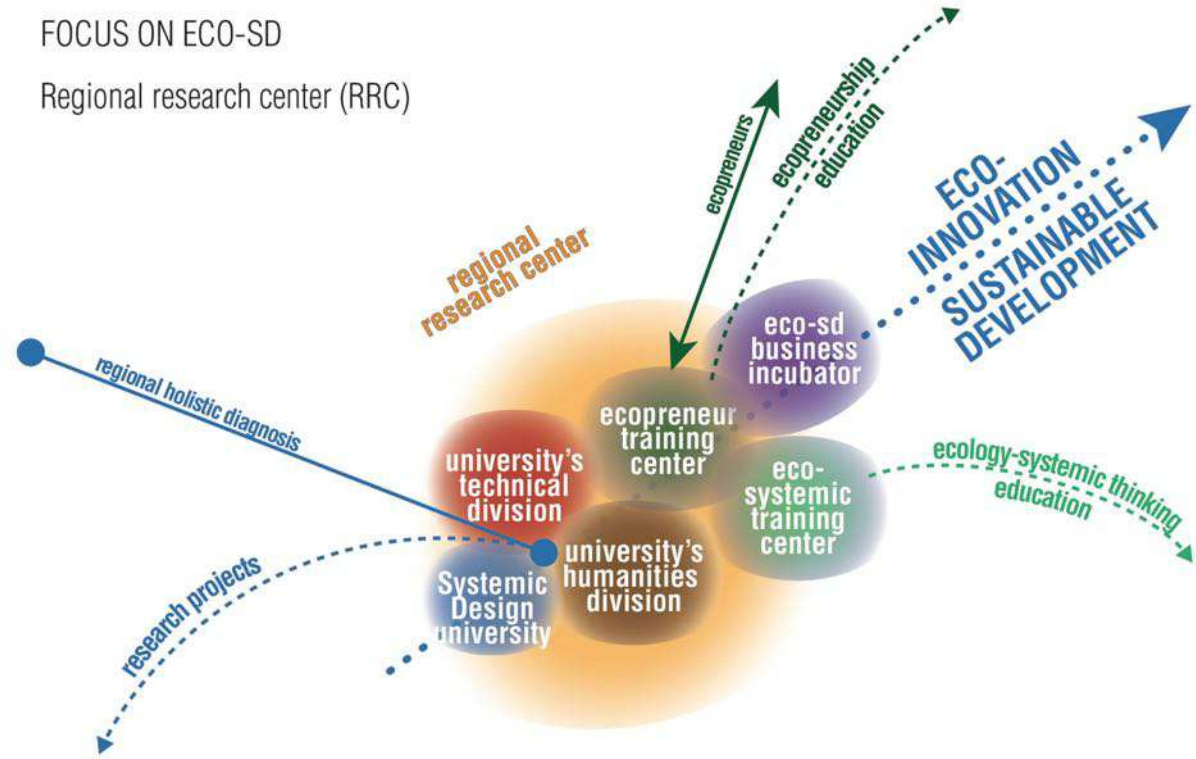

Figura 8 graphic representation of the RRC inside the ECO-SD

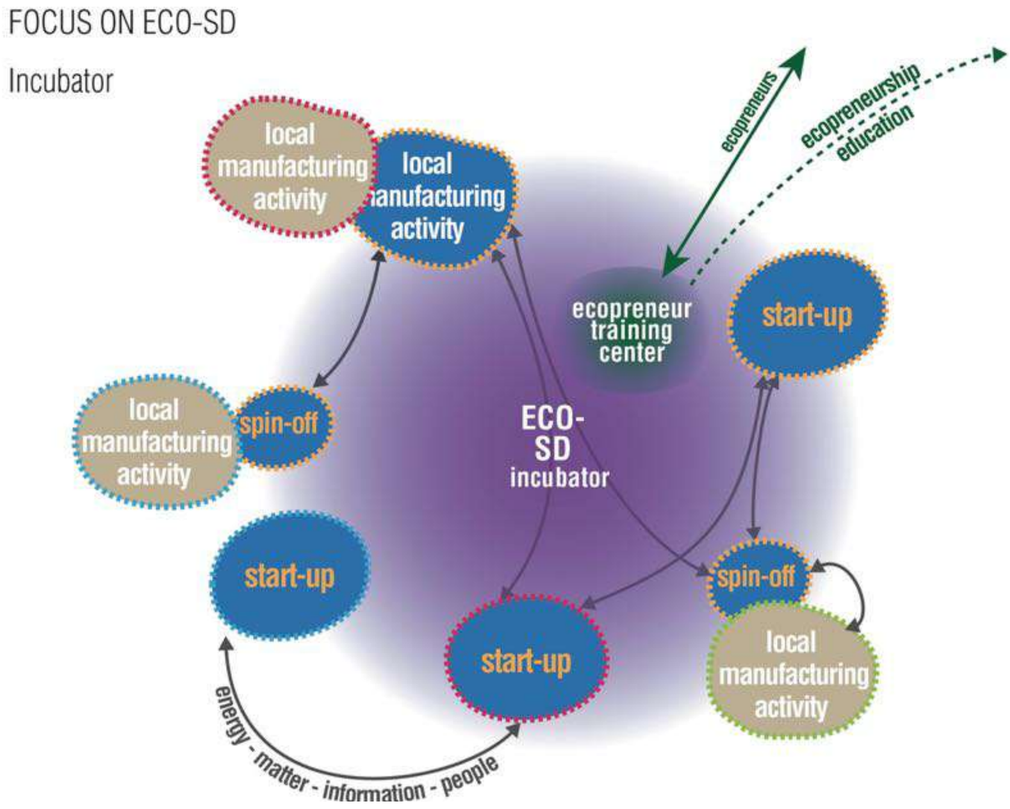

Figura 9 graphic representation of the ECO-SD incubators and the possible new start-ups created.

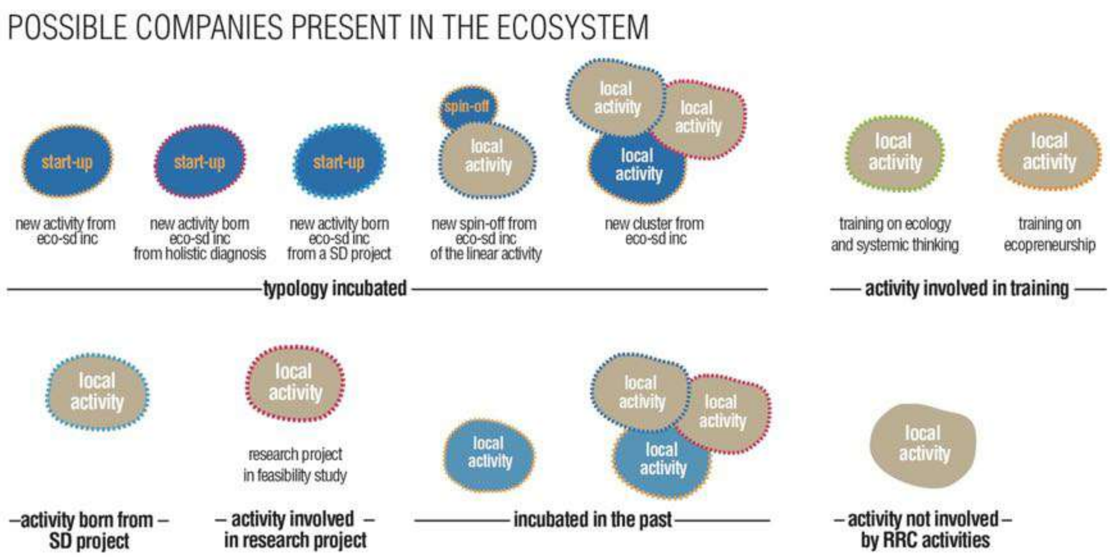

Figura 10 possible typologies of companies presents in ECO-SD

5. Discussion and conclusions

The different results of this research were necessary to the definition of the main result, the ECO-SD. It finds roots in previous studies on helix models of innovation and on EE and in a previous study by authors which has shown its limitations. In this new definition, in the ECO-SD is present the ECO-SD inc which continues to focus on the economic sustainability of the ideas and business models received. As previously stated by van Weele et al. (2018), incubators are evolving entering services more related to the idea creation, which by our opinion, should be an action done in collaboration with multiple actors, comprehending designers as they are trained and worked to frame new ide and opportunities by currents problems and necessities.

In the graphic representations in fig. 6 the net which is creating between all the different actors is implicit in the grey colour. A future research, which now is only is a tentative attempt represented in fig. 11, is to find all the relationships created by the ECO-SD between the different actors and the outcomes created by them. The principal outcomes created by ECO-SD can be represented in the 'sustainable local and circular development', which subsequently can be split in the creation of ecopreneurship, sustainable economic development, low environmental impact, high social impact and participated policies. Further studies should be concentrated also on the future vision about what this ecosystem can create in the local territory as represented in fig. 12. Another future research will be to find and analysis case-studies where similar realities to ECO-SD are already in action thanks to similar goals which are not present in the scientific literature. This step will help to define better the hypothesis done in this study and it will be into a real context of application. The most likely and eased to implement is related to the Torino municipality in Italy where the Systemic Design research group is located and already working.

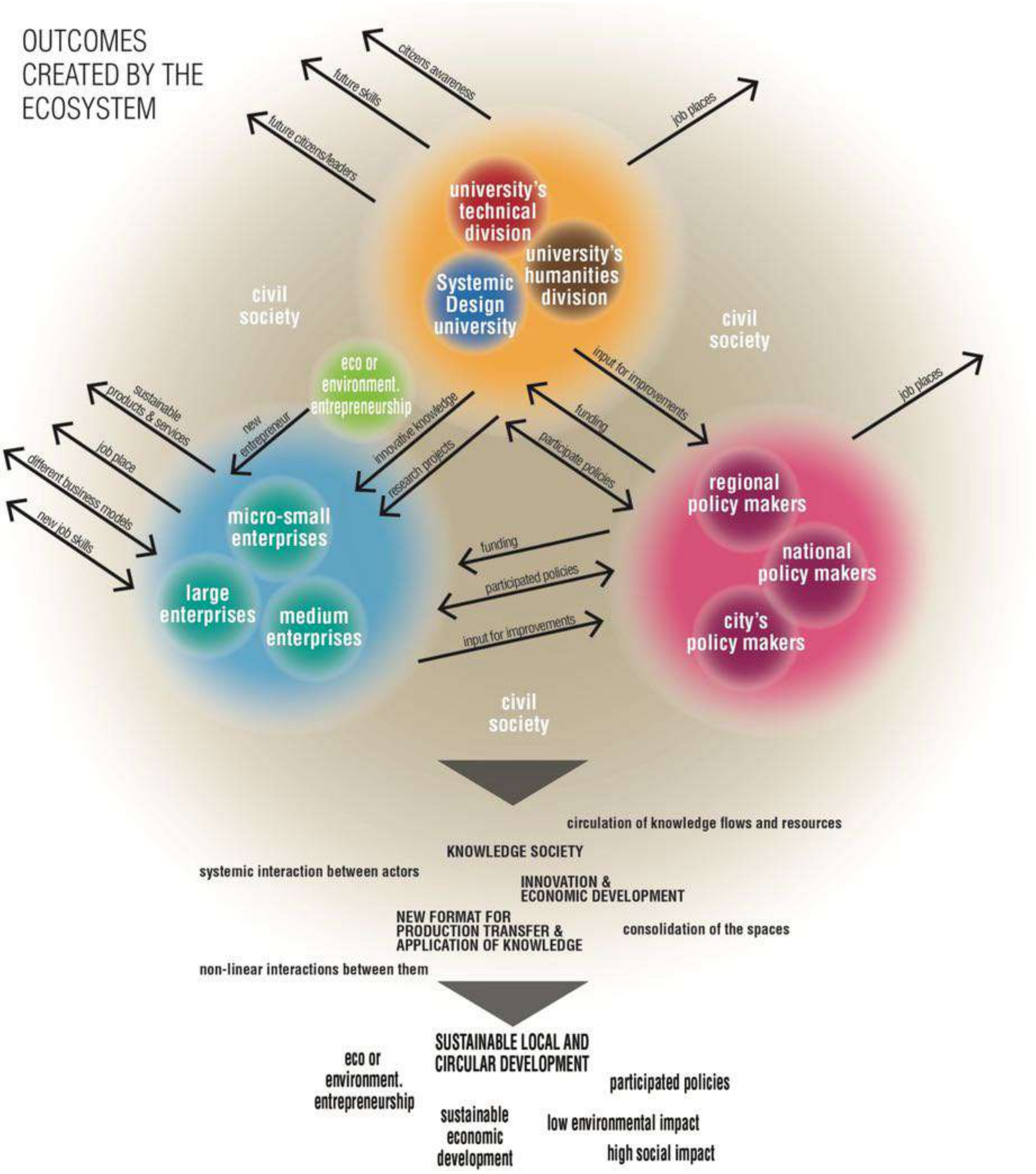

Figura 11 graphic representation of the relationships between the different actor in the ECO-SD and the outcomes that these relatinships create.

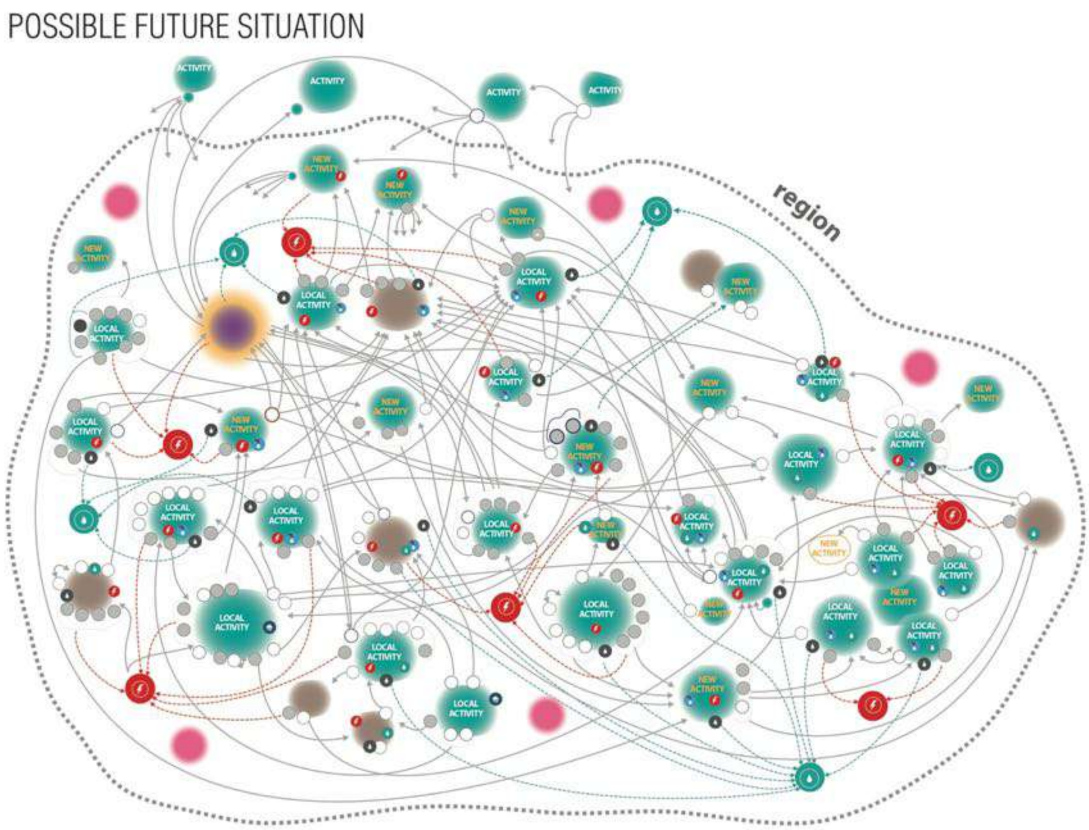

Figura 12 graphic representation of the possible future situation inside the region

References

Aernoudt, R. (2004). Incubators: tool for entrepreneurship?. *Small business economics, 23(2),* 127-135.

Barbero, J. L., Casillas, J. C., Ramos, A., & Guitar, S. (2012). Revisiting incubation performance: How incubator typology affects results. *Technological Forecasting and Social Change, 79(5),* 888-902.

Barbero, S. (2017). Edited by. *Systemic Design Method Guide for Policymaking: a Circular Europe on the way.* Torino, italy: Allemandi.

Barbero, S. (2016). Subject of change: micro and small enterprises. In Bistagnino, L. (2016). *microMACRO*. Milano, Italy: ed. Ambiente.

Barbero, S. (2012). Cross analysis of theory (Systemic Design) and practice (case studies) to design and test framework for Local Economic Development. In: *18th Annual International Sustainable Development Research Conference*, University of Hull (UK), 24-26 June 2012.

Barbero, S., Battistoni, C. (2016). From the sustainable biscuit production to territorial development through systemic incubator. In: *8th International Scientific Conference Management of Technology - Step to Sustainable Production (MOTSP 2016), Porec (HR), 01–03 June, 2016.*

Barbero, S., Bistagnino L. & Peruccio P.P. (2016). Awareness. In Bistagnino, L. (2016). *microMACRO*, 168-175. Milano; ed. Ambiente.

Barbero S., Tamborrini P. (2012) Systemic Design in AgroFood Sector: EN.FA.SI project. *Proceedings of International Conference on Designing Food and Designing For Food, London 28-29/06/2012*. pp. 285-296

Bassis, N. F., & Armellini, F. (2018). Systems of innovation and innovation ecosystems: a literature review in search of complementarities. *Journal of Evolutionary Economics*, *28*(5), 1053-1080.

Battistoni C. & Barbero S. (2019). Systemic incubator for local ecoentrepreneurship to favour a s ustainable local development: Guidelines definition. Accepted paper for EAD2019 Dundee conference https://ead2019dundee.com/.

Battistoni C. & Barbero S. (2018). Systemic design for territorial development: ecosystem to support autopoietic local economies. (abstract) In *Conference abstracts RSD7, Relating systems thinking and design 7, 24-26 October 2018, Torino, Italy.*

Battistoni, C., Barbero, S. (2018). The Holistic Diagnosis as a method to support urban mining actions: the case study of the European project *Retrace* for Piedmont region (Italy). In: 4th symposium on urban mining and circular economy (SUM 2018), Bergamo (IT), 21-23 May, 2018. Bergamo: CISA Publisher.

Battistoni, C. & Barbero, S. (2017). Systemic Design, from the content to the structure of education: new educational model. *The Design Journal, 20:sup1, S1336-S1354: Design for next. Proceedings of the 12th European Academy of Design Conference - Sapienza University of Rome (IT), 12-14 April 2017.*

Battistoni, C., Bicocca, M., & Pallaro, A. (2016). Social values, economic, ethical and well-being. In Bistagnino, L. (2016). *microMACRO*, 176-207. Milano; ed. Ambiente.

Battistoni, C., Daghero, A. (2016). High Sangone Valley (Turin), The territorial potentialities. In Bistagnino, L. (2016). *microMACRO*, 371-398. Milano; ed. Ambiente.

Battistoni, C., Daghero, A. (2013). *Alta Val Sangone Nuove Opportunità Generate Dal Territorio*. Master thesis. Available at https://pico.polito.it/primo-explore/fulldisplay?docid=39pto_aleph000233199&context=L&vid=39pto_v&lang=it_IT&search_scope=everything&adaptor=Local%20Search%20Engine&tab=default_tab&query=any,contains,battistoni%20sangone&offset=0

Battistoni, C., Ferru, A., Fiore, E. & Pallaro, A. (2016). Anzasca and Chisone Valley. In Bistagnino, L. (2016). *microMACRO*, 399-423. Milano; ed. Ambiente.

Battistoni, C. & Giraldo, N. C. (2017). The Retrace Holistic Diagnosis. In Barbero S. (2017). *Systemic Design Method Guide for Policymaking: a Circular Europe on the way.* Torino, Italy: Allemandi.

Battistoni, C., Pallaro, A., & Arrizabalaga-Arambarri, L. (2016). Systemic Design for a sustainable local economic development: Lea-Artibai case study. In B. Hernandis Ortuño (Ed.), Systems & Design, Beyond Processes and Thinking 2016 Proceedings (pp. 883–990). In: 6th International Forum of Design as a Process Systems & Design: Beyond Processes and Thinking, Univertitat Politècnica De València, June 22–24 2016 Valencia. Valencia: Editorial Universitat Politècnica de València.

Bennett, S.J. (1991). *Ecopreneuring: The Complete Guide to Small Business Opportunities from the Environmental Revolution*. New York: John Wiley. Cited in Holt (2011).

Bergek, A., & Norrman, C. (2008). Incubator best practice: A framework. *Technovation, 28(1-2)*, 20-28.

Bertola, P., & Teixeira, J. C. (2003). Design as a knowledge agent: How design as a knowledge process is embedded into organizations to foster innovation. *Design Studies, 24(2),* 181-194.

Bistagnino, L. (2016). Edited by*. microMACRO. The whole of micro systemic relations generates the new-economic-productive model*. Milano, Italy: edizioni Ambiente. 2° edition

Bistagnino, L. (2011). Edited by*. Systemic Design, designing the productive and environmental sustainability*. Bra, Italy: Slow Food. 2° edition.

Bistagnino, L. (2008). *The outside shell seen from inside*. Milano: casa editrice Ambrosiana

Bistagnino, L., Celaschi, F., & Germak, C. (2008). *Man at the center of the project*. Torino; Allemandi.

Bozzola, M. & De Giorgi, C. (2016) Design and Craftsmanship for Cultural Heritage: The 'Materialmente' Project – An Experience from Italy. *The Design Journal, 19:2, 205-219,* DOI: 10.1080/14606925.2016.1129213

Bozzola, M., De Giorgi, C. and Germak, C. (2012). Edited by. *Design for regional cultural heritage. Museum merchandising and craftmanship*. Torino: Celid, p.44–55

Braungart, M. & Mc Donough, W. (2009). *Cradle to Cradle. Re-making the way we make things*. London, Uk: Vintage books.

Brown, T. (2009). *Change by design – how design thinking transforms organizations and inspires innovation.* New York, HarpenCollins.

Catania, A. (2011). *Design, territorio e sostenibilità: ricerca e innovazione per la valorizzazione delle risorse locali.* Milano; Angeli.

Capra, F. (1996). *The web of life: A New Scientific Understanding of Living Systems*. Doubleday, New York: Anchor Books.

Capra, F. (1982). *The turning point*. New York; Bantam Books

Capra, F. & Luisi P. (2014). *The Systems View of Life: A Unifying Vision*. Cambridge, UK: Cambridge University Press.

Celaschi, F. (2008). Design as a mediation between areas of knowledge. In Bistagnino, L., Celaschi, F., Germak, C., (2008). *Man at the center of the project*. Torino, Italy: Allemandi.

Celaschi, F., & Deserti, A. (2007). *Design e innovazione: strumenti e pratiche per la ricerca applicata [Design and innovation: instruments and practices for the applied research]*. Milano, Italy: Carocci editore.

Ceschin F. and Gaziulusoy I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies, vol. 47, 118e163*

Cohen, B. (2006). Sustainable valley entrepreneurial ecosystems. *Business Strategy and the Environment, 15(1), 1-14.*

CSES (2002). *Benchmarking of business incubators*. Enterprise Directorate General, European Commission, Brussels.

Ellen Macarthur Foundation (2013). *Towards the circular economy.* Vol 1. Retrieved from https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf

European Commission. Closing the Loop—An EU Action Plan for the Circular Economy; COM (2015) 614 final; European Commission: Brussels, Belgium, 2015.

Fischer, M. M. & Nijkamp, P. (1988) The role of small firms for regional revitalization, *The Annals of Regional Science, 22(1),* pp. 28–42. doi:10.1007/BF01952841

Franzato, C., & Celaschi, F. (2017). A design-driven innovation process for the exploration of organisational scenarios: action research conducted in a manufacturing company. *Journal of Design Research, 15(3-4),* 309-328.

Garetti, M. & Taisch, M. (2012) Sustainable manufacturing: trends and research challenges, *Production Planning & Control, 23:2-3,* 83-104, doi:10.1080/09537287.2011.591619

Gast J., Gundolf K., Beate Cesinger K. (2017). Doing business in a green way: A systematic review of the ecological sustainability entrepreneurship literature and future research directions. *Journal of Cleaner Production, Volume 147, 2017*, 44-56. https://doi.org/10.1016/j.jclepro.2017.01.065.

Holt, D. (2011), Where are they now? Tracking the longitudinal evolution of environmental businesses from the 1990s. *Bus. Strat. Env., 20: 238–250. doi:10.1002/bse.69*7

Ines Costa (2011). *The Dynamics of Regions and Networks in Industrial Ecosystems, 23:1, 125-129*, DOI: 10.1080/09535314.2010.524885

Jones, P. H. (2014). Systemic design principles for complex social systems. In *Social systems and design* (pp. 91-128). Springer, Tokyo.

Jones P., Kijima (2018). *Systemic Design. Theory, Mehtods, and Practice*. Ed. Springer

Jones, P. H., & Upward, A. (2014, October 15–17). Caring for the future: The systemic design of flourishing enterprises. In: *The Third Symposium of Relating Systems Thinking and Design (RSD3), Oslo, Norway, 3(1), 1-8.*

Kiron, D., Kruschwitz, N., Reeves, M., & Goh, E. (2013). The benefits of sustainability-driven (business model) innovation. *MIT Sloan Management Review, 54 (2), 69-73.*

Lanzavecchia C. (2012). *Il fare ecologico*. Milano; Ed. Ambiente. 2° edition edited by Tamborrini P. and Barbero S.

Littig, B., Grießler, E., 2005. Social sustainability: a catchword between political pragmatism and social theory. *Int. J. Sustain. Dev. 8,* 65-79. Cited in Gast (2017)

Moore, J. F. (1996). *The death of competition: leadership and strategy in the age of business ecosystems* (p. 297). New York: HarperBusiness. Cited by Bassis and Armellini (2018).

Neck H, Meyer D, Cohen B, Corbett A. 2004. An entrepreneurial system view of new venture creation. *Journal of Small Business Management* 42(2): 190–208.

OECD (1997). *National innovation systems*. OECD Publishing, Paris. Cited by Bassis and Armellini, 2018.

Patel, P. (1994) The nature and economic importance of national innovation systems. *STI Review* 14:9–32. Cited by Bassis and Armellini, 2018.

Pauli, G. (2010). *The Blue economy, report to the club of Rome.* Taos, New Mexico; Paradigm Publications.

Pedone, G. (2016). The economy is generated by the network of different activities in the jurisdiction. In Bistagnino, L. (2016). *microMACRO*. Milano: ed. Ambiente.

Peruccio, P. P. (2014). The contribution of future studies and computer modelling behind the debate on sustainable design: the role of the report on The Limits to Growth. In *Diversity: Design/Humanities. Proceedings of the Fourth International Forum for Design as a Process*. Belo Horizonte, Brazil: EduEMG. pp. 206-213

Raworth K. (2017). *Donought economics: Seven Ways to Think Like a 21st-Century Economist*. London; Penguin random house.

Reeves, M., Levin, S., & Ueda, D. (2016). The biology of corporate survival. *Harvard Business Review*, 94(1), 2.

Santini, C. (2017). Ecopreneurship and Ecopreneurs: Limits, Trends and Characteristics. *Sustainability, 9, 492.*

Sevaldson, B. (2011). Gigamapping: Visualization for complexity and systems thinking in design. In: *Proceedings of the Nordic Design Research Conference*. Aalto University, Helsinki, Finland.

Scaringella, L., & Radziwon, A. (2018). Innovation, entrepreneurial, knowledge, and business ecosystems: Old wine in new bottles?. *Technological Forecasting and Social Change*, *136*, 59-87.

Spigel, B. (2015). The relational organization of entrepreneurial ecosystems*. Entrepreneurship Theory and Practice,* Forthcoming. doi:10.1111/etap.12167.

Stam, E. (2015). Entrepreneurial Ecosystems and Regional Policy: A Sympathetic Critique. *European Planning Studies*, 23:9, 1759-1769, DOI: 10.1080/09654313.2015.1061484

Stanford University website. Triple helix research group. Retreived from https://triplehelix.stanford.edu/3helix_concept

Steven, M. (2013) Platforms, communities, and business ecosystems: lessons learned about technology entrepreneurship in an interconnected world. TIM Rev 3(2) Retrieved from http://timreview.ca/article/655. Cited by Bassis and Armellini, 2018.

United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development. In: *Resolution adopted by the General Assembly on 25 September 2015*. Retrieved from: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E

Upward, A. (2013). *Towards an ontology and canvas for strongly sustainable business models: A systemic design science exploration*. 1–1116 (i–xxii).

Upward, A., & Jones, P. (2016). An Ontology for Strongly Sustainable Business Models: Defining an Enterprise Framework Compatible With Natural and Social Science. Organization & Environment, 29(1), 97–123. https://doi.org/10.1177/1086026615592933

Von Zedtwitz, M., & Grimaldi, R. (2006). Are service profiles incubator-specific? Results from an empirical investigation in Italy. *The Journal of Technology Transfer, 31(4),* 459-468.

World Economic Forum (2016). *The Future of Jobs, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution.* Retrieved from: https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/

Designing resilient creative communities through biomimetic service design

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Abstract: Creative communities are grassroots, bottom-up initiatives of people who through their diffuse design capacity propose new, desirable service futures that address the problems of everyday life. These creative communities exist within a transition from modernity towards sustainment, their adversarial character embodies alternative values such as conviviality, solidarity, openness and shift the focus from growth to flourishing. The sociotechnical system that is a creative community creating social innovation faces constant threats due to the collapse of traditional support structures and their disruptive, adversarial character and so, identifying strategies to increase its resilience is necessary. We turn to nature for inspiration and mentoring. Biomimisis is a framework that designs solutions inspired by biological systems. We argue that permaculture, provides an interesting direction for the development and research in the context of social innovation.

Keywords: Design for sustainability; Service design; Resilience; Biomimisis; Permaculture

1. Introduction

This paper aims to support the idea that increasing the resilience of creative communities by fostering the emergence of greater diffuse capacity on a local level can act as a successful exit strategy for service design. To achieve this goal, we turn to Biomimisis, the study of biological systems to translate their principles in sociotechnical ones. Applying these through design can provide a way to reconstitute the domains of everyday life (Kossoff, 2015) and transition towards sustainability in some grassroots, distributed way. At the same time these different ways of looking at provide a direction that seems to provide an answer to many emerging issues in the context of service design within a systems thinking framework. The paper is divided in six sections. In the first section we position our work in the context of the discourse in the field of service design and social innovation. In the second section we present the systemic perspective of the field of resilience followed up by a brief overview of the practice of Biomimisis. In the fourth section we focus on the idea of permaculture, a systemic view of agroecological models. In the second to last section the case study of working with the 'apano meria 'social enterprise on the island of Syros in relation to the research question are presented. The focus of this section is about translating the lessons extracted from biological systems to social systems. In the final sections we present our conclusions.

2. Social innovation

In the last couple of decades service design has emerged as a field with promising potential to minimize the material flows and increase the overall sustainability of human activities on the planet. One of the central reasons for this is the adoption of 'service dominant' logic as opposed to the 'goods dominant' logic of traditional economies. Service dominant logic sees value as dynamic and co-created when a service provider and a client interact (Meroni & Sangiorgi; 2011) whereas goods dominant logic asserts that value as static and embodied in material products. The intersection of design for sustainability and service design goes far beyond simply minimizing the ecological footprint of our society. John Ehrenfeld (2008) posits that everything done to minimize unsustainability is not conductive to the emergence of sustainability, the possibility that all life flourishes forever. In this sense the social and the esoteric are aspects of the human experience that have to transition towards the "reconstitution of the domains of everyday life" (Kossoff; 2015) in order to alleviate the catastrophic failings of the instrumental thinking that is so closely associated with modernist ways of thinking.

According to Manzini (2017) social forms are made possible, durable and, where appropriate, relocatable by acting on a social ecosystem to make it more desirable. This can be done through two main courses of action: the creation of dedicated enabling systems that foster the existence of a specific family of social forms; or through the modification of the characteristics of the environment as a whole, so as to make it more desirable for a multiplicity of social forms. Creative communities that use the diffuse design capacity to co-create collaborative services sit in the center of social innovation and transition studies. This difference between collaborative services and standard services (Cipolla & Manzini; 2009) exemplifies the dichotomy between reducing unsustainability and enabling the emergence of unsustainability. Collaborative services can be understood that the level of the cooperation is higher in building the service itself. There is a form of cooperation to its core that is of complementary nature. Due to that complementary nature ideally, we would be talking about Deriu's conviviality in the context of degrowth: "Conviviality refers to a society in which contemporary tools are used by all in a comprehensive and common way, without being dependent on a body of experts who control them" (Deriu; 2015).

These creative communities exist within a transition from modernity towards sustainment, the next epoch of human development (Fry, 2003). The adversarial character of these systems causes them to embody alternative values such as conviviality, solidarity, openness and shift the focus from growth to flourishing (Ehrenfeld, 2008). Not only are the systems of values adopted by these communities more compatible with sustainability they also challenge a hierarchical order. Such action is collective rather than individual, such a disruption is what Rancière calls a "dissensus" (2010). A dissensus is not merely a disagreement about the justice of particular social arrangements, it is also the revelation of the contingency of the entire perceptual and conceptual order in which such arrangements are embedded, the contingency of what Rancière calls the partition or distribution of the sensible (le partage du sensible) (Rancière, 2010). Increasing the variety of these systems is a necessary perquisite to both overcome control from the hegemonic ideology (law of requisite variety) as well as to increase the resilience of these systems.

Today social innovation and social entrepreneurship have garnered a lot of attention from professional designers and funding agencies (Telalbasic, 2015). Due to the externalities of this approach the social enterprises and creative communities that are structured are not emergent, bottom up but exist due to external reasons. In addition, the designers associated with the project are not embedded in the community and there is rarely special attention given to increasing the diffuse design capacity in the community. In a sense the community becomes dependent on external resources and as such when this stops the community withers because it lacks the capacity to exist without the supporting apparatus. This lack of 'exit strategy' has been identified as an issue that becomes more and more important in-service design discourse. The theoretical model presented and the supporting case study aspire to provide the initial structure of a framework for designing with creative communities in a way that increases the odds of a self-sustaining community creating social innovation. However, this process has several shortcomings in relation with spatial and temporal sustainability. If the expert designers engaged in the projects are removed the diffuse design capacity has not reached a level of maturity that allows the community to continue evolving and flourishing. This field is referred to as designing 'exit strategies' for the design team. This project aims to present the initial thought process of such an exit strategy developed in an action format informed by Participatory Action Research methodologies (Fassi et al 2013)

Within this context we posit that applying resilience thinking and biomimetic design methods, in the context of a systemic perspective these ecosystems of creative communities can be enabled, strengthened and better achieve their goals. Increasing resilience by fostering the diffuse design capacity can be a viable exit strategy in any service development within a community.

3. Resilience

Resilience is defined as the capacity of a system to retain its organisational closure while absorbing external perturbations (Walker and Salt, 2012). The sociotechnical system which is a creative community creating social innovation faces constant threats due to the collapse of traditional support structures and their disruptive, adversarial character. Identifying strategies to increase the capacity of any system to resist external forces are necessary to ensure their survival in a time of unprecedented environmental and social pressures but in the context of the wider transitions towards sustainment and the necessary reconstitution of the domains of everyday life. "Three aspects can help us to achieve resilience: Persistence to withstand shocks or unexpected events, transformability, to move from crisis to innovation, adaptability, or able to understand change." (Rockstrom, 2009) Meadows (2008) explains that once we see the relationship between structure and behaviour, we can begin to understand how systems work and how to shift them into better behaviour patterns. Systems thinking, she adds, can help us to manage, adapt and see the wide range of choices we have before us and help us to identify root causes of problems and see new opportunities. So, systems thinking are behavioural patterns, and learning to use them along with design can result in the design of resilient strategies to forecast the effect of a design.

Another tool is the notion of the Panarchy which is developed by Gunderson and Holling. This tool attempts to understand the source and role of changes in systems which transform and take place in adaptive systems (Gunderson and Hollng, 2001). Based on the study of ecosystems, the researchers describe how nature proceeds through recurring cycles that contain four basic phases: 1) Rapid growth (r); 2) conservation (K); 3) release (omega); and 4) reorganization (alpha).

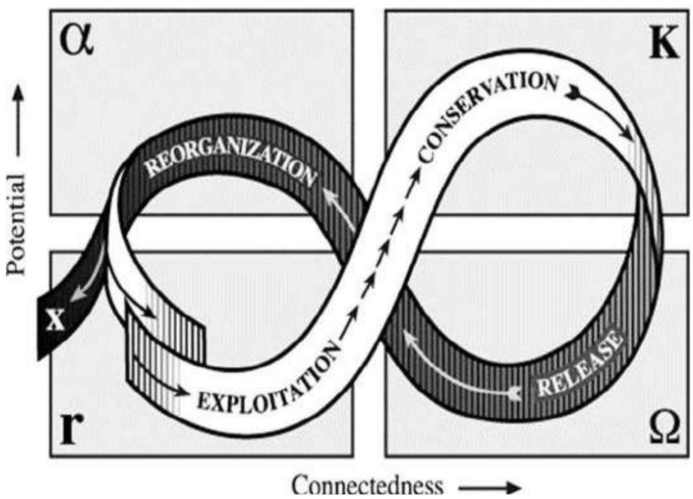

Figure 1 Panarchy. Source:

In panarchy, adaptive cycles take place at different scales (global and local) of time and space (gradual and episodic, rapid and slow unfolding). Panarchy is explained as the antithesis of hierarchy. The original meaning is defined as a set of sacred rules or as a framework of nature's rules. This term is now widely used to visualize systems theory and complexity. The theory of panarchy 'rationalizes the interplay between change and persistence, between the predictable and unpredictable and how panarchies represent structures that sustain experiments, test the results, and allow adaptive evolution' (Resilience Alliance, 2015).

The three-levelled system of a panarchy is used to emphasize the connections that are critical in creating and sustaining adaptive capability. The number of levels in a panarchy varies, is usually rather small, and corresponds to levels of scale present in a system. Visualizing panarchy is both creative and conserving, and the interactions between cycles combine learning with continuity. The cycle is then represented as the engine that periodically generates the variability and novelty upon which experimentation depends. As a consequence of the periodic but transient phases of destruction (omega stage) and reorganization (alpha stage), here a system's structure and processes can be reorganized. This reshuffling allows for the establishment of new system configurations and opportunities for the incorporation of exotic and entirely novel entrants into the system. Finally, the adaptive cycle explicitly introduces mutations and rearrangements as a periodic process Within each hierarchical level in a way that partially isolates the resulting experiments, reducing the risk to the integrity of the whole structure.

The tools above represent a contemporary notion of resilience thinking, looking at the rhythms of creating, conserving, revolting and finally declining within a continuous cycle. Although it requires deeper study, the idea offers a principle that designers can incorporate into their philosophy of making ecological and social systems. (Ruano, 2016) One approach to further incorporate natures teaching in the design process is Biomimisis, a trans-disciplinary approach to problem solving which has emerged through the integration of design with other disciplines, such as biology and engineering and attempts to translate biological mechanisms to components of socio-technical systems.

4. Biomimisis

In order to create the strategies necessary, we turn to nature for inspiration and mentoring. Biomimisis is a framework that designs solutions inspired by biological systems. It opens up possibilities of seeing the way nature works, teaches and informs arts and sciences (Ruano, 2016). It encourages deeper studies in order to arrive at technologies and strategies that may be achieved through interdisciplinary dialogues. Ecosystems display differing degrees of resilience. Understanding the strategies developed by nature to increase the resilience of eco-systems is a first step. Identifying and reframing these solutions can foster the resilience necessary for creative communities to flourish. The emerging fields of biomimetic design of services can support the evolution of service design (Ivanova, 2014). methods in the context of social innovation and shift the underlying assumptions behind the decisions made. Biomimisis has proven a robust methodology for the development of solutions in the fields of material engineering and product design, applying lessons from nature is a frontier for service design and the creation of resilient organisations.

We can explore the relationship between ecology and social innovation through the lens of a biomimetic idea generation tool for service design as it is proposed by Ivanova. This process takes into consideration the ecology metaphor, the fact that service design and ecology share the same level of organization and lastly, the relation of their definition - both terms study interactions of organisms with their environment, in ecology with the natural inhabitant and in service design with resources, people, organisations, nature and technology. (Ivanova, 2014)

Biomimicry is a tool that can help us find options and can sometimes force the researcher to find answers (Benyus 1997). Using a natural pattern does not guarantee that the biomimetic artifact or system will work; for this reason, a prototype (digital or physical mock-up) is required. As the prototype is developed, it will be acquiring features that can be evaluated and modified, if necessary 'How does nature do...?' is a key question to ask in the process of implementing biomimetic thinking in design. It suggests new ways of inquiry in designing infrastructure, messages or artefacts using keywords related to natural forms, functions, processes and systems found in nature. The difficulty occurs when the learner must structure this information, or validates its accuracy. (Ruano, 2016). This action format is incredibly compatible with the massively co-designed approach used in social innovation. The service itself is in continuous iterative redesign process evolving and growing.

Ivanova proposes "a conceptual proposition of what biomimetic service design might "look like"", a tool inspired by the TRIZ methodology and the Lotus Blossom tool by Namahn and Design Flanders and follows the following steps: definition of the design challenge and definition of eight design requirements; abstraction of design principle which needs to define each design requirement in more general terms; searching for a biological analogue to each abstraction; and extraction of the principles behind each biological example which is intended to prompt a deeper understanding behind "how does nature do this." (Ivanova, 2014)

5. Permaculture

We argue that permaculture, an agroecological systemic design tradition (Cassel, 2015), provides an interesting direction for the development and research in the context of social innovation. In contrast to monoculture where only one type of value is the goal of the system, permaculture provides a systemic view that is focused in fostering virtuous cycles and cooperation between different symbiotic systems. Looking at creative communities as an interconnected ecosystem instead of discrete systems provides a different avenue for increasing their resilience and capability for flourishing by creating positive feedback within a wider ecosystem of bottom up initiatives on both a local and global level.

In order to draw inspiration, the prairie was selected as the basis for designing an ecosystem of creative communities entangled in virtuous circles aiming to increase the resilience of a bottom up organisation while increasing the overall flourishing in an insular environment. The example of prairies shows the significance of multiple and different "crops" in order to succeed resilience. This metaphor leads us to the idea that a social-ecological system requires many and diverse creative communities interacting each other and applying the principles of the community resilience.

Due to the high level of complexity of the systems of polyculture in general and the prairies specifically, are diverse by their nature and they interact transferring knowledge and leaving constant feedback, ensuring the maximization of the community resilience by the constant creation of new variety and the emergence of redundancies.

The Prairie metaphor suggests a polycentric model (Benyus 1995), as well. Classic studies on the sustainable governance of social-ecological systems highlight the importance of so called "nested institutions". These are institutions connected through a set of rules that interact across hierarchies and structures so that problems can be addressed swiftly by the right people at the right time. Nested institutions enable the creation of social engagement rules and collective action that can "fit" the problem they are meant to address. In contrast to more monocentric strategies, polycentric governance is considered to enhance the resilience of ecosystem services in six ways, which coincide elegantly with other principles aiming to increase the resilience of local creative communities and ecosystems: it provides opportunities for learning and experimentation; it enables broader levels of participation; it improves connectivity; it creates modularity; it improves potential for response diversity, and builds redundancy that can minimize and correct errors in governance.
Another reason why polycentric governance is better suited for the governance of social-ecological systems and ecosystem services is because traditional and local knowledge stands a much better chance of being considered. This, in turn, improves sharing of knowledge and learning across cultures and scales. This is particularly evident in local and regional water governance, as in watershed management groups in South Africa or the management of large-scale irrigation systems in the Philippines, where polycentric approaches have facilitated participation by a broad range of actors and incorporation of local, traditional and scientific knowledge. (Simonsen et al, 2014)

6. The 'apano meria' social cooperative as a resilient service polyculture

In order to elaborate the strategies recognised the 'Apano Meria' Social enterprise will be analysed with respect to the relationships between different focus groups and how these can increase the overall resilience of the system. The object of this case study is a collection of different creative communities with various interests but connected by a common theme: enabling the flourishing of the island of Syros. In order to achieve this goal three main themes have been adopted: the environment, culture and people. Each of these themes is made up of different special interest groups that are interconnected both within the theme and in the wider scope of the community. The breadth of the whole enterprise is visualised in the system map below.

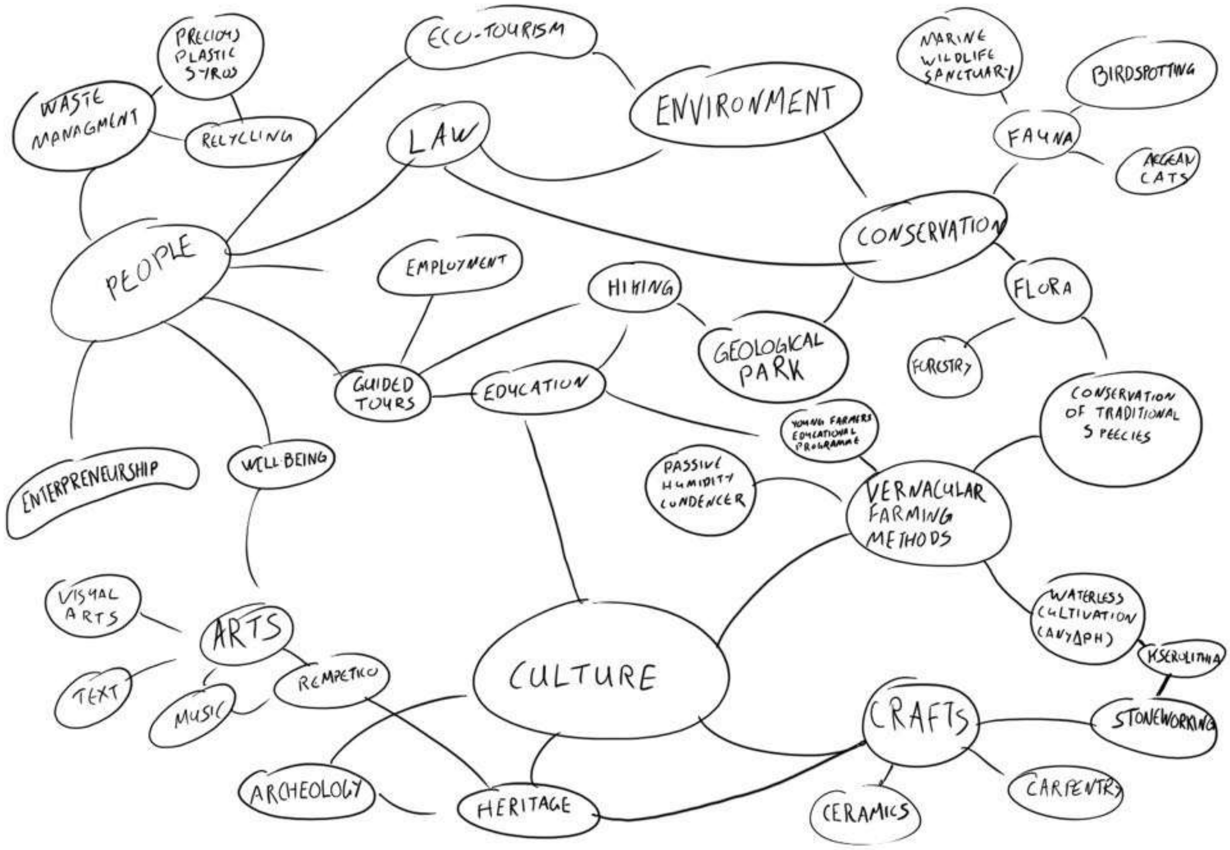

Figure 2 System map of the 'apano meria' social cooperative

The three main thematic areas around which the activities take place are People, Culture and Environment. The high connectivity between the issues and the crosspollination between different focus groups increases the overall variety of the whole venture. Some notable attractors within the system are: The designation of the area of ‘apano meria’ as an Environmental and Geological Park, to protect all natural, architectural, geological and marine features, to maintain and restore human-built structures that form the living history of the area and the Cyclades in general, and finally for the area to become a centre for sustainable activities, such as walking and geological tourism, climbing, diving, fishing, ecotourism and the promotion of archaeological sites. The goal is the establishment of a geological park in the network of UNESCO Global Geoparks which are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development.

A different issue is associated with the conservation of traditional farming methods and varieties. This touches on the environmental aspects (conservation of native species) as well as heritage management and environmental stewardship. The Cyclades region is a very arid one and as such vernacular methods for cultivation with minimal water use were developed. In order to aid local farmers in transitioning toward such, labour intensive, methods a Passive Humidity Condenser was developed in collaboration with the local university. These types of interconnected relations increase the resilience of the systems and point to the leverage points to further increase the diffuse design capacity.

All of these teams are in an open dialogue amongst them and the goal is to foster the evolution of the diffuse design capacity in a way that creates design redundancies throughout the system. Understanding the flows of information, the juxtaposition of people in different roles as well as increasing the overall diffuse design capacity of the participants in the social enterprise is the first step in creating a resilient organisation. Identifying relevant biological models that create virtuous cycles and translating these to design strategies will increase variety, resilience and the contingency between different people and communities. Functional redundancy, or the presence of multiple components that can perform the same function, can provide insurance within a system by allowing some components to compensate for the loss or failure of others. Redundancy is even more valuable if the components providing it also react differently to change and disturbance. This, response diversity (differences in the size or scale of the components performing a particular function give them different strengths and weaknesses, so that a particular disturbance is unlikely to present the same risk to all components at once).

Within a governance system, a variety of organisational forms such as government departments, NGOs and community groups can overlap in function and provide a diversity of responses, because organisations with different sizes, cultures, funding mechanisms and internal structures are likely to respond differently to economic and political changes. Diverse groups of actors with different roles are critical in the resilience of social-ecological systems, as they provide overlapping functions with different strengths. In a well-connected community, where functions overlap and redundancy is present, creativity and adaptability can flourish. In the next section the five lessons from the biological methods analysed are presented. Permaculture was central in the selection of biological metaphors but not the only one. Social insects and hermit crabs were also used as inspiration for the extraction of design principles for the project.

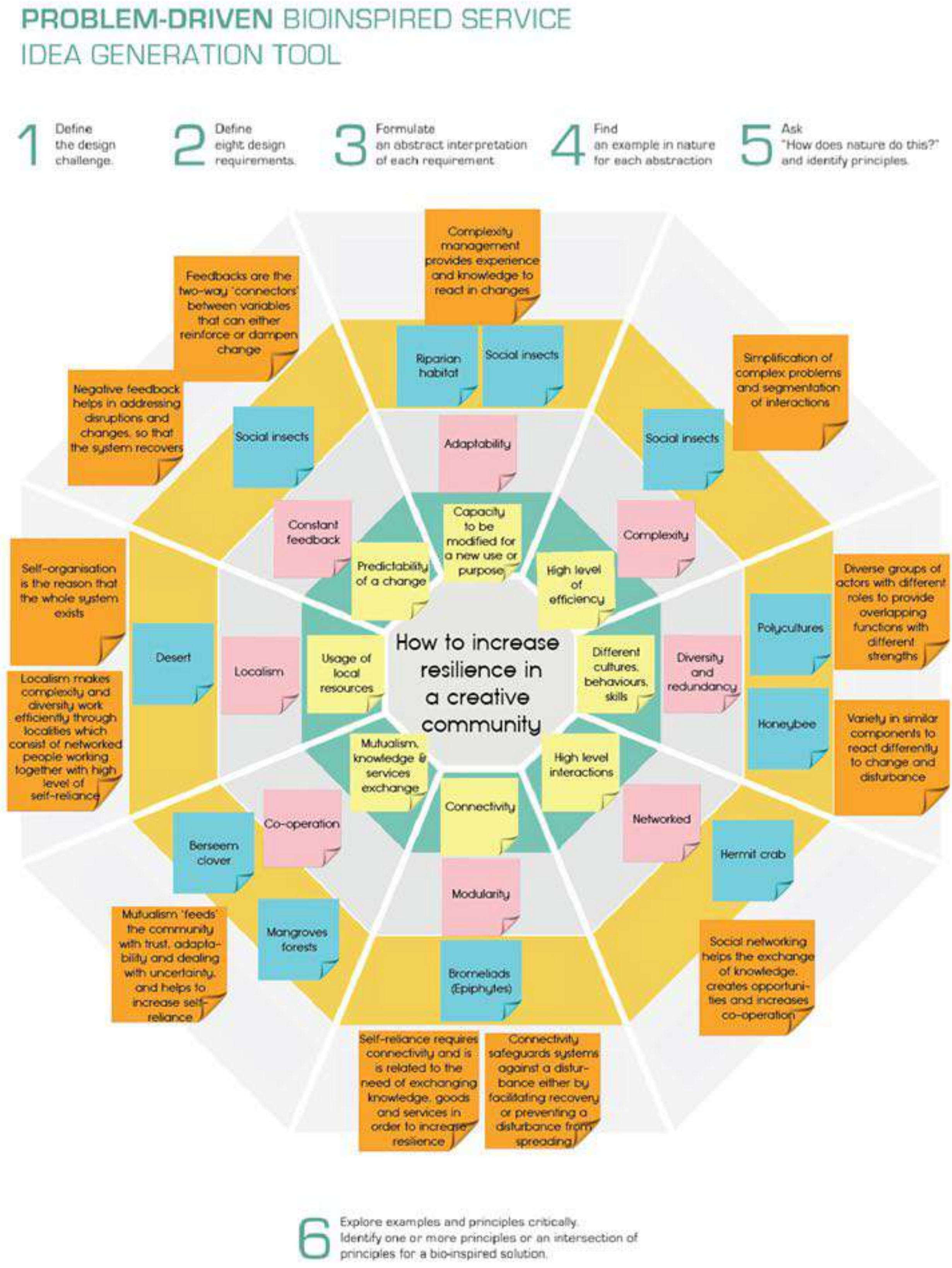

Figure 3 Bioinspired service design. Adapted from Ivanova 2014

A diversity of users and designers can also safeguard the sustainable use of a resource. The case study of the Mangroves forests. Its mutualism in ant-plant relations underlines the significance of the collaboration between different species in the same ecosystem which benefits all the participants. It presents a mutual social-ecological interaction - the place can be the shelter for the society, where people can live and build homes, harvest crops, etc. but the society can be the shelter for the place at the same time, by offering important “nutrients”, through socialecological interactions. However, in a community of creative entities, the metaphor of mutualism can be related to people’s exchange of knowledge and services which, at the same time, “feed” the whole community with trust, multiple options for responding to change and dealing with uncertainty and helps to increase self–reliance. All these “nutrients” contribute to the resilience of the creative community

Self-reliance requires connectivity. Connectivity refers to the structure and strength with which resources, species or actors disperse, migrate or interact across patches, habitats or social domains in a socialecological system. Consider, for example, the epiphytic plants connected in Bromeliads: Bromeliad is the system, the epiphytes are parts of the system. How they are linked together determines how easy it is for an organism to move from one module to another. In every system, connectivity refers to the nature and strength of the interactions between the various components. From a social network perspective, people are individual actors within a system embedded in a web of connections.

Connectivity can influence the resilience of ecosystem services in a range of ways. It may safeguard ecosystem services against a disturbance either by facilitating recovery or preventing a disturbance from spreading. The effect on recovery is demonstrated in riparian habitat. Closely situated plant communities with no physical barriers enhance recolonisation of species that may have been lost after disturbances such as floods. The basic mechanism is that connection to areas that serve as refuges can accelerate the restoration of disturbed areas, thus ensuring the maintenance of functions needed to sustain the habitat and their associated ecosystem services.

Perhaps the most positive effect of epiphytic connectivity is that it can contribute to the maintenance of biodiversity. This is because among well- connected habitat modules local species extinctions may be compensated by the inflow of species from the surroundings. Local resources form the fourth principle of how nature maintains its high levels of resilience. Looking at the desert ecosystems, a process of 'local facilitation' among plants enables the usage of the local resources enabling the whole ecosystem exists. As Meroni posits “Within the next few years, we will have to learn to live (and to live better, in the case of most of the inhabitants of this planet) consuming fewer environmental resources. And we will have to do so by establishing new social undertakings at all levels.” () The groundwork for great systemic changes, for macro-transformations, is laid by micro-transformations, i.e.

by the radical innovations introduced into local systems. Therefore, we can make complexity and diversity work efficiently through localities which consist of networked people working together with high level of self-reliance.

The fifth and last principle which arose during this idea generation tool, is the necessity of feedback between the actors. In the study of social insects, we understand that the most of the individuals would be trapped and probably die, without the feedback each one leaves through its pheromones. In resilience we refer to fast and slow variables, drivers (external to the system, or from higher scales) cause change in “slow” (controlling) variables; as slow variables approach threshold levels, the fast-moving variables in the system fluctuate more in response to environmental and other shocks; and these shocks or directional change in the drivers can push the system across a threshold into an alternate stability regime. Therefore, feedbacks play an essential role in complex systems

7. Conclusions

The possibility of an exit during the post design process in services is probably the greatest concern of any service designer today. The example of panarchy shows an unending process for creating and maintaining adaptive capability. However, what could happen if this diffuse design capacity of each creative entity could be translated into expert through the biomimetic model for resilience? Unfortunately, the usage of the principles of biomimetic creative communities is a process that has a timeframe that makes it impossible to lead to concrete data. The very design process adopted in the context of the ‘apano meria’ social enterprise is similar to panarchy and as such no beginning or end exists only adaptive cycles between the different phases.

However, combining the early research findings extracted in the last two years, we can assume that the model of biomimetic creative communities creates an optimistic scope for further research. Adressing the community one domain higher provides the opportunity to maximise the diffuses design capacity of the members.

Although not evidently being biomimetic, creative communities exhibit biomimetic elements. During the process of bio-inspired idea generation tool we kept confirming that all the important characteristics of a social-ecological system for resilience thinking into a creative community exist in nature. We explored case studies from nature which prove their resilience is based on these characteristics.

Therefore, the logical outcome is that if by enhancing resilience, we enhance the design capacity of a creative community, this enables the exit of the designer during the post-design process if the system has gained enough adaptive capability to maintain its resilience in high levels. The preliminary research findings suggest that the research thesis is valid and we will continue to report the ongoing, massive co-design process undertaken on the island of Syros.

8. References

Alliance, R. (2015). Santa Fe Institute 2004 Thresholds and alternate states in ecological and social-ecological systems. Resilience Alliance. See http://www. resalliance. org/index. php.

Benyus, J. M. (1997). Biomimicry: Innovation inspired by nature.

Cassel, J. B. (2015) Permaculture as a Systemic Design Practice, contributions, Challenges and New Developments. In Proceedings of Relating Systems Thinking and Design (RSD4) 2015 Symposium. Banff, Canada, September 1-3, 2015.

Cipolla, C., & Manzini, E. (2009). Relational services. Knowledge, Technology & Policy, 22(1), 45-50.

Deriu M.,(2015) Conviviality in Degrowth: A vocabulary for a new era.Editors: D'Alisa, G., Demaria, F., & Kallis, G.

Ehrenfeld, J. (2008). Sustainability by design: A subversive strategy for transforming our consumer culture. Yale University Press.

Fassi, D., Meroni, A., & Simeone, G. (2013, November). Design for Social Innovation as a form of Design Activism: An action format. In Social frontiers: The Next Edge of Social Innovation Research" Conference Proceedings (pp. 14-15).

Fry, T. (2003). The Dialectic of Sustainment. Design Philosophy Papers, 1(5), 289-297.

Gunderson, L. H. (2001). Panarchy: understanding transformations in human and natural systems. Island press.

Ivanova, D. (2014), Biomimetic Services. A new perspective on the design for services, (Master's Thesis) Ravensbourne University, London

Ivanova, D., 2014, BIOMIMETIC SERVICES. A new perspective on the design for services, A Master's Thesis, Ravensbourne University, London

Kossoff, G. (2015). Holism and the reconstitution of everyday life: a framework for transition to a sustainable society. Design Philosophy Papers, 13, 1, 25-38

Manzini, E. (2015). Design, when everybody designs: An introduction to design for social innovation. MIT press.

Manzini, E. (2017). Designing coalitions: Design for social forms in a fluid world. Strategic Design Research Journal, 10, 2, 187.

Meadows, D. H. (2008). Thinking in systems: A primer. chelsea green publishing.

Meroni, A., & Sangiorgi, D. (2011). A new discipline. In A. Meroni & D. Sangiorgi (Eds.), Design for services (pp. 9-33). Aldershot, UK: Gower Publishing.

Rancière, J. (2015). Dissensus: On politics and aesthetics. Bloomsbury Publishing.

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., ... & Nykvist, B. (2009). Planetary boundaries: exploring the safe operating space for humanity. Ecology and society, 14(2).

Sanchez Ruano, D. (2016), Symbiotic Design Practice Designing with-in nature, (PhD Dissertation) University of Dundee

Sanchez Ruano, D., (2016), Symbiotic Design Practice Designing with-in nature, PhD dissertation, University of Dundee

Simonsen, S.H, R. Biggs, M. Schlóter, M. Schoon, E. Bohensky, G. Cundill, V. Dakos, T. Daw, K. Kotschy, A. Leitch, A. Quinlan, G. Peterson, F. Moberg (2014), Principles for Building Resilience: Sustaining Ecosystem Services in Social- Ecological Systems, Cambridge University Press

Telalbasic, I (2015) Design in a Time of Crisis: Social Innovation in Product-Service-Systems Interconnections Between Existing Developing and Developed Economic Models Towards Social Innovation. In Emerging Practices: Design Research and Education, Shanghai, China, pp.107-118, ISBN: 978-7-5608-6031-2.

Walker, B. & Salt, D. (2012). Resilience thinking: sustaining ecosystems and people in a changing world. Island Press.

Walker, B., & Salt, D. (2012). Resilience thinking: sustaining ecosystems and people in a changing world. Island Press.

Packaging reconditioned household appliances

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Abstract

The contribution proposes a research and project activity developed in collaboration by three subjects, active in the academic, commercial and social fields, who have created the conditions to produce new packaging systems for regenerated appliances, in order to reintroduce them on the market.

The activity is developed within the Ri-Generation project, initiated by Astelav and Sermig (Turin, Italy), which aims to recover disused equipment in order to prevent the formation of waste in landfills, enhancing the used products still in good condition and at the same time guaranteeing employment opportunities for socially marginalized people.

The aim of the packaging project is to maintain the same spirit of the Ri-Generation operation: the protective system is in fact produced by transforming and assembling the used clothes recovered every day from Sermig. The resulting soft mattress can easily be used to wrap the regenerated washing machine and protect it during transport and sale.

Keywords: Packaging, re-use, Ri-Generation, social, new-economy

1. Introduction

This contribution describes a research and design action aimed at developing systems for the protection and communication (packaging) of used products that are recovered and replaced on the market, in particular with reference to the WEEE waste of large household appliances.

Obviously, the disposal of household appliances is an important issue in terms of waste materials produced. In Italy, in the last three years, the collection and treatment of WEEE have significantly increased and their weight has reached about 300,000 tons in 2017. The most impacting waste, with 32% of the total weight, belong to the R2 group "Large white goods" (which corresponds to large household appliances such as washing machines, dryers, dishwashers, ovens, etc ...) (AAVV, 2017).

These numbers also clarify that today we waste too much energy and material, and in doing so we contribute to the emission of too many greenhouse gases. Obviously one of the main reasons for this state of affairs is the dominant economic model, based on a linear logic of increasing consumption (Pauli, 2012).

Furthermore, it is estimated that only about 40% of the total number of used devices is processed correctly. The remaining 60% ends up in unauthorized landfills or is illegally exported to developing countries, both as working appliances and as a source of components and raw materials for recycling. This is an international problem, related to spheres ranging from economics to ecology, culture and public health.

Considering that the big appliance is a type of product with high purchase and maintenance costs, it has also been observed an increasing tendency of users to repair rather than buy a new one. According to some observers, this preference translates into a real "right to reparation", also seen as the behaviour of opposition to an electronic industry that, often, intentionally hinders us from repairing products, controlling repair plans and limiting the access to components that need to be replaced (Fowler, 2015).

All these elements confirm the value of an operation, which is the object of this paper, aimed at launching a virtuous system of recovery and reconversion of disused and potentially polluting products, providing an innovative response to the real market demand.

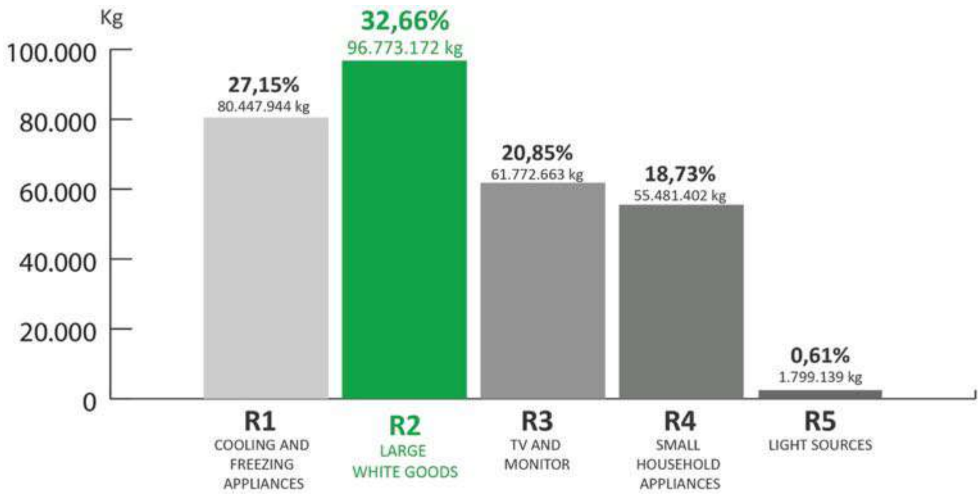

Figure 1. WEEE collection and treatment in Italy 2017 (source: Annual Report 2017, Centro di Coordinamento RAEE, Milano).

2. Research Context

The research activity, which develops within this consumption context, is carried out by the research unit of the Politecnico di Torino - Design and is part of a research agreement activated with Astelav, a company based in Piedmont, in Nichelino (Turin), leader in the distribution of components and spare parts for household appliances, in collaboration with Sermig, a non-profit foundation based in Turin, committed to providing hospitality and helping marginalized people who experience social, economic and employment problems. The activities of Sermig in the social sphere are various, developed in the local area (e.g. hospitality to the homeless, activation of laboratories and training courses for people in need, organization of meetings and seminars on social issues, collection of used clothes and other goods for the redistribution to needy people, etc.), but also internationally - especially in developing countries - where Sermig activates cooperation programs to combat poverty and to promote actions for the livelihood of the local population.

The partnership, therefore, involves actors in the academic, commercial and social fields, with the aim of developing a project capable of relating individual paths and specific perspectives, for a common goal also in terms of the narration of identity.

Astelav recently launched the Ri-Generation project together with Sermig. This project involves the restoration of "white goods" abandoned (washing machines, dishwashers, refrigerators, ovens, etc.) Intercepting the WEEE chain - Waste electrical and electronic equipment, as well as acquiring donations from private parties or entering into agreements with retail chains for recovery of returned goods. At the same time, the project facilitates the development of new skills for people in conditions of social marginality, which are involved to assist technicians specialized in the regeneration of electrical appliances. The activity involves the replacement of damaged or malfunctioning parts, a sanitation process and the return of household appliances on the market. It is an example of a circular economy (Geissdoerfer et al., 2017), useful for preventing waste dumping in landfills, offering previously discarded products a new life cycle and a new added value, creating new economies, job opportunities and rehabilitation for people in precarious economic and social conditions.

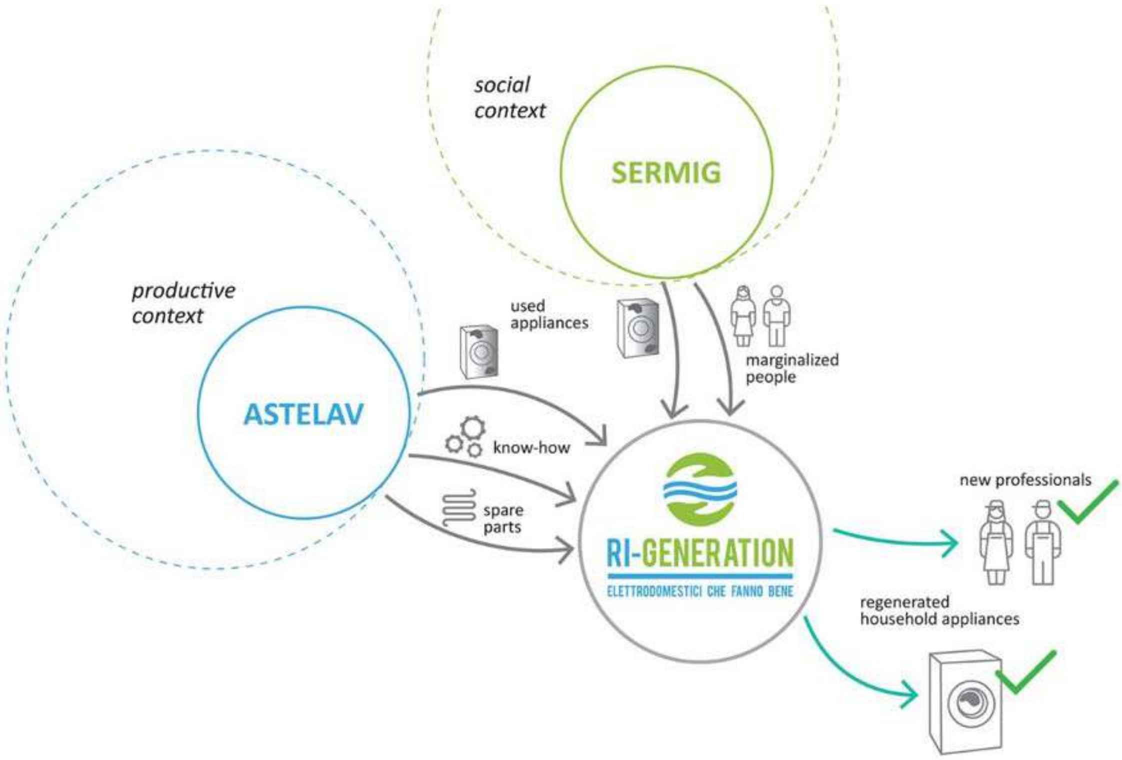

Figure 2. Ri-Generation working model: Astelav and Sermig roles for cooperation.

Figure 3. Check and regeneration of the appliances in the Ri-Generation laboratory (credits: Ri-Generation).

The target for Ri-Generation is rather heterogeneous, but mainly consists of people with low income or living in "fragile" conditions, such as:

- *students from other cities*, looking for an appliance to share with their roommates for a few years, but not for a particularly long time;
- *young couples*, who have to furnish their first home with a limited budget;
- *separated or divorced people*, who need to furnish a second home where accessories and appliances are not necessarily first choice products;
- *recently immigrated families* from other countries, for whom home appliances are a need but are not a key priority.

In general, they are users who need a functioning appliance, even if it is not the most recent or the most performing; they are interested in the economic advantage offered by reconditioned appliances and, in many cases, they are fully aware of the environmental and social values of the initiative.

3. Design Objective

The objective of the operation, from the design point of view, is to develop new systems for the protection, transportation, presentation and sale of used, recovered and reconditioned appliances, in particular washing machines (90% of the products recovered from Ri-Generation), allowing their redistribution in the market and the communication of a clear identity during the marketing phase. A "sui generis" packaging project, also due to the fact that the products sold are different from each other while sharing common typological characteristics.

The design challenge regarding the packaging for Ri-Generation is addressed in terms of functional and communication response, but also in accordance with a broader cultural paradigm which envisages the development of a complex system of activities and relationships able to create, in line with the mission of the Ri-Generation project, innovation and sustainability at different levels:

- *social*, involving vulnerable people and social cooperatives in the production of the packaging element;
- *environmental*, recovering used clothing in bad condition to be used as filling material for the packaging and at the same time exploring the possibilities of reuse of packaging after delivery;
- *productive*, in the training of *ad hoc* personnel and in the organization of a new "chain" of handicraft production that involves marginalized people;
- *linguistic*, in the application of new ways and means of expression, exploring aesthetics that are far from the traditional context of the packaging of household appliances, triggered also by experimentation, particularly in the artistic field.

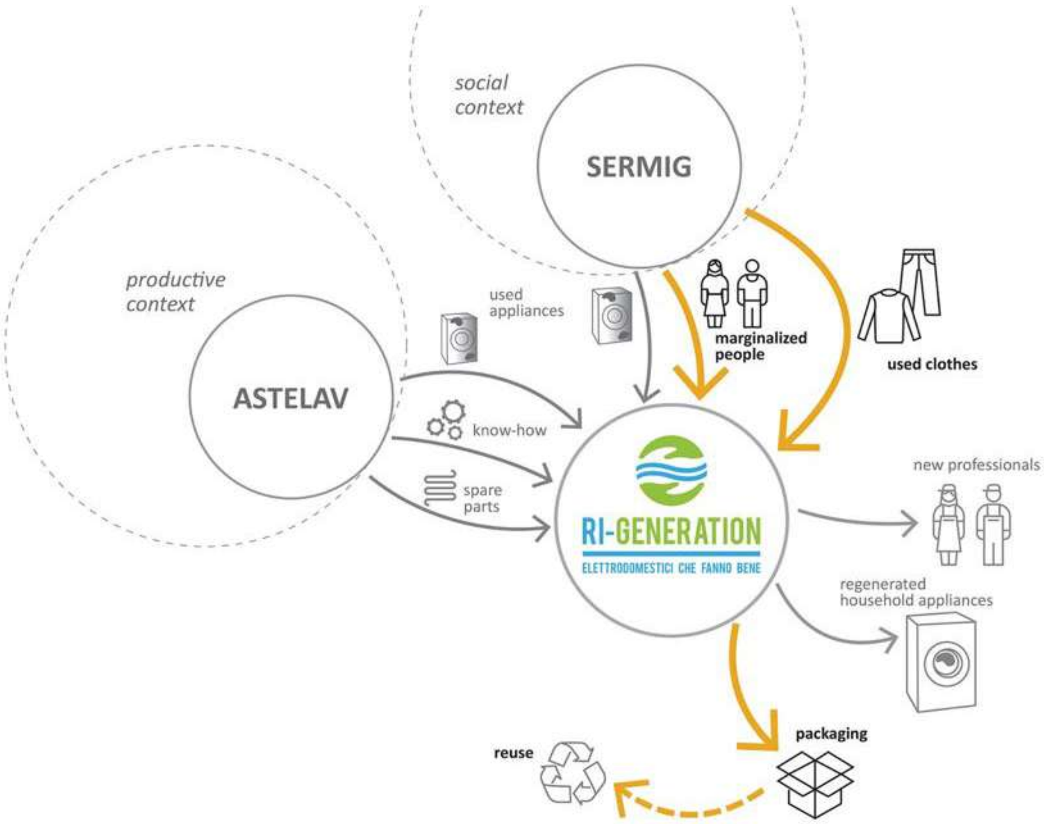

Figure 4. Packaging design concepts: reuse of faulty clothes collected by Sermig; creation of capabilities for disabled people; packaging reuse; narrative aesthetics.

The packaging is developed using the discarded part of used clothing collected by Sermig, otherwise useless because not suitable for donation to needy people, due to the fact that they are damaged, stained or too old.

Out of a total of about a ton of used clothes collected daily by Sermig, most of them are redistributed to needy people in Italy and abroad (especially in Romania, thanks to the collaboration that Sermig has established with the Somascan fathers), while a small part (about 3%) is not in good enough condition to be redistributed.

The packaging project for Ri-Generation foresees that these garments are collected and transformed into packaging following a “protocol”, designed “ad hoc” by the authors of this paper, which describes how to cut, overlay and sew these textile parts, and use them to pad a transparent PE mat with stitching. The packaging activity will be carried out by Cooperatives of needy or disabled people, who participated in the creation of the protocol, making this activity their future work. Moreover, the fabric, by its nature, has always been a suitable material to be reused to make other products. An example of this practice is “patchwork”, a technique that has been developed over the past few centuries by the American pioneers who used to recover the parts in better conditions of the worn garments in order to repair other garments or to create new ones through the juxtaposition of remnants (Pulvirenti, 2009).

In this scenario, the project intends to face issues such as the valorization of poor materials and waste, the scarcity of renewable resources, the social value of manual labour (Pietroni, 2005). The value of reuse is further emphasized by the fact that the packaging can be reused by the end user once the appliance has been transported to the destination: the enclosed information materials and the graphics on the packaging suggest a "catalogue" of possible alternatives uses (such as giving protection to accessories and furnishings when moving, making car bumpers on garage walls, informal poufs, cushions for pets, base for picnic blankets, etc.). In practical terms, the sustainable aspect of re-use consists of delaying the disposal of packaging, with a consequent reduction of waste produced (Bozzola, 2014).

Furthermore, this ability to prevent waste through re-use (both the packaging and the product) (Dalisi, 2009), is in line with the possible actions recommended by the European legislation on sustainable waste management (Directive 2008/98/EC, implemented in Italy with Legislative Decree 205, 3 December 2010). In fact, the regulation considers some intervention priorities for managing the end-of-life of products in order to prevent waste, including re-use, recycling, recovery (eg energy recovery) and, ultimately, disposal.

If we consider the overall life cycle of packaging (Verghese et al., 2012), once the dual function has been completed (primary and secondary use), the Ri-Generation mat will be sent to a disposal path which provides two main options: landfill, or the separation of the two components (textile and plastic film) for the recycling of materials. In this case, the sewing technique can be optimized in order to make the separation of the two components as agile as possible.

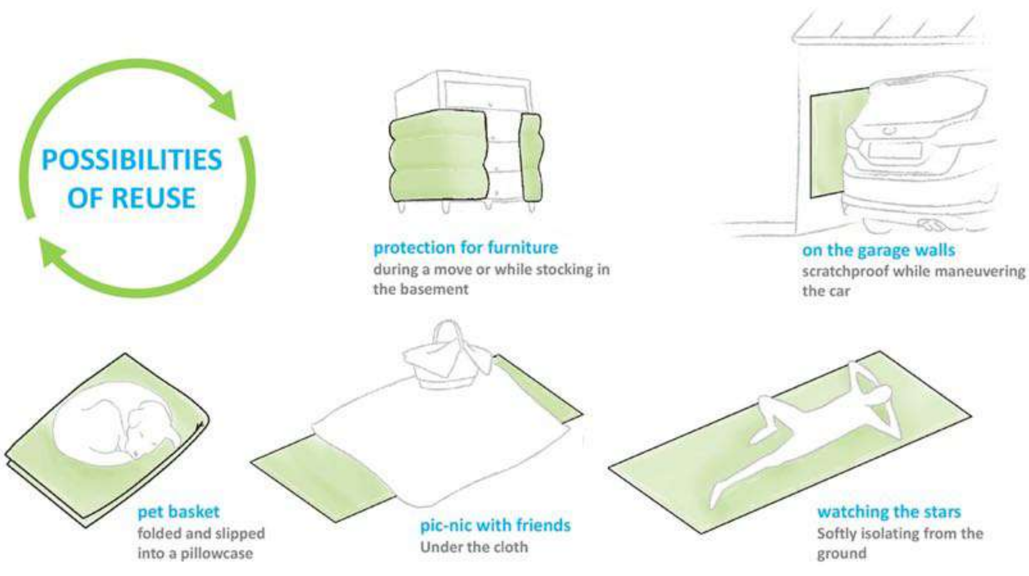

Figure 5. possible reuses of packaging.

The design approach contextualizes the operation in the area of eco-design, in particular in relation to the use of recovered materials and the enhancement of their end-life: the Ri-Generation project promotes the reuse and regeneration of products and materials (both the appliance and its packaging). The action also follows some of the principles and methods of social design, in designing not only products but also strategies to promote social inclusion processes, providing tools to help designers work with abstract entities such as services and communities rather than with objects (Chen, Cheng, Hummels and Koskinen, 2015).

4. Methodology

The research and development process has been organized in phases, according to a working method that allows facing the product design activity (usually performed by the designer) within a different production and relations system. The methodological approach consists in the articulation of some specific steps, each of which involves the different actors (Politecnico di Torino, Astelav, Sermig) organized in different configurations and with different roles:

• **Scenario analysis**: an analysis of the context related to the research object. This tool allows an interpretation of the social and cultural context, as well as the technological and market framework. Furthermore, it activates the development of critical knowledge on specific topics, such as the identity of the partners, the social enterprise models, the WEEE products and the characteristics of the appliances, the packaging methods of the appliances, the sustainability issue in terms of production, management and use, the target market, the state of the market, the socio-cultural scenarios in terms of conscious and sustainable consumption, etc. This informative documentation was the point of reference for the subsequent design process and a fundamental component to outline approaches, solutions and opportunities in order to realize a conscious evolution of meta-design (Dal Palù, D., Lerma, B., Bozzola, M., & De Giorgi, C., 2018).

For example, during the scenario activity, a comparative study was conducted by the authors on the types of packaging most used for household appliances: it showed that a "multi-material approach" is mainly used, in which polystyrene is grouped with other plastic components. such as polyethylene film and straps; sometimes these elements are also accompanied by cardboard and wood parts: a wide range of very different materials that are not always easy to separate and recycle. These systems, although efficient from the performance point of view, still have some ecological problems. The most significant environmental problem for packaging is in fact related to the need to prevent waste already before its production (Badalucco, 2011).

But the same study has also focused on some interesting cases developed on a "service" approach, such as the “Free Pack Net system”: the manufacturer provides the company with expanded polypropylene packaging, which is recovered (and restored) after each use and then supplied again, allowing the company to "rent" the package to use it multiple times and save money.

Similar operations have also been explored in the recovery and regeneration of household appliances for sale (such as “Envie” in France, “Environcom” in Belgium or “Rreuse” in Belgium): it was noted that these companies currently do not present "ad hoc" packaging systems, but instead use traditional industrial packaging systems such as shrink wraps or polystyrene. This is a missed opportunity to strengthen corporate identity and communicate specific values during the distribution and sale phase.

Concept definition: it’s the identification and development of the design guidelines in terms of product and process organization. Starting from the Ri-Generation model, the goal was to develop useful and functional packaging, able to enhance the identity of the regenerated appliance. In fact, since the packaging is both a functional and a communication product, it has to express the intrinsic values of the project and reinforce its specific identity. This is why the developed proposal was based on the same principles as the main Ri-Generation project: the concept is based on the recovery of waste materials that Sermig receives daily in the form of private donations: in particular, among the used clothes that are collected and selected for redistribution to people in economic and social difficulty, those that are defective, stained, torn or consumed can be reused and transformed into efficient padding for packaging systems. At the same time, the production process has been organized so that social cooperatives belonging to the Sermig circuit can create job opportunities for marginalized people through the organization of clothing transformation activities.

The **concept development** focused on the creation of the mat, carrying out technological and functional tests and experiments, also with the partners who participated in some preparation workshops, aimed at drafting a shared protocol useful for the management and control of all the necessary actions to produce the packaging. The product development process involved the management of Sermig and its staff (three managers and five guests), the Astelav management and employees (four people), and two social cooperatives (two staff members and ten guests). These subjects collaborated in some participatory activities coordinated by the Politecnico Research Unit in workshop mode, aimed at testing the production methods and evaluating the incoming and outgoing skills of the people involved in the production of the packaging elements. The assembly was carried out by social cooperatives identified by Sermig, appropriately trained through the aforementioned activities of direct experimentation and partial co-design.

The production phase mainly involves a social cooperative that has been identified by Sermig to produce the packaging. The fundamental aspect is the preparation of the working area, where the people of the social cooperative will create the mats, working around very large tables where the scraps will be cut, assembled inside the polyethylene tubular films and finally sewn with a special sewing machine.

At this time, the production of the "zero series" has been almost completed: this should soon lead to testing the handling and transport of "wrapped" appliances. Once feedback has been received from the test activity, a quick optimization of the production will take place, in order to proceed with the final production of about thirty mats-packaging per week.

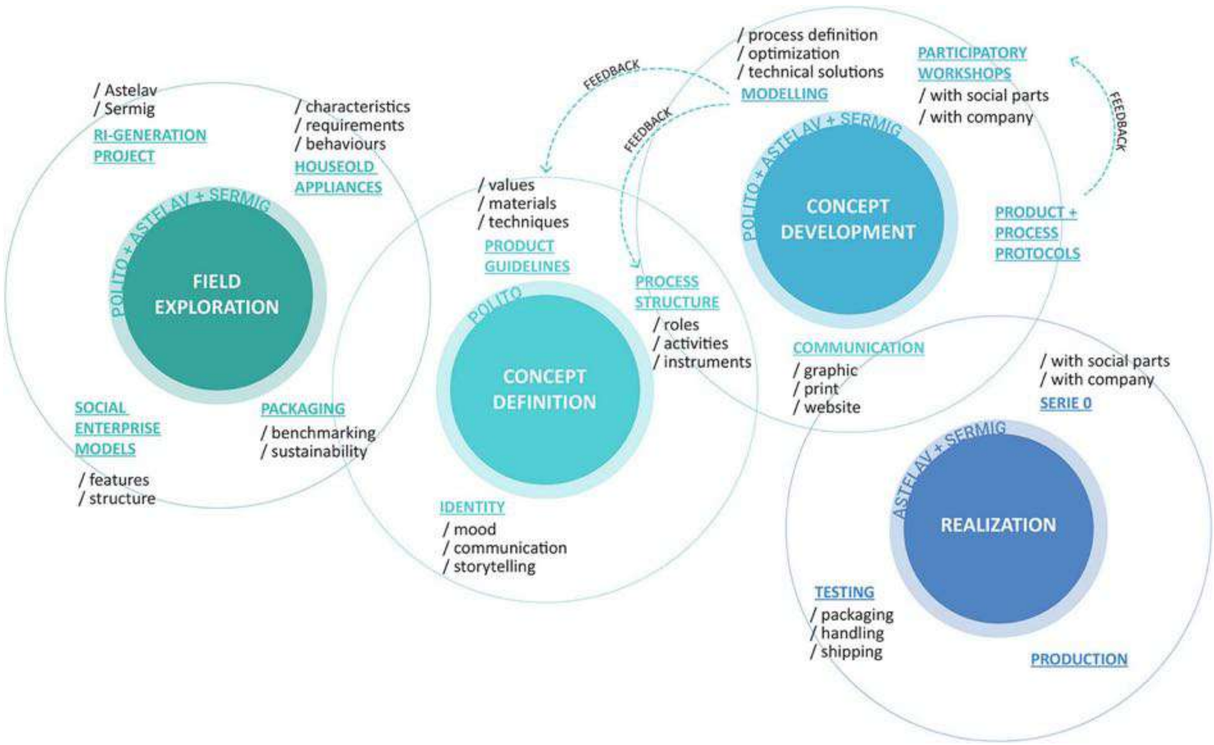

Figure 6. Methodological framework and roles.

5. Outputs

The packaging element, therefore, consists of a sort of waterproof "padded sheet" that is strong enough to wrap and effectively protect the regenerated household appliance during transport, storage and sale, also providing the customer with some information on the renewed life of the product. The padding is made with used clothing, which is cut and assembled according to a specific protocol, then positioned, fixed and sewn inside polyethylene tubular films.

The production protocol was developed by the research unit of the Politecnico di Torino with the contribution of the subjects involved in the Ri-Generation operation (Sermig, Astelav and social cooperatives) in order to provide all the information necessary to set up the work and produce the packaging product. These instructions have also been translated into a graphic panel which the staff can refer to, during the manufacturing process. In particular, it explains which tools are needed and the characteristics of the working area, the correct positioning and the right way to cut the plastic film, how and where to trace the sewing lines, the average size and shapes of the fabric remnants, how to cut the clothes, the way to insert the cut garments into the plastic film and then the possible sewing techniques.

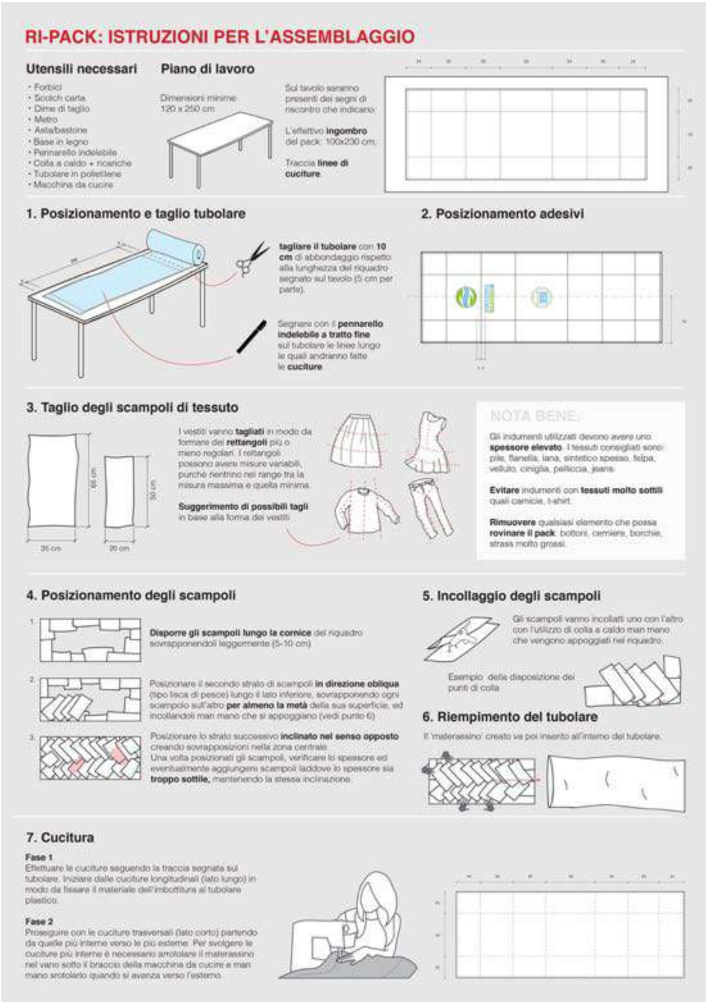

Figure 7. Realization instructions translated into a graphic panel to refer to during the different phases of the production process

The resulting product is characterized by a strong expressive charge, according to an approach that highlights the semantic value of packaging (Germak, 2013): fragments of garments of different colors and types of fabric envelop the household appliance, almost a block of clothes that, from one side, disorients and intrigues, and, on the other, tells a story on several levels: the garment, that symbolizes the product (the washing machine) and emotionally declares its function, but also tells the story of the recovery of waste items, the heart of the Ri-Generation project.

Figure 8. Main packaging element: protective mat made with used clothes contained in polyethylene tubular film.

Figure 9. The appliance packed ready for transport and sale.

The packaging, therefore, appears coherent with the appliances that it protects: ideally, the clothes "come out" from the drum of the washing machine to wrap and protect it during transport to its new owner.

6. Participatory Activities

As already mentioned, the product development process involved staff of Sermig, Astelav and social cooperatives during some participated workshops coordinated by the Research Unit of the Politecnico di Torino, aimed at testing the production methods and the potential of the activity to become an economic opportunity. In particular, three sets of workshops were organized and developed with different people and with different aims:

- The first set of workshops involved the managers of Sermig and Astelav who worked with the researchers of the Politecnico di Torino in order to identify the possible bodies suitable for the production of packaging.
- The second set was carried out at a volunteer center affiliated with Sermig. The goal was the optimization of tools and processes.
- The third set was developed with a social cooperative identified by Sermig, in which disabled people participate in activities for the final production.

In this context of direct experimentation and partial co-design, the role of design transcends the traditional task of interpreting needs and identifying opportunities, instead, becoming a facilitator of the process, triggering actions of mediation between the parties. This means that the designer does not only deal with the design activity, identifying product performance, meanings, materials and production techniques but also interfaces with other figures that in some way intervene in the design and development process (in particular marginalized subjects, disabled people and educators). Its role changes from being proactive to adopting a position of observation and organizational behaviour.

In particular, the third experimentation laboratory intended to lead to a pre-series of twenty units. This activity is ongoing at this time and will be tested during transport and sale to end users. The feedback gathered from this activity will allow us to optimize packaging production methods and the operation of the entire sales chain.

Figure 10. Participatory workshops with volunteers and people from social cooperatives.

A communication system has also been developed, with the aim of completing the packaging in terms of visual and communication functions. The graphics on the packaging state the possibility of reuse and the attached brochure illustrates the history of the entire Ri-Generation project, including the potential alternative use of packaging.

7. Future developments

The defined packaging system, regardless of its specific application in the context of the distribution of reconditioned household appliances, can be considered, to all intents, as a new semi-finished product which, when suitably reshaped, can also be used in other product sectors. First of all, in the context of the donation of goods by Sermig (recovered electronic products, educational materials for school education, medicines, technological systems, etc.), which are daily sent in the Third World and in the developing countries.

Among the possible developments, some of which are underway while others are in a start-up phase, we point out some potential actions aimed in particular at the diffusion of the activity, in order to transform it into a replicable or re-interpretable best-practice and to enhance the cultural content of the project, such as:

- *Creation of a special section on the Ri-Generation website*: definition of texts, images, animations, etc., able to describe the partnership with the Politecnico di Torino, the design process and the scientific-cultural value of the packaging-design operation and further suggestions on possible reuse by end users. Another idea would be to propose a contest with awards dedicated to the theme "take a picture of how you reuse Ri-Pack", generating the interest of the client in the competition (an online vote/evaluation of the most useful and original way to reuse Ri-Generation packaging) able to further participate in the dissemination and communication process.

- *Definition of content and editorial project per single publication/story*: the case history of a sustainable packaging project can be the subject of a story conveyed by a small and agile typographic product, to be distributed during specific events aimed at spreading the initiative and promote the activity of Ri-Generation.
- *Curating and design of possible exhibitions*: definition of possible exhibit concepts for the participation in fairs and events on the theme of sustainable packaging, or for the creation of a specific “ad hoc” event dedicated to the Ri-Generation case history.

References

AA.VV. (2018), Annual Report 2017. Collection and treatment of waste electrical and electronic equipment in Italy, Centro di Coordinamento RAEE, Milano.

Badalucco L. (2011). Il buon packaging. Imballaggi responsabili in carta, cartoncino e cartone. Ed. Dativo, Milano.

Bozzola, M. (2014). Reuse of packaging at the end of its life: current practices and outlook. In C. Ceppa & B. Lerma (Eds), *Towards conscious design. Research, environmental sustainability, local development*. (pp. 124-135). Torino, Umberto Allemandi & C.

Chen, D. -S., Cheng, L. -L., Hummels, C., & Koskinen, I. (2015). Social design: An introduction. *International Journal of Design*, 10(1), 1-5.

Dal Palù, D., Lerma, B., Bozzola, M., & De Giorgi, C. (2018). Merchandising as a Strategic Tool to Enhance and Spread Intangible Values of Cultural Resources. *Sustainability, 10*(7), 2122. doi:10.3390/su10072122

Dalisi, R. (2009). *Decrescita. Architettura della nuova innocenza*. Corraini, Mantova.

Fowler, A. G. (2015, September 8). We Need the Right to Repair Our Gadgets. *The Wall Street Journal*. Retrieved from https://www.wsj.com

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production, 143*(1), 757–768.

Germak, C. (2013).The Poliedro project. A multicriteria model to evaluate the sustainability and quality of a typical food product. In C. De Giorgi C. (Ed), *Sustainable Packaging? A multicriteria evaluation method for food packaging*. Torino, Umberto Allemandi & C.

Pauli, G. (2015). *Blue Economy 2.0*. Edizioni Ambiente, Milano.

Pietroni, L. (2005). Humberto e Fernando Campana: Dal riuso all'invenzione. *DIID Disegno Industriale Industrial Design n.12*, 86-99.

Pulvirenti, E. (2009). *Design del riuso*. La Mongolfiera, Doria di Cassano Jonio (CS).

Verghese, K., Carre, A. (2012). Applying Life Cycle Assessment. In K. Verghese, H. Lewis, & L. Fitzpatrick & (Eds.), *Packaging for Sustainability* (pp. 171-210). New York, Springer.

Landscapes and systemic design: Po river Delta (Italy) case

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Abstract In this work a model of regenerative systemic design was applied to the delta of the Po. The Po Delta is one of the most important ecologica areas in Italy, (with over 370 species including resident birds, migratory birds and migratory birds) and the largest wetland in Europe, has been included, since 1999, in the list of Italian heritage sites by UNESCO and has been declared a Biosphere Reserve since 2013 by the UNESCO's Mab (Man and biosphere) program.
Despite the economic development made possible by the biodiversity of the Po Delta, Italy and regions had not been able to guarantee in any way the environmental protection of the area. Pollution, aquaculture, fishing, climate change effects has become widespread in the area.
A model of regeneration using systemic design is proposed.

Keywords: landscape ecology, landscape/seascape metabolism, geographical systemic design, regenerative design, blue economy

1. Introduction

Po Delta is World Heritage since 1999 and MaB Unesco Biosphere Reserve since 2015. IIn this area impacts of climate change can be easy predicted effects, it is clear that a more resilient landscape will be imperative if local society are to adapt and respond to the challenges of the future.

The needs of matching structural expressions of ecological integrity with cultural perceptions is particularly highlighted, by reference to the cultural bases for landscape perception and management (Nassauer, 1997), the landscape archetypes (Bell, 1999), and to the concepts of cultural and ecotone landscapes (Farina, 2006). These are examined for their potential role in creating a new synthesis of nature and culture.

Development of a realistic vision for Systemic Design in a regenerative landscape depends upon understanding the peculiar circumstances of its physical geography and biogeography linked to local history, culture and economic system (Bistagnino, 2011). The regeneration is based on scenarios of potential vegetation and hemerobiotic state of an area (the magnitude of the deviation from the potential natural vegetation caused by human activities, see Eurostat, 2017). The regeneration is also based on integration between Firms, Agricultural and wild habitats in order to reach a Blue Economy approach (Pauli, 2017).

The Blue economy concepts and the Circular economy agenda, as a set of strategic objectives, offer principles and guidance to identify blue economy potential for Po river Delta and its urban, landscape and coastal processes.

2. Methods

Robust ecosystems underpin resilience in landscape function. To achieve these, healthy soils, dune recover, better use and conservation of available rainfall, pragmatic use of vegetation and groundcover, and increasing biodiversity are key.

Following systemic design approach, the local economy will be based on:

coastal landscape regeneration;

production of new materials (paper, textiles, clothing, biodegradable plastics, paint, insulation, biofuel, food, and animal feed);

increasing resilience to climatic changes, sea level rise;

design a new production environment with a Biofactory system integrating food, material and energy production. Proposed system (based on rice, hemp, wood, weeds, and shells) can be developed into a variety of commercial items including chemicals, paper, textiles, clothing, biodegradable plastics, paint, insulation, biofuel, food, and animal feed.

Analysis of the state-of-art and configuration of sustainable development scenarios have been performed by adopting the approach of Geograhical Systemic Design: This allows local solutions to be addressed locally.

The priorities here are the enhancement of biodiversity and socio-economic growth, encouraging the possibility of carrying out multiple territorial functions based on sustainable development. Therefore, this area represents the possibility of experimenting with the sustainability and elaboration of proposals that realize this orientation for development, for the benefit of local communities.

Interviews and inspections have shown that the pivot of the context under study is the mollusc farming production system. Hence the hypothesis that:

a) there is a potential for continual regeneration of the ecosystem

b) the potential is linked to geographical, socio-economic, legal and planning factors

c) the potential is spatially identifiable within specific areas characterized by factors

of dynamism

All these conditions can be considered as general feasibility conditions that reinforce the framework of spatial knowledge and provide input for designing regenerative strategies.

Regenerative model is linked to negotiated planning scenarios. This analysis has highlighted a sort of missing link in the planning system and territorial governance, in particular in relation to the following aspects:

• integration with other initiatives;

• cycle closure to avoid waste and waste;

• active role of primary sector operators.

With the help of the geographic approach, based on the use of GIS technologies combined with Systemic Design, a mapping of the local system has been designed, highlighting the links between the activities and the operators, which is the basis of the project proposal for regeneration of the territory with ecosystem value. The connections have highlighted new opportunities for economic, social and ecosystem growth in a logic that goes beyond the "input-output" scheme of the Circular Economy in the strict sense, outlining a strategy for transforming waste into precious resources to be reused at a territorial level.

In particular, the method applied to the study area highlights the opportunity for recycling the shells of the mollusc farming sector and the excavation sands of lagoon canals. Through the creation of a map of the places dedicated to regeneration, based on the reinterpretation of soil maps in terms of potential vegetation superimposed on the information deriving from the real land use map, the research proposes an adaptive resilient model of application of the strategy " from waste to resource. The model as the goal to reduce pollution and waste of resources and to create the conditions for adaptation to climatic changes. The proposals are to apply on territorial areas that meet specific criteria are inspired by the "Blue Economy" case studies.

3. Results

We have also built some project proposals in details: they go in the direction of re-generating agricultural lands. They can be considered as a sort of business model, that means that the benefits by migration from business-as-usual to new ecological based business models has been defined, by given the numbers of economical value outcomes.

These are long-term solutions as we wanted to contribute to improve the resilience of the studied area.

Project proposals are inspired by the Blue Economy and can be summarised as follows:

The beach dunes and beach areas can be rebuild using only a reshaping of areas and beach management.

In the back-dune area the regenerate wetlands (dominated by Phragmites australis) will became a multifunctional ecotope, acting from water depuration to salt intrusion barrier. In this area a regenerative agriculture is also based in aquaculture waste recycling (Morris et al, 2018) is integrated into design of a new ecosystem mosaic: rice (*Oryza sativa*) - traditional in the Po river Delta agriculture landscape - and hemp cultivation (*Cannabis sativa*) can be integrated with phramites grooves and willow shrubs.

A Quercus ilex forests and psammophyl vegetation in coastal areas can be redesigned in rural landscape. The dunes can be built as is mainly due to successional stages linked to it, herbaceous vegetation of grey dunes and mantles using mollusc aquaculture waste (production of calcareous shells from *Mytilus galloprovincialis, Venerupis decussata, Tapes philippinarum*).

The rice and hemp will be integrated with grassland with *Vicia faba var. Minor* in order to regenerate agriculture and integrate it with pasture activities (*Ovis aries*). Pigs (*Sus scrofa domesticus*) will be growth in new woodlands (*Quercus ilex* forests).

Some of the benefits of proposed scenarios include:

Reduction of flooding and sea storms risks.

Effective erosion control.

Reduced water consumption.

Reduced maintenance costs and increasing local growth economy.

Increased natural capital and ecosystem value.

Elimination of chemical use.

Reduced visual impact of development.

Better soil conditions due to the use of native plants.

The regeneration is based on a potential ecosystem assessment (at scale of 1: 50,000). The model individuates 7 homogeneous fields (potential vegetation):

Homogeneous area "a" - Potential vegetation of lagoons and fishing valleys.

Homogeneous area "b" - Potential vegetation characterized by a mosaic of vegetations linked to the different water availability.

Homogeneous area "c" - Potential vegetation of the white, stabilized and fossil dunes.

Homogeneous area "d" - Potential vegetation of soils with good water availability but well drained.

Homogeneous field "e" - Potential vegetation of the soils with partial stagnation of water.

Homogeneous field "f" - Potential vegetation of sub-salt soils.

Figure 1. Map of regeneration places. Outcome of the Geographical Systemic Design approach. Localition of the solutions.

The test verifies the hypothesis on limited portions of territory, in correspondence with the application of the proposals of 1%, 5% and 10%, or providing respectively total conversion areas of 73, 04 hectares, 365, 22 hectares and 730.05 hectares in the three scenarios.

Whitin this test the ecological connectivity is improved (from 10% of connected areas to 33%), and the carbon stock in soil is 120 tonnes, 540 tons and 1400 tons in the 3 scenarios.

Identification of regenerative design proposals, as a result of the study of the vegetation series, has allowed to outline a scenario of sustainable and resilient development of the territory that requires appropriate land management, in order to promote the conditions for the enhancement of biodiversity and of socio-economic growth through multiple territorial functions for the benefit of local communities. Geographical Systemic Design approach, based on the use of GIS technologies combined with the Sistemic Design, maps of the local system. The model designed, highlighting the links between the activities and the operators, which is at the basis of the project proposal of regeneration of the territory with ecosystem value. The connections designed in the area under study have highlighted the opportunity to recycle the shells of the mollusc farming sector and the excavation sands of lagoon canals to be used as resources in the implementation of interventions in places dedicated to regeneration. Inspired by the Blue Economy case studies, the proposed solutions have highlighted new opportunities for economic, social and ecosystem growth in a logic that goes beyond the "input-output" scheme of the Circular Economy *sensu strictu*.

4. Conclusions

In Po Area regenerative coastal landscapes are proposed. Those landscapes are that restore the environment and encourage long-term sustainability, increased biodiversity, and enhanced resilience. A well-designed regenerative landscape can also complement property value, reduce water and maintenance costs, and create seamless, yet visually pleasing, harmony with surrounding natural open spaces.

The path that leads to the drafting of the hypothesised Adaptive Regenerative Plan based on the "waste to resource" strategy can be explored through the following steps:

➢ Phase A - Identify the main actors of the territory;

➢ Phase B - Analysis of the starting situation through systemic diagnosis, according to the Geographical Systemic Design approach and identification of the opportunities deriving from the circulation of waste materials, for key sectors, connected through material flows;

➢ Phase C - Definition of the expected strategic vision. All options must be identified and evaluated, taking also into consideration possible initiatives of similar territories;

➢ Phase D - Drafting of the actions of the Plan, by sectors and skills, through the de fi nition of actions to be carried out in the short / medium / long term, taking care to envisage any risks and opportunities for each of them;

➢ Phase E - Implementation of the Strategic Plan, through the planning tools, favoring the adaptation of the already existing ones;

➢ Phase F - Evaluation of the results of the implementation of the strategy through a Monitoring Plan able to provide in good time the inputs to adapt the Plan adopted on the basis of the observed results.

References

Bell, S. (1999). Landscape: Pattern, Perception, and Process, London: Taylor & Francis, 344 p.

Bistagnino, L. (2011). Systemic Design: Designing the productive and environmental sustainability, 2nd ed., Bra: Slow Food, 292 p.

Eurostat (2017). Glossary: Hemeroby index http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Hemeroby_index

Farina, A. (2006). Principles and Methods in Landscape Ecology:Towards a Science of the Landscape, Hedelberg and Berlin: Springer, 412

Morris, J., Backeljau, T. Chapelle, G. (2018). Shells from aquaculture: a valuable biomaterial, not a nuisance waste product, Reviews in Aquaculture, 10.1111/raq.12225 https://doi.org/10.1111/raq.12225

Nassauer, J. (1997). Placing Nature: Culture and Landscape Ecology. Washington DC: Island Press, 202 p.

Pauli, G. (2017). The Blue Economy 3.0: The marriage of science, innovation and entrepreneurship creates a new business model that transforms society. Sydney: XLibris, 275 p.

Post-industrial areas on the lens of Systemic Design towards flourishing urban resilience

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Over the years, our economy has evolved into a global multidimensional process that has manifested itself in cities through radical changes in human population densities and urban fabric, this has resulted in the rise of post-industrial cities on that complex scenario, how can Systemic Design approaches in post-industrial areas can foster Circular Economy frameworks to address the current environmental and economic challenges of society? This paper aims to delve into a better comprehension on Post-industrial areas on the lens of the Systemic Design as an expertise to identify Circular Economy strategies which are economically self-sustaining. In order to foster resilient livelihoods for the economic, ecological and social regeneration of deprived urban areas result of deindustrialization processes. To exemplify this, it is intended to examine the case study of the post-industrial area of Mirafiori sud in Turin, Italy.

Keywords: Systemic Design, Circular Economy, Urban Transitions, Post-industrial , Sustainable Development.

1. Introduction

Over the years, our economy has evolved into a global multidimensional process that has manifested itself in cities through radical changes in human population densities and urban fabric. Such transformations are so rapid that not all cities can cope with the demands of the market and population. This drastic shift has left many formerly manufacture/extractive or Fordist cities with deprived and outdated urban fabric, this has resulted in the rise of post-industrial cities (ICLEI, 2018).

In the past, these precincts flourished socially and economically due to stable industrial relations, which delivered social welfare and local consumption systems (Kazepov, 2005). These upcoming industries based on "Fordist cities" witnessed an accelerated development of industrial infrastructure such as; factories, warehouses, railroads, and harbors, parallel to this came de massive development of social welfare facilities such as housing, schools and recreational areas (Cucca & Rancci, 2017).

As global economic trends evolve in the last 30 years towards a dematerialized/service-based economy, these Fordist cities suffered the negative consequences of this brutal shifts. From a market demand perspective, these precincts urban fabric couldn’t cope with the transitioning industry, generating economic recession, rising unemployment, and population decline. As a result, this flourishing neighborhoods turned into desolate areas with predominantly brownfields and outdated urban fabric. Over time this phenomenon highlighted the trend on the disconnection between economic growth and social welfare (Cucca & Rancci, 2017). Such accelerated changes lead to acknowledging these urban environments as challenging precincts to address sustainable development issues (Bulkeley et al., 2011).

Many post-industrial cities face the pressing of revamping infrastructure and services with the purpose of meeting their current and future needs. To surpass the systemic outcomes of deindustrialization, it is imperative for these areas to re-frame their urban identity in order to boost urban transitions on restoring sustainable livelihoods (ICLEI,2018). Hence, to support such post-industrial legacy it must be approached as ‘hubs’ for radical innovation towards flourishing resilient cities (Ernstson et al., 2010; Bulkeley and Broto, 2012). Therefore, is important to consider such cities as ecosystems that contain individual and embedded systems from three interconnected spheres: the natural, built and socio-economic environment (McDonnell et al., 2009). This perspective addresses a holistic overview of the geographical and socio-cultural idea of the city, focusing on the dynamic feedback relationship that interacts within the post-industrial precincts and the city ecosystems (Ernstson et al., 2010)

On that view, the Sustainable Development Goals (SDG) trace an important roadmap for the post-industrial urban environment.Specifying that resilient and inclusive cities shall ensure sustainable consumption and growth patterns. To address that goal cities will have to go towards a Circular Economy (CE) a new paradigm which is gaining momentum, in order tackle the systemic consequences of deindustrialization and convene for a long-term transition on sustainable resource consumption. Furthermore, this will serve to overcome the existing contradiction between economic growth and sustainable development in urban environments (Pomponi, 2017).

Taking into account that, "Cities are not actors; they are places where people and economic activities are concentrated; complex social, economic and physical systems" (Otto-Zimmermann, 2011). To approach such complexity in areas with post-industrial legacy, it is very likely to undertake them with anticipatory strategies. "The more complex the network is, the more complex its pattern of interconnections, the more resilient it will be of our context" (Capra, 1996). On that view Design as a discipline is evermore approaching complexity fields with diverse ways of application (Jones & VanPatter, 2009), such as design thinking, participatory and systemic perspectives. These design initiatives are particularly sensitive to the SDG goals fostering a transition towards a more resilient and sustainable society. (Buchanan, 1992). Those practices have proved that the combination of technology, design and social organization can generate new mechanisms to regenerate these deprived areas.

These precincts which are facing local and global challenges must enable a shift in the way they have been undertaken, it is important to introduce a profound holistic vision which can make more comprehensible the complexity of urban context (Grimm et al. 2000; Mehmood 2010; Newman 1999). On this critical urban fabric, how can these scenarios reach an inclusive, sustainable and cohesive urban resilience, that can decrease future economic, environmental and social costs, but at the same time strengthening economic competitiveness? How can Systemic Design approaches in post-industrial areas can foster CE frameworks to address the current environmental and economic challenges of society?

This paper aims to delve into a better comprehension on Post-industrial areas on the lens of the Systemic Design as an expertise to identify CE strategies which are economically self-sustaining. In order to foster resilient livelihoods for the economic, ecological and social regeneration of deprived urban areas result of deindustrialization processes. To exemplify this, it is intended to examine the case study of the post-industrial area of Mirafiori sud in Turin, Italy.

2. Systemic design approaching the city as Living ecosystem

Nowadays there is higher complexity of social, economic and environmental challenges as they are ever more interconnected, it is required an innovative approach in order to find systemic an interconnected solutions (Brown and Wyatt, 2015). On such a scenario emerges the Systemic Design (SD), which intends to approach problems on a systemic and complex level. This expertise combines human-centered design inside complex, multi-stakeholder systems. Furthermore, the SD merges the designer skills such as research, reasoning methods and visualization practices generating new reconfigurations for complex services and systems (Jones, 2014).

On that view, the Department of Architecture and Design of Politecnico di Torino developed the SD approach that reconfigures the flows of material and energy from one component of the system to another, modifying outputs of one process into input for another one, in order to obtain zero emissions (Bistagnino, 2011). This methodology promotes new relations among the entities of a territory, enabling the visualization of hidden assets which will support a proactive synergy among local actors. Reactivating all source of territorial resources anticipating local development and enhancing locally-based value chains (Barbero,2012). The creation of such a relationship network promotes a general wellness improvement in the community, activating a cash flow between the various system participants. (Bistagnino,2011).

In order to deliver efficient urban transitions, it's needed new anticipatory approaches on sustainable development from a holistic and systemic point of view that create cohesive and smooth transition (Barbero, 2017). In the case of sociotechnical systems and urban environment relations from an SD approach, it allows capturing and interpreting the complete complexity of urban systems (Grimm et al. 2000). The overall identification of these relationships and interactions among the different parts allows visualizing solutions that combine the potentialities and criticalities of such living systems (Newman and Jennings 2008). Delivering a proactive collaboration between local actors and simultaneously creating innovative decision-making strategies. In order to accomplish this, the SD approach proposes the Holistic Diagnosis (HD) tool which hands design approaches on strategies, services, and governance that can enhance the complex urban scenario while fostering social cohesion and flourishing local economies.

3. Systemic approaches for a Circular City

In order to tackle climate change and its economic impact, cities should be regarded as complex, dynamic ecosystems or living metabolisms through which resources flow between actors, across multiple scales and sectors (Williams, 2019). On that regard, there is continuous support at the frontline of the cities agendas for a paradigm shift on resource management from the conventional linear to CE. As the aim of the CE is to regenerate the economy meaning to “keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles” (EMF, 2013). This circular approach could serve cities to address the way they produce and consume resources, but also it could decrease waste, greenhouse gas emissions, underutilization of resources and the decline of urban ecosystem services. (Williams, 2019).

So, to empower urban transitions in those scenarios it is required design approaches on innovative strategies, services, and governance that can activate local resources while promoting social cohesion and flourishing local economies (Nevens, F, et al., 2013). However, given the complexity of the current environmental and economic challenges on the urban environment, the systemic approach can be an efficient way to interpret and give solutions. The SD is understood as one of the most effective expertise on enhance future CE strategies and to find innovative anticipative paths for urban transformation, economic restoration, and social cohesion. Achieving an effective CE vision which generates a wide range of services fostering local resources and therefore urban transitions (EMF, 2017). Such CE strategies are synthesized by the EMF on the ReSOLVE framework on six business actions: Regenerate, Share, Optimize, Loop, Virtualize and Exchange. Furthermore, translated by Prendeville et al., 2018 on a conceptual framework of a Circular City which delivers an overview from which to understand the ways CE could demonstrate in an urban environment (Figure 1).

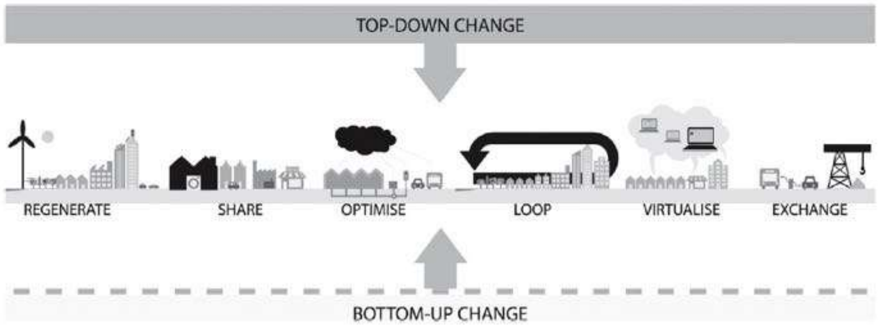

Figure 1. The circular city framework, adapted from the ReSOLVE framework (EMF, 2015). Taken from (Prendeville et al., 2018)

Based on the previous, to enable an effective approach towards Circular City framework (CCF), the SD approach through a Holistic Diagnosis (HD) tool delivers an anticipatory instrument for territorial development, that delivers new starting point for system mapping (Battistoni, Giraldo Nohra, 2017). Enabling an overview of such complex urban scenarios, in order to trigger a new economic model that arises from the appraisal of the resources offered by on post-industrial cities. Through a transdisciplinary approach, it invites actors from different sectors such as governments, civil society, and industry to co-create CCF strategies undertaking bottom-up and top-down. Allowing all local stakeholders to pull different economic activities that coexist to deliver social and economic welfare, which are the impacts of the CE fostering urban transitions. On the quest of flourishing resilience in cities, how can territorial thinking in post-industrial areas foster CCF to address the current environmental and economic challenges of society?

4. Holistic Diagnosis Tool for post-industrial areas

To deliver an effective interpretation of this complex scenario the SD describes the HD as a mapping tool in order to design a system (Bistagnino, 2011). The HD approaches a complete overview of the system context/product/process/service defining an exhausting study on behavioral patterns and interactions (Battistoni & Giraldo, 2017). This analysis combines both field and desk research to deliver a visualization of qualitative and quantitative data of the system components, also considering both the surrounding context and the flow of energy and matter. Consequently, the complex data collected in HD highlights the problems and leverages for change to enable the delivery if eco-guidelines for the new complex system and making the outcomes become accessible to a wider public and do not only serve the experts (Barbero, 2016).

This paper aims to delve into a better comprehension on the SD tool HD to identify CE strategies which are economically self-sustaining and which supply flourishing livelihoods for the economic, ecological and social regeneration of deprived urban areas result of deindustrialization processes. To exemplify this, it is intended to examine the case study of the post-industrial area of Mirafiori sud in Turin, Italy. Focusing on the outcomes of HD study approached in the area which was tailored to the characteristics of the precinct to deliver systemic approaches for urban transitions within CCF strategies that can be cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. This holistic overview, it is aimed to foster urban resilience by delivering innovative strategies addressing new economies shared between public authorities, civil societies, and industry/SMEs.

The HD is characterized by 2 main steps of analysis which can be customized to scales/scenarios offering the possibility of adding different elements to create an outline for each context. The HD addressing post-industrial areas will be composed of the following steps:

1. Analysis of the urban framework: The first phase starts with an analysis of the urban context.
2. Top-down and Bottom-up analysis: From current policies to grassroots activities (NGO, entrepreneurs, ...) regarding axes related to CE and SD.

5. Mirafiori Sud District Through the Lens of Holistic Diagnosis

The Mirafiori Sud Precinct with 34.000 inhabitants is situated in Turin capital of the Piedmont region (North-West Italy)(Figure 2). Historically this precinct allowed Turin to be known as the 'automobile city'. As a matter of fact, Mirafiori is embedded along FIAT’s history, after 1939 its fate has also transformed the area into the workers' district par excellence. However, the breakthrough point came after World War II, when the city population arrived at one million inhabitants, triggering Mirafiori to an exponential growth going from 3,000 artisans and farmers to over 50,000, mostly workers at the FIAT factory. This accelerated process brought fast urbanization of the precinct, predominantly with social housing infrastructure. At the same time, the social welfare services of the area make evident the strong connection between capital and labour of mass industrial production (De Filippi & Vassallo, 2016). Later on, the decline of the automotive production in the ’80s carry the crisis that initiated the slow agony of the FIAT as a city-factory era. As consequence, came to a progressive abandonment process with the impoverishment of residential buildings and the depletion of commercial activities (De Filippi & Vassallo, 2016). The end of an era for Mirafiori precinct meant that without FIAT, it became a most evident space of social segregation.

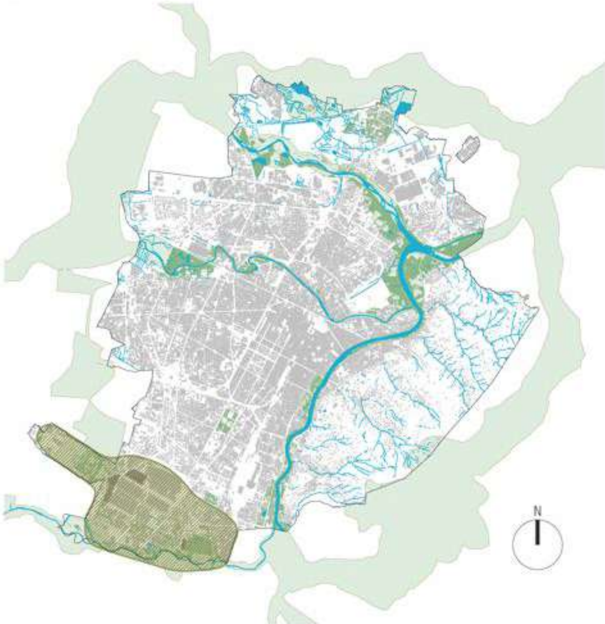

Figure 2. City of Turin Map, On the dark area is Located the Mirafiori Sud District. (Author: City of Turin, 2018)

5.1 Territorial Thinking ; Step 1 Holistic Diagnosis

To achieve a complete overview of the Mirafiori precinct, this first part of the HD analysis approaches territorial framework from different points of view: from the urban fabric to demography, culture, and economy. The entire process is led by designers so in that view is important to emphasize the constant advisory from multidisciplinary specialists in order to certify their right interpretation (Barbero, 2017). The obtained data, in this case, comes from qualitative and quantitative databases:

Database	Entity
Census of the ISTAT (2011)	Statistical office of the Piedmont Region
Urban land registry (GIS) (2008)	Municipality of Turin
Geo-referenced data (2017)	Geoportal of the Municipality of Turin
Territorial Agency for the Home (2017)	ATC Office /Social Housing
Business Directory (2015)	Piedmont Region - Sustainable Development and Qualification Sector of the production system of the territory
Real estate values (2018) OICT	Real Estate Observatory of the City of Turin
School Observatory (2017)	City of Turin / Educational Services Department

CO-City Projects (2017)	Mirafiori Foundation
Projects AxTO (2017)	Municipality of Turin
Local projects (2018)	Mirafiori Foundation
Social Assistance Municipality of Turin	Mirafiori South Social Service
Population	Statistical office Municipality of Turin
Environmental Data Report	ARPA - Piedmont regional Environmental Agency

Table 1. Resource database for Holistic Diagnosis

Thus, to channel the amount of information towards the scope of the research (CE strategies), this data collection was represented within maps of the precinct to have a better understanding of the spatial dynamics before the new reinterpretation of the system. Below there is the analysis of each of the selected categories for post-industrial area:

a) Urban Fabric

This category was focused on morphological features and natural resources having special attention on existing infrastructure, urban voids and public services (with a focus on quantity) (Figure 3). Considered a periurban area with a total surface of 11,491 km^2 A the aspect of the district and morphology of the neighborhood design around the FIAT. The Mirafiori precinct is surrounded by a considerable belt of green areas (i.e Corona Verde). Moreover, the fact that its borders are delimited by the Sangone river has given the district a network of naturalistic pathways. There is a considerable extension of public greenery with like Parco Colonnetti and Piemonte. The urban biodiversity and local ecosystem are connected by greenery present on the most important mobility corridors such as Corso Agnelli, Settembrini, Unione Sovietica or via Plava.

From the morphology of its public spaces, it can be divided the distribution of the district originally planned as Garden city (De Filippi & Vassallo, 2016) the accessibility to public recreational spaces is limited as they are concentrated in one side of the precinct. In fact, this resembles on the mobility components which give priority to the private vehicle use area (significant extensions of FIAT Parking area), there is a lack of public transport connectivity and scarce cycling infrastructure within the precinct. The analysis of the built environment enables to see the vast extension of the land occupied by FIAT and the urban voids part of the ex-industrial areas revealing the challenges and disconnection between the services of the district and the rise of brownfields and polluted areas. Moreover, it also reveals the considerable amount of social housing which subsequently expanded and finally downsized.

Nowadays only 30% of the total industrial complex of FIAT is in operations, identifying the deployed and active areas. As a result, many of the social welfare infrastructures such as schools, universities, markets, libraries, and social housing quality average have been shutdown or abandon.

On regards, public service is a well-served area, what rises the attention is the presence of the incinerator on the precinct, which not only arises considerably the emission of the neighbourhood but also there is very little awareness on regards wastes management on the precinct due to its dominant role. Concerning food security, even though this precinct is peri-urban area with huge potential there is no local supply of products. Over the years there has been initiatives to promote km 0 as Mirafiori Social Green VOV102 and local markets these ones have constantly failed because of price and supply, making local residents to do groceries on the few supermarkets of the area or other neighbourhoods.

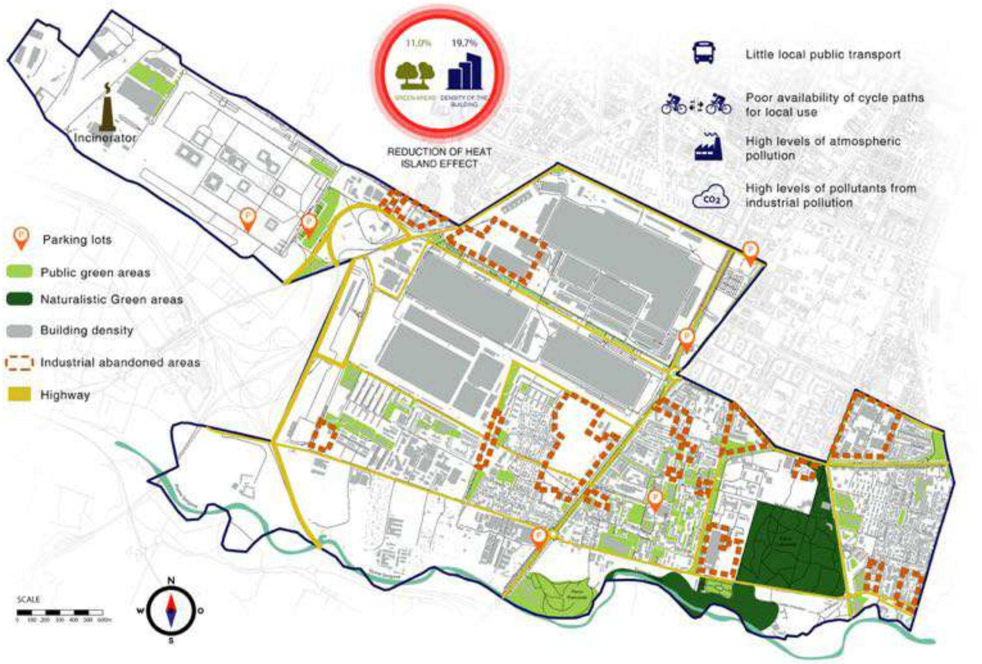

Figure 3. Mirafiori Urban Fabric map, Holistic Diagnosis. (Author: M .Di Giovanni , E. Ferruli, C. Giraldo Nohra, 2018)

b) Demography

This category focus in Mirafiori as workers' precinct par excellence. Specifically focused radical changes in their demographics from high levels migration in the 1950s from southern Italy to the diaspora crisis of FIAT in the 80s the transformation of the social fabric over the years (Figure 4). The district presents the characteristics of an enclave: a concentration of people with a high incidence of social problems and a strong cultural mix, physically isolated and socially separated from the surrounding areas. At the same time, this condition gave a strong sense of belonging to the inhabitants of the area character that still tries to survive in the third sector associations.

From the sociotechnical perspective, the analysis delivered radiography of the post-industrial society of Mirafiori. This phenomenon has reflected on a decline of the population density in the on almost 50% since 19701. Consequently, this has reflected on the high rates of adult and elderly which represent 60 % of the total population. In fact, the high rates of unemployment on the area also have an influence on the diaspora of young people and the scarce settling of new families into the precinct. Additionally, the population of young people with low education or at risk of school dropout, neighbourhoods in conditions of environmental degradation and high risk of exclusion and poverty.

Even though the presence of FIAT is still significant as an employer of the area, the types of jobs were forced to diversify on the decline of the automobile sector with single man enterprises. Another key actor on the territory as leverage for change is the Politecnico di Torino (Mirafiori campus) and University of Turin (chemistry faculty) which have brought a considerable student community along with universitarian residences that aim to change the social and economic dynamics of the area.

Figure 4. Mirafiori Demography map, Holistic Diagnosis. (Author: M .Di Giovanni , E. Ferruli, C. Giraldo Nohra, 2018)

c) Economy

The economic indicators are evidence of how the precinct has transitioned from a Fordist economic model and to the poor of economic diversification since FIAT left as a main economic actor this is reflected with low speared entrepreneurial activity and infrastructure property value (Figure 5). This revealed the numerous urban voids on the area show a progressive depletion industrial and residential buildings and the reduced commercial activities.

Moreover, is important to highlight the increasing role of the third sector as a potential force of economic reactivation. The Mirafiori's thirds sector gathers over 30 public and private partnerships to help improve the precinct from an environmental and social point of view, support the processes of transformation initiated, increase the equality of access to the opportunities of its inhabitants, preferring intervention modalities that involve actively recipients.

From multinationals to entrepreneurial activity to oversee what other sectors have emerged in the district beyond FIAT. The companies based in Mirafiori Sud they employ a total of more than 139,000 employees divided into two categories: employees family members and subordinate employees. The first is a total of just over 2,000 while subordinate employees reach 137,000.

Sectors of Family Business	Sectors of Subordinate Business
• Retail sale of other non-food products • Construction Sector • Wholesale of audio video recorded media • Restaurants • Mechanical repairs of motor vehicles • Real estate • Manufacture of metal structures	• Manufacture accessories for motor vehicles and engines • Transport • Manufacture of machinery and equipment • Manufacture of spacecraft aircraft and related devices • Incinerator- waste management

Moreover, is important to highlight the increasing role of the third sector as a potential force of economic reactivation. These activities have been promoted by a strong presence of the Third sector actors which are gathered under Fondazione Mirafiori management. On regards the economic reactivation the presence of TNE (Torino Nuova Economia) is relevant as an intervention company with predominantly public capital, established to implement these former disused industrial areas become fertile ground for the creation of new urban redevelopment opportunities through the reindustrialization and establishment of service activities. The analysis aims to focus on shifts then to areas of innovation, from a CCF point of view for Mirafiori precinct.

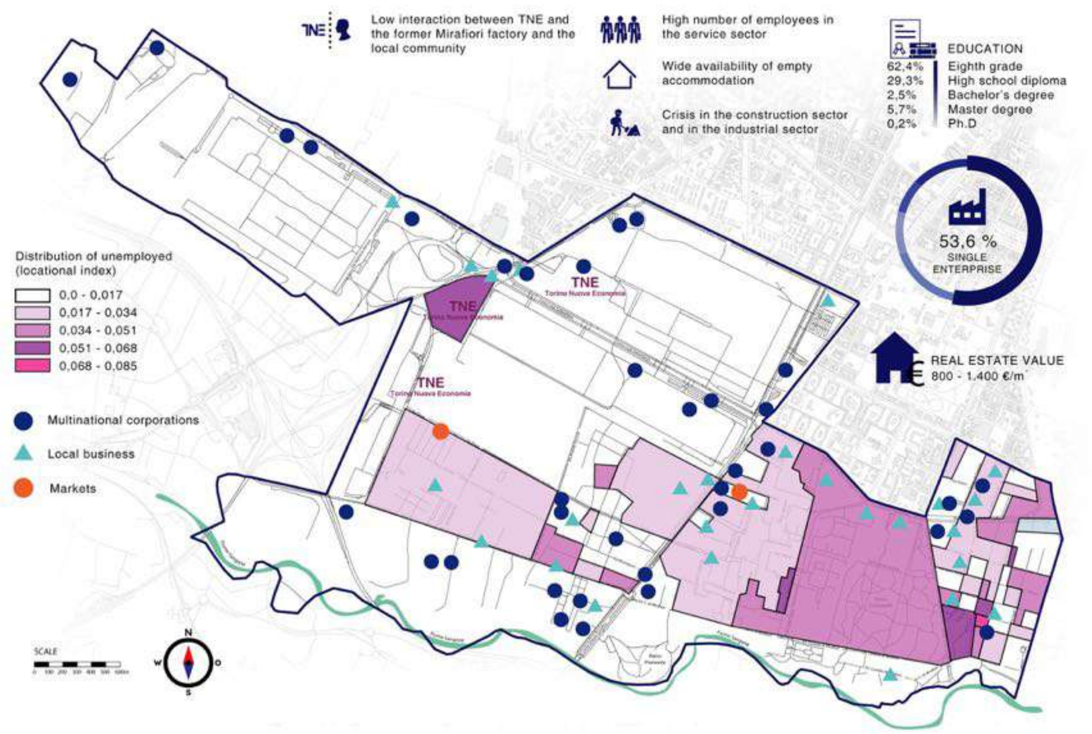

Figure 5. Mirafiori Economy map, Holistic Diagnosis. (Author: M .Di Giovanni , E. Ferruli, C. Giraldo Nohra, 2018)

c) Cultural

Given the historical background of this precinct shall be approached as Post-industrial Cultural heritage site (Figure 6). As the history of the area is embed with FIAT on every cultural aspect showing the influence of the company on who has resided in the area and how it has shaped all aspects from the urban fabric to demographic and economic. The current cultural agenda has been promoted by a strong influence of the Third sector actors over 30 organizations working on the precinct. These organizations are promoting the conservation of the cultural heritage and new urban identities to arouse on one side reflection and sense of belonging by the inhabitants; on the other hand, interest, and attraction for the territory by the city of Turin and beyond the municipal boundaries; implement inclusive and participatory cultural initiatives. As historical working class precinct, the sense of belonging has been a constant over the years making a very active community despite the current challenges of depopulation and increasing aging bring much influence from south Italy's influence.

On regards the architecture heritage since the ‘90s, different urban regeneration projects were promoted to preserve and enhance the urban fabric and Post-industrial Cultural heritage sites, to give a new image to the district. Nevertheless, despite the huge amount of resources and expertise, they have always reached rather modest outcomes. A focus on the industrial dismissed areas of FIAT and other historical sites related to the principal landmarks and their location.

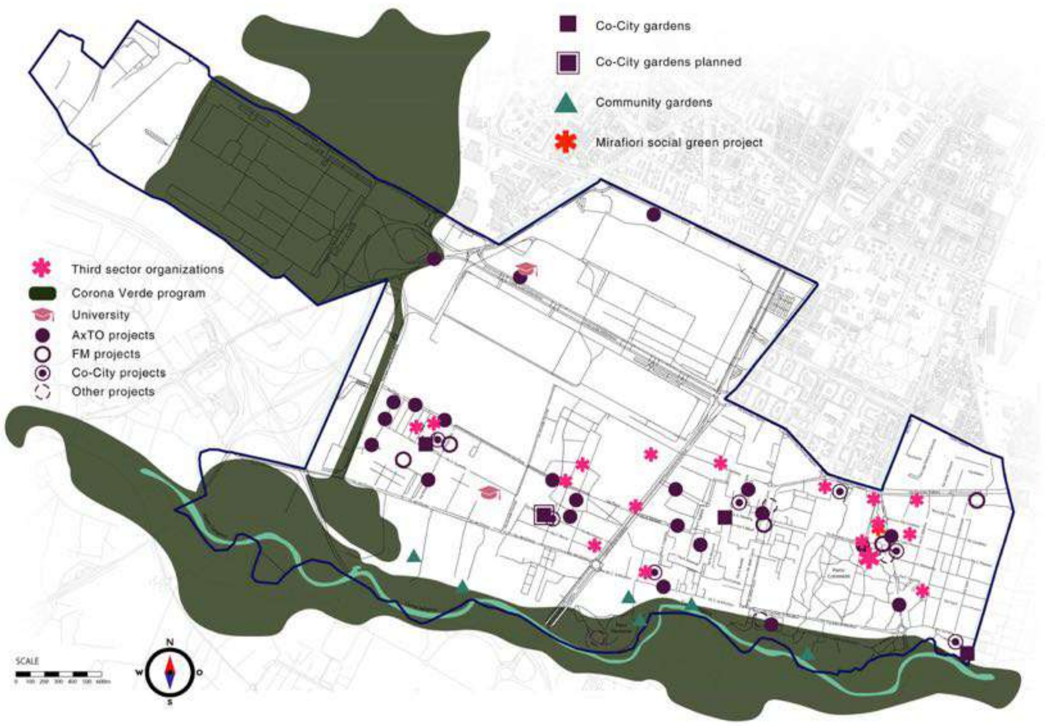

Figure 6. Mirafiori Culture map, Holistic Diagnosis. (Author: M .Di Giovanni , E. Ferruli, C. Giraldo Nohra, 2018)

5.2 A Top-down and Bottom-up approach; Holistic Diagnosis 2nd step

On the HD1 it was aimed to render the aspects on the potentialities and challenges of Mirafiori precinct, in this case through maps that highlighted the adjacency of such factors. From that point of view, the second phase of the HD approaches the area from a Top-down and Bottom-up perspective (Barbero, 2017). In this case, creating a panorama from current policies to grassroots actions regarding axes related to CE and SD. Furthermore, this phase aims at describing their main features and priorities but at the same highlight the potentialities and criticalities from an SD and CE perspective. On this view the analysis was divided into two:

Top-Down: A panorama of the current policies that in execution in the Mirafiori precinct.

- Torino Metropoli 2025,
- AxTo - Action for the suburbs of Turin,

- Metropolitan Strategic Plan 2018-2020,
- Urban program 2001.

These instruments address regeneration as a multidimensional concept containing economic development, employment opportunities, services effectiveness, cultural and social regeneration, inclusion. This action has to do with the economic dimension of sustainability. It aims to reach opportunities offered by innovation through more efficient use of resources creating socio-economic value with minimum impact on natural systems. In particular, the Mirafiori precinct since the begging of its decline in the '90s the city government has stimulated a series of policies for urban regeneration, entrepreneurship, and social cohesion. Promoting coordinated actions on the efficiency of use of natural resources, but also landscape restoring and rehabilitation and sustainable economic models. Nevertheless, these traditional regeneration instruments require to coordinate new forms of social inclusion of the community and stakeholders as the CCF to activate public and private resources.

Bottom-up: A panorama of the organizations that are leading current grassroots actions on Mirafiori precinct delivering a state-of-the-art on the potentialities and challenges of local stakeholder interactions. These are the key players along the local community in such actions:

- Fondazione Mirafiori
- Progetto Casa Artemisia
- Cooperativa Sociale Mirafiori
- Centro Mirafleming

These are the most relevant of an entire network of 30 entities of the third sector present in the precinct. Whose activities have built a more effective citizen-public administration relationships. Promoting local development through actions on social innovation, entrepreneurship, health, food security, and cultural heritage. Their interaction with citizens intends to act as a catalyst for initiatives that arise from the territories and facilitate the synergies of interventions - emerging, ongoing and future - that provide for the active participation of citizens in the co-design and implementation of interventions for the redevelopment and regeneration of collective spaces. Also in a perspective of co-planning and co-production of services and management of collective assets which facilitates the involvement and active participation of citizens, encouraging the inclusion of all the groups of communities involved in the process, with attention to the weaker groups. Last but not least, FIAT continues to be one important player to bring regeneration on the area as they aimed to provide a strong CSR component that shows the commitment of the company to enrich the Post-industrial Cultural heritage site.

These actions deliver a state-of-the-art highlighting the major strengths and weaknesses. Moreover, identifying the relationships generated by these local and government actions as a key asset. This combined vision of bottom-up and top-down actions delivers a complimentary on how the SD should stimulate local assets towards urban resilience and foster CE. The overlapping of HD1 and HD2 features how some components from the HD of the precinct are not taken into account from the Top-Down and Bottom-up actions, accede an accurate approach to the gaps towards a CE.

6. Conclusions

The previous illustrates how the HD territorial thinking on complex phenomena scenarios can be an efficient way to interpret paving a way for innovative solutions. On that view, the SD approach is poised to be an instrument which benefits all stakeholders leading them to paths where all can reach an effective sustainable development creating new scenarios of economic profit and cooperation (Barbero, 2017). The presented HD outcomes broaden the first approach of Mirafiori precinct on the lens of CCF at multiple levels such as : (a) On the technical level based on the components of the urban metabolism networks through which will result in the creation or redesign of local, circular supply chains, (b) On the social level enabling citizen-based ownership of local resources on post-industrial areas through co-designing, co-creating, and co-implementing of new protocols for the integration of CE strategies, (c) On the economic level through systemic approaches boosting circular business models for products and services, the output will be a framework with strategies for post-industrial areas highlighting market opportunities and public-private partnership models for circular productive activities, (d) At Policymaking level these results will aim to change local policies on post-industrial areas and, fostering a better governance and disseminate innovative solutions towards a CE addressing current funding programs.

In order overcome the systemic effects of de-industrialization and reactivate economic growth, post-industrial cities have had to reactivate their urban fabric through circular strategies, fostering a transition into a productive and stimulating place to live and work in that would restore residents' sense of belonging and attract investment. This holistic urban regeneration in a CCF lens is gaining traction in an effort to improve the social, economic and physical environment. Eventually, this holistic approaches on post-industrial precincts such as Mirafiori shall foster urban transitions and evolve the current planning and policy environment, as a result, the design and implementation of city development strategies on CE. On that context, this expertise pretends to turn into a role model methodology for cities with industrial legacy. Fostering local actors towards sustainable development and better governance, disseminating innovative solutions to reinvent and shape more cohesive post-industrial cities.

References

Barbero, S. (Ed.) (2017). Systemic Design Method Guide for Policymaking: A Circular Europe on the Way. Turin, Italy: Allemandi.

Barbero, S. (2012). Systemic Energy Networks Vol. 1. The Theory of Systemic Design Applied to the Energy Sector. Morrisville, North Carolina, USA: Lulu Enterprises, Inc, Raleigh.

Battistoni, C., Giraldo Nohra C. (2017). The RETRACE Holistic Diagnosis. In Barbero, S. (Ed.). Systemic Design Method Guide for Policymaking: A Circular Europe on the Way. (pp. 112-120) Turin, Italy: Allemandi.

Bistagnino, L. (2011). Systemic Design: Designing the Productive and Environmental Sustainability. Bra (CN), Italy: Slow Food.

Brown, T., & Wyatt, J. (2015). Design thinking for social innovation. Annual Review of Policy Design, 3(1), 1-10

Buchanan, R. (1992). Wicked problems in design thinking. Design Issues, 8(2), 5–21.

Bulkeley, H., Castán Broto, V., Maassen, A., et al., 2011. Governing low carbon transitions. In: Bulkeley (Ed.), Cities and Low Carbon Transitions. Routledge Taylor and Francis Group, London and New York, pp. 29e

Bulkeley, H., Broto, V.C., 2012. Government by experiment? Global cities and the governing of climate change. Trans. Inst. Br. Geographers, 1e14.

Capra, F. (1996). The web of life (pp. 153-171). Audio Renaissance Tapes.

Cucca, R., & Ranci, C. (Eds.). (2017). Unequal cities: The challenge of post-industrial transition in times of austerity. Routledge Taylor and Francis Group, London and New York.

EMF, (2015). Delivering the Circular Economy: A Toolkit for Policymakers, Available at: https://www.ellenmacarthurfoundation.org/publications.

EMF, (2013). Towards the Circular Economy: Opportunities for the Consumer Goods Sector, Available at:https://www.ellenmacarthurfoundation.org/publications.

EMF, (2012). Towards the Circular Economy: Economic and Business Rationale for Accelerated Transition, Available at:https://www.ellenmacarthurfoundation.org/publications.

Ernstson, H., van der Leeuw, S., Redman, C., Meffert, D., Davis, G., Alfsen, C., Elmqvist, T., 2010a. Urban transitions: on urban resilience and human- dominated ecosystems. Ambio 39, 531e545.

Grimm, N., M. Grove, S. Pickett, and C. Redman. (2000). Integrated approaches to long-term studies of urban ecological systems. Bio-Science 50(7): 571–584.

Hjorth P. and Bagheri A., (2006). Navigating towards sustainable development: a system dynamic approach. Futures 38, 74-92. Elsevier.

ICLEI (2018) Urban Transition Insights from Industrial Legacy Cities. Bonn, Germany.

Jones, P. H. (2014). Systemic design principles for complex social systems. In Social systems and design (pp. 91-128). Springer, Tokyo.

Jones, P. H., & VanPatter, G. K. (2009). Design 1.0, 2.0, 3.0, 4.0: The rise of visual sensemaking. NextD Journal; ReThinking Design.

Kazepov, Y. (2005). Cities of Europe: Changing contexts, local arrangements, and the challenge to social cohesion. Cities of Europe, 1, 3-33.

Mehmood, A. (2010). On the history and potentials of evolutionary metaphors in urban planning. Planning Theory 9(1): 63–87.

McDonnell, M. J., Hahs, A. K., & Breuste, J. H. (Eds.). (2009). Ecology of cities and towns: a comparative approach. Cambridge University Press.

Murray, A., Skene, K., and Haynes, K. (2015). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. Journal of Business Ethics, vol. 140, no. 3, 369–80. doi: 10.1007/ s10551-015-2693-2.

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban Transition Labs: co-creating transformative action for sustainable cities. Journal of Cleaner Production, 50, 111-122.

Newman, P. and I. Jennings. (2008). Cities as sustainable ecosystems: Principles and practices.Washington, DC, USA: Island Press.

Newman, P. W. G. (1999). Sustainability and cities: Extending the metabolism model. Landscape and Urban Planning 44(4): 219–226.

Otto-Zimmermann, K., 2011. Embarking on Global Environmental Governance. In: Thoughts on the Inclusion of Local Governments and Other Stakeholders in Safeguarding the Global Environment. ICLEI Paper 2011-1. URL:http://www.stakeholderforum.org/fileadmin/files/ICLEI_Global_Governance_Local_Govt_ Zimmerman.pdf.

Pomponi, F., & Moncaster, A. (2017). Circular economy for the built environment: A research framework. Journal of cleaner production, 143, 710-718.

Prendeville, S., Cherim, E., & Bocken, N. (2018). Circular cities: mapping six cities in transition. Environmental innovation and societal transitions, 26, 171-194.

Ruggieri, A., Braccini, A.M., Poponi, S., Mosconi, E.M. (2016). A Meta-Model of Inter-Organisational Cooperation for the Transition to a Circular Economy. Sustainability, 8 (1153), 1-17. doi:10.3390/su8111153.

Williams, J. (2019). Circular cities. Urban Studies, 0042098018806133.

Williams, J. (2019). Circular Cities: Challenges to Implementing Looping Actions. Sustainability, 11(2), 423.

Systemic Network Around Education and Community Gardens

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Abstract

Recently, the majority of the Brazilian population is living in cities, and the slums are growing within poor living conditions, in a context of enormous social-economic inequality. One of the local challenges is the poor nutrition of its inhabitants, together with the high cost of healthier food. This article presents the results of an urban farming project, developed through the partnership of universities and some communities at Belo Horizonte, Minas Gerais. It represents university research and extension projects on building community gardens, aiming at the constitution of a social-economic innovative process to increase local social cohesion, popular protagonism and food sovereignty. Each garden is facing particular challenges in relation to its social, environmental and economic sustainability, but the initiative is proving to be a significant alternative to humanize those spaces, systemically bringing together approaches as Design, Agroecology and Food Sovereignty and Solidarity Economy, Integral Endeavours and developing cooperative and innovative actions.

Keywords: Systemic Design, Agroecology, Social Economy, Solidarity Economy, Brazilian communities.

1. Introduction

World leaders, in September 2015 at a United Nations Summit, have decided to fight against some global long-lasting problems related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice, proposing the United Nations' Sustainable Development Goals as part of a global agenda with targets for 2030. "Over the next fifteen years, with these new Goals that universally apply to all, countries will mobilize efforts to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind." (United Nations, 2018)

It is also important to point out that Brazil is facing many challenges due to social-economic and environmental problems that deeply affect the lives of their inhabitants, and need new theories and methodologies to overcome them.

In order to deal with these chronic problems, it is necessary a different approach from the current traditional emphasis on specialized knowledge that, up to now, has been incapable of tackling these problems efficiently. A systemic approach that embraces the complexity of dealing with many variables at once, despite being a challenge that requires cultural changes, also presents itself as a promising good strategy.

Systemic Design is one of the methodologies available that has tools to structure the work using a holistic mode. Working with this methodology already for some years has provided the opportunity to put some of its theory into practice and to recognize the complementarities and intersections with other known concepts. Its association with values and concepts that are becoming more and more widespread, such as the circular economy, sharing economy, agroecology, social and solidarity economy, shows a potential of producing substantial changes in the contemporary societies.

Those are subjects that are going to be discussed in this article that presents, together with theoretical concepts, cases where communities and academy get together to deal with issues such as nutrition, economic sustainability and social expression.

2. Methodologies and Concepts

2.1 Systemic Design and Integral Endeavours

An *Integral Endeavour* is any organization for productive activity (be it an industry, a household, an individual or the nature) that operates considering its holistic relations and is grounded on integral sustainable values (that is, works aiming at having social, economic and environmental resources to provide indefinite duration of its activities). It defines goals and builds networks, based on Systemic Design principles: 1) generating zero waste, by using the **output** (waste) of a system as the **input** (resource) of another one, optimizing the use of resources and creating an increase of cash flow and also new job opportunities; 2) identifying and fostering **relationships**, since the components of the network have common values and interests, and due to the recognition of the importance of connections of multiple areas of knowledge and performance, making systemic networks; 3) being

self-productive, sustaining itself defining its own paths of action and the joint coevolution of the elements of the system, all of which with equivalent importance; 4) giving special value to the **local** context and resources (human, cultural and material), which contribute to solving local problems and to create new opportunities; 5) placing people in the centre of the projects valuing **people** over products (contributing to the quality of life, with inclusion and accessibility, is considered more important than the production of goods).

Systemic Design is a methodology that makes available some tools to model the context/ business to be qualitative and quantitatively analysed. First, representing it as it actually is, and then creating its systemic ideal model. Its five principles give the guidelines that must be always present at the planning decisions. Depending on the endeavour that is being studied other systemic approaches that have, for instance, the influence of System Dynamics, may be used.

"Systemic thinking" is a way of reasoning that consider the complexity of the whole, a cognitive process that leads to the capacity of perceiving, modelling and evaluating the consequences of actions in an expanded way in terms of time and space (Andrade, 2014). It is related, but different from "Systems Thinking" that regards production, and is mainly about delivering to the customer the service he needs instead of just a product with a specific function […] making products work together seamlessly (Mendonça, 2014). The "Product Service System" (PSS) is a methodology that follows this strategy, and is about "a smart combination of products and services to create a high market value", "function/ value creation for clients", "working modular" and "combining sustainable concepts with powerful presence in the marketplace" (Halen, C., Vezzoli, C., Wimmer, 2005).

The Systemic Thinking, and specifically the Systemic Design, instead of focusing on a central industry and on the objective of each single business, aims at the increase of its production as a means of maximization of its profit and works with "a network of activities and products focusing on the environmental and cultural protection". It involves actors who are equally important and may come even from different biological kingdoms (animals, plants, algae, bacteria and fungi) with no notion of centrality (Mendonça, 2014).
The rationale behind these methodologies, such as optimizing matter and energy, recognizing every output of the system as a resource and stimulating connections, is a source of innovative endeavours that become new productive opportunities.

2.2 Agroecology and Food Sovereignty

Agroecology is an agricultural practice adapted to the productive requirements of the land available, encompassing the multiplicity of farming forms, as far as adopting ecological solutions in tune with the territorial, cultural and social-economic conditions of each agro-system. It is qualified by its principles, that maintain the management forms faithful to the natural environments available, contributing to preserve the biodiversity, the natural resources and the ways of life, building a character of broad sustainability. According to EMBRAPA (2006) agroecology aims at fulfilling the economic level (to boost income, work and market insertion), the ecological level (to preserve or increase the quality of the natural resources and the ecological relations of the ecosystems), the social level (to include the poorest and promote food security), the cultural level (to respect the traditional expressions), the political level (to organize changes and the participation on the decisions) and ethical level (to adopt transcendental values).

Therefore, agroecology offers a theoretical reference that respects the “place”, decreasing the environmentally harmful agrochemicals and highlighting the importance of the diversity in farming, transforming its principles and practices into reality and valuing the ancestral sources of knowledge, as a product of the popular knowledge (EMBRAPA, 2006). For these reasons, agroecology happens throughout a plurality of formats, as far as encompassing historical gathered knowledge, reinforcing solidarity values and practices and preserving the identity of the local actors.

The propagation and valorization of the agroecology principles rescued initiatives that update and improve it as a science, nurtured by the indigenous and agricultural knowledge from different parts of Brazil (some of those experiences are well presented in the book Fraxe, Castro and Santiago, 2015) Some non-governmental, governmental and academic organizations are proving the fruitful association between agroecology and the improvement of food security, preserving the sovereignty, the conservation of natural resources and the agro-diversity of hundreds of rural communities (Altieri, 2010).

The concept of food sovereignty arised in the 1990s, associated to the agroecology concept, through the social demands of the Via Campesina association, that reunites peasant organizations around the world, mobilized against neo liberal rural politics recommended by the World Bank and by the World Trade Organization and adopted by many governments, affecting the way of occupying the land, to produce and commercialize food (Campos e Campos, 2007). It defends the right of autonomy of the countries to deal with its politics and strategies of production, distribution and consumption of food, protecting the small and medium agriculture, coincidently with the basis of the agroecological principles (Burity et al., 2010).

The connection of Food Sovereignty and Nutritional Sovereignty demands the assurance of the food autonomy of a nation and the implementation of a fair way of production and distribution of food (Burity et al., 2010).

> In this sense, the extent of the interventions that intend to be materialized at the format of community gardens, within the principles of solidarity economy and agroecology has the potential to reach a complex list of solutions to face the deprivations suffered by […] communities that are poorly included at the market economy, by promoting an unpredictable endogenous process […] in which it is observed the promotion of latent resources and knowledge in favor not only of food sovereignty, but also of the local development (Mello et al, 2018, p.13).

2.3 Social and Solidarity Economy

In Brazil, since the end of the 1970s, communities affected with high levels of shortage began to practice the sharing and reciprocity to fulfill certain needs and improve their quality of life, originating a new economy, with opposite patterns to the hegemonic capitalism, called social and solidarity economy (Singer, 2001).

Within its scope came out associative forms to solve public local problems and the mutualism, product of a disposition to create a collaborative schema of generalized gain and self-management (Alves e Bursztyn, 2009; Ribeiro e Müylder, 2014; Borinelli et al, 2010).

This creates enterprises with shared properties of the productive resources and horizontal productive relations, as well as equal rights, responsibilities and opportunities among the participants (CNES, 2006 apud Singer, 2009). Their production tends to be accomplished at the networks, broadening the exchanges within the same organizational system (Simon, 2013; Mance, 2009).

Therefore, this is a plural new model of economy, encompassing many models of organization (Pinheiro, 2016; Ramos, 2013; França Filho, 2008; França Filho e Cunha, 2009). Despite some variations of the models, there are convergent principles in respect with the valorization of the work produced, the use of technologies to fulfill the needs of all, the recognition of the importance of the feminine concerning solidarity, the respect of the environment and the emphasis on cooperation and solidarity (FBES, 2005, s/p), principles constituting the basis of this project at the community gardens that are being built with real participation of the local residents.

3. The opportunities of the Educational Context

3.1 At ED-UEMG

Motivated by the Brazilian Law n. 9.795, from April 27th, 1999, that establishes the National Environmental Education Policy, the environmental education is considered “an essential and permanent component of national education and must be articulated at all levels and modalities of the educational process, both formal and non-formal”. For this, the graduate course in Visual Arts, offered at the Design School of the State University of Minas Gerais (ED-UEMG), that forms art teachers of basic education, has in its program the discipline “Special Topics in Environmental Education”.

ED-UEMG also offers academic extension activities with short courses on vegetable and flower urban gardens in small spaces that create, within the university, a dialog on different aspects of Design, on product lifecycle, new Economies (such as the Distributed Economy and Sharing Economy), and also promote exchanges between the academic community and the society.

Considering the intertwined nature of the environmental issues to the social and economic aspects and the fundamental goal of increasing integral sustainability, the main purpose of the discipline is to foster Systemic Networks of Integral Endeavours, applying the Systemic Design principles. As the discipline is very interactive, with students also bringing their experience to the classroom, some very rich opportunities arise.

3.2 At UNA

The University Centre UNA receives research and extension projects at its Extension and Research Board, having as selection criteria projects that are committed to the sustainable development, as those foresee at the The Earth Charter, proposed by the United Nations World Commission on Environment and Development, at 1987, and ratified by UNESCO at 2000. Its principles are the basis for the constitution of the LEIA – "Laboratório Ecossistêmico Interdisciplinar de Aprendizagem" (Ecosystemic Interdisciplinary Laboratory of Learning).

LEIA has a social character that integrates teaching, research and extension, putting together practices and studies of social relations, interdisciplinary knowledge and intersectoral actions. Its objective is to work with people from collective groups, that promote participatory and proactive actions, to "make it happen" and spread the principles of food sovereignty and urban agroecology, promoting the organization of production and consumption according to the principles of the sustainability and solidarity economy.

The LEIA achievements include the constitution of an experimental garden at one of the unities of the University, where workshops on sustainable relations take place. Outside, the Laboratory contributes, by means of actions of research and extension, to the implementation of community gardens, following its core principles.

3.3 At UFMG

At the context of Federal University of Minas Gerais, UFMG, parameters are being established for the institutional inclusion of this work, characterized as a Research and Extension Project that intends to increase the number of students and teachers involved with the community gardens movement. The intention is to involve different areas of study, at the Interdisciplinary Program of Master and Doctoral Degrees of Built Environment and Sustainable Heritage, at the Architectural School.

Also, the LIDEP - "Laboratório Integrado de Design e Engenharia de Produção" (Design and Product Engineering Integrated Laboratory) from the Department of Product Engineering from UFMG, is involved in these projects. LIDEP proposes a multidisciplinary and integrated approach on the Product Project subject, and its members have expertise and experience developing projects focused on product lifecycle, working with Design for Sustainability, Product Ergonomics, Quick Prototyping and Computer Aided Design.

4. Application Opportunities

Very interesting opportunities are evolving, considering the connection among the communities of four slums in different areas of Belo Horizonte (the third most populated and developed city of Brazil), three universities and the urban planning institution from the local administration (URBEL), as experiences aiming to overcome some of the local problems and also to apply those theories and methodologies presented above, creating a continuous circular process by the exchange of ideas and practices. All four ongoing cases have in common the existence of a vacant area within the community, some residents that see it both as a threat if left unused and as an opportunity to make some action for the collectivity, and as the chance of receiving the support of the academy and public administration, having cultural activities as a bond. In some cases, it is also being built opportunities of association with entrepreneurs, generating a new source of income for the group involved.

4.1 "Morro das Pedras"

The first community of the project is the "Morro das Pedras" Agglomerate, which is a neighborhood in the western region of the city of Belo Horizonte, formed by seven villages: Antena, Santa Sofia, São Jorge I, II, III, Leonina and Pantanal, in the place where there were originally several farms and a quarry. Today it is equipped with schools, nursery, public transport, medical and police stations. Nevertheless, the community still claims for basic sanitation, public lighting and security. Still, Morro das Pedras is a place of a significant cultural presence.

A student from the Visual Arts at ED-UEMG, Marcos Paulo de Jesus Horácio (Horacius de Jesus), who lives at Vila Antena, has invited us to give a workshop within the community to produce fertilizer from organic waste in order to enrich the soil of an area where there used to be some sheds, removed by local administration because it was beneath a high voltage powerline.

In this area, as described by Horacius, they have now a community vegetable garden, where 6 persons from the community volunteered to work donating 2 hours a day during working days and 5 hours on Saturdays Organic waste, some seeds and seedlings are donated by 11 families that participate in the project in exchange for a weekly bag of vegetables distributed to the children of the local school that also participate in this movement.

After about a year of development of the vegetable garden along with artistic and cultural activities, the community has won a contest for a financial support of the Brazil Foundation organization and Horacius has won a photography contest with an image picturing the community. The values of Integral Endeavours have served as guidelines to define activities as well as style of leadership, community engagement, local education and economic sustainability decisions.

Figure 1. A local fair in Vila Antena, where the community offers its own production (including vegetables) and services (left), and the plot where a new community garden is being built, together with other sustainable activities (right).

4.2 "Santa Lúcia" Community

The second community is in the "Santa Lucia", also involving an area that has been made vacant by local authorities (URBEL), because of its geological risk. Professors from the private university UNA have been asked by locals to give support to make a community garden. From the partnership established among UNA, ED-UEMG and UFMG due to their common interests in research and extension projects, the group is working together with the community in this initiative, making collective actions ("mutirões") and surveys to understand the culture of the community and their needs. It is being an interdisciplinary effort with the engagement of designers, architects, economists, agronomists, sociologists, engineers, gastronomists, nutritionists, with the support of URBEL, gathering human and material resources.

Figure 2. The site where the community garden of Santa Lúcia is being built. On the left, locals harvesting their initial production. On the right, one of our team's agronomist, facilitating the process of levelling the terrain

Throughout this work, a spontaneous management group has emerged, establishing unprecedented interactions in the community, increasing their social cohesion. From the principles of Integral Endeavours, Agroecology and Solidarity Economy, the group of residents, researchers and students have developed a series of collaborative actions, different from the capitalist traditional market logic. At the same time, rich discussions about the principles of the vegetable gardens, its management and distribution of production are promoted, emphasizing the quality of the local production (healthy food, without pesticides) and the importance of the conscious consumption. It is noticed that some residents extended their autonomy and voice, because before they were reluctant and now are expressing themselves and realizing interventions that are gradually transforming the space.

It is important to highlight the relevance of the adoption of some principles that guide the interventions and are intended to be internalized by the community, in order to create an authentic endogenous local development (Martins, Vaz e Caldas, 2010; Paula, 2008; Oliveira, 2001). The election of a model of social management with its main features (participation, dialogue, respect to the autonomy, shared decision-making, collective implementation) is a requisite to reach this goal (Gohn, 2004; Justen e Neto, 2012; Macke, Carrion e Dilly, 2010; Kleba e Wendausen, 2009; Cançado, Pereira e Tenório, 2013). For that, the methodologies and references adopted to base actions and research include observant participation and field diaries, as well as participatory action-research (Tripp, 2005) as a guiding center line, together with the principles of Systemic Design, Agroecology and Solidarity Economy.

4.3 "Taquaril" Community

The third community is in the neighbourhood of Taquaril. In this case, URBEL has invited the academy (represented by UNA, UEMG and UFMG) to support some families to develop their urban gardens, in a preservation area. There, the growth of dense bushes nearby the residences represented a danger to the families for hiding illicit activities as well as synanthropic animals that are a threat to human health.

In this context one of the residents decided to clean the area in front of his house and began cultivating some vegetables. He is a retired resident with previous expertise on agriculture and is becoming a reference and inspiration for the neighbours.

The first contact was to understand the community needs and, for that, a focus group was made with some residents who lived near this area. Other meetings happened to the exchange of knowledge on how to fight pests and how to build protection against harsh weather. The university team also conducted a practical workshop on composting.

The resident who began this movement is succeeding in developing a very productive space, but the neighbours are not quite engaged yet, although our research group is willing to make activities to involve and foster collaboration within the community.

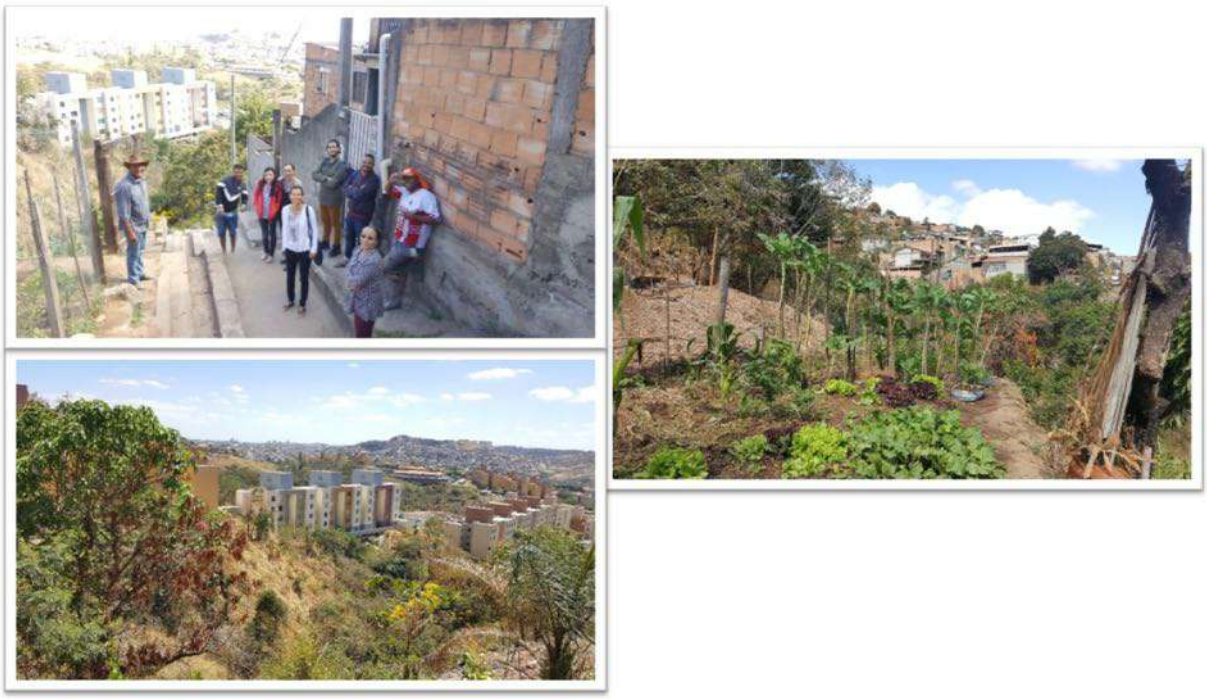

Figure 3. The site of the community garden of Taquaril. On top left, our team and the residents who participate in the initiative.

4.4 The "Aglomerado da Serra"

The fourth case is at the "Aglomerado da Serra". There, there is a group that is rather independent, having already a practice of involving the community in the selective collect and organic compost making with and without worms. Some leaders of the community give workshops on this practice and sell boxes for vermiculture. We have participated as students in their workshop and afterwards have invited them to take part in a short extension course on vegetable and flower urban gardens that was promoted in the ED-UEMG. Agroecological practices have been the main focus of this group, as a way of life, along with healthy eating and income generation.

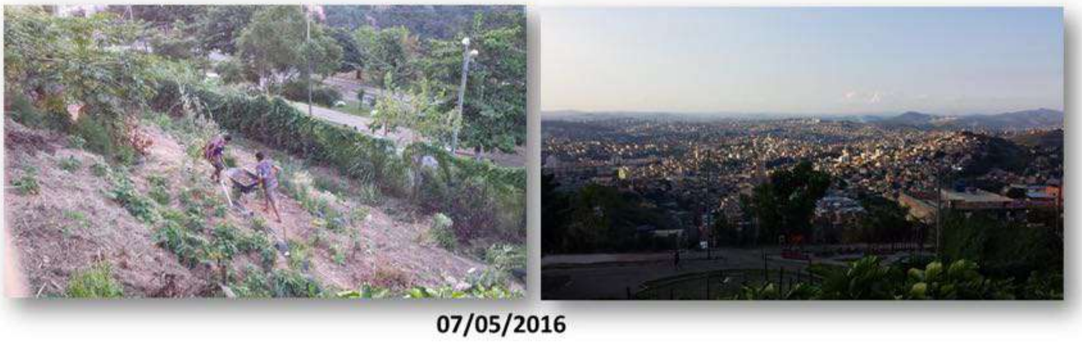

Figure 4. The "Aglomerado da Serra" region and one of the sites where a community garden is being built.

5. Conclusion

Much has been discussed on the search for solutions to the problems arising from the accelerated process of urbanization, perceived in England in the nineteenth century, in Brazil from the 1950s on, and now in countries such as China and India. In situations like these the previously existing forms of production (such as small agricultural production and handicrafts) collapse, as well as structures of social relations based on tradition. Among the different problems encountered, access to adequate food, culture and leisure can be mentioned, as well as the loss of the principles of social structuring aimed at the cohesion and articulation of groups of neighbors aiming at common improvements (of which the Brazilian tradition of the "mutirão" is a good example).

Taking as reference the food issue, the urbanization, the growing inclusion of women in the labor market, the availability of processed foods at low cost and high costs of the healthy ones have brought about considerable changes in eating habits and serious public health problems due to obesity, affecting also the child population.

In the experiences presented in this article, the problem of food is not considered in isolation, but within its social context, including the necessity (or opportunity) of the generation of work and income. This approach to social innovation through Systemic Design makes an important contribution to the development of appropriate solutions for socially complex contexts as seen in large brazilian cities and demonstrates how design methodologies (as the Integral Endeavours) can contribute significantly to the solution of human problems.

All these initiatives have as main goal the strengthening of social cohesion within the communities and the widening of their autonomy to be reflected in self-management, broadening of collective identity and health promotion by food sovereignty, strengthening conscious agents, protagonists of relationships and of their living spaces. The theoretical foundations are the principles of Systemic Networks of Integral Endeavours, Agroecology for Food Sovereignty and Social and Solidarity Economy. Social inclusion, valorisation of diversity, exchange of academic and empirical knowledge are also cornerstones of this project that has the potential to promote exponential impacts at people's lives.

References

Altieri, Miguel. (2010, jan-jun). *Agroecologia, agricultura camponesa e soberania alimentar.* Revista NERA. Presidente Prudente. Ano 13, n. 16, p. 22-32.

Altieri, Miguel. (2004). *Agroecologia: a dinâmica produtiva da agricultura sustentável* (4.ed.). Porto Alegre: Editora da UFRGS.

Alves, M. O.; Bursztyn, M. (2009, julho/setembro). *Raízes e prática de economia solidária articulando economia plural e dádiva numa experiência do Ceará.* Revista Econômica do Nordeste, 40(3).

Andrade, A. L. (2014). *O Curso do Pensamento Sistêmico.* (Digital Publish & Print Editora, Org.) (1a ed.). São Paulo.

Borinelli, B. et al. (2010) *Economia solidária em Londrina: aspectos conceituais e experiência institucional.* Londrina: UEL.

Burity, V. et al. (2010). *Direito humano à alimentação adequada no contexto da segurança alimentar e nutricional.* Brasília, DF: ABRANDH. 204p.

Campos, C. Campos, R. (2007, agosto). *Soberania alimentar como alternativa ao agronegócio no Brasil Scripta Nova.* Revista Electrónica de Geografía y Ciencias Sociales. Barcelona: Universidad de Barcelona, vol. XI, núm. 245 (68). [ISSN: 1138-9788].

Cançado, A. C.; Pereira, J. R.; Tenório, F. G. (2013). *Gestão Social*: *epistemologia de um paradigma.* Curitiba, PR: CRV.

EMBRAPA: Empresa Brasileira de Pesquisa Agropecuária. (2006). *Marco referencial em agroecologia.* Brasília/DF: Embrapa Informação Tecnológica. 70 p.

FBES. Fórum Brasileiro de Economia Solidária. (2005). *Carta de princípios da economia solidária.* Retrieved at 2017, from http://fbes.org.br/2005/05/02/carta-de-principios-da-economia-solidaria/.

Flach, L. (2011, septiembre-diciembre). *A autogestão ensinando e encenando: um estudo etnográfico em uma organização cultural de Porto Alegre.* Revista de Administração da Universidade Federal de Santa Maria, vol. 4, núm. 3, pp. 378-389.

França Filho, G. C. (2008, abril/junho). *A via sustentável-solidária no Desenvolvimento Local.* O&S. 15(45). Retrieved at 2015, from http://www.scielo.br/pdf/osoc/v15n45/v15n45a17.pdf.

França Filho, G. C.; Cunha, E. V. (2009, outubro/dezembro). *Incubação de redes locais de economia solidária: lições de aprendizado a partir da experiência do projeto Eco-Luzia e da Metodologia da ITES/UFBA.* O&S, 16(51), pp. 725-747.

Fraxe, T.; Castro, A; Santiago, J. (Org.) (2015). *Agroecologia em Sociedades Amazônicas.* Manaus: Editora e Gráfica Moderna.

Gohn, M. G. (2004, maio/ago). Empoderamento e participação da comunidade em políticas sociais. *Saúde e Sociedade,* São Paulo, v. 13, n. 2, p. 20-31.

Halen, C., Vezzoli, C., Wimmer, R. (2005). *Methodology for Product Service Innovation.* Assen, The Netherlands: Partners for Innovation and Royal Van Gorcun. Retrieved at 2018, from http://books.google.it/books?hl=en&lr=&id=EtUBsq-CfmIC&oi=fnd&pg=PA3&dq=carlo+vezzoli&ots=XRA_zX_l1c&sig=rj1aUuFFo8N7FoWLuSRSxvt-tU0&redir_esc=y#v=onepage&q=carlo vezzoli&f=false

Justen, C. E.; Moretto Neto, L. (2012). *Do economicismo à dialogicidade: as contribuições do paradigma da ecologia profunda e da noção de gestão social para a temática da sustentabilidade empresarial.* Cadernos EBAPE.BR, v. 10, n. 3, p. 736-750.

Kleba M. E.; Wendhausen, A. (2009). *Empoderamento: processo de fortalecimento dos sujeitos nos espaços de participação social e democratização política.* Saúde e Sociedade, São Paulo, v. 18, n. 4, p. 733-743.

Macke, J.; Carrion, R. M., Dilly, E. K. (2010, set/out). *Programas Sociais Corporativos e Capital Social: Proposta de Qualificação* RAC - Revista de Administração Contemporânea [online], v. 14, n.5, p. 836-853.

Mance, E. A. (2009). *Redes de Colaboração Solidária.* In: Cattani, A. D. et al. (Org.). Dicionário Internacional da Outra Economia. Coimbra: Almedina.

Mello, E. M. R. et al. (2018). *Economia Solidária e Segurança Alimentar: Pesquisa e Intervenção em Hortas Comunitárias.* Paper presented at the VI Conferência Internacional de Pesquisa sobre Economia Social e Solidária (CIRIEC): "Economia Social e Solidária, Sustentabilidade e Inovação: enfrentando os velhos e os novos problemas sociais.". Manaus (AM) UFAM: Even3. Retrieved from <https//www.even3.com.br/anais/CIRIEC/59167-ECONOMIA-SOLIDARIA-E-SEGURANCA-ALIMENTAR--PESQUISA-E-INTERVENCAO-EM-HORTAS-COMUNITARIAS>. Aces in 13th of february. 2019.

Mendonça, R. M. L. O. (2014). *Systemic Network Innovation and Its Application in the Brazilian Context of the "Estrada Real"*. Politecnico di Torino. https://doi.org/DOI:10.6092/polito/porto/2534088

Oliveira, F. (2001). *Aproximações ao enigma: o que quer dizer desenvolvimento local?* São Paulo, *Pólis*. Programa Gestão Pública e Cidadania/EAESP/FGV.

Paula, J. (2008). *Desenvolvimento local: como fazer?* Brasília: SEBRAE.

Pinheiro, D. C. (2016, abril/junho). *O estado da arte da produção científica em Economia Solidária.* Administração Pública e Gestão Social, 8(2), pp. 95-103.

Ramos, M. C. P. (2013). *Solidariedade, inovação social e empreendedorismo no desenvolvimento local. The Overarching Issues of the European Space.* Porto: Faculdade Letras Universidade do Porto, pp. 313-342.

Ribeiro, S. D.; Müylder, C. F. (2014). *Economia solidária: em busca dos elementos essenciais da sustentabilidade e solidariedade.* Revista O&S, 71.

Simon, V. P. (2013, março). *Redes de movimentos sociais e economia solidária: uma interação promissora.* III Colóquio Internacional de Epistemologia e Sociologia da Ciência da Administração. Anais. Florianópolis, SC, Brasil.

Singer, P. (2001, junho/dezembro). *Economia solidária versus economia capitalista.* Soc. Estado, 16(1-2). Brasília.

Singer, P. (2009). *Relaciones entre sociedad y Estado en la economía solidaria. Iconos - Revista de Ciencias Sociales, 33.* Quito, pp. 51-65. Retrieved at 2012, from http://redalyc.uaemex.mx/src/inicio/ArtPdfRed.jsp?iCve=50903303.

Tripp, D. (2005, set./dez). *Pesquisa-ação: uma introdução metodológica.* Educação e Pesquisa, São Paulo, v. 31, n. 3, p. 443-466.

Narrative and value: Authoring our preferred values into the money we exchange

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Abstract Money has value because we agree that it does. This study frames that collective agreement as an epic narrative and through that lens, considers the dynamics by which the agreement of money's value has been and continues to be authored. Using Sohail Inayatullah's Causal Layered Analysis the project considers what that story is "about" towards an understanding of our collective values inasmuch as they are held by, or noticeably absent from, the most readily used monetary signifier in the world; debt at interest, issued by a central authority, backed by the legal jurisdiction of a nation.

Within the wider provocation of "how might we get really rich?", the study then asks, how is the story of money created in its telling? Who is authoring this story? Where and how does the "telling" of the story of money take place? This framing suggests the financial transaction as a tangible site to design for specific experiences, the attributes of which can correlate to the preferable values we'd like money to express and exchange.

Keywords: money, finance, narrative, CLA

Introduction

The study was born from an earlier study exploring the bitcoin and blockchain community in Toronto. In that research, a similar thing kept coming up. An expert who was exploring these new technologies would articulate something along the lines of "money is valuable because we agree it is valuable”, as a quickly-visited precursor to discussing their perspective on some aspect of cryptocurrency, fintech or new finance.

This study delves deeper into the idea that the value of money is sourced from a collective agreement that it is valuable using a hybrid model that combines Sohail Inayatullah’s 4-level, U-shaped Causal Layered Analysis (litany, system, worldview, myth) and a 4-level Computer Operating system model (user, application, OS, hardware). The model was used to explore what that story/collective agreement is “about” towards an understanding of the values held by, or noticeably absent from, the most readily used monetary technology in the world; debt at interest, issued by a central authority, backed by the laws of a nation.

With a sense of what our money is about by looking at how it is authored, the study then considers the arena of self-esteem as a tactical framework to actively reinterpret the current myth, at the level of the financial transaction, towards a preferable financial system orientation over time. The study brings up the question for further research, how might the specific emotional experiences that are the desired outcomes for the applied tactics and tools of raising self-esteem on a personal level, be applied to user experience design within the financial transaction to shift to a more secure financial system(s) for all?

1. Incidents in relationship

Yuval Noah Harari suggests that “the real secret of success of our species is that we alone can talk about things that don’t exist at all. Anywhere. Except in our own imagination, in the stories that we invented.” (Harari, 2014)

He goes on to say, “...the easiest example to give is of course religion, but it’s not just religion. It’s the same with our legal system, with our political system, with our economic system. Money is also just a story….it is based on a story that only exists in our imagination… if enough people believe that story, then it becomes a very effective story.” (Harari, 2014) Money, and its interplay within the arenas of banking and finance is a very effective story.

Over time and transactions, a story is created that is "about" the things that money can turn itself into. (Atwood, 2008) The myriad transactions where money turns itself into something can be thought of as the incidents that make up the story that is money.

The narrative that is money can then be described, in part, as the succession of resonant "incidents", or experiences of value, manifested within relationships. The idea of a succession is evocative of a linear time frame and in most story formats, incidents relate to each other chronologically.

The definition of story for this study assumes that the incidents that tell the story of money be in relationship, but that it not necessarily always be linear. For example, Blockchain technology has a unique way to "tell" the story of its economy by incentivizing a decentralized network of transaction-witnesses to put the semi-simultaneous incidents of value exchange (transactions) of an economic platform into a chronological order. (Gansky and Kedrosky, 2016)

1.1. Experiences of value

Each transaction using a monetary signifier yields an incident where something of objective value has been connected to an abstracted concept of value held in the imagined space of a relationship. This idea is built on three premises:

1. There is an objective reality and an imagined reality existing together. (Harari, 2016)
2. All value manifests in experience and all experience manifests within relationship (Diller, Shedroff, and Sauber, 2016)
3. Homo sapiens negotiate premises/signifiers as tools to bridge the tangible objective reality with the abstract imagined reality of their relationship to each, to themselves, to the outside world (causes, organizations) and to an inner world (belief structures, faith).

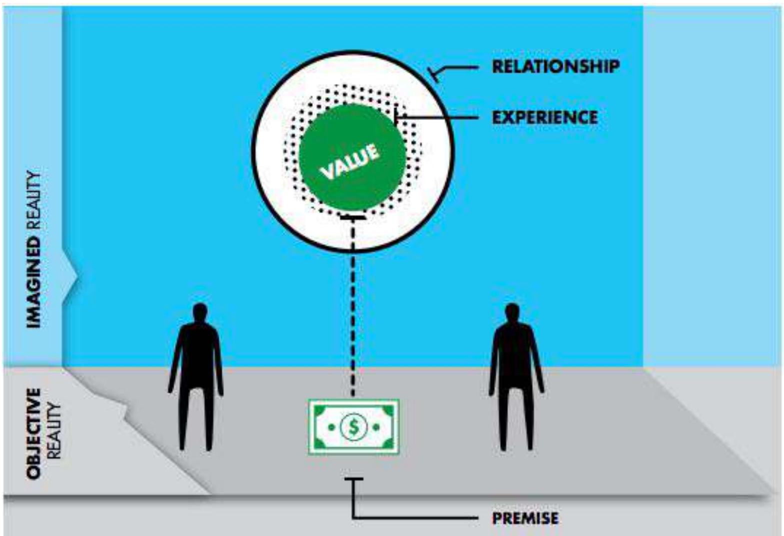

Figure 1. Objective reality signifier bridges to an abstract concept of value

Analysis

2. A hybrid CLA model

2.1. Causal Layered Analysis

Causal Layered Analysis, identifies the driving forces and worldviews underpinning diverse perspectives about the future (“Innayatullah.”, 2005). The CLA provided a framework to reveal a route from what the system was manifesting in plain view, to what was perhaps concealed in the underlying belief structures and myths.

2.2. Financial operating system

Douglas Rushkoff ’s “Throwing Rocks at the Google Bus” introduced the metaphor of the global financial system as a computer operating system (Rushkoff, 2016). This premise articulates aspects of the current financial system with a focus on the impact of a debt-based currency.

Considering the current worldview of the system as an operating system (user, application, OS, hardware) allowed the following narrative features about the current system to be leveraged from the metaphor:

1. It is running in the background, impacting everything.
2. It is written, or authored, or coded, and so can be re-written, re-authored, or re-coded.
3. Its widespread use perhaps conceals other operating systems, or even the possibility of other operating systems.

2.3. The hybrid model

A hybrid model was conceived that combines Sohail Inayatullah’s 4-level, U-shaped Causal Layered Analysis (litany, system, worldview, myth) and a 4-level Computer Operating System model (user, application, OS, hardware).

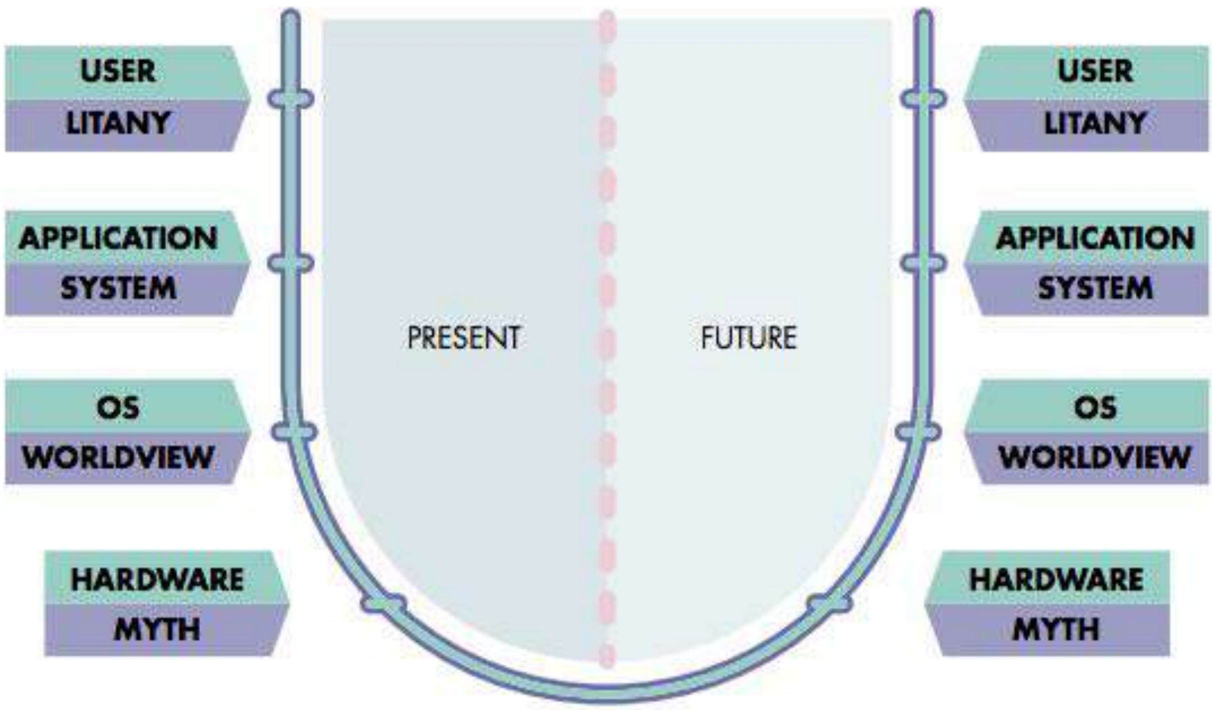

Figure 2. Hybrid CLA model

What worked was that they were both 4 levels and those levels were built on top each other making the placement of the layer important, while at the same time both models make clear that each layer is equally and uniquely important in making up the whole.

Connecting the worldview level in the CLA to the OS level in a computer operating system allowed, from the CLA perspective, a way to frame a worldview as a kind of technology or tool; worldview as software or algorithm. From the computer operating system perspective, the combination allowed for framing an OS as practiced ideology, or a set of incidents designed in relationship to each other; OS as story or narrative.

Finance as an OS describes the voracious extractive quality of a current system that does indeed seem to operate on a level seemingly outside of our collective control, embedded in our collective imaginations and as a result, concealed in plain sight as “the way of the world”. Stepping back, this view does provide a kind of explanation for the reality that 62 people in the world control 50% of the common currency. (White, 2016). The diagram that follows articulates how the hybrid model mapped the current financial system:

DESCRIPTION OF THE HYBRID LEVELS

USER
LITANY

THE USER LEVEL

Describes the real economy level where people and institutions interact with real goods and services in exchange for financial products including currencies, mortgages, and loans.

- This level associates to the **LITANY LEVEL** of the CLA

APPLICATIONS
SYSTEM

THE APPLICATIONS LEVEL

Describes the financial services within the global financial system. This level includes financial products and services, including currencies, mortgages and other loans, stocks, bonds, insurance, as well as each and any of these products as the roots of more exotic derivative products. The creation and exchange of these derivative products also occurs, in large part, at this level. This level also includes the institutions that are delivering these products and services, including banks, brokers, asset managers, markets, payment networks, insurers, and credit card companies (Kedrosky, 2015).

- This level associates to the **SYSTEM** or **SOCIAL CAUSATION LEVEL** of the CLA.

OS
WORLDVIEW

THE OPERATING SYSTEM LEVEL

Describes the interconnected network of national banks, licensed or chartered banks connected to the central bank, national governments, corporations, and high wealth individuals that control and influence the issuance of currency and the management of large sums of money through monetary policy and financial regulation. The operating system describes the constellation of entities that are in relative degrees of proximity to the authority to issue currency. It is this level that contains the real-world dynamics of the essence communicated in the now-evolved story of the goldsmith, as well as other worldviews on money and monetary systems.

- This level associates to the **WORLDVIEW LEVEL** of the CLA

> It is at this level that the meaning from Rushkoff's metaphor becomes a worldview in the CLA

HARDWARE
MYTH

THE HARDWARE LEVEL

Describes the foundational myth by which value and its pursuit is framed. It is at this level that the myth that precedes the story of money exists. The hardware level describes hard limits of the system in a similar way that the technological resources a desktop computer are hard limits to what an operating system can allocate to application for the purposes of providing functionality to the user.

- This level also associates to the **MYTH LEVEL** of the CLA.

Figure 12 — BREAKDOWN OF HYBRID CLA

3. Scarcity in the origin narrative of money

3.1. The Common Currency

The hybrid CLA model isolates and explores the monetary technology (fractional reserve central banking) by which most of the money in the world is issued into existence (Huber, 2017). This common currency is debt-based and issued into the system as a loan at interest by a central authority, backed by the legal frameworks of a nation. One outcome of this dynamic is a system always short the interest, and therefore always beholden to the mechanism by which money is created.

3.2. Valuing lack

If the monetary exchange relationship is facilitated by a premise (signifier) that holds lack as valuable, then it follows that the experiential outcomes in those transactional relationships have a propensity to be influenced by that value, although not determinedly so. The proposition is, that when you use an IOU at interest, issued by a central authority, backed by a legal framework, as the premise (the holder of value) in a transaction, you get an objective reality signifier of value that gives an abstracted concept of value in the imaginary that is married to an abstracted concept of scarcity.

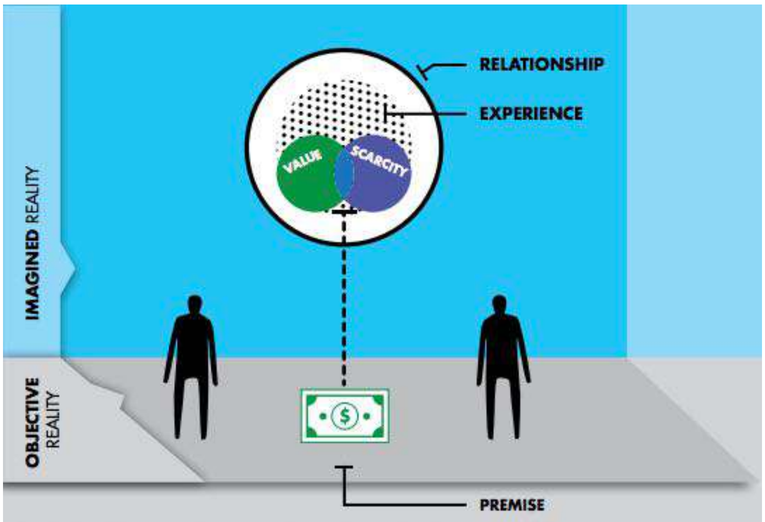

Figure 4. Value and scarcity

It follows that there is a connection to the widespread belief in scarcity as a primary fact of life in that the issuance of currency embeds scarcity as valuable at its inception. It begs the question, is scarcity such a predominant component in economic dialogue because it has been designed into the source code of the system to be valuable? Of course, there is value in identifying what is scarce, but has our monetary medium overvalued this quality?

To be clear, the idea that the myriad transactions using this (or any) kind of money is a ritual that makes more real the narrative of the current system, is not necessarily to dissuade or admonish the spending of money or the power of market forces. On the contrary, the degree to which the widespread belief in scarcity is so often held as a fact of life is a strong endorsement to the ability of market forces to spread the values held by money.

Instead, it is to look at the "wicked problem" of ongoing and expanding financial inequality and proposing a rationale to why, beyond the very real greed and malfeasance of individual actors in the system, that dynamic is entrenched as normal at the level of a caricature. The optimistic question to frame further research is what other value(s) beyond scarcity might be held by the monetary technology we use to express and exchange value?

3.3. The underlying hardware: The myth of the system

Current state myth: A finite game

James P. Carse's book, Finite and Infinite Games: A Vision of Life as Play and Possibility, brings forth the idea that there are (at least) two kinds of games. (Carse, 1986) One could be called finite, the other, infinite. A finite game is played for the purpose of winning. An infinite game is played for the purpose of continuing the play.

The study frames the current system myth as a finite game, played repeatedly with a central rule that says, to win, the player must have more money than other players having less.

Scarcity, to whatever degree it is experienced in the objective reality or believed the imagined reality, results in predicable behavioral patterns; if we believe that things are scarce, we accumulate. The demonstrable adherence to these rules gestures to the foundational myth of the system: that value is created by scarcity, and so things of value are predominantly scarce.

Future state myth: An infinite game

The foundational myth of an alternative system is might say that things of value are predominantly in abundance. The source of that abundance is not just in the fact that the word "abundant" is the opposite of the word "scarcity". Rather, the abundance is in our unique ability "to talk about things that don't exist anywhere" (Harari, 2014); to create fictional realties, worlds, in the incidents that exist in the shared imaginaries of our relationships.

There is always the possibility (although exercising it is sometimes at great cost) to define the abstract concept of value in any terms agreed to within the relationship. Or as Noam Chomsky puts it, we all have the capacity to produce new expressions, new in our experience, new in the history of the language (Chomsky, 2014), and, to build on this idea, perhaps also in the history of the currency. It is this demonstrable ability that is unique to homo sapiens that is the cornerstone of a foundational myth about abundance.

3.4. Summary

The key issue within the system today and the essence of this study; not that the finite game of pursuing profit within timeframes to win in terms of money is wrong or bad or flawed, but that when the finite game is perceived to be the only kind of game, anything outside of it is first devalued, and then dismissed and/or demolished. The power to author the story of money, the agreement of our shared values, is concealed within the perspective of a finite game.

The infinite game perspective includes conscious attention to the entire cycle by which the narrative is authored and re-authored. This wider perspective allows us to consider how we might generate wealth in terms of what we would like to more readily experience in the transaction, in contrast to how much we can accumulate within the transaction.

4. Self-esteem

In search of a way to develop tangible tactics to shift the myth of the current system, the study sought a model that articulates the finite game/infinite game dynamics on a more personal level. Self-esteem provides a human-centered framework to explore how connecting scarcity with value impacts human beings.

4.1. What is Self Esteem?

Nathanial Branden frames self-esteem by these tenets: (Branden, 2004)

1. It is an internal valuation based on the presence or absence of specific attributes, the coherence or synergy of those attributes are one's self esteem.
2. It is at a level of the "deepest vision of competence and worth"–it's a truth, (perhaps concealed to the very person making the valuation), beneath any self-delusion.
3. It is a human need, on the level of oxygen, and humans make the evaluation one way or another.

4. If self-esteem is attempted to be fulfilled through false sources it creates an addictive cycle where actual self-esteem deteriorates and addiction dynamics intensify. The study looks at outside validation as a false source of self-esteem.

4.2. Outside validation

In instances where the internal valuation is low and/or it's outcome avoided, the evaluation will still be made using false sources (McKay and Fanning, 2016). One false source is outside validation. While outside validation is framed as very important and good and expansive (for example in the form of a salary or award), when used in the valuation of self-esteem, it serves as a false source. Outside validation used as self-esteem, brings a short term "hit" but is not sustainable and erodes true self-esteem.

4.3. Self-esteem described in system archetypes

Escalation

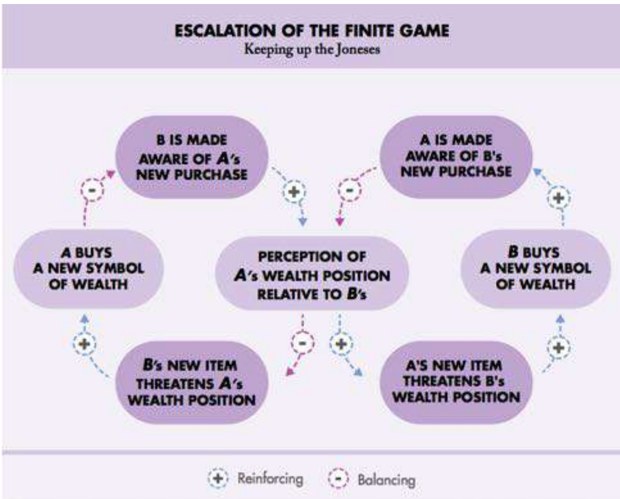

Figure 5.

The escalation archetype describes the dynamic that entrenches the finite game and conceals an infinite game perspective. To the degree that participant B has a healthy self-esteem, (or is not using money as a part of the evaluation that is self-esteem), is the degree to which the threat posed by a differential in relative wealth position, although still potentially threatening, is not an existential threat.

Hooked on Heroics

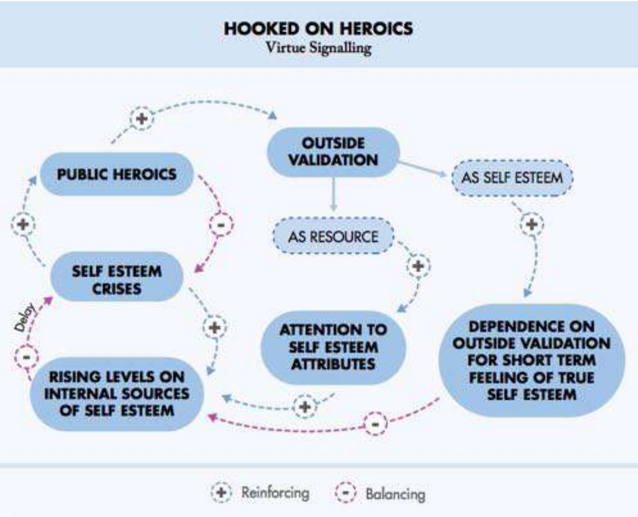

Figure 6.

The hooked on heroics system archetype describes how public heroics generate outside validation in the form of awards, monetary compensation, celebrity etc. When outside validation is available, there is a choice in the intention of how to receive or use it. If used within the evaluation of self-esteem, it ultimately lowers self-esteem, increasing the frequency and intensity of self-esteem crises and driving behaviour towards more public heroics. Used as a resource (for example, an award can lead to collaboration with new partners, more money can lead to more time and space for internal reflection, etc.) more attention can be paid to the attributes of real self-esteem, lowering the intensity and frequency of self-esteem crises.

5. Conclusion

Moving from a myth of scarcity one of abundance, the study suggests the tactics and tools of building self-esteem on a personal level be applied to the experience design of (increasingly digital) monetary transactions. How might we design transactions that increase the determination to be powerful, the ability to think and feel, the willingness and desire to understand, and principle-based versus opportunistic-based motivations?

5.1. Consciousness as wealth

It was made clear in the analysis that the naming of a foundational myth of abundance is not simply because the word “abundance” is the opposite of the word “scarcity”. It is the output that those two words are opposites in their meaning, but the source of the abundance is in the conscious awareness of our unique human ability to create an imagined world in the shared experiences of our relationships.

This ability to create is a demonstrable fact and not a new-age postulation. It is evidenced in imagined realities like Canada, Google, and Human Rights. If we were to cut open a human body, there are no human rights inside, (Harari, 2016) and yet we have deep and meaningful relationships with that imagined reality and those like it; they impact and drive our motivations and behaviours. This study argues that the same is true for money. The value of money is not only an objective reality fact, it is a narrative that has been authored to varying degrees of consciousness at the site of the transaction. The study has revealed that over time, there have been design choices that have manifested a transaction site that conceals the impact of the experience on the story of money, on our collective agreement of what we value.

The study proposes that our collective intervention point is at the site of the monetary transaction, designing experiences that improve the specific attributes that comprise personal self-esteem. Each of us can contribute to the construction of the imagined reality that is money in our conscious consideration of what we turn it into, how we do it, and who we do it with. We can collectively write the story of money, (and incentivize the support of each other in that authorship) to hold the values that we prefer by taking the authentic and uncomfortable risk to understand what we each hold as valuable, and then to share with each other what our true values are. Said another way, we can play infinitely in the context of money towards an outcome of keeping the game going. The process of becoming more conscious of our values, of what we hold as valuable, that process itself would seem to be the value of the future. What else is money but a protocol for the expression and exchange of value?

It is important to note that the current system engaging in this subject matter might generate the terrifying question of how will we monetize consciousness? The unease that comes with this question from the left-hand side of the “U” speaks to the stakes of dealing with foundational myths; it is precarious in the transition. From an infinite perspective, the study hopes to gesture to another the other way, changing where the momentum is; from a hierarchical mandate of what value is to a decentralized discovery of the values we want money to hold. We might build a new version of our collective wealth by bringing our conscious values to the holder, or holders, of value, and circulating them.

References

Atwood, M. (2008). Payback: Debt and the Shadow Side of Wealth (CBC Massey Lectures). House of Anansi Press.

Branden, N. (1991). Our Urgent Need for Self-Esteem. Retrieved September 02, 2017, from http://www.nathanielbranden.com/our-urgent-need-for-self-esteem

Branden, N. (2004). The Six Pillars of Self-Esteem. New York: Bantam.

Branden, N. (2013). Self-Esteem in the Information Age. Retrieved September 02, 2017, from http://www.nathanielbranden.com/self-esteem-in-the-information-age

Chomsky, Noam. (2014, February 17). Language Design - Noam Chomsky. Retrieved September 01, 2017, from https://www.youtube.com/watch?v=MLk47AMBdTA

Diller, S., Shedroff, N., & Sauber, S. (2016). Blind Spot: Illuminating the Hidden Value of Business. Brooklyn, NY: Two Waves Books.

Eisenstein, C. (2011). Sacred Economics: Money, Gift, & Society in the Age of Transition. Berkeley, CA: Evolver Editions.

Gansky, L., & Kedrosky, P. (2016, March 9). The Future of Jobs, Money, and the New Continuum. Retrieved May 26, 2016, from https://soundcloud.com/instigatingco/the-future-of-jobs-money-and

Harari, Y. N. (2014, September 30). Yuval Noah Harari on Imagined Realities. Retrieved September 01, 2017, from https://www.youtube.com/watch?v=zen-m0rMp4I

Harari, Y. N. (2017). Homo Deus: A Brief History of Tomorrow. S.l.: Vintage Publishing

Huber, J. (2017). Split-Circuit Reserve Banking. Retrieved September 01, 2017, from https://www.sovereignmoney.eu/split-circuit-reserve-banking/

Inayatullah, S. (2005). Causal Layered Analysis: Poststructuralism as Method. Retrieved September 01, 2017, from http://www.metafuture.org/Articles/CausalLayeredAnalysis.htm

Rushkoff, D. (2016, February 18). Twitter Is Not a Failure. Retrieved September 01, 2017, from https://www.theatlantic.com/business/archive/2016/02/twitter-failure/463248/

Rushkoff, D. (2016). Throwing rocks at the Google bus: How growth became the enemy of prosperity. Londen: Portfolio Penguin.

Waddington, D. I. (2005). A Field Guide to Heidegger: Understanding 'The Question Concerning Technology'. Educational Philosophy and Theory, 37(4), 567-583. doi:10.1111/j.1469-5812.2005.00141.x

White, G. B. (2016, January 19). Where Is All the World's Money Going? Retrieved September 01, 2017, from https://www.theatlantic.com/ business/archive/2016/01/widening-wealth-gap/424695/

5 | SOCIAL CARE AND HEALTH SYSTEMS FOR SUSTAINABLE LIVING

Relating Systems Thinking and Design Symposium 2018
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WORKING PAPER

Systemic and participatory design processes in care systems

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Abstract The paper discusses the topic of participatory design processes with systemic approach as a tool to negotiate, shape and prototype new inclusive models of citizenship and care to benefit marginal groups in society.

The topic will be addressed via three case studies from the field experience of our action research through Design and Anthropology toward social inclusion. Our research approach entails both methodological analysis and transformative actions that have tangible effects on social care systems: marginalized people, caregivers, services' management organizations.

The projects described move from the stakeholders' desire of tangible transformations in order to improve the quality of their social services: development of new products, redesign of spaces and housing processes, the innovation of the service. In order to support and facilitate this "desire of change", it seems to be preferable to operate according to a *systemic design* approach and to develop projects based on a wide participation and on a multi-stakeholders collaboration in the decision making processes.

Keywords: co-creation, social inclusion, care, co-design, vulnerability

1. Introduction

The paper discusses the topic of participatory design processes with systemic approach as a tool to negotiate, shape and prototype new inclusive models of citizenship and care to benefit marginal groups in society.

The topic will be addressed via three case studies from the field experience of our action research through Design and Anthropology approach toward social inclusion (World Bank, 2013). In the context of the action research, the two disciplines shaped a collaborative and vibrant research environment challenging the issues of participation in design processes. Since 2009, the research operates in several Italian cities, entailing both methodological analysis and transformative actions that have tangible effects on social care systems: marginalized people, caregivers, services' management organizations.

Italian welfare policies, norms and regulations define the general framework of social care system. These are acquired by regions and subsequently applied by municipalities. In this paper, when we refer to social care systems we talk about local systems that are shaped in a specific territory. Each local social care system is composed by several single services managed by diverse private social institutions from the third sector working in synergy with the municipalities. According to our field experiences, if it's true that social care system is an emergent entity in each territory, this doesn't necessarily implies that it can be considered as a robust and coordinated network of services with interrelated functions that aims to produce clearly established and common outcomes. In the reality, each service is characterized by his own specificity, in terms of the different needs to which each of them has to respond, in terms of management and operative practices adopted to respond to their mandates, in terms of the multiple individualities that work within each service and, nonetheless, in terms of the places and spaces in which the services are provided. So a single service can be intended as a subsystem encompassed by the main, at least less defined, one.

Our research involves three typologies of beneficiaries of social care systems: people with disabilities, migrants and homeless people.
They are usually intended as "fragile" people since they manifest urgent and highly impacting needs that require specific answers, usually provided by different system's services. But beneficiaries' needs are multi level (Brandolini, Saraceno, Schizzerotto, 2009) - housing, health, income, work, social relationships, autonomy - and interconnected. This means that the single service implicitly fulfils, in a certain way, not only to a single need but to a system of interrelated needs. In the same way, we can say that the service involves the beneficiary but also his/her social network (family members, friends) and, often, the caregivers. All these interconnected aspects give us the idea of the complexity of social care systems and why they are not easy to define and circumscribe. More than ever, they are not crystallized entities but ever-changing systems that are constantly in transformation and that needs to be transformed to better answer to social change.

All the projects we are going to describe move from the stakeholders' desire of tangible transformations in order to improve the quality of the single service. The expected changes arise from diverse level of design interventions aiming at the development of new products, the redesign of spaces and housing processes, the innovation of the service. Our thesis is that, in order to support and facilitate this "desire of change", it seems to be preferable to operate according to a systemic design approach (Jones, 2014) and to develop projects based on a wide participation and on a multi-stakeholders collaboration, in order to include most of the users in decision making processes.

2. Method and tools

Since 2009, we have been developing a specific interdisciplinary method, influenced both by design and anthropology, and a set of practical tools to operate into complex social systems.

The fundamental strategies that define our method are:

1. To observe and analyse the contest (e.g. the service) in order to define it as a system and to understand it in its complexity. We focus on the social relationships that occur among people and the stakeholders, and we analyse how they shape the system through the usage of spaces and objects. To do so, we use focus-group, in-depth interview, video-tour and participatory observation when the project has been undertaken.

2. To carry out co-design processes: all the actors are involved as expert users. We build shared decision making processes in order to better respond to an explicit request or designing together a shared vision of change. We co-design also tools and procedures to achieve the change.

3. To encourage co-production of the intervention with every stakeholders. They are invited to make available resources in order to produce and manage the interventions.

4. To lead co-creation processes of the most tangible and practical stage of the project set out during the co-design process. We invite the actors to take part to the process sharing knowledge, skills, and competences.

The results of the co-design processes are intended as ongoing solution, powered by the participation of the stakeholders and open for collaborative improvements and negotiation in order to better meet the needs and desires of the users.
Every practical design interventions can be conceived, at the same time, as an output and as a prototype. They are output, because they represent the final stage of a creative process that finds its formal expression in real objects. They are prototypes, because the final results are rarely pre-determined by a top-down approach and they can be constantly re-discussed and improved by the stakeholders with new creative processes in an iterative way.

The participatory workshop is the practical tool we adopt to materially build the prototypes of the products/services, shaping the desired change. Our workshops consist of on-site interventions through creative and collaborative processes, working from within the context. The workshop is an opportunity to stimulate synergies among the actors in an informal and dialogic environment. During the workshop new connections between all the actors are found out, tried out and tightened. The workshop is a dialogic environment (Sennet, 2012) where solutions can be tested, discussed and implemented with all participants.

We take great care in designing also the practical work. We promote the use of techniques and tools that anybody can handle in order to give the opportunity to participate to as many people as possible. In this way, the workshop offers also the opportunity to invite in the "outside" to take part to the processes: university students, volunteers, citizens. This allow us to try and connect the social care system services, so often marginalized, with the society.

3. Case studies

3.1 Design for Each one. Co-design of personalized devices for people suffering from multiple sclerosis and muscular dystrophy

How to open thickened water packaging can independently, how to protect the electronic component of a wheelchair during rainy days, how to play table football from a wheelchair or how to hold cards for playing: those are some of the everyday life problems of sufferers from multiple sclerosis and muscular dystrophy that are investigated and targeted during the project by a group of designers and caregivers.

The co-design process of ‘Design for each one’ involves users, care givers, design students and researchers; it promotes collaboration between an university (Politecnico di Torino), a national social association (AISM, Associazione Italiana Sclerosi Multipla) and the social cooperative managing the care service (Animazione Valdocco).

Via participant observation, the group investigates on those gestures that users cannot do in order to prototype small tools to facilitate those gestures. Within a one-week workshop, the prototype is developed by a continuous collaborative process with the user. Than, with the same method, the prototype is implemented and tested (through everyday use) for a long time (6-12 months) until it is ready to be released as a working product.

REMARKS:

In most cases, the traditional care market doesn’t offer appropriate aids because of the specificity of the disease. In fact, the needs of the person affected by multiple sclerosis are extremely individual (every sufferer present a specific progression of the symptoms of the disease) and they can change extremely quickly. However, even if they are not “commercially appealing” for the mass production market, those personal unanswered needs compromise the quality of life of the suffer.

With this premises, the workshop offers the opportunity to give voice to the suffers needs with a collaborative process working both around and with the individual. The workshop has been acknowledged by the Associazione Italiana Sclerosi Multipla, in fact it took root in the yearly calendar of the organization as an extraordinary framework to deepen the needs of their users.

The next challenge is to monitor how the aids could impact also on the care networks that rotates around the individuals (families, organizations). Whereas, on a wider perspective, the challenge is to understand how many sufferers could benefit from a customized production of the aids and how to reach them. So a scaling process of the project can be discussed in terms of transferability of the products to other AISM beneficiaries.

Figure 1. Antonino: a co-designed tool to open thickened water packaging can.

3.2 Progetto Bellezza. Participatory renovation of shelters for migrants and homeless people in Milan

'Progetto Bellezza' consists in a participatory renovation of shelters for migrants and homeless people in Milan. It aims to stimulate a discussion on buildings, on their improvement, and their new design, according to the psycho-emotional and social needs of migrants and homeless people through an inclusive method (Campagnaro et alii, 2018).
The project relies on the collaboration of the homeless people and migrants living in the shelters and workers belonging the organization managing the reception service (Fondazione Progetto Arca Onlus) in the role of expert users, designers from Politecnico di Torino, young volunteers as high school students and citizens in general.
The design action places emphasis on ideal of "co-created beauty" as trigger to reshape reception services and spaces that are often hosted in buildings constructed for specific purposes (schools, offices, factories) which, once their original function ceases, are temporarily transformed into housing.

The co-design process is stimulated by preliminary focus groups with hosts and workers, in order to understand the critical issues and to define together solutions that all the actors can agree on. Than, the group of participants is engaged in the tangible transformations initiatives: furniture building, wall painting, wayfinding set up. The project generates a sort of temporary “creative revolution” in the shelter: everybody is welcomed to participate and help with the design interventions. The vibrant environment of the workshop challenges the reception service’s routines and fixed roles and create a positive impact, also because it involves operators and users in the actions, giving value to people’s skills and aspirations (Campagnaro, 2018).
The effects of this process are diverse in relation to each category of participant: for migrants people, participation acts as a trigger for a sense of protagonism and gratification, while, for the organization’s workers, the project offers the chance to rethink to the way the service is provided and to imagine how the spaces could contribute to improve it.

REMARKS:

In the case of ‘Progetto Bellezza’ we recorded an improvement of the perception of the shelters by the actors. Although the participatory approach for the amelioration and maintenance of the spaces has been appreciated by the organization it has not been undertaken completely. In fact, even if there is an ideal agreement on the values promoted by co-design approach, these are not transferred to the praxes level, where the decisions about the quality of the spaces (decoration, refurbishment, usage of spaces) are still taken by a Foundation’s technician on his own.
As researchers, we assume that at this stage our participation is still indispensable. We act as creative directors and workshop animators, fostering an experimentation of a new design process of the spaces, based on care and relationship, that the organization is unable to perform yet. So, the next challenge of ‘Progetto Bellezza’ is to create the conditions that will enable a release of the model. The project needs to consolidate the adoption of the participative model as a strategy to improve the quality of the spaces and, consequently, of the reception service itself, even without the presence of the designers on field.

Figure 2. A shelter's dining room co-designed and co-produced during Progetto Bellezza interventions.

3.3 Costruire Bellezza. Design Anthropology led lab based in Turin aiming at social inclusion

'Costruire Bellezza' was born in the context of a ten-year action research conducted in collaboration within the homeless reception services of the municipality of Turin. 'Costruire Bellezza' is a participatory lab that include homeless people, care givers, social workers, students and researchers in design and social sciences and creative talents, via creative experiences.

The process is rooted in the collaboration between the Municipality services for homeless people, the social cooperative managing these services and our universities (Politecnico di Torino and Università di Torino). The lab functioning is based on regularly held workshops leading to the production of co-design and co-created artifacts for the participants of the project and for the neighborhood communities.

REMARKS:

The main outcome of the project can be traced on what the collaboration of the participants generates in terms of empowerment of the homeless people (Sen, 1992) putting in value their capabilities, development of new skills in the students (Margolin and Margolin, 2002). It also offers an innovative and more informal occasion of contact and dialogue, during which the relationships between social operators, educators and homeless people are tightened.

One of the core values of 'Costruire Bellezza' is reciprocity. The exchange happens simultaneously on two levels: at the level of the creative workshops, where the participants share competences, skills and mutual help in order to co-design the products, and at a systemic level, where the relationship between the creative potential offered by the group "inside" of the project meets the opportunities coming from the "outside", offering a participative learning environment based on doing together.

The next challenge in 'Costruire Bellezza' is to sustain design practices that promote learning, experimentation, connection with external realities, toward a continuous regeneration of the project itself. This goal can be achieved only by working on the values shared among the actors. These values can be generated and enhanced throughout design activities that are able to bring together innovation, personal creativity, sharing, flourishing, personal development and optimism, in a systemic perspective.

Figure 3. Designing together in the carpentry lab of Costruire Bellezza.

4. Facing complexity with awareness

The specificity of the case studies presented can be traced in the extensive use of the co-design method in order to develop all the (tangible-intangible) artifacts together with the users. This happens either the output is a tool, a space or a new social service.

The theory of the “design domains” (Jones, Van Patter, 2009) can be useful to notice the different degree of complexity between the projects. As we mentioned, despite this distinction, they all act via specific and defined interventions (products or spaces) that, for us researchers, work as a “can opener” (Collier and Collier, 1986) allowing us to look deep inside the complexity of the system.

In ‘Design for each one’ the focus is on the efficacy of the products (domain 1.0). The evaluation of the impact is certainly connected to the question of how good the products are in meeting the personal needs of the user. But we can also trace and highlight positive consequences in terms of empowering the organization and the educational work.

In ‘Progetto Bellezza’ the participatory renovation of the shelter suggests the opportunity to undertake a design process at a more complex scale, working on a service dimension (domain 2.0). According to our perspective, to assume the co-design model as “a new way to do things” can led to the improvement of the reception service itself in terms of both quality and functionality of spaces. This could benefit all the stakeholders, connecting them systematically as agents of change. The co-design practice, in fact, suggests the enhancement of not only physical changes but also of the strategy that lies behind the service (Campagnaro, Di Prima, 2018). In the case of ‘Progetto Bellezza’, all the interventions in the different shelters helped us researchers to better define the whole system, to map and connect the elements in order to understand its complexity. At the same time we notice that the awareness of all the actors of the system is crucial in order to co-create a (new) demand regarding the innovation of the whole care system itself, whenever this is desirable and/or possible.

Lastly, it is possible to read ‘Costruire Bellezza’ as an example of a project operating on the high level of complexity of the scale of the design domains (3.0). Started as an experiment (Binder, Redström, 2006) in 2014, it is now recognized by the public administration as part of public service for homeless people. Nevertheless, as an initiative of social cohesion, Costruire Bellezza provides an example of how co-designed services can suggest new policy models.

5. Final Remarks

Producing co-design interventions is a kind of activity that entails a multitude of processes such as learning, sharing, creating and experimenting (Manzini, 2015; Verganti, 2009; Cross, 1981); it can generate shared values between designers and individuals from non-creative occupations or fields.

Furthermore, this can affect an individual's motivation to collaborate and the motivation of a group to pursue common interest/benefits through which the knowledge sharing is enhanced.

In order to innovate a social care system, it is necessary to involve the stakeholders in a collaborative definition of the relationships that occurs within the system. Since this process can be difficult for the group because it implies the comprehension of a high level of complexity, to start working together on specific products can be very strategic. This entry level of co-design focused on tangible outputs is effective in developing, first, a common understanding of the problems and, secondly, sets of shared solutions. Whenever the complexity is not understood via a collaborative process, the actors of the system won't be able to develop awareness about the chances of strategic innovation offered by its relationships. In fact, the researchers intuitions about future possible developments can be seized as an opportunity only if the system recognises it as such.

According to our experience, the systemic vision combined with a participative Design Anthropology approach enhances the relationships among all the stakeholders. Moreover, new visions of the services can be developed, promoting to move away from the standardized roles usually defining relationships in the care system (operators/workers that assist/help people in needs), toward the idea of a care system as an organic entity in which every actor can be a "beneficiary" of other's resources. In order to facilitate and foster an horizontal environment of mutual exchange and collaboration, it is compulsory that the researches stay within the processes in its making. Doing so, they understand attitudes, behaviors, unspoken needs and outcomes and they can reorient the process on the basis of what the field and the people respond. Places of care can become places of strategic innovation if the project's system is open, flexible and sensitive to context and individuals. This fosters the cohesion and the inclusiveness of the care systems and it generates the opportunity for all those involved to flourish.

References

Binder, T., Redström, J. (2006). Exemplary Design Research, paper presented at the *DRS Wonderground conference*, 1-4. November, 2006.

Brandolini, A., Saraceno, C., Schizzerotto, A. (eds), (2009). *Dimensioni della disuguaglianza in Italia: povertà, salute e abitazione*. Bologna: Il Mulino.

Campagnaro, C. (2018). Projets interdisciplinaires et participatifs pour/avec les sans-abri, in Duhem, L., Rabin, K., *Design Écosocial: convivialités, pratiques situées et nouveaux communs*, pp. 35-52. Facougney-et-La-Mer: it éditions.

Campagnaro, C., Ceraolo, S., (2017). Fighting food waste towards a new social food chain: The Egg of Columbus workshop. In: International Journal Of Food Design, vol. 2 n. 1, pp. 103-116. - ISSN 2056-6522.

Campagnaro, C., Ceraolo, S., Di Prima, N., Porcellana, V., (2018). *Shelter as a place of wellbeing and dignity*. Retrieved from https://www.feantsa.org/download/spring-2018-feantsa-homeless-in-europe-magazine3972490471031025956.pdf

Campagnaro, C., Di Prima, N. (2018). Empowering actions. The participatory renovation of a shelter, in *Interventions/Adaptive reuse*, vol. 9, pp.68-75, ISSN:2154-8498.

Collier, J., Collie, M., (1986). *Visual Anthropology: Photography as a Re- search Method*. Albuquerque: University of New Mexico Press, ISBN 978-0826308993

Cross, N. (1982). 'Designerly ways of knowing', *Design Studies*, Vol.3 No.4, pp. 221–227.

Jones P.H. (2014). Systemic Design Principles for Complex Social Systems, in Metcalf G. (eds) *Social Systems and Design*. Translational Systems Sciences, vol 1. Tokyo: Springer.

Jones, P.H., Van Patter, G.K. (2009). 'Design 1.0, 2.0, 3.0, 4.0: The rise of visual sensemaking', NextD Journal, Special Issue, March 2009, New York: NextDesign Leadership Institute.

Lewin, K. (1951). *Field Theory and Social Science; Selected Papers On Group Dynamics*. New York: Harper & Row.

Manzini, E. (2015). *Design, When EveryBody Designs: An Introduction to Design for Social Innovation*. Cambridge, London: The MIT Press.

Margolin, V., Margolin, S. (2002). A "Social Model" of Design: Issues of Practice and Research', in *Design Issues*, Vol. 18, No. 4, pp. 22-30.

Sen, A. (1992). *Inequality Reexamined*. Oxford: Oxford University Press.

Sennet, R. (2012). *Together: The Rituals, Pleasures, and Politics of Cooperation*. New Haven-London: Yale University Press.

Verganti, R. (2009). *Design-Driven Innovation. Changing the Rules of Competition by Radically Innovating what Things Mean*. Harvard: Harvard Business Press.

World Bank (2013). *Inclusion Matters: The Foundation for Shared Prosperity*. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0

Holistic outcome-based visualisations for defining the purpose of healthcare system.

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Abstract: Various stakeholders in the complex healthcare systems often prioritise and pursue different purposes, values and outcomes. Understanding/sharing/negotiating the trade-offs between them is a critical action in the development and design of complex healthcare systems. Some approaches like work domain analysis or soft systems methodology attempted to map the complex interactions, but it remains unclear how those maps and visualisations are in line with how people conceptualise in practice. This study aims to explore how designers visualise complex system interactions using healthcare outcomes to define the purpose. A workshop was conducted with 23 designers to generate outcome-based visualisations. The results indicate that designers conceptualise the purpose of the healthcare systems in different ways. Complexity was expressed through organic circles and messy arrows. However, support elements are needed to conduct open visualisations. These results may play a role in developing a visualisation-based method to address the complexity of purpose definition in healthcare.

Keywords: Systems Thinking, System Visualisation, Healthcare Outcomes, Boundary Object, Design Method.

1. Introduction

Systems thinking is fast becoming an essential paradigm to deal with the increasing complexity of healthcare design and development (Carayon et al., 2014; Carey et al., 2015; P. Jones, 2013; Peters, 2014; Waterson & Catchpole, 2016; Wilkinson, Goff, Rusoja, Hanson, & Swanson, 2018). Systems thinking is the ability to understand world phenomena as an interrelated whole complex and adaptive system (Adam & de Savigny, 2012; Flood, 2010; Peters, 2014). Systems thinking aims to assist in the holistic understanding of the system across the different stakeholders involved. But the different stakeholders constantly face disagreements and clash of values even in critical decisions such as defining the purpose of the system.

The purpose of the system is a changeable higher order principle that enables and guides the design of systems (Jones, 2014). Although the healthcare system purpose could be perceived as a persistent agreement, there could be discrepancies about how to achieve it (Barbero & Pallaro, 2017). These discrepancies are influenced by value conflicts, lack of common vision and priority of goals and outcomes (Haynes, 2018), so they should be consensually negotiated by the different stakeholders from the early stages of design (Jones & Bowes, 2017). Hence, it is critical to explore how to consensually define the purpose of the system in healthcare between multidisciplinary teams of stakeholders at the earliest stage of the design process.

Several systems thinking approaches rely on the use of visualisations to build consensus. Visualisations are graphical representations aiming to holistically communicate the relationship between the elements of the system. Historically, visualisations have helped to address the discussion of complex topics (Comi, Bischof, & J. Eppler, 2014; Crilly, Blackwell, & Clarkson, 2006) and to facilitate sensemaking from multidisciplinary perspectives complex systems (Holden et al., 2013; P. Jones & Bowes, 2016; Read, Salmon, Lenné, & Stanton, 2015). Despite those benefits, there are few methods that address the purpose definition supported by visualisations.

Among the system thinking approaches that aim to define the system purpose supported by visualisations are *Cognitive Work Analysis* (CWA) and *rich pictures*. CWA presents five different domains to map the system from purpose to values, functions, physical processes and objects (Rasmussen, 1985; Read et al., 2015; Salmon, Jenkins, Stanton, & Walker, 2010). The purpose domain is the highest level that defines the reason for the existence of the system, and it maintains a straightforward relationship with the values. CWA offers a structure of the expected visual output that comprises the five-domain definition prior to start further actions. However, it remains ambiguous how each of the domains should be addressed or whether how each of them could inform further design stages. In a related example, *rich pictures* is a soft system method that illustrates complex situations by connecting hand-drawn sketches (Bell & Morse, 2013). During the drawing process, not only traditional system components are incorporated, but also subjective and *hidden* elements such as prejudices, points of view and values are aroused. Rich pictures evoke a broad range of inner system issues, consequently, the visual result could be overwhelming to analyse and to apply as an input to further stages.

These systems approaches have offered insights into the importance of defining the purpose of the system while a system is going to be designed, but less attention has been paid into the practical aspects of facilitating the visualisation method. For example, to conduct a visualisation-based method often required a trained facilitator able to apply the tools or guide the process. It remains unclear how greater support can be provided to the facilitators that conduct visualisations as a mean to negotiated and define the purpose of the system. Traditionally, designers have occupied the role of facilitators and they could provide meaningful initial feedback on how they could be supported while conducting a visualisation method.

Therefore, the purpose of this study is to explore how designers visualise complex system interactions using healthcare outcomes to support the definition of a system purpose. This will provide an initial overview of the dynamics of a visual-based method towards the definition of better support elements to define the purpose of the healthcare system. To achieve this aim, the study conducted a visualisation-based workshop that employs a novel visualisation support tool.

2. Methodology

A three-hour workshop was conducted with a group of designers and design researches. The aim of the workshop was to explore how they visually conceptualise complex interactions between purposes, values and outcomes of a healthcare delivery system for diabetic patients. The structure of the workshop was adapted from general recommendations of Jones and Bowes (2016) Sevaldson (2015) and Skjelten (2014).

2.1. Participants and samplings

This workshop was arranged at an international Design conference (DRS2018). The attendees of this conference have the opportunity to participate in this workshop. The abstract of the workshop was posted in advance on the conference website allowing attendees to have an overview of the expected activities, major expected outcomes and gaining interested from those participants with previous experience in healthcare design.

The participant recruitment was achieve using a non-probabilistic sample of convenience with a space limit of twenty-five participants. Twenty-three design practitioners/researchers with experience in healthcare design participated in the final workshop. Smaller groups were formed through the first activity in the workshop by assigning participants randomly. The description of the participants is presented in Table 1.

Table 1. Descriptive information of the participants

Group	Number of participants	Professional Background	Experience in Healthcare
1	5	Academic, industrial design	Medical device design, assistive product, service design
2	5	Product design, Design research, industrial design	Relative living with, service design, design research, medical device manager
3	4	Academic, industrial designer	Service design
4	5	Product designer	Service design
5	4	Designer	User experience

2.2. Materials

Prior to the workshop, the research team prepared outcome cards (Figure 1) to facilitate group discussion and visual conceptualisation. The cards consist of two-sided 105x148 mm rectangles presenting a wide range of diabetes outcomes. On the front, the name of the outcome was written, while in the back part it showed a basic description of the outcome, tools to collect or monitor the outcome, the frequency of the collections and space for feedback.

Figure 1. Example of outcome cards used in the workshop (front and back)

Each team received thirty-three outcomes divided into five categories. The outcomes were selected based on a comprehensive literature review of the most relevant outcomes in diabetes care including patient-related, staff-related, organisation-related outcomes as well as clinical. Examples of provided outcomes are biometrics, health-related behaviours, safety, quality of care, subjective wellbeing and happiness. The outcomes included in the workshop are summarised in Table 2.

Another material was provided such as blank papers for individual visualisations, A0 blank paper for group visualisations, 5 cm round outcome stickers that contain the outcome name to facilitate their outcome mapping on the blank paper, markers and post-it notes.

Table 2. Outcomes included in the workshop of the preliminary study

Group	Outcomes included
Quality and Cost	Trust in physician, patient satisfaction, safety culture, adherence to clinical guidelines. Cost, hospitalisation
Comorbidities	Chronic kidney disease, functional status, depression, symptoms of complication, long-term complication, cognitive functioning, survival
Clinical	Hypoglycaemia, Diabetic ketoacidosis, HbA1c, blood pressure, cholesterol, risk factors,
Behavioural	Health literacy, self-care, adherence to treatment, physical activity, physical functioning, healthy lifestyle
Psychosocial	Health-related quality of life, happiness, social functioning, the economic burden of treatment, subjective wellbeing, perceived health status, diabetes distress, fear of hypoglycaemia,

2.3. Procedure

Pilot session

A pilot session was conducted to test the major activities of the workshop. This pilot session was held on month in advance on a different venue. Ten design researchers who were in their PhD programme were recruited.

One activity which asked the participants to analyse the existing outcome-based visualisations was dropped since it was found too time-consuming and overwhelming for the participants. In addition, an individual visualisation step was added. Participants mentioned that individual time was needed to familiarise with outcomes. The rest of the activities tested in the pilot session were considered appropriate and included in the workshop.

Final workshop

A design brief for visual outcome mapping and the aforementioned supporting materials were provided, but, no pre-defined template or rigid structure was imposed. This open mapping approach is similar to GIGA-Maps (Sevaldson, 2015; Skjelten, 2014), but outcome cards were additionally provided to facilitate the mapping process.

Participants were asked to carry out three main tasks. First, they were asked to generate an *individual* visualisation based on their first understanding of the outcome relationships. Second, they were asked to synthesise each perspective and to create one visualisation for each group. The group visualisations were basic models that represent the collaborative knowledge and agreements of the relationship of the outcomes. Finally, during the third activity participants were asked to produced oral narratives on their visualisations. They also provided feedback on the workshop activities.

2.4. Data Collection and Analysis

The visualisations were analysed based on the identification of the type of structures, frequencies of outcomes and other elements. The type of structure was identified by choosing the dominant structure that stands out the most from the visualisation. If more than one structure dominated the visualisation, both were identified and reported in the results. Afterwards, the visualisations were compared with each other to identify similar graphic patterns. Frequencies were also counted manually in each of the visualisations and the top five were reported.

In the case of narratives, the audios were transcribed and coded using an open thematic analysis following an inductive and critical realist perspective (Braun & Clarke, 2006). This perspective aims to report the experiences of participants but retaining the focus on the limits of reality. The thematic analysis allowed the extraction of the major themes mentioned by the groups. These themes are about how the participants used outcomes to define a purpose and how they used the materials provided. Coding was conducted using nVivo software.

3. Results

Overall, the data consisted of twenty-three individual visualisations and five group visualisations accompanied by their narratives. The results are presented in the following three sections: i) the analysis of the individual visualisations; ii) the group visualisations and iii) the thematic analysis of the narratives.

3.1. Individual visualisations

Each of the individual visualisations was analysed to find structure patterns, the frequency of outcomes and new elements added by the participants. Figure 2 shows an example of a mixed visualisation that illustrated a timeline and a location structure.

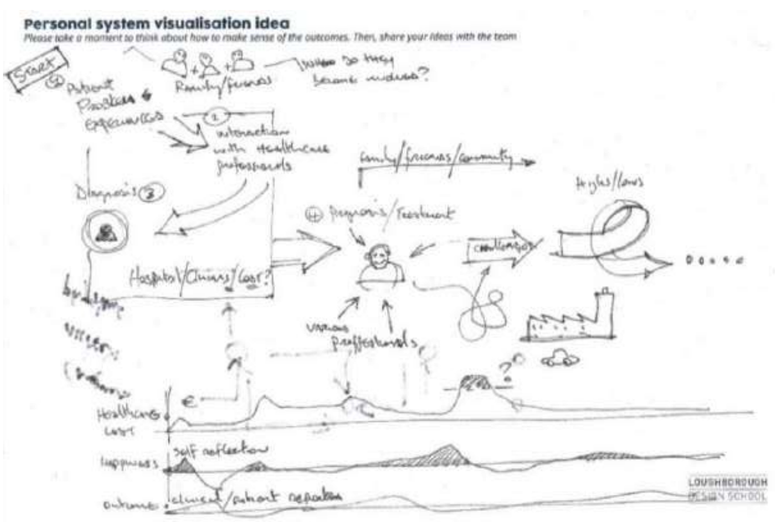

Figure 2. Example of individual visualisation

Table 3 summarises the findings from the rest of the individual visualisations. The results did no show a clear dominant structure among the participants, but timeline, location and intensity (arrange outcomes according to its importance and severity) were the three most common. Participants used this intensity structure to express outcomes changed over time.

Table 3. Types of structures in personal visualisations

Structures			
Timeline + location	Network + location	A to B (multiple) + Loops	Venn
Timeline + hierarchy	Clusters + Loops	Concept map + -Intensity	
Timeline + intensity + location	Clusters + intensity	A to B + Loops	
Concept map	Classification (symptoms, functions)	Patient-centred + intensity	
Classification (happiness)	A to B (multiple choices)	Concept map	

3.2. Team visualisations

Five team visualisations results (Figure 3) were analysed to identify the main structure, outcomes and relationships. The figure shows the individual structures on the top to compare with the group visualisation.

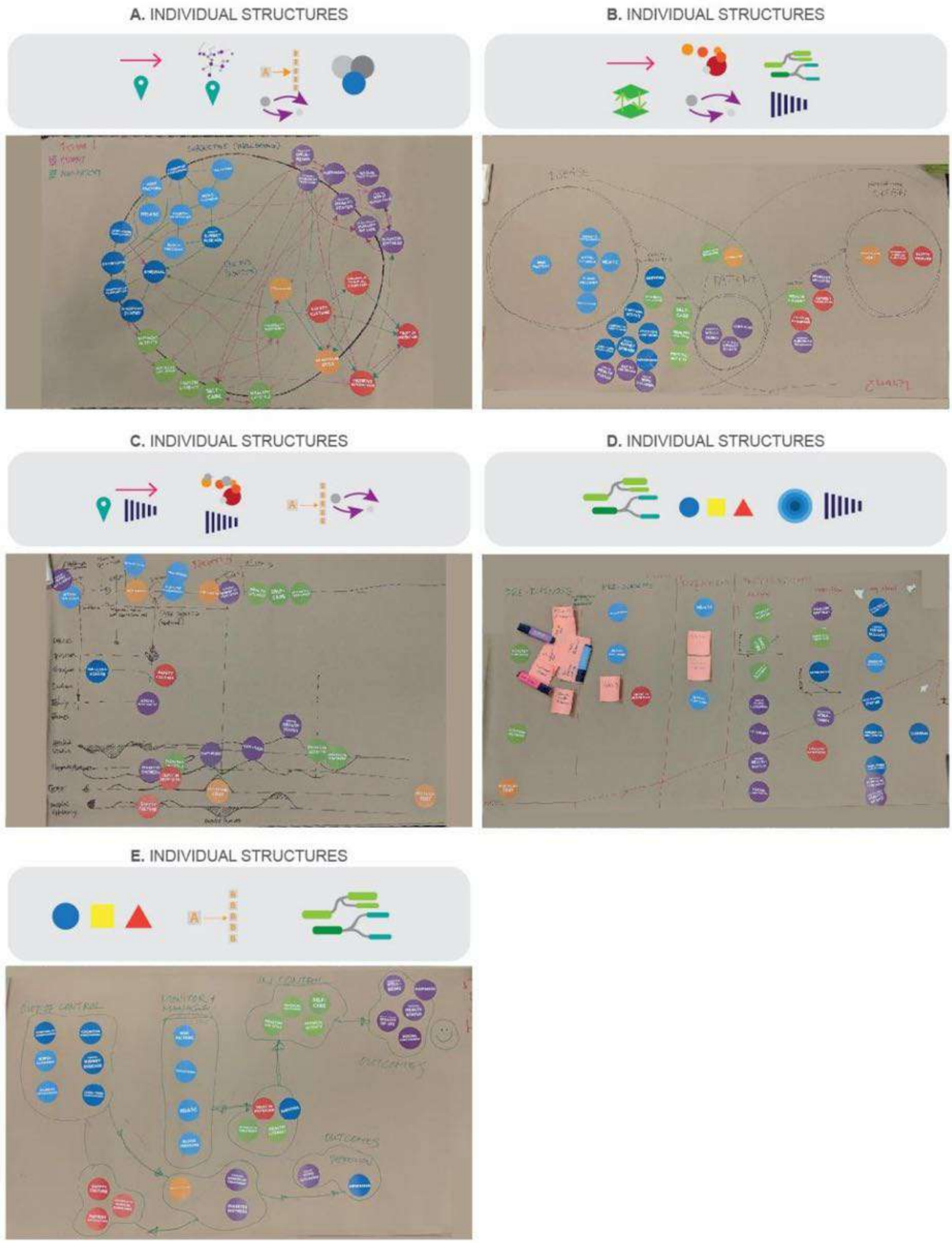

Figure 3. Team visualisations in contrast with the individual structures.

The most striking observation from the data comparison of the visualisations was the lack of a dominant structure across the five visualisations. A timeline appeared in two examples (C and D), but just in the example D the timeline structure dominated the visualisation. The timelines in example C were used to represent that outcomes are not statics and intensity fluctuations occur across time. Instead, circle, organic shapes and messy connectors (arrows) were preferred to represent the system. Interestingly, four out of five groups (A, B, D and E) generated completely new structures with respect to the individual visualisations. Only one of the group visualisations (C) was derived from a specific individual visualisation structure. This could suggest that the group visualisation process was not much influenced by the individual visualisation structure.

In four visualisations (A, B, D, E), outcomes were grouped and arranged into categories (Table 4). All the visualisations included outcomes from the five categories. But there were differences regarding which outcomes were included in the visualisation. Table 4 shows the percentages of the outcomes included in the group visualisation by five outcome categories. 100% indicates that all the outcomes provided of that category were included in the visualisation. Overall percentages were calculated considered the total of outcomes. These overall results show that behavioural and psychosocial outcomes tend to be more represented than the other groups. The group of quality and cost were less included.

Table 4. Management and percentage of use of outcomes in the group visualisations

Group	Categories created by each group	1. Quality and cost	2. Comorbidities	3. Clinical	4. Behavioural	5. Psychosocial
A	Patient and non-patient Objective and subjective	100%	100%	100%	100%	100%
B	Disease, patient and healthcare system	100%	100%	100%	100%	100%
C	No categories created	66%	14%	50%	83%	75%
D	Pre-diabetes, diagnosis and treatment	50%	100%	83%	100%	100%
E	Out of control, in contro and monitored	83%	86%	100%	100%	100%
Overall percentages		80%	80%	87%	97%	95%

3.3. Narratives on group visualisations

The thematic analysis of the narratives identified how participants used the outcomes and their opinions about how their visualisation can be applied in design. Three major topics arisen from the analysis are presented in Table 5.

Table 5. Main topics from thematic analysis

Theme	Comments from participants
How the outcomes should be/were used?	Outcomes should be continuously monitored rather than discussed once upfront.
	Psychosocial outcomes should be considered as long-term.
	Health status, happiness, cost and efficiencies were the most mentioned outcomes.
What did graphics represent?	Circle was used to represent continuous and organic process.
	Lines were used to segregate outcomes.
	Timelines were considered easy to use, but unhelpful in communicating complexity.
	Graphics should look messy to represent complexity.
How visualizations can be used in practice?	Visualisations are a great and simple tool (for designers) to identify correlations and improvement areas.
	Visualisations can help to solve conflicts between patient and providers.

Narratives clarified issues about the use of outcomes and the graphic conventions. Participants related psychosocial outcomes with long-term. These long-term outcomes also were linked to the *aim* of the system. Although it is not the same, participants used 'aim' and 'purpose' as interchangeable words. Participants mentioned that timelines (and lines, in general) did not communicate the messiness and the complexity of the system. Instead, participants alluded that circles, waves and organic arrows express the sensation of an 'unstructured' system. Finally, participants suggested that patients and providers could solve conflicts by doing a visualisation. Participants also declared that the material provided was an easy-to-use tool.

4. Discussion

The aim of the study was to explore the use of visualisations as a mean to define the purpose of the system. The results suggest that designers conceptualise complexity in different ways. Therefore, the outputs/visualisations could not be standardise. Nevertheless, the use of support elements (outcome cards) helped the participants to try different outcome arrangements. These outcomes arrangements evidenced how participants have negotiated the consensus during the workshop. Three findings emerged from this exploration: i) the lack of agreement between the group structures; ii) supporting material (outcome cards) was perceived very helpful and iii) some groups tend to quickly move forward design activities rather that purpose finding.

An unexpected finding of the study was the lack of a consistent structure among the five visualisations. Individual visualisations tended to use timeline and location structures. But the structures of group visualisations were completely different. The *purpose finding* tended to be related with the idea of the future. However, this future reference did not influence participants for using timelines. Some participants manifested that a timeline was too *simple* to represent the complexity of the system. Consequently, participants opted to express complexity through messy connections and organic circle structures.

None of the visualisation structures generated in this workshop were similar from CWA (Rasmussen, 1985) and other well-known design tools such as blueprints or journey maps. As this workshop recruit participants only with design backgrounds, a greater influence was expected from those widely-know design tools. Some individual visualisations, however, showed the similarity with rich pictures (Bell & Morse, 2013). These similarities denote the inclusion of sketches. These sketches could have been incorporated probably because drawing is a common designer activity. The resemblance with *rich pictures* was missed in the group visualisations. These group visualisations were lacking drawings. The discrepancies between the visualisations may suggest that participants visualise systems different when working in groups. Also, the lack of a pre-defined structure did not constrain the flow of the session; on the contrary, the open space encouraged the creativity of participants to generate visualisations with unexpected insights.

Consequently, the facilitation of the workshop played a vital role. Participants felt supported by the outcome cards in different ways. At the begging of the session, outcome cards were useful to 'break the ice' among participants, while in later stages, cards brought complex and meaningful issues into the discussion. Complex issues emerged when participants tried to relate apparently distant outcomes. To relate outcomes, participants created categories. These categories were different among the five visualisations, but psychosocial outcomes were related with the long term and with the patient expectations.

Participants needed to holistically comprehend the outcomes prior to relate them. Therefore, participants evoked personal experiences to complete the understanding of outcomes. The changes in the understanding of outcomes were evidenced by how participant moved the outcomes. Participants moved the outcomes around the surface trying to integrate insights from all the participants. This type of function could be considered analogous to the role of a boundary objects (Star & Griesemer, 1989).

Boundary objects are a common ground *interface* to help communities of practice to translate idiosyncratic meanings towards a better collaboration. The boundary objects should be *flexible* enough to be adapted by participants to different situation (Sajtos, Kleinaltenkamp, & Harrison, 2018; Star & Griesemer, 1989). Previous research in organisational sciences have proposed that boundary objects enable consensus-based interprofessional collaboration (Fominykh, Prasolova-Førland, Divitini, & Petersen, 2016; Sajtos et al., 2018); in addition, similar benefits have been found in healthcare practices (Keshet, Ben-Arye, & Schiff, 2013b; Sampalli, Shepherd, & Duffy, 2011). In this study, the outcome cards took the role of a boundary object. The *flexible* component emerged from the disagreements about the meaning and importance of outcomes. Psychosocial outcomes such as happiness, wellbeing and quality of life still are facing disagreements about their meaning and importance. These disagreements were used as provocations to discussion overarching elements of the system such as the purpose and values. This indicated that an open visualisation process could be positively supported by the implementation of a boundary object. A boundary object could enhance the communication of the participants and guide discussions to negotiate complex issues.

Finally, it was important the tendency of designers to move forward the design process. During the workshop session, participants were immersed in the activities of the purpose definition. But participants also showed hesitation because of the lack of a design application in the instructions. Consequently, participants related the visualisations with a practical design implication such as service design. The rush to jump into the next stage should be balanced by encouraging a slower and deeper reflection. Bell & Morse (2013) also identified that as soon as *problems* were spotted on the rich picture, participants are encouraged to move to the next step. This quick progression of the process leaves behind the richness of the picture. Nevertheless, this observation needs further research to define a balance between reflection and practical development.

Limitations

The scope of this study was limited in terms of the group of participants focusing exclusively on designers. This could have an influence on the perceived confidence to develop the activities. Designers normally feel comfortable dealing with the graphic-related assignment, but it remains in doubt how the rest of the healthcare stakeholders react to this visualisation method. A natural progression of this work is to explore the use of visualisation with patients and providers.

5. Conclusions

In summary, this study aims to explore how designers visualise complex systems using healthcare outcomes. The study illustrated that complexity could be graphically conceptualised different across participants. Individual structures were radically transformed into unique representation by group discussions. Groups found challenged to express complexity through graphic conventions such as timelines and appreciate the graphic flexibility of the expected output. This workshop also reflects that an open-based visualisation could engage participants in the task of discussing complex topics and solving conflicts. This study also shows that the use of support could be highly beneficial to conduct an open visualisation session. Outcome cards, as supported elements, were a promising support for modelling healthcare systems.

Further research needs to be conducted to compare these results with patients and providers. The comparations would verify if the structures and the process could be analogous. This further study could also contribute to developing a system thinking method to deal with value conflicts in healthcare. More research is also needed to study in detail the role of outcome cards as boundary objects. This progression could transform the cards into a feasible 'common language' to visualise healthcare systems. Potential opportunities arise from exploring interactive artefacts to promote different arrangements and relationships.

References

Adam, T., & de Savigny, D. (2012). Systems thinking for strengthening health systems in LMICs: need for a paradigm shift. *Health Policy and Planning*, *27*(suppl 4), iv1-iv3. https://doi.org/10.1093/heapol/czs084

Barbero, S., & Pallaro, A. (2017). Systemic Design for Sustainable Healthcare. *The Design Journal*, *20*(sup1), S2473–S2485. https://doi.org/10.1080/14606925.2017.1352762

Bell, S., & Morse, S. (2013). How People Use Rich Pictures to Help Them Think and Act. *Systemic Practice and Action Research*, *26*(4), 331–348. https://doi.org/10.1007/s11213-012-9236-x

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Carayon, P., Wetterneck, T. B., Rivera-Rodriguez, A. J., Hundt, A. S., Hoonakker, P., Holden, R., & Gurses, A. P. (2014). Human factors systems approach to healthcare quality and patient safety. *Applied Ergonomics*, *45*(1), 14–25. https://doi.org/10.1016/j.apergo.2013.04.023

Carey, G., Malbon, E., Carey, N., Joyce, A., Crammond, B., & Carey, A. (2015). Systems science and systems thinking for public health: a systematic review of the field. *BMJ Open*, *5*. https://doi.org/10.1136/bmjopen-2015

Comi, A., Bischof, N., & J. Eppler, M. (2014). Beyond projection: using collaborative visualization to conduct qualitative interviews. *Qualitative Research in Organizations and Management: An International Journal*, *9*(2), 110–133. https://doi.org/10.1108/QROM-05-2012-1074

Crilly, N., Blackwell, A. F., & Clarkson, P. J. (2006). Graphic elicitation: using research diagrams as interview stimuli. *Qualitative Research*, *6*(3), 341–366. https://doi.org/10.1177/1468794106065007

Flood, R. L. (2010). The Relationship of ‘Systems Thinking’ to Action Research. *Systemic Practice and Action Research*, *23*(4), 269–284. https://doi.org/10.1007/s11213-010-9169-1

Fominykh, M., Prasolova-Førland, E., Divitini, M., & Petersen, S. A. (2016). Boundary objects in collaborative work and learning. *Information Systems Frontiers*, *18*(1), 85–102. https://doi.org/10.1007/s10796-015-9579-9

Haynes, P. (2018). Understanding the influence of values in complex systems-based approaches to public policy and management. *Public Management Review*, *20*(7), 980–996. https://doi.org/10.1080/14719037.2017.1364411

Holden, R. J., Carayon, P., Gurses, A. P., Hoonakker, P., Hundt, A. S., Ozok, A. A., & Rivera-Rodriguez, A. J. (2013). SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients. *Ergonomics*, *56*(11), 1669–1686. https://doi.org/10.1080/00140139.2013.838643

Jones, P. (2013). *Design for Care: Innovating Healthcare Experience*. New York: Rosenfeld Media.

Jones, P., & Bowes, J. (2016). Synthesis Maps : Systemic Design Pedagogy , Narrative , and Intervention. *RSD5 Symposium*, 1–13.

Jones, P., & Bowes, J. (2017). Rendering Systems Visible for Design: Synthesis Maps as Constructivist

Design Narratives. *She Ji: The Journal of Design, Economics, and Innovation*, *3*(3), 229–248. Retrieved from https://www.sciencedirect.com/science/article/pii/S2405872617301028

Jones, P. H. (2014). Systemic Design Principles for Complex Social Systems. In G. Metcalf (Ed.), *Social Systems and Design* (Vol. 1, pp. 91–128). Springer. https://doi.org/10.1007/978-4-431-54478-4

Keshet, Y., Ben-Arye, E., & Schiff, E. (2013a). The use of boundary objects to enhance interprofessional collaboration: integrating complementary medicine in a hospital setting. *Sociology of Health & Illness*, *35*(5), 666–681. https://doi.org/10.1111/j.1467-9566.2012.01520.x

Keshet, Y., Ben-Arye, E., & Schiff, E. (2013b). The use of boundary objects to enhance interprofessional collaboration: integrating complementary medicine in a hospital setting. *Sociology of Health & Illness*, *35*(5), 666–681. https://doi.org/10.1111/j.1467-9566.2012.01520.x

Peters, D. H. (2014). The application of systems thinking in health: why use systems thinking? *Health Research Policy and Systems*, *12*(1), 51. https://doi.org/10.1186/1478-4505-12-51

Rasmussen, J. (1985). The role of hierarchical knowledge representation in decisionmaking and system management. *IEEE Transactions on Systems, Man, and Cybernetics*, *SMC-15*(2), 234–243. https://doi.org/10.1109/TSMC.1985.6313353

Read, G. J. M., Salmon, P. M., Lenné, M. G., & Stanton, N. A. (2015). Designing sociotechnical systems with cognitive work analysis: putting theory back into practice. *Ergonomics*, *58*(5), 822–851. https://doi.org/10.1080/00140139.2014.980335

Sajtos, L., Kleinaltenkamp, M., & Harrison, J. (2018). Boundary objects for institutional work across service ecosystems. *Journal of Service Management*, *29*(4), 615–640. https://doi.org/10.1108/JOSM-01-2017-0011

Salmon, P., Jenkins, D., Stanton, N., & Walker, G. (2010). Hierarchical task analysis vs. cognitive work analysis: comparison of theory, methodology and contribution to system design. *Theoretical Issues in Ergonomics Science*, *11*(6), 504–531. https://doi.org/10.1080/14639220903165169

Sampalli, T., Shepherd, M., & Duffy, J. (2011). Clinical vocabulary as a boundary object in multidisciplinary care management of multiple chemical sensitivity, a complex and chronic condition. *Journal of Multidisciplinary Healthcare*, *4*, 91. https://doi.org/10.2147/JMDH.S17564

Sevaldson, B. (2015). Gigamaps: their role as bridging artefacts and a new Sense Sharing Model. *Proceedings of Relating Systems Thinking and Design (RSD4) 2015 Symposium, Banff, Canada, September 1-3, 2015.*, 1–11. Retrieved from https://app.box.com/s/tsj7ewtcy9dr63knf64tvo3yrepmzdov

Skjelten, E. (2014). *Complexity and other beasts. A guide to mapping workshops*. (T. Sletterod, Ed.). Oslo: The Oslo School of Architecture and Design.

Star, S. L., & Griesemer, J. R. (1989). Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science*, *19*(3), 387–420. https://doi.org/10.1177/030631289019003001

Waterson, P., & Catchpole, K. (2016). Human factors in healthcare: Welcome progress, but still scratching the surface. *BMJ Quality and Safety*, *25*(7), 480–484. https://doi.org/10.1136/bmjqs-2015-005074

Wilkinson, J., Goff, M., Rusoja, E., Hanson, C., & Swanson, R. C. (2018). The application of systems thinking concepts, methods, and tools to global health practices: An analysis of case studies. *Journal of Evaluation in Clinical Practice*, *24*(3), 607–618. https://doi.org/10.1111/jep.12842

The impact of food production on public health: systemic strategies for a diffused and transversal prevention plan

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Abstract: Linear agro-food production systems have led to a high social impact, translated into a growing spread of chronic diseases and prolonged health costs. This obvious disconnection between food networks and health systems has often led consumers to make unhealthy food choices. The problem, in its complexity, is currently mainly faced by exponents of the Integrative Medicine, without however reaching transversal dissemination. Through the analysis of representative projects aimed at managing and resizing the problem, the purpose of this article is to identify new fields of investigation and action for systemic designers, who deal with the re-planning of food and health experiences of the individuals who wish to protect their health. This happens through the creation of relationships, the mediation of different languages and the sharing of knowledge. Furthermore, the paper traces the foundations for the definition and development of future design solutions in the field of Food for the Healthcare.

Keywords: systemic design, food production, public health, prevention strategies, multidisciplinary collaboration

1. Introduction

Nowadays talking about industrial agri-food production also means referring to different environmental, economic and social repercussions. Although attention given to the way in which the food is produced has grown, the social costs linked to food production have been investigated with a more superficial approach. In many cases the most common mistake is to separate human health from the quality of production processes of food, forgetting that social costs also translate into health costs if they become burdensome and prolonged over time. However, an insufficient and fragmented level of information about the strong link between food undeclared contaminants and chronic diseases has reduced the consumer's capability of choice in the purchase of food, further diminished by food primary selection executed by the large-scale retail trade (Figure 1).

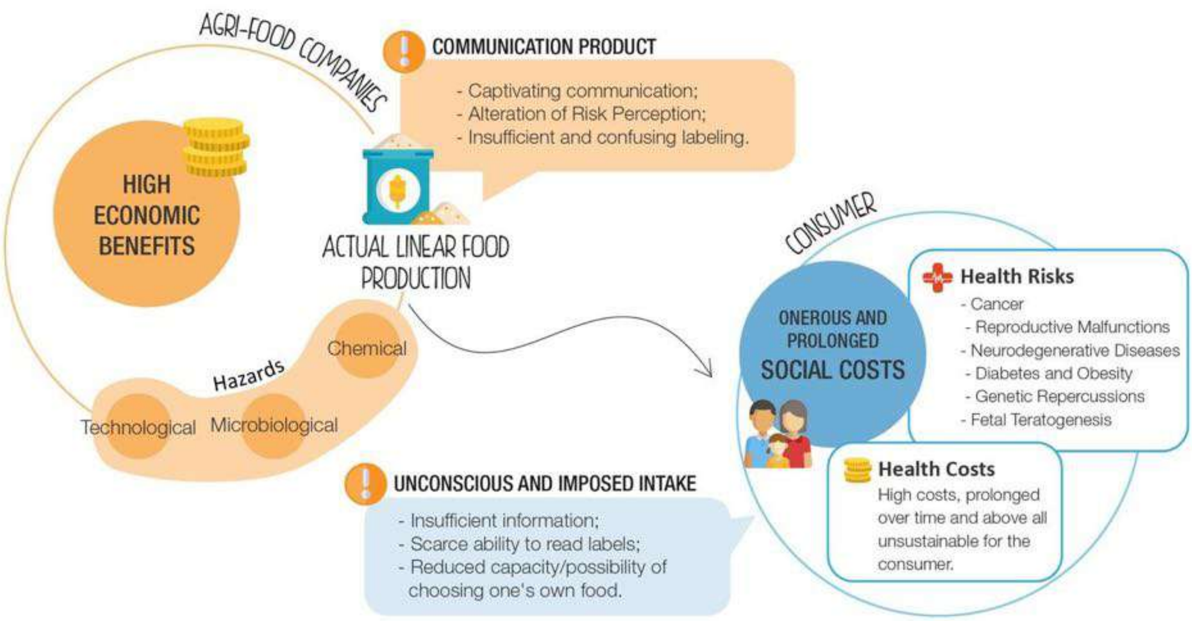

Figure 1. Overview of a Food and Health System (by authors)

It is good to make a comparison: while smoking is a choice, getting sick through unreported contaminants contained in our food is not. Smoking is a bad habit, food is a necessity and as such, it should not *poison* humans. In fact, it is right to know that the most widespread diseases such as diabetes and obesity are not the only disorders related to the quality of food production processes, where production processes refer to all the activities carried out along the entire production cycle, from seed to sale. In this complex scenario, a systemic design approach acts as a tool for reading and analyzing linear agri-food supply chains, characterized by chemical inputs such as antibiotics, hormones, pesticides, and fertilizers (Bistagnino, 2011). However, nowadays the range of such contaminants is widening, especially considering all the chemical additives used during the extensive phases of food processing and all those substances released from polymeric packaging in the industrial or domestic conservation phase (Figure 2). In the human body, they act as endocrine disruptors, interacting with other contaminants assimilated during the years (Maga, 1995) and therefore representing huge risks that are hard to predict. The purpose of this contribution is to investigate how systemic designers can serve the community through powerful tools, methodologies, and potentialities, in order to prevent the emergence of complex global problems through the design of a system of relationships among a variety of specialized figures. This system aims to generate, in the near future, a complete service available to the citizens who seek the improvement of their health status, whether ill or not, within their own territory.

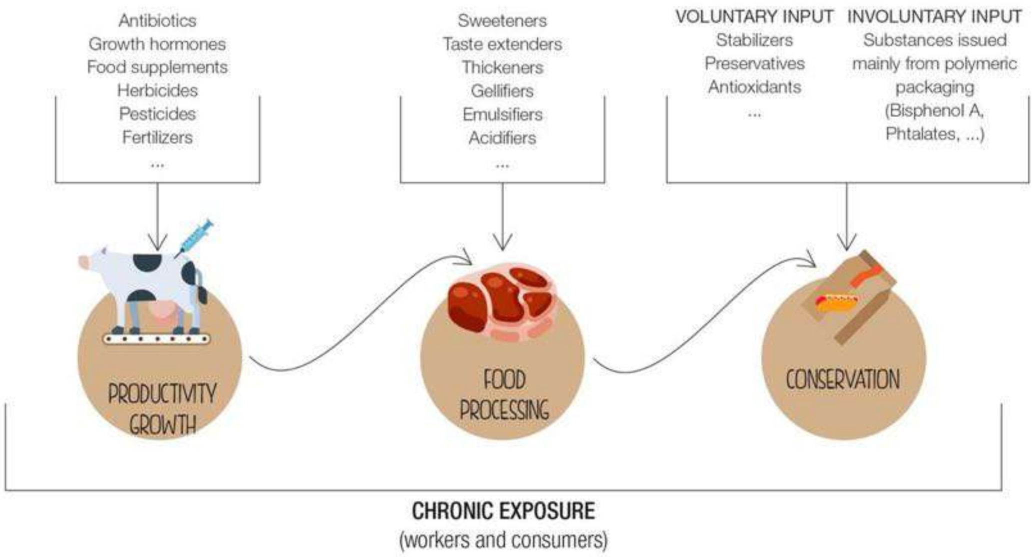

Figure 2. Phases of administration of chemical toxic pollutants in the Linear Agri-Food Production (by authors)

2. Food production and health: an overview

Food safety in Europe has become an important issue of public interest, particularly since the advent of the *Bovine Spongiform Encephalopathy* (BSE) and after the spread of genetically modified organisms. Today, food consumption is attracting global attention because of the constant chemical risks to which humans are exposed daily. On the subject of food risk[1], it is necessary to deal with its sources. They can be essentially classified into three categories (Yeung & Morris, 2001):

[1] The risk is defined as "a combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence" (Royal Society, 1992; HMSO, 1995). Specifically, within the agri-food sector it is not only relevant the analysis of pre-sale food risk, but also and especially the perception of the same risk by the end-consumer at the time of purchase.

- Microbiological sources, connected to the negative action of microorganisms such as bacteria, fungi, and yeasts that can cause food spoilage and the consequent possible poisoning of the consumer;
- Technological sources, referring to the potential negative consequences of technological processes in the food sector, such as the irradiation and genetic modification of food;
- Chemical sources, associated with the use of chemicals in the agri-food industry, aimed at maximizing market returns or preserving specific product characteristics.

This article focuses on the consequences of the chemical risk associated with food production, which in most cases coincides with the development of chronic diseases of different nature. To fully understand the complexity of this phenomenon, it is necessary to further grasp two concepts. These are the *Acceptable Daily Intake* (ADI), that is the quantity of pollutants legitimated to be swallowed daily without any apparent risk to health and the *Chemical Body Burden*, that represents the accumulation and interaction of chemical contaminants in the body (Robin, 2012) (Figure 3), that is usually not taken into account in the diagnosis of illnesses, despite its relevance. The effects and the mutual interaction of these chemical substances, not chosen by the consumer, are responsible for what the *World Health Organization* defines as an *epidemic* capable of perturbing the health of present and even upcoming generations. The list of diseases related to industrial food production is destined to lengthen, especially considering neurodegenerative diseases, reproductive dysfunctions and cases of teratogenesis in the fetus. It is estimated that most of the future pathologies will be of fetal origin and the transgenerational effects will gradually increase. For this reason, it is of primary importance to translate the concept of sustainable development and the same sense of environmental responsibility also in the field of public health. It is crucial to start from prevention, to defend the health of our posterity.

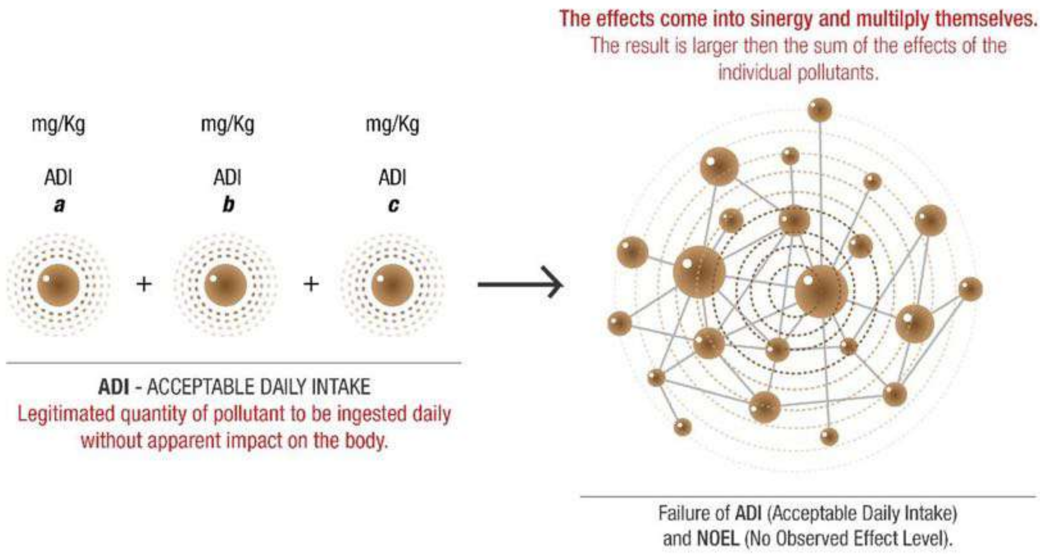

Figure 3. Interaction between the acceptable daily doses of several toxic substances (by authors)

This problem, intrinsically complex and not immediate to manage, is currently mainly addressed by medical professionals in the field of the *Integrative Medicine*[2], in particular biologists, pathologists and oncologists who conduct independent studies, whose disclosure sporadically reaches the community of consumers, that remain passive victims of an agri-food system bankruptcy. However, between the 1980s and 1990s, the topic of food consumption related to the health status of a reference population has witnessed considerable growth, particularly in urban North American settings, such as Canada and the United States (Calori & Magarini, 2015). As a matter of fact, they were the first countries to develop food policies aimed at improving the lifestyle of citizens, starting from their health conditions. Citizens were negatively affected by the consumption of fast-food and by the lack of availability of fresh and nutritious food in the so-called *food deserts*[3].

Within these sensitive contexts, there are few cases in which the potentials of systemic design have been taken into account. Most of the times, designers have been distinctly dealing with problems connected to the themes of health and food, while rarely intersecting the two contexts. If in the first case it is possible to talk about *Medical Design*, therefore of the design of equipment, services, and sanitary structures, within which extreme importance has been given at the involvement of the user in the treatment and prevention process (Pereno, 2017), in the agro-alimentary context instead, the systemic designer focuses on the redesign of the production chains in order to optimize resources, reducing environmental impact and enhancing the local culture of a territory[4] (Fassio & Tecco, 2018). Nevertheless, on the basis of these research paths that have been already explored to a large extent, systemic design can still offer a significant contribution, in the creation of greater awareness within the communities, on the connections between food production, choices of purchase and the correlated chronic diseases. Moreover, the involvement of psychological and social sciences can lead to a behavioral change both in the end consumers and in the actors involved in health and agri-food fields. In fact, in order to allow the future population to enjoy an optimal state of health, a radical paradigm shift needs to take place within the management of the public health sector, involving a focused and widespread prevention system, that starts from the control of pollutants during the entire food production process.

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[2] Born around the 40s and spread in the 70s by doctors, biologists, psychologists, scientists, and even nuns, *Integrative Medicine* considers the patient as a whole within the diagnostic act (which precedes the therapeutic steps). This means that the patient is interpreted as a single sick entity, and not connoted by single disconnected disorders. Formerly known as *Holistic Medicine* or *Alternative Medicine*, it pursues a unitary vision of the human organism, opposite to that of the official medicine.

[3] According to the definition given by the American Nutrition Association (2009), food deserts are parts of the country vapid of fresh fruit, vegetables, and other healthful whole foods, usually found in impoverished areas. This is largely due to a lack of grocery stores, farmers' markets, and healthy food providers. More info at americannutritionassociation.org/newsletter/usda-defines-food-deserts

[4] At the University of Gastronomic Sciences of Pollenzo (Cuneo, Italy), within a Master's Degree in Food Innovation and Management, the Systemic Food Design Lab was established by Prof. F. Fassio. It is a laboratory of analysis and systemic design that aspires to develop (on a theoretical and applied level) an approach based on the design of collaborative and valuable relationships. It is applied to food in its multiple meanings. See unisg.it/ricerca-unisg/systemic-food-design-lab/ for further information.

3. Redesigning relations among stakeholders

Since the 1930s the industry has controlled and influenced research on the toxicity of products, counterfeiting the veracity of scientific results (Robin, 2012): this fast-growing phenomenon has allowed higher thresholds of ADI and the legitimization of new hazardous substances. This is the reason why a bottom-up paradigm shift needs to take place within communities and the involved stakeholders. The systemic designer has a responsibility in this sense, not only as an activator of relationships but above all as a processor of a sustainable action strategy that necessarily includes a reversal of the approach to chronic diseases and food production/consumption. In order to plan a *social sanitary service*[5] (Capra & Luisi, 1997), it is of primary importance to act simultaneously on three different fronts. Firstly, the collaboration with professionals closely linked to the biological and medical fields and with public and private health facilities: the doctor should keep his mentorship, rebuilding it with greater awareness and considering the links between diseases, environment, lifestyles and eating habits. This broader and complete vision implies an attentive listening of the patient within the treatment path. Listening means tracing past and present of the individual, pursuing an analysis of the social and natural environment in which he lives, deepening his disturbances, eating habits, lifestyle, relationship with the food and with people, places where he spends his time and in which he suffers potential exposures. This is a complete investigation that has to become the basis of any systemic project for healthcare: a product, a service, or a strategy. In support of this analysis, there must then be a unitary conception of the human organism as a system of closely interconnected organs, which interacts with the natural and social environment. Secondly, it is of great importance the interaction with patients and less aware individuals, so that a system of prevention and precaution can be put in place, extending also to those who are not affected by any diseases but who seek a balanced state of health. This implies a health education program, in order to lead the consumer to understand how the eating habits affect his state of health, helping him to discern misinformation and advertising of unhealthy products and lifestyles. Finally, the third factor is the active involvement of food producers, so that they can move towards a production free from chemical contaminants, that follows the seasonality and that favors the production of local agricultural varieties. It is also essential to adopt recognized certifications and labels to reassure, inform and guide the users towards conscious consumption.

In a multidisciplinary scenario involving health, biological and agro-food disciplines, systemic designers draw a dense network of relationships among different actors mentioned, within which the patients and the healthy individuals to be protected represent an active part of the system, directly

[5] In the book "The web of life. A new scientific understanding of living systems" (Capra & Luisi, 2014), the authors affirm that a Social Health Service provides for both the integration of health education programs and health policies. In the first case, the aims are to increase the level of awareness of people on the link between health, environment, and lifestyle and to encourage companies responsible for the health costs involved in their production processes. On the other hand, Health Policies envisage the production of nutritious and chemical-free food, social policies that improve the economic and educational level, and health taxes for the producers that endanger the health of citizens.

involved in the treatment and prevention process, where prevention means knowledge, conscious purchase and even self-production (Figure 4).

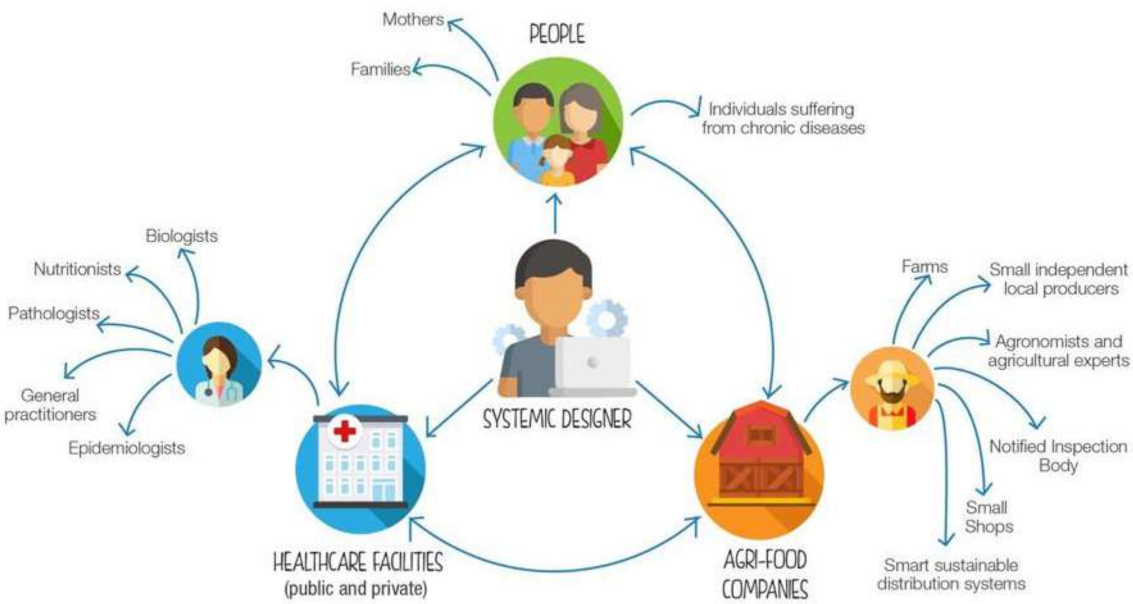

Figure 4. Connected actors of a sustainable Food and Health System (by authors)

4. A systemic approach: the role of designers

It is legitimate to ask why the designer assumes such a significant role in this network of relationships, even without possessing health and agro-scientific skills. The first answer is represented by the fact that he is simultaneously planner and user of food/health systems, consumer and *health seeker* (Jones, 2013). The real motivation lies instead in his transdisciplinary education, that allows him to deal with the most disparate branches of knowledge. By working in the perspective of sustainability and territoriality, the designer responds to global challenges with ethics and great intellectual honesty, always taking into consideration the peculiarities of the communities and of the places in which he operates, that are an integral part of a sustainable, functional, and efficient project. Nevertheless, there is another aspect that is not negligible: an ethical systemic designer stands above all the conflicts of interest, moving away from the will of the big agro-industrial and pharmaceutical corporations, planning for sustainable well-being shared by the collectivity, that does not allow tampering and disinformation. Therefore, the designer plans a path that can become a guide towards a behavioral change, through educational projects that stimulate daily qualitative actions and choices (Wendel, 2014). Products, services, and territorial strategies change their focus, moving from the maximization of profits to the health of individuals and the environment in which they live. However, in order to achieve constructive and long-lasting connections between users, producers, food and health institutions, the designer needs to create a dialogue between disciplines, languages and distant professions, minimizing conceptual and communicative obstacles, reconciling different cultural backgrounds. Thus, its mediator role becomes fundamental for the achievement of sustainable compromises between different visions, through the objectification of critical points and possibilities. He, therefore, stands as a designer and observer of the system, avoiding imbalances in terms of costs and benefits (Figure 5).

The lack of sectorial skills is what makes systemic designers able to achieve a great disciplinary permeability. Far from a weakness, this is the main strength of a generalist (Rodgers, 2007). In addition, with constant attention to the social and environmental systems, they interact to mitigate the perturbations and trying to mend the wounds of a compromised organism. This starts from the basic societal needs: food production, health management, protection of resources and of territories. In this way, a systemic designer assures a holistic vision and places the human at the center of the project (Germak, 2008), interpreting it as part of a larger whole, such as the environment that nourishes and supports it. Through this methodology, it becomes easier to trace and understand the links between human health and the health of the planet, where for the health of the planet we refer to a set of factors, such as the quality of resources, soil, water, and food. The current health crisis reflects, indeed, a long series of critical elements belonging to the environmental and economic sphere, among which it is possible to mention: a failed food system, the alteration, and contamination of the soil, water, and air, the abandonment of natural and organic food systems, and the adoption of high impact production, processing, and distribution processes[6] (Shiva, Shiva, & Patwardhan, 2018). Therefore, in order to cope with this crisis, it is essential to act in a systemic and collaborative manner, not only at the health level but also and above all through the further involvement of the environmental, food and production system.

[6] In 2018 Navdanya International Association presented the "Food for Health" Manifesto. It is a document that denounces the limits and the costs of the current food production system, addressing the important risks to human health. Furthermore, it is a mobilization tool to claim a transition to a local, ecological and diversified food system. For the preparation of this document, some of the main international experts in the food and health sectors were brought together in the international Food for Health campaign and in continuation of the work of the International Commission on the Future of Food and Agriculture. Association's official website: www.navdanya.org/site/

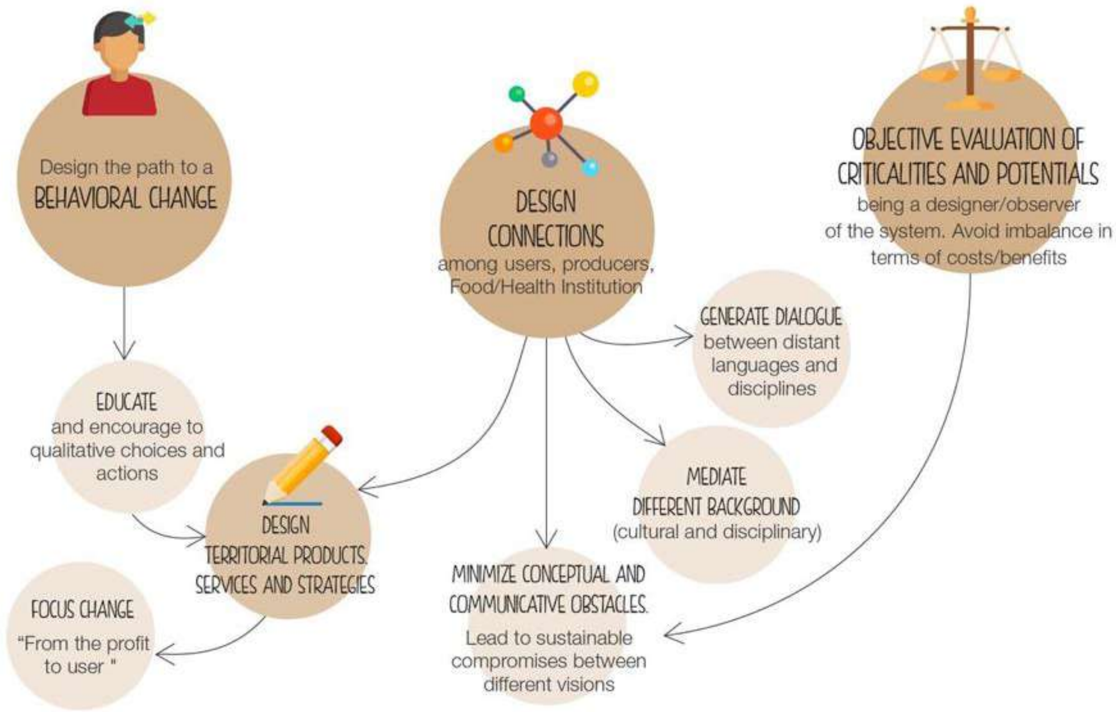

Figure 5. Transversal roles of a Systemic Designer (by authors)

5. Limits and possibilities of interdisciplinary synergies

As a designer, responding to such a vast problem of great significance, means facing a very important challenge. Certainly, the issue of healthcare costs linked to a bankruptcy food system (made up of highly impacting productive practices and serious misinformation) is a common question to most of the countries worldwide, even if manifested in different forms[7]. For this reason, it is necessary to act from the micro to the macro scale, starting from a given territory, in order to develop a flexible and sustainable design model, to be replicated (Bistagnino, 2016) with the appropriate re-adaptations. Addressing a project that involves the health and agri-food sectors, undoubtedly puts the systemic designer in front of different difficulties, especially when acting outside the academic world to put the results of the research into practice. The first step to be taken is, without any doubt, the clear communication of the own role, so that it can be understood by other professionals such as doctors, biologists, agricultural experts, food producers, health and agri-food institutions and the final users. The acceptance and the overcoming of mistrust is an essential phase. In most cases, the lack of

[7] In the book "Food and the Cities" (Calori & Magarini, 2015) it is possible to consult an overview of the different types of food policies implemented in many cities worldwide, according to the challenges they are facing. While in North America these policies aim to fight and reduce obesity, in Latin America, Africa, and Asia there is an attempt to guarantee food security and economic development, together with the support of local NGOs. The cases reported in Europe mainly focus on enhancing the producer-consumer relationships and the fairness of the food markets.

knowledge on the evolution of the design discipline in the last decades leads the actors to ask themselves why trusting a professional figure whose skills are so distant from the sector in which he is acting. "Mutual understanding of each expertise" in interdisciplinary collaborations between designers and scientists is crucial (Dawson, 2009). The acquisition of trust by all the parts becomes the basis of a successful systemic project in which there is a disciplinary confrontation, sharing of information and sectorial notions, and concrete contributions from all the parties involved. It turns out to be even more relevant if related to the end user, especially if the goal of the project is identified in the modification of a rooted wrong mentality and therefore in the generation of a higher level of awareness. Finally, another main difficulty is the monitoring of the results. Rittel and Webber (1973) suggest that complex problems, defined as *wicked problems*, cannot be treated with a conventional approach and, the case of health costs connected to a high impact productive food system, is a tangible example. Being a multi-disciplinary topic, it possesses in all its aspects the characteristics of a wicked problem. Even if, as emerges from the scientific literature, there is a precise formulation of the phenomenon, it is extremely difficult to trace rigid limits since these would be subject to continuous changes and redefinitions. For the same reason, it is not possible to define with certainty how the designer can precisely act to contain the problem. Moreover, representing a scenario whose developments will be visible only in the long term (therefore foreseeable only within the limits), there is no range of precise solutions and immediate proof of the effectiveness of the experiments undertaken (Jones, 2014).

6. Representative projects to reconnect food and health systems

Despite the extreme complexity of this social problem, nowadays there are several projects developed to bridge the disconnection between food networks and health systems. A very interesting reference model is a Canadian project called *Nourish. The future of food in HealthCare*[8], which is based on different strategic levers including the measurement of the patient's nutritional experience, the development of sustainable menus and careful research on food for health policies. These areas of research are accompanied by initiatives for the well-being of patients and residents, concrete strategies to generate awareness through a constructive influence on people, wrong beliefs, and flows of resources entering and leaving the food/health systems. The concept of users expands: the patient and the health personnel are involved, up to the entire community, with a view to positive repercussions. Certainly, among the winning aspects of such a complete project, there is the close collaboration between specialized and institutional figures that range from the field of design to the health and agri-food sector. The research shows that, at present, this type of interaction is often absent. For example, in Europe, there are many case studies developed to bring people closer to the theme of psychophysical well-being through food. However, in most of these cases, the collaboration between professionals from different fields of research is rare. By

[8] More info on the official website: www.nourishhealthcare.ca

comprehending the numerous points of contact, it has been possible to break them down into three categories, based on their final objectives:

1. purchase of local products and direct meetup with producers;
2. guide to a greater awareness of food choices;
3. prevention and treatment of health problems through natural products and healthier preparation techniques.

The largest number of cases belongs to the first category, with the intent of helping users to find local goods and meet direct producers. Most of them involve the use of online media such as mobile apps and websites, to facilitate the purchase. Their target users are the health seekers, people that want to improve their health through qualitative and local products[9].

The second category consists of projects that aim to guide users towards a more knowledgeable purchase, through the disclosure of information that is often neglected, such as the seasonality of the products, their nutritional values, and the ingredients that move the food away from its naturalness, among many others. Frequent common negative aspects of these platforms are the absence of a reliable source of information and the lack of involvement of specialized supporting figures.

The third category collects some very interesting isolated cases that do not take the involvement of designers into account, but they successfully lead the interaction among patients, medical figures, chefs and food-producers for the prevention of diseases. One example is the *Diana 5 Project*[10], conducted by Dr. Franco Berrino and the *National Cancer Institute*, based in Milan (Berrino, 2017). This project helps to prevent breast cancer and to support the healing process through special cooking classes. Users rediscover the properties and the benefits of food, the seasonality of vegetables, and have the chance of meeting local farmers. Through this type of project, the level of awareness increases, thanks to the direct involvement of the patients in the production process of their daily meal. This category is an excellent example, consistent and aligned with the Systemic Design approach: it draws strength from relationships, from concrete and educational experiences, and from direct meet up with specialized figures.

The collection of these cases is an important support for the future and potential applications of the current research, even if this classification is not intended to be stiff. The attention to the theme of food and health is growing slowly but considerably. For this reason, it will be necessary to revise and keep this collection up to date.

[9] A representative example of this category is L'alveare che dice sì, a startup company incubated at Politecnico di Torino (Italy), that operates all over Europe. Consult alvearechedicesi.it/it for further information.
[10] For more information it is possible to consult the official websites of Foundation IRCCS - Istituto Nazionale dei Tumori (www.istitutotumori.mi.it/modules.php?name=News&file=article&sid=304) and AIMAC - Associazione Italiana Malati di Cancro (http://www.aimac.it/download/allegati/Progetto_Diana.pdf).

7. Conclusions

The holistic way of approaching this research is not far from the one adopted by the frontier of the *Medical Design*, however, it considers an additional variable, that is the potential impact of food and food practices on human health. By capturing the critical elements of a high-impacting food system and the enormous social consequences, through the research of representative projects developed globally, this article identifies the salient points in which the systemic designer can operate, the actors with whom can collaborate, and the main challenges to be faced. The rediscovery of the centrality of the designer as a reader of complexity, activator of relationships, and mediator of knowledge lays the foundations for redesigning the food/health experiences of consumers, patients, and health seekers. In the following phases of the research precise guidelines for a concept development will be defined, in order to test and assess design experimentations in real-world contexts to prevent, rather than cure, chronic disease. The scientific community of design is invited to further explore the possibilities presented so that, through the implementation of projects characterized by a high degree of social responsibility, consumers can turn into aware decision makers. Already in 460 BC the philosopher Aristotle, who made important contributions to the development of Ancient Medicine, wrote: “Let thy food be thy medicine and thy medicine be thy food”. Today, the application of this timeless ancient wisdom would be desirable. Health is, in fact, a balance to be sought, achieved, maintained and defended with constant individual commitment and with an honest and sustainable contribution of those who manage the health, food, natural and economic resources (Dimonte, 2005). For this reason, a double revolution is urgently necessary, both in the production of daily food and in the management of public health. However, this can only be carried out through the redesign of the entire food-health system, by connecting two entities that are dissociated. It is therefore essential to start from the schooling and food rehabilitation of adults, so that knowledge and awareness can become an instrument of power, while food a mean of prevention, rather than the cause of diseases.

References

Beck, U. (2012). *Risk Society: Towards a New Modernity.* London: Sage Publications Limited.

Beglehole R., Yach, D., (2003). *Globalisation and the prevention and control of non-communicable disease: the neglected chronic disease of adults.* Lancet, Issue 362, 903-907.

Berrino, F. (2015). *Il Cibo dell'uomo. La via della salute tra conoscenza scientifica e antiche saggezze*. Milano: Franco Angeli Editore.

Berrino, F. (2017). *Alimentare il benessere. Come prevenire il cancro a tavola.* Milano: Franco Angeli Editore.

Berrino, F. (2017). *Medicina da mangiare*. Milano: Casa Editrice la Grande Via.

Bistagnino, L. (2011). *Systemic Design. Designing the productive and environmental sustainability.* Bra: Editore Slow Food.

Bistagnino, L. (2016). *MicroMACRO. Micro relazioni come rete vitale del sistema economico e produttivo.* Milano: Edizioni Ambiente.

Bistagnino, L., Cantino, V., Gibello, P., Puddu, E., Zaccone, D. (2015). *Il settore agroalimentare. Scenari e percorsi di crescita sostenibile.* Bra: SlowFood Editore, Milano: Deloitte & Touche S.p.A.

Boehnert, J. (2018). *Design, Ecology, Politics. Towards the Ecocene***.** London: Bloomsbury Academic.

Buchanan, R. (1992). Wicked Problems in Design Thinking**.** *Design Issues,* Vol. 8(2), 5-21. doi:10.2307/1511637.

Calori, A., Magarini, A. (2015). *Food and the Cities. Politiche del cibo per città sostenibili*. Milano: Edizioni Ambiente.

Capra F., Luisi, P. L. (2014). *Vita e Natura. Una visione sistemica*. Aboca Edizioni.

Capra, F. (1982). *The Turning Point. Science, Society and Rising Culture.* New York: Simon and Schuster.

Capra, F. (1997). *The web of life. A new scientific understanding of living systems*. New York: Anchor Books.

Cerutti G. (2006). *Residui, Additivi e Contaminanti negli alimenti.* Milano: Tecniche Nuove Editore.

Chen, Y. (2014). *Trade, Food Security and Human Rights. The Rules for International Trade in Agricultural Products and the Evolving World Food Crisis.* London: Routledge.

Coultate, T. P. (2016). *Food. The Chemistry of its Components.* 6th Edition. Cambridge: The Royal Society of Chemistry.

Counihan, C., Siniscalchi, V. (2014). *Food Activism. Agency, Democracy and Economy.* Oxford: Berg Publishers.

Dawson, E. (2009). On Constructing Collaborations between Engineers, Designers and Publics. In Interaction Research Studio. *Material Beliefs*. London: Goldsmiths, University of London.

Dimonte, M. (2005). *Per un medico più vicino al problema ecologico e partecipe al cambiamento.* Bari: Levante Editori.

Fassio, F., Tecco, N. (2018). *Circular Economy for Food. Materia, energia e conoscenza, in circolo.* Milano: Edizioni Ambiente.

Fry, T. (2008). *Design Futuring. Sustainability, Ethics and New Practice.* Oxford: Berg Publishers.

Germak, C. (Ed.). (2008). *Uomo al centro del progetto*. Torino: Umberto Allemandi & C.

Harrington, A. (2008). *The Cure Within: A History of Mind-Body Medicine*. New York: W.W. Norton & Company.

Henson, S., Caswell, J.(1999). *Food safety regulation: an overview of contemporary issues* in *Food Policy.* 43. Vol. 24, Issue 6, 589-603. https://doi.org/10.1016/S0306-9192(99)00072-X

HMSO (1995). *A Guide to Risk Assessment and Risk Management for Environmental Protection*, Department of the Environment, HMSO, pp. 77-80.

Jones, P. H. (2013). *Design for Care: Innovating Healthcare Experience.* Brooklyn, N.Y: Rosenfeld Media.

Jones, P. H. (2014). *Systemic Design Principles for Complex Social Systems.* Chapter 4 in Social Systems and Design, Gary Metcalf Editor. Volume 1 of the Translational Systems Science.

Lee, K. (2004). *Globalisation: what is it and how does it affect health?* MJA 2004, 180 (4):156-158

MacFie, H. (2007). Consumer-Led Food Product Development. UK: Hal MacFie Editor. Woodhead Publishing Series in *Food Science*, *Technology and Nutrition.*

Maga, J. A., Tu, A. T. (1995). *Food Additive Toxicology.* New York: M. Dekker.

McMichael, Aj., Beaglehole, D. (2000). The changing global context of public health, in *Lancet*; 356:49599.

Onen, Cl. (2004). Medicine in resource-poor settings: time for a paradigm shift?, in *Clin Med*; 4:355-360.

Papanek, V. (1985). *Design for the Real World: Human Ecology and Social Change.* Chicago: Chicago Review Press.

Patel, R. (2008). *I pradroni del Cibo*. Milano: Feltrinelli Editore.

Peano, C., Sottile, F. (2017). *Agricoltura Slow.* Bra: Slow Food Editore.

Pereno, A. (2018). *Systemic Design for Sustainable Healthcare. Designing for the treatment of chronic diseases.* Ph.D. Thesis. Scudo. Politecnico di Torino.

Peruccio, P. P., Vrenna, M., Menzardi, P., & Savina, A. (2018). *From "The Limits to Growth" to Systemic Design: envisioning a sustainable future.* In Z. Linghao, L. Yanyan, X. Dongjuan, M. Gong, & S. Di (Eds.), *Cumulus Conference Proceedings Wuxi 2018 - Diffused Transition and Design Opportunities* (pp. 751–759). Jiangnan University, 31st October-3rd November 2018. Wuxi, China: Huguang Elegant Print Co., Ltd.

Petrini C. (2011). *Come non farci mangiare dal cibo.* Bra: Slow Food Editore.

Petrini C. (2016). *Buono, pulito e giusto. Principi di una nuova gastronomia.* Bra: Slow Food Editore.

Pollan, M. (2006). *Il Dilemma dell'Onnivoro.* Milano: Adelphi Edizioni.

Pothukuchi, K. (2004). Community food assessment: A first step in planning for community food security. *Journal of Planning Education and Research*, *23*(4), 356-377. https://doi.org/10.1177/0739456X04264908

Rakel, D. (2017). *Integrative Medicine*. Philadelphia: Elsevier.

Rittel, H. W. J. (1988). *The Reasoning of Designers*. Stuttgart: Institut fur Grundlagen der Planung.

Rittel, H.W.J. (1984). *Second Generation Design Methods*. Interview in Design Methods Group, 5th Anniversary Report, DMG Occasional Paper 1, 1972, pp. 5–10. Reprinted in N. Cross (ed.), Developments in Design Methodology, John Wiley & Sons, Chichester, pp. 317-327.

Robin, M. M. (2012). *Il veleno nel piatto. I rischi mortali nascosti in quello che mangiamo.* Feltrinelli Editore.

Rodgers, P. A. (2007). *Designing the Next Generation of Designers.* In IASDR07: International Association of Societies of Design Research. The Hong Kong Polytechnic University 12-15 November 2007.

Royal Society (1992). *Risk: Analysis, Perception, and Managemen*t. London: The Royal Society.

Shiva, V. (2009). *Campi di battaglia. Biodiversità e agricoltura industriale.* Firenze: Edizioni ambiente.

Shiva, V. (2015). *Chi nutrirà il mondo? Manifesto per il cibo del terzo millennio.* Milano: Feltrinelli Editore.

Shiva, V. Shiva, M., Patwardhan, B. (2018). *Cibo e salute. Manuale di resistenza alimentare.* Firenze: Terra Nuova Edizioni.

Soma, T., & Wakefield, S. (2011). The emerging role of a food system planner: Integrating food considerations into planning. *Journal of Agriculture, Food Systems, and Community Development*, *2*(1), 53–64. https://doi.org/10.5304/jafscd.2011.021.006

Steel, C. (2008). *Hungry City: How Food Shapes Our Lives.* London: Chatto & Windus.

Wendel, S. (2013). *Designing for Behavior Change: Applying Psychology and Behavioral Economics.* Cambridge: O'Reilly.

Yeung, R. M. W., Morris, J. (2001). Food Safety Risk. Consumer perception and purchase behaviour. *British Food Journal*, Vol. 103, Issue 3, 170-187.

6 | MODELS AND PROCESSES OF SYSTEMIC DESIGN

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WORKING PAPER

Systems Thinking for Service Design: more-than-human-centered tools

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Abstract: Service Design has been long discussed as an exemplary case for the application of systems thinking methods as by its human-centered and intangible nature it deals with typical “wicked problems”. Many service design tools are indeed already built upon similar system diagrams. However sometimes exaggeration of human-centered focus undermines possibilities of envisioning the services that produce not just immediate value, but a long-term impact. One of the solutions for it could be in the improvement of the traditional tools to expand their horizons and scopes of application and support more systemic design process. In our paper we reflect on the possibility of “augmentation” of service design tools allowing them to shift the focus from human-centeredness towards becoming more system-oriented. We illustrate the benefits of their application with the case-studies from our design practice.

Keywords: systems thinking, design thinking, service design, service design tools, more than human-centered design

1. Introduction

Service design is a discipline that, more than any other in the field of design, deals with the behaviour of human beings, focusing on the immaterial aspects of the interaction between people who use and people who provide a service. The ability to understand and correctly interpret people's behaviour (at the core of service design and human-centered design methodologies) is essential to understand and satisfy the most profound needs of the final users, as well as help operators, stakeholders and organizations better managing their activities. Nonetheless, in the current situation, characterized by an important environmental crisis and questioning of the socio-economic apparatus in which we live, there is a growing awareness that the focus on human behaviors and needs may not be entirely sufficient to design services that create a positive impact in the surrounding world. Shaping solutions that perfectly meet the current needs of users and organizations does not necessarily mean generating common value or trigger long-term improvements, both for the individuals and their surrounding system. This raises the question of what contribution service design can actually offer in the face of the complex problems we live in and how to increase the design practice so that it becomes more conscious and effective. It is essential to explore new horizons in which human beings are not the only central element of investigation: dimensions like time, system dynamics and impact need to become part of the design activity of problem framing and solving. This requires designers to adopt a more systemic approach, acquire new skills and enlarge their understanding of the ecosystem, and systems thinking methods could be of real use for this purpose.

Dealing with complex intangible components has always been part of what service design do. Service designers have developed a broad toolkit to understand, visualise and work with elements that can be difficult to perceive and design otherwise. For example, they use personas and scenarios to tell stories about user needs and behaviours, experience journeys and workflow maps to describe the interaction among users and service providers, (eco) system maps to frame all the elements and players involved in the service delivery, and so on. Within the broader context of building services that satisfy the needs of all the parts involved, the type of thinking and action around these tools focus mostly on filling the gaps, making the processes more efficient, finding solutions to pain points in the experience. At the same time, if the attention shifts towards other elements such as behaviours and structure, these tools already represent a very good starting point to apply systems thinking to service design. In fact the service blueprint adopts swim-lane charts to understand layering of the various channels and actors while providing a service, the user-journey can be seen as a detailed view of the system interactions and dynamics and the (eco)system mapping is already used to analyse interconnections and value exchanged.

In our paper we suggest to take a step back and analyse service design methods and tools to make sure they encompass systems thinking and really empower designers to deal with the consequences of the solutions they create, building services that have a more positive impact on both individuals and systems in the long-term. In particular we identified three essential directions in which service design can gain inspiration from systems thinking theories and approaches:

1. The need of **observing systems in dynamics** to better understand their behaviour and how they can evolve over time, with a specific attention on human dynamics;

2. The importance of **understanding the interconnectedness** of a given system, its subsystems and other external systems, mapping out all the relationships involved;

3. The need to focus on the **long-term consequences** of our actions and of the externalities that were not taken care off in the previous solutions, in order to achieve a more positive impact.

In following text we show how augmented service design tools can help designers better include systems thinking in their everyday practice demonstrating it with some ongoing trends in the field and case-studies from our practice.

2. Evaluating Human Dynamics

2.1 Context

The need to observe a system in dynamics to understand its behaviour and changes over time is one of the crucial points in systems thinking. As Donella Meadows sums it up: “a system is more than the sum of its parts. It may exhibit adaptive, dynamic, goal-seeking, self-preserving, and sometimes evolutionary behavior,” - and as a very complex system any human being should be also perceived from this point of view.

In most cases, during service design processes, practitioners are asked to analyse and design very specific moments of interaction with a given service (e.g. the experience of underwriting an insurance policy); these are very limited moments in time when compared to the duration of human life or geological time. This temporally restricted dimension of projects limits, prevents or even hinders the perception of the long-term impact of the service on the general system to which the service belongs, and on the behavior of the people who use it. *How to expand the time-span designers consider when thinking of solutions to the problems they are asked to solve?*

It is also important to remember that the user is not a stable figure over time. The personas, built to facilitate design and creative reasoning, often depict human beings as static types. In reality, however, we observe that the same person can behave in different ways according to specific circumstances, dynamically moving from one type to another. Going beyond that, we also observe how behaviors can be influenced by the service itself, and therefore evolve, expressing new needs and expectations over time. As designers, we are called to use our ability to understand the human being as well as the impact that the use of a specific product, service or feature can have over time.

How to work for a continuous enrichment and improvement of each individual, instead of increasing their weaknesses and addictions?

We can find an easy example of these type of challenges in the use of technology and social media. Some of those platforms stimulate the uninterrupted use of their services, based on continuous cycles of gratification, with negative consequences on the offline life of their users. Finally nowadays this negative impact becomes acknowledged even by the biggest players in the industry with programs like Google's Digital Wellbeing or the Mindful Technology movement that give the opportunity to take a break from this continuous technological interaction, making users more aware of their consumption levels and pushing them to regain balance in their lives. An interesting question that Mindful Technology suggests to designers is: *what would you do differently if your client was the human race?*[1], expressing the need for a design approach more oriented towards the whole life of a human and humanity itself (rather than an approach oriented to the specific individual user only in the moment of interaction with the service).

2.2 Suggested Tool: From Personas to Dynamic Personas

Personas is one of the most used tools of service design, it is a fictional narrative used to describe the needs, expectations and desires of specific types of users, and come up with ideas and solutions that meet those needs.

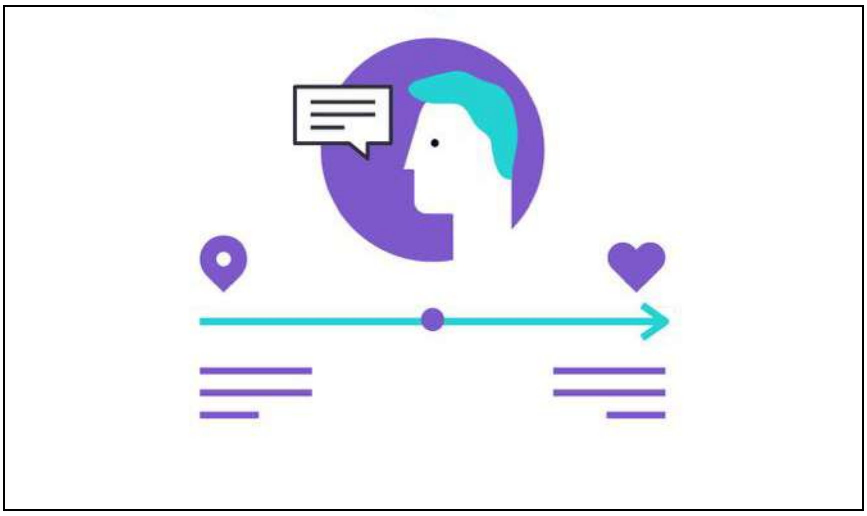

Fig. 1 The concept of dynamic personas (http://www.systemthinking.it/)

Developing a new **Dynamic personas** tool we tried to extend this concept by looking at how the user behaviour could evolve over time. This means defining a target (or multiple targets) for them to

[1] https://www.mindfultechnology.com/

reach and flash out the possible scenarios in which that persona would or wouldn't be able to achieve those goals, set potential end-states and work on the evolution and transformation of behaviours over time. In a certain way, this shifts the focus from designing for the current user needs to designing the user we would like to have, understanding actions and triggers that could be beneficial for their behaviour change.

2.3 Case study - Designing (for) Conscious Choosers

Mozilla has identified the Conscious Choosers as a cohort of people who exhibit signs of "everyday activism" in their offlines lives, and express those through the product and services they choose and use. These same people often don't apply similar values and behaviours in their online lives, where they often use services that don't reflect their ethical choices without thinking that could go against their principles. Starting from the assumption that the Conscious Choosers represent a good audience for Mozilla and Firefox, we collaborated on a research project[2] to better understand them and what arguments or product features could better engage them (e.g. How do they make their online decisions? What's their perception of privacy? What are their main concerns nowadays?).

A combined digital and traditional ethnographic approach allowed to discover more about the Conscious Choosers. We used web ethnography to explore the main topics and actors connected to the main Internet Health issues (data privacy and security, decentralization, web literacy, digital inclusion and open innovation). In parallel, a mixed quantitative and qualitative research study allowed to identify different types of Conscious Choosers and conduct in-depth interviews with about 24 of them in the USA (in Atlanta, Kansas City and Austin) and the same amount in Germany (in Hamburg, Leipzig and Munich). The in-depth interviews were essential to assess their online and offline behaviours across a variety of contexts, understand their mental models around data privacy, and explore their knowledge of Internet-related issues. The interviews were complemented by direct observation in specific spots of each town with high presence of Conscious Choosers (e.g. co-working spaces, artist galleries, social innovation hubs, etc.) and by organizing small events with local experts to get their opinion on the current beliefs and behaviours related to technology.

Three American and four German personas emerged during the study, for a total of seven different approaches that Conscious Choosers may have, considering their value system and use of technology. Each persona has been described in depth, detailing the motivation behind their online and offline choices and their point of view on Internet and technology in general. The descriptions also included a map showing the personas along a continuum that goes from **unaware to aware, active and advocate**: there could be different enabling and blocking factors that help Conscious Choosers moving further in that journey and those need to be considered in order to engage them more and more. This has become a very important part of our thinking on that project: as a key goal for Mozilla is to raise the awareness around Internet Health issues and drive users towards a more

[2] http://oblo.design/stories/understanding-the-conscious-chooser

responsible behaviours, we needed to analyse what that evolution could look like for each user archetype, and make sure we were considering ideas and features to help them move along that path.

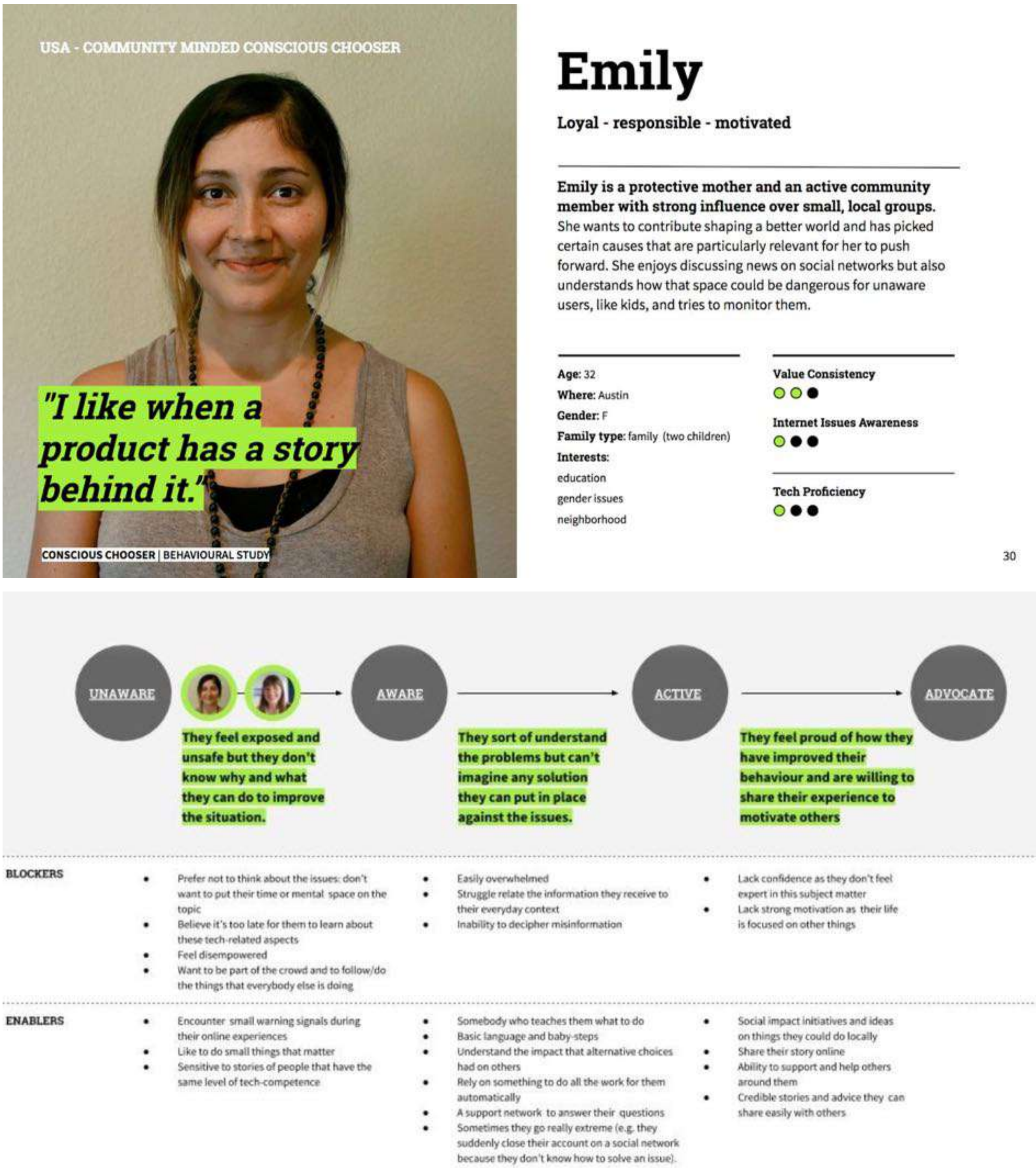

Fig. 2 Example of Dynamic Personas from the Mozilla project

This approach can be applied to many other projects when a long-term relationships between organisation and the user are supposed to be built, during which user passes through transformative stages based on the experiences they get through the service. It can become a first step to recognizing and designing for the long-term human life needs instead of the immediate gratification.

3. Analyzing Systemic Interconnectedness

3.1 Context

By a classical definition “a system is an interconnected set of elements that is coherently organized in a way that achieves something” (Meadows, 2008), each project that we deal with includes multiple interconnected parts, but also is by itself a part of the bigger whole, and the definition of boundaries for the reach of our design is a challenging task.

The scope of service design is often associated with the evolution of the economy towards a more sustainable model than that proposed by traditional industry. In fact, from an environmental point of view, combined systems of products and services offer the advantage of replacing the previous model based on the purchase and possession of goods with a new model based on access and use in times of need, potentially leading to an overall reduction in the number of manufactured physical objects. Nonetheless, a complete dematerialization is a pure illusion as digital systems (essential building blocks to access and provide services) are also rooted in the physicality and use of limited resources. We need to acknowledge the environmental impact generated by the physical production of digital devices (which materials often include rare metals, found only in specific territories) as well as the energy consumption needed to power them, (and as for now the *carbon footprint* of the ICT industry is equal to 2% of global emissions, and has thus reached the same notorious level of pollution generated by air flights)[3]. *How to become more conscious of the consequences of specific project decisions and aware of their implications on multiple dimensions?*

Regarding this aspect one peculiar model to gain awareness of the environmental impact of digital platforms and underlying infrastructure was proposed by Benjamin Bratton, with the name of *The Stack* (Bratton, 2016). Bratton identifies six *layers* involved in the interaction with a digital service (user, interface, address, city, cloud, planet) and clarifies which of these *layers* must be activated to allow the operation of platforms such as Amazon, Google, Facebook , etc. The model offers a representation of what really happens when a user accesses the digital service in question: the extreme simplicity of the single interaction, perceived as immaterial, hides in reality the activation of a very complex infrastructure, which involves the whole planet. Surely the existence and functioning of this infrastructure surpass the scope of intervention of the single project on which the service

[3] Various sources: https://www.nature.com/articles/d41586-018-06610-y

designer is working, but knowing these dynamics is essential to reason concretely on the theme of sustainability, in relation to the proposed solutions. This model also suggests how in the system maps that we draw to design various services a new dimension of depth of interactions can be added to analyze new levels of infrastructure and resources enabling the interactions perceivable by the final user. It is a good way to shift the focus from only the human in the center to a more holistic vision of the interconnected system of resources and relations and to remember the concept of *interdependence*, which underlines how the different participants in a system, both human and non-human, are emotionally, ecologically and morally dependent on each other.

3.2 Suggested Tool - From System Map to System Loops

System maps are synthetic representations that describe how a system is structured, by displaying all the actors and showing their connections.

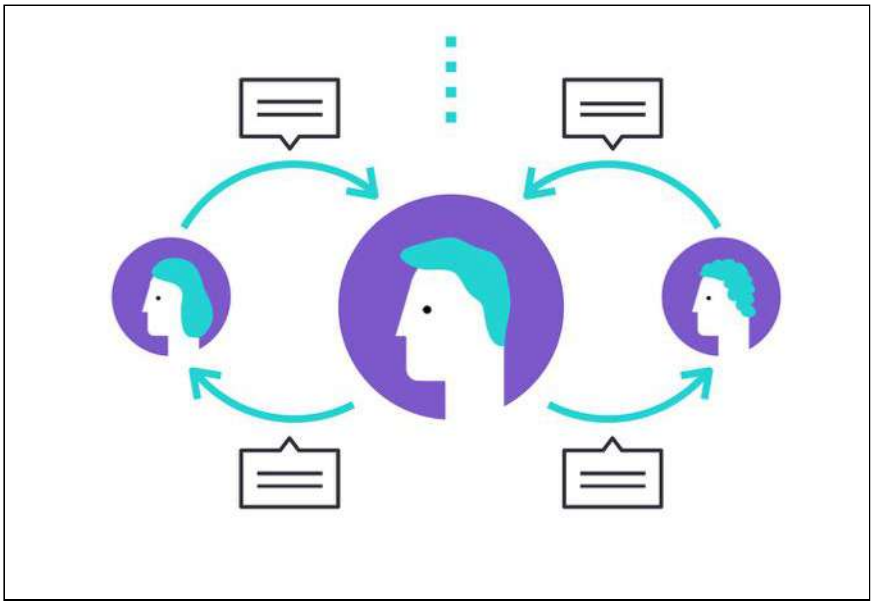

Fig. 3 The concept of system loops (http://www.systemthinking.it/)

The idea of **System loops** tool is to enrich system maps by always showing the relationship among two actors as an exchange in which they are both giving and receiving something. This means analysing more in depth the dynamics that sustain the system, mapping out tangible and intangible exchanged values and immediately visualising critical issues, gaps and redundancies. The idea of loops is based on the both feedback loops and the need for circularity and closing the cycle of resources exchange within the system.

3.3 Case study - Service Design for the Public Administration

Working with the Team for the Digital Transformation of Italian Government[4], we have been asked to put together a proposal for the redesign of a web-based service provided by the Police Department for the registration of all guests staying in hotels, b&b or any other type of accomodation.

Being asked to redesign the interface of the existing service, we decided first to analyze what exactly that platform is used for, who is using it and which part it plays in the overall relationship between visitors, hosting facilities and Public Institutions in the given context. In order to do that, we started to study national and regional prescriptions, interview hotel managers, airbnb hosts and relevant stakeholders in the public sectors, and map all the insights collected in an accurate description of the workflows involved in registering guests and of the entire system connected to that process.

The system map was particularly relevant in this case, allowing to see that specific platform in the context of all the other activities that the hosting facility is required to do by the Public Administration. . Seeing the amount of connections and their distribution helps to perceive disbalances in the system, as in this case where the main user in the center is overwhelmed with all the actions they have to undertake, while the public entities have no connections between them and are not exchanging the information already provided to one of them and needed by another. This visualization helped demonstrating that there are three different systems asking users the same type of data, all in different moments with different tools and purposes - and proved that we could think of a transversal solution that could at the same time reduce the effort required to the host/hotel manager and optimize/distribute the information to all the institutions involved.

This map also demonstrates well the location of the interface at question - as just a peripheral mediator of one of the flows in the system: only redesigning it better would not make the whole system work better..Understanding this led to redesign not just of the interface of the portal, but of the whole system to which it belongs and its role within it. At the same time, this exploded the scope of our work to engage new stakeholders and interlocutors, which caused delays and pauses in the activities. At the moment, we have completely redesigned the whole system but the implementation hasn't started, due to the complexity of the relationships involved.

[4] http://oblo.design/stories/improving-public-services

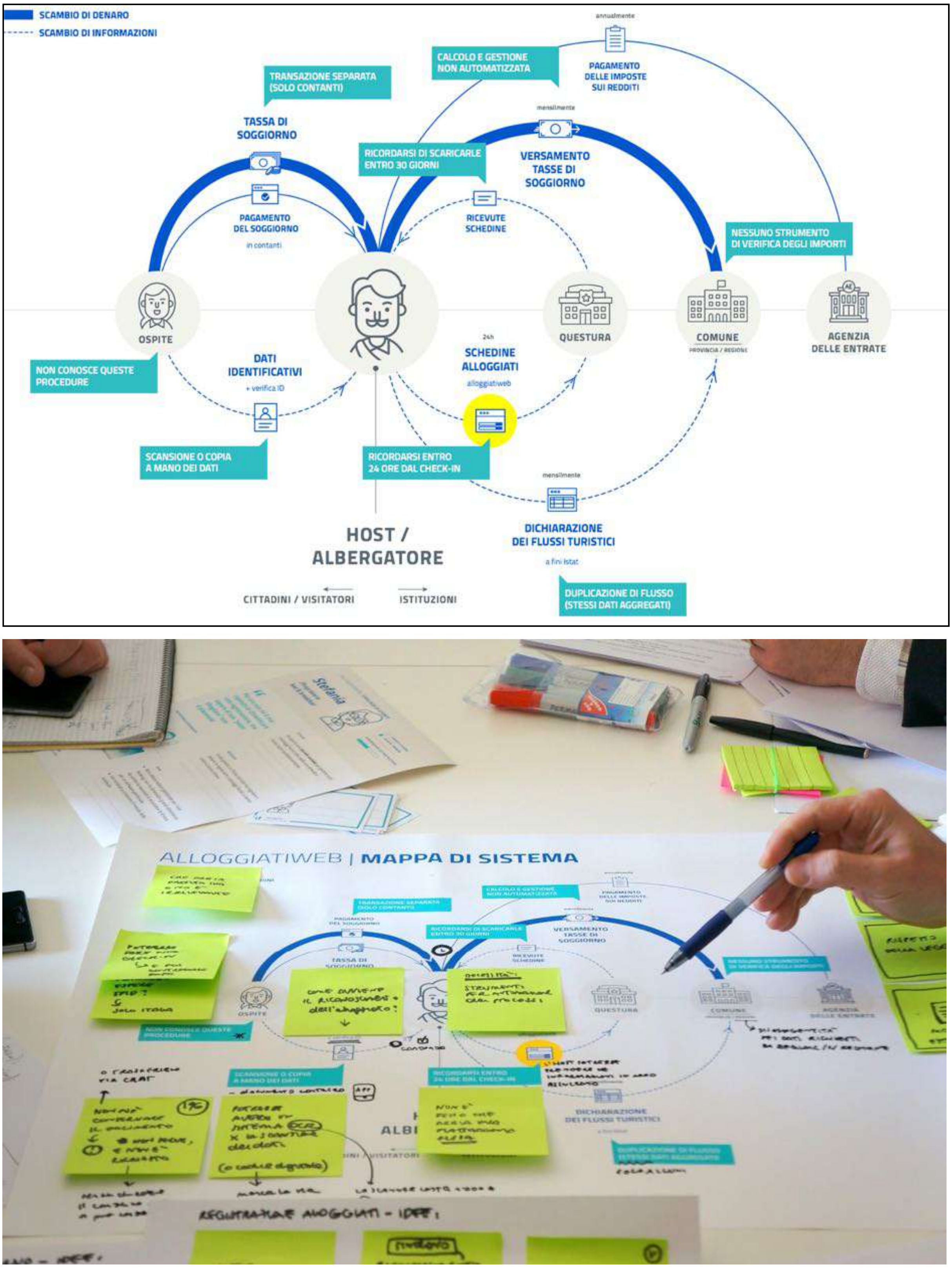

Fig. 4 System loops applied to the analysis of Alloggiatiweb.

4. Designing for Long-term Impact

4.1 Context

Putting together the focus on a longer time scale rather than specific moments of interaction with services and the understanding of the interconnectedness of the systems we can finally approach the holistic view of the impact produced by the services that we design.

One of the ways to deal with long-terms consequences was proposed by Alan Cooper in his "Oppenheimer Moment" keynote at Interaction'18[5] conference where he spoke about drawbacks of the technological systems designed recently like the infamous situation with the misuse of social media platforms to affect the results of the US elections, for example. To deal with it he proposes an approach that he named *Ancestral Thinking*. The suggestion is to evaluate any proposal for new products, services or features from the point of view of the impact they will have on subsequent generations, with the ultimate goal of always leaving the world in a better state than the one in which we have found it. To do this, it is necessary to shift attention from the actual development of the current service to the analysis of what will happen later, once the service is implemented and used for some time: which new possibilities will open and which problems could emerge instead? An example of an attempt to apply this way of thinking could be perceived recently from Airbnb, a company widely known and criticized for having distorted the short-term rental market, with devastating consequences for the long-term rents prices and the shape of the cities themselves. In their letter[6] Airbnb expresses the ambition to become a company with an *infinite time horizon*: constantly questioning the evolution of the systems in which we live and therefore the evolution of its role and business in future contexts. We can imagine how an approach of this kind can lead to design of a platform that not only deals with solving the need for short stay for vacation, but takes equally effective care of those same users when they start looking for a new accommodation in their city and find themselves in difficulty facing the deeply transformed market.

Developing a good awareness of the environmental impact of the designed service is the first step to fully reflect on the value it can deliver to people, the environment and the organization that offers it. Erika Hall[7] suggests another model of *triple timeline* that helps to take care of these aspects, observing the service itself from multiple perspectives (rather than just from the user's point of view). On a practical level it is about building *user journeys* to which two storylines are added, related respectively to the business path and the planet / environment. In this way it is possible to highlight the gaps, distances or misalignments between user satisfaction, the well-being of the company and

[5] Talk: **The Oppenheimer Moment**, https://interaction18.ixda.org/program/keynote--alan-cooper/). Medium post: **Ancestry Thinking** https://medium.com/@MrAlanCooper/ancestry-thinking-52fd3ff8da17

[6] From: **Open Letter to the Airbnb Community About Building a 21st Century Company** (January 2018) https://press.airbnb.com/brian-cheskys-open-letter-to-the-airbnb-community-about-building-a-21st-century-company/

[7] **Erika Hall** is co-Founder and Strategy Director at Mule; these considerations have been extracted from her article Thinking in Triplicate https://medium.com/mule-design/a-three-part-plan-to-save-The-world-98653a20a12f

the environmental impact of the project. The model leads to more balanced decisions from a systemic point of view, aiming to achieve an equilibrium that generates value and stability over time for all the dimensions involved.

4.2 Suggested Tool - From Project Roadmap to Impact Roadmap

A **project roadmap** is a very functional tool that allows a company or organization to define all the steps needed to bring a certain service or product to life.

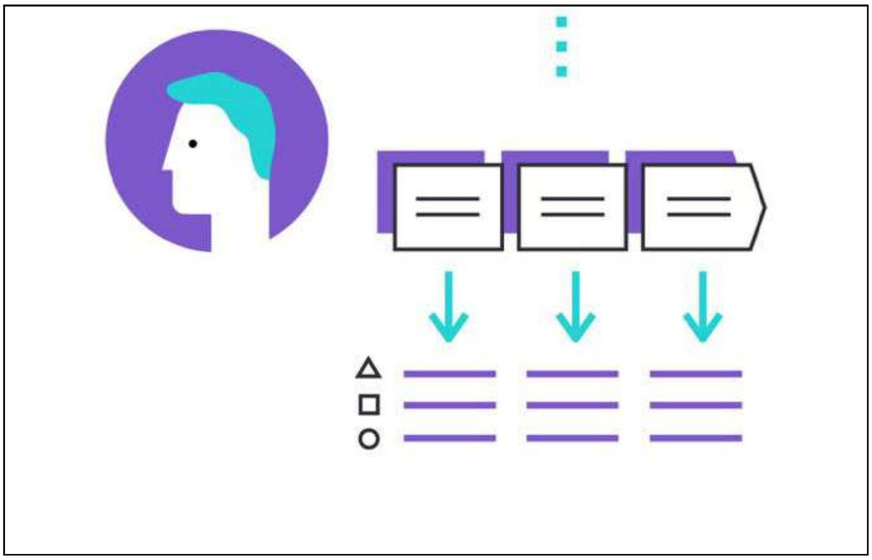

Fig. 5 The concept of impact roadmap (http://www.systemthinking.it/)

A new development of it into an **impact roadmap** expands the project phases and milestones with additional layers, enlightening possibilities to generate value while moving along the process, as direct or indirect consequence of the main activities and actions. This means reflecting on all the actors surrounding the development of a solution and identifying strategies to generate positive engagements.

4.3 Case study - Fire Club

In 2015 frog and American Red Cross collaborated on a project aimed at applying emerging technologies to disaster prevention and preparedness in developing economies. The specific goal of the project was to redesign the fire response service in informal settlements through the introduction of cheap connected fire sensors that could accelerate the detection of fire outbreaks and the activation of the intervention. Based on some first experiments, the application of the fire sensors in that context was very promising, but the definition of the whole service around them was full of unknown variables, such as: who could distribute and maintain the sensors? What type of reaction should they trigger? How should the response and rebuilding processes be organized? We decided to work closely with the communities of Khayelitsha (Cape Town) and Mukuru (Nairobi) to answer all the open points and shape the whole service together, by going through a collaborative journey of learning, designing and testing.

Instead of just running the project across the usual progressive steps, we asked ourselves how to build the relationship with the communities in a way that could bring them value from the beginning, regardless the evolution of the project itself and its final outcomes. This led us to modify the way in which we would typically approach certain steps of the design activities, and in particular to pay attention to all the knowledge and learning that could be left behind, as a way to provide immediate benefits to the local participant. For example, we decided to involve students from the same settlements we were working with as a way to have help during the research and co-design sessions, while teaching them user-centered design skills. At the end of the project, we gave them a certificate to demonstrate they collaborated with frog and American Red Cross on that project, they could re-use to apply for similar positions with other NGOs who needed to do community activation or ethnographic research.

All the activities we conducted also contributed to raise awareness around the specific problem of fire in the informal settlement, and distribute information that stayed within the community. During the fire sensors workshops, the community members learned how to better prevent fire outbreaks and what to do to extinguish them, save their belongings and protect their kids. The groundwork had been set for a potential multiplicative learning approach as some of them promised to start training peers using the same approach in order to increase their fire prevention awareness. Again, we decided to deliver training certificates to some of the community leaders to legitimize what they were doing and learning, which could potentially help them find jobs (e.g. a training certificate on fire response).

Fire Club (the service concept designed with the communities to take action and responsibility against the problem of fire) was after piloted in other cities in South Africa and India, but struggled to really succeed and scale, mainly due to lack of funding and support from the organizations that initially started the whole initiative. As this can always happen when working on any type of projects, it’s an additional demonstration of the value of establishing roadmaps that considers impact at all the possible layers and moments of the process, intermediate results and partial outcomes included.

Fig. 6 Communities during the Fire Club workshop sessions

5. Conclusions

These three examples are just the beginning of possible augmentation of service design tools for more sustainable and impactful practice. We started to apply them to our projects, tested them with other practitioners during the ArchitectaDay18 in Turin, and we hope to have the opportunity to further extend this conversation, and expand the systemic service design toolkit.

Besides our attempts we were observing a series of reflections and techniques emerged recently among various design disciplines, such as the Systemic Design Toolkit[8], the Actionable Futures Toolkit[9], the Thing-centered Toolkit[10] among others aiming to encourage designers to incorporate new perspectives into their work, going beyond the human-centered approach to more system-oriented perspectives. These new tools can be a good indication and a source of inspiration, but to apply them consciously with the positive impact we need to question the designer's approach and to accept the importance of reflections on the behavioral, systemic and temporal aspects related to service design. Although in many cases the choices of the designer concern only a small part of the system, not considering all the variables mentioned increases the risk of creating a positive experience for someone but destructive for others, or ideal for today but devastating for tomorrow. “Living

8 https://www.systemicdesigntoolkit.org/
9 https://futures.nordkapp.fi/
10 https://www.tcdtoolkit.org/

successfully in a world of complex systems means expanding not only time horizons and thought horizons; above all, it means expanding the horizons of caring.” (Meadows, 2008) We can no longer afford to design for a specific human at a time, ignoring the global impact of our actions.

References

Bratton B. (2016). *The Stack: On Software and Sovereignty.* Cambridge, Mass.: MIT Press.

Buchanan R. (1992). Wicked Problems in Design Thinking. *Design Issues,* vol. 8, n. 2, pp. 5-21.

Cisero C., Tassi R. (2016). For us by us: market creation through community engagement, *Ethnographic Praxis in Industry Conference Proceedings,* pp. 264-293.

Darzentas J.,Darzentas J. (2014). Systems Thinking for Service Design: a natural partnership to understand, manage and use Complexity. *RSD3 Relating Systems Thinking and Design 2014*

Manzini E. (2015). *Design, when everybody designs. An introduction to design for social innovation.* Cambridge, Mass.: MIT Press.

Meadows D. (2008). *Thinking in systems.* Vermont: Chelsea Green Publishing.

Papenek V. (1971). *Design for the real world. Human ecology and social change*. Chicago: Academy Chicago Publishers

Rifkin J. (2000). *L’era dell’accesso. La rivoluzione della new economy.* Milano: Mondadori.

Vezzoli C., Manzini E. (2008). *Design for Environmental Sustainability*. London: Springer-Verlag.

The Visual Representation of Complexity: Sixteen Key Characteristics of Complex Systems

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Abstract

Sustainability practitioners have long relied on images to visualise complex ideas and display relationships in complex adaptive systems on various scales and across domains. This research addresses the need for visual representations of complexity that are widely understood in different fields and sectors. The project used a participatory concept mapping process to identify, define and illustrate 16 key characteristics of complex systems and contribute to an evolving visual language of complexity. This research was initially funded by CECAN (Centre for the Evaluation of Complexity Across the Nexus) at the University of Surrey with the aim to facilitate communication, learning, collaboration and evaluation within the CECAN network. The research sought to aid researchers, policy makers, design practitioners and evaluators develop a shared understanding of systemic processes. This paper describes the research process and reflects on its contribution.

Keywords: complexity, visualisation, systems, concept mapping

1. Introduction

Images have traditionally played a role in facilitating communication and collaboration on social, economic, technological, environmental and biological issues that are characterized as complex systems. Complexity science is associated with an emerging systems "field of fields" across disciplines including design, public health, education, management, earth sciences, engineering, biology and ecology, sustainability, and science in general (Cabrera & Trochim 2006, 2). Within these systems approaches to knowledge, complex adaptive systems are described as "systems in which the individual behavior of agents following simple local rules leads to complex and emergent properties" (Cabrera 2008, 1). This relationship between simple rules and complexity is described by Nobel laureate Murray Gell-Mann:

> What is most exciting about our work is that it illuminates the chain of connections between, on the one hand, the simple underlying laws that govern the behavior of all matter in the universe and, on the other hand, the complex fabric that we see around us, exhibiting diversity, individuality, and evolution. The interplay between simplicity and complexity is the heart of our subject (1995/1996, 3).

The 'simple rules' that govern complex systems are foundational for systems work. These rules are continuously defined by communities that study complex systems as systems knowledge evolves. The research described in this paper aims to consolidate knowledge on a few of the most useful 'simple rules' or key characteristics of complex systems with the creation of new visual icons. Using a participatory visualisation and conceptual mapping method, the research aims to contribute to an evolving visual language of complexity.

With this research I sought to design new visual representations of key features of complexity. The project was initially funded by CECAN (Centre for the Evaluation of Complexity Across the Nexus)[1] for a period 16 days over six months. Loughborough University supported the final documentation and dissemination of this work including this paper. The project employed participatory knowledge visualisation and concept mapping research methods. The process involved identifying key concepts, collecting ideas and images from the systemic design research community (at the Relating Systems Thinking And Design symposium - RSD6 Oslo) and then making space for deliberation and the generation of new visual outcomes. Best visual practices were identified and used to make the final visualisations. The final outcomes were published as a poster that identifies, defines and illustrates 16 key characteristics of complex systems. This paper describes the research process, reflects on its progress and speculates on its contribution.

[1] The Centre for the Evaluation of Complexity Across the Nexus (CECAN) is a research centre hosted by the University of Surrey working on policy evaluation in Nexus areas (food, energy, water and the environment).

2. Methods

The research used participatory mixed methodologies drawing on ideas from systems-oriented design (Sevaldson 2013; Jones 2014, 2014), knowledge visualisation (Masud *et al*. 2010) and concept mapping (Greene & Caracelli, 1997; Trochim and Cabrera 2005) practices. These approaches enabled knowledge sharing between a community of designers working on systems (at RSD6 and RSD7) and the evaluation community at CECAN. Concept mapping has particular methodological relevance to the research objectives. In the tradition described by William Trochim and Derek Cabrera, concept mapping allows shared conceptual frameworks to emerge while enabling groups to address the adaptive properties associated with complexity:

> The method is consistent with an evolving paradigm of complex adaptive systems thinking and helps groups address complexity in several ways: it is inductive, allowing shared meaning to emerge; it is based on a simple set of rules (operations) that generate complex patterns and results; it engages diverse agents throughout the process through a range of participation channels (synchronous or asynchronous web, face-to-face, etc.); the visual products -- the concept maps, pattern matches, action plots -- provide simple high-level representations of evolving thinking; the results are generative, encouraging shared meaning and organizational learning while preserving individuality and diversity; the maps themselves provide a framework that enables autonomous agents to align action with broader organizational or systems vision (Trochim and Cabrera 2005, 3-4).

The concept mapping method provides a robust theoretical foundation for the research project. According to Trochim and Cabrera, there are six major steps in concept mapping processes:

1. Preparation and Focus Formulation
2. Generation of Ideas or Issues
3. Structuring of Ideas or Issues
4. Representation of Ideas or Issues
5. Interpretation of Results
6. Utilization of Results (Trochim and Cabrera 2005, 4-7; Trochim, 1989)

In this project, these steps were developed over the six months period. Step 1, Preparation and Focus Formulation, was conducted with the research proposal and initial conversations with the CECAN working group. Step 2, Generation of Ideas, was enacted at RSD6 with the surveys. These surveys resulted in a rich source of primary data as a starting point for the two workshops in Step 3, Structuring Ideas. Step 4, Representation of the Ideas occurred during the months after the workshops when I created new visual representations of the key concepts. These visual outcomes were then refined during Step 5 as I received feedback from the CECAN working group and from the RSD7 community where I presented the final outcomes (a poster and paper). Currently, the work is in the Step 6 Utilization of Results stage as evidenced on multiple reference to the project on Twitter by practitioners and academics. The research used a range of participatory processes including: surveys, design crits, sketching workshops, Twitter interactions, emails and phone conversations. The results are new visualisations as high-level representations of the thinking of at least two communities of systems practitioners (RSD6 and CECAN).

3. Research Process

3.1 Preparation and Project Formulation: Proposal and Initial Conversations

The project started with a research proposal submitted to CECAN in an open call for proposals in July 2017. I proposed a participatory practice-based research project that was originally titled: 'A Typology of Visual Codes for Systemic Relations'. The project aimed to bring design knowledge and skills to CECAN and its stakeholders by addressing

> the need for images that are widely understood across different fields and sectors in order to facilitate conversations and decisions making between researchers, policy makers, practitioners and evaluators (with varying degrees of familiarity with complexity science). By attempting to identify the best visual practices and standardise visual codes used to represent the features of complex systems (such as tipping points or thresholds; domains of relative stability; levers and hubs; time-dependent evolution; feedback loops; emergence and self-organisation; adaptation, etc.) this project will contribute to the evolving the visual language used to communicate complexity (Boehnert 2017).

I proposed to do this work using systems-oriented design and knowledge visualisation approaches. The proposed research process included a survey of relevant imagery, two workshops and close collaboration with the CECAN research group (Alex Penn, Pete Barbrook-Johnson, Martha Bicket and Dione Hills) during the 16-day fellowship over several months. With this short design research project, I aimed to refine approaches to the visual communication of complex systems within and beyond the community of evaluators at CECAN.

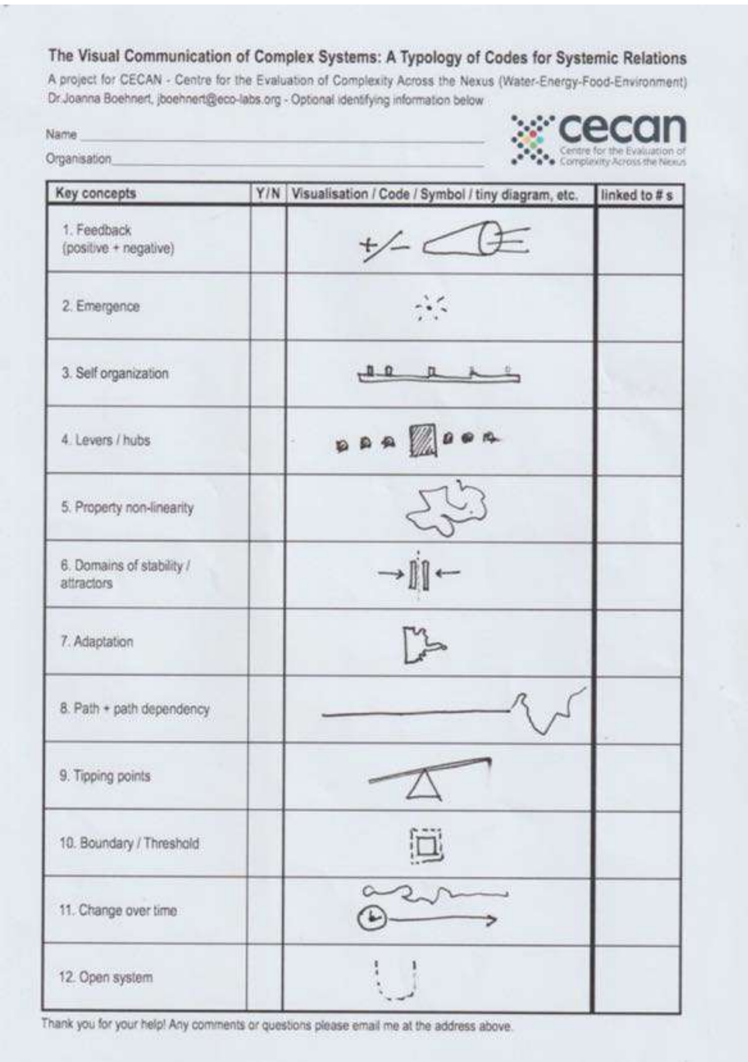
Once the proposal was accepted, the project started with conversations with a CECAN research group. These conversations clarified organisational priorities and goals for the research project. As I worked with the CECAN research group exploring potential outcomes, I modified my initial research proposal to accommodate their newly articulated concerns and newly identified project goals. A new research process was designed to identify, define and illustrate key characteristics of complexity with surveys and participatory design research to inform the design of new visual outcomes as illustrative icons rather than codes (which would have been symbolic devices that did not resemble the concepts). The name of the research project was changed to reflect the new priorities.[2]

The first step was to identify the specific features to be illustrated. Initially 12 characteristics of complexity were identified by the CECAN research group (four more were added later). Once this initial stage was completed, I sought to gather information from communities both inside and outside the CECAN network. The surveys at RSD6 were not written into the original proposal. This step emerged as I was presenting another research paper at the RSD6 conference and I noted the convergence of systemic designers provided an unique opportunity to harvest ideas on visual representations of complexity. The RSD6 organisers agreed to a last-minute request to engage delegates at the conference and made space in the plenary for a short presentation and survey.

[2] This change from codes to icons made the project significantly more time consuming.

3.2 Generation of Ideas: Surveys at RSD6 Oslo

In order to gather ideas from academics, sustainability practitioners and designers with expertise in the visualisation of complexity and systemic design, I conducted a survey at the Relating Systems Thinking and Design RSD6 The Environment, Economy, Democracy: Flourishing Together RSD6 conference (at the Oslo School of Architecture and Design, Oslo, Norway, October 18-20, 2017). I was offered a last-minute opportunity to run a participatory session at the RSD6 plenary. After a brief introduction, I distributed 50 surveys with 12 key characteristics of complexity in a room with approximately a hundred people. I asked the group to work in pairs to visualise each concept. Audience participation, including pictures of multiple surveys, is documented on the #RSD6 hashtag on Twitter. The survey (figure 1) include spaces for participants to sketch visual responses. I collected 46 surveys and two additional survey sheets submitted on Twitter. Each survey contain visual responses for some or all characteristics. This work produced a rich starting point for the creation of new visual outcomes.



The Visual Communication of Complex Systems: A Typology of Codes for Systemic Relations
A project for CECAN - Centre for the Evaluation of Complexity Across the Nexus (Water-Energy-Food-Environment)
Dr.Joanna Boehnert, jboehnert@eco-labs.org - Optional identifying information below

Name

Organisation

cecan
Centre for the Evaluation of Complexity Across the Nexus

Key concepts	Y/N	Visualisation / Code / Symbol / tiny diagram, etc.	linked to # s
1. Feedback (positive + negative)		+/-	
2. Emergence			
3. Self organization			
4. Levers / hubs			
5. Property non-linearity			
6. Domains of stability / attractors			
7. Adaptation			
8. Path + path dependency			
9. Tipping points			
10. Boundary / Threshold			
11. Change over time			
12. Open system			

Thank you for your help! Any comments or questions please email me at the address above.

Figure 1. Sample completed survey at RSD6

3.3 Structuring of Ideas: CECAN Participatory Workshops London

After the RSD6 conference, I organised the images from the surveys. The 46 surveys included 12 images on each survey (but not all surveys were complete). The results were several hundred individual images. I collected all icons for each characteristic on its own sheet using a scanner and Photoshop to digitally manipulate the images. The individual images for each characteristic were organised by type on two axes to reflect visual devices and strategies employed (see figures 2 to 13). The icons were organised according to types of abstractions. This visual sorting strategy enabled the identification of patterns as it became clear that most characteristics were commonly understood with similar visual conventions – although there were also random, unique and provocative interpretations. I published a blog on the research process on the CECAN website that included the survey characteristic sheets. These sheets become the starting point for the next stage of the project: the CECAN participatory workshops.

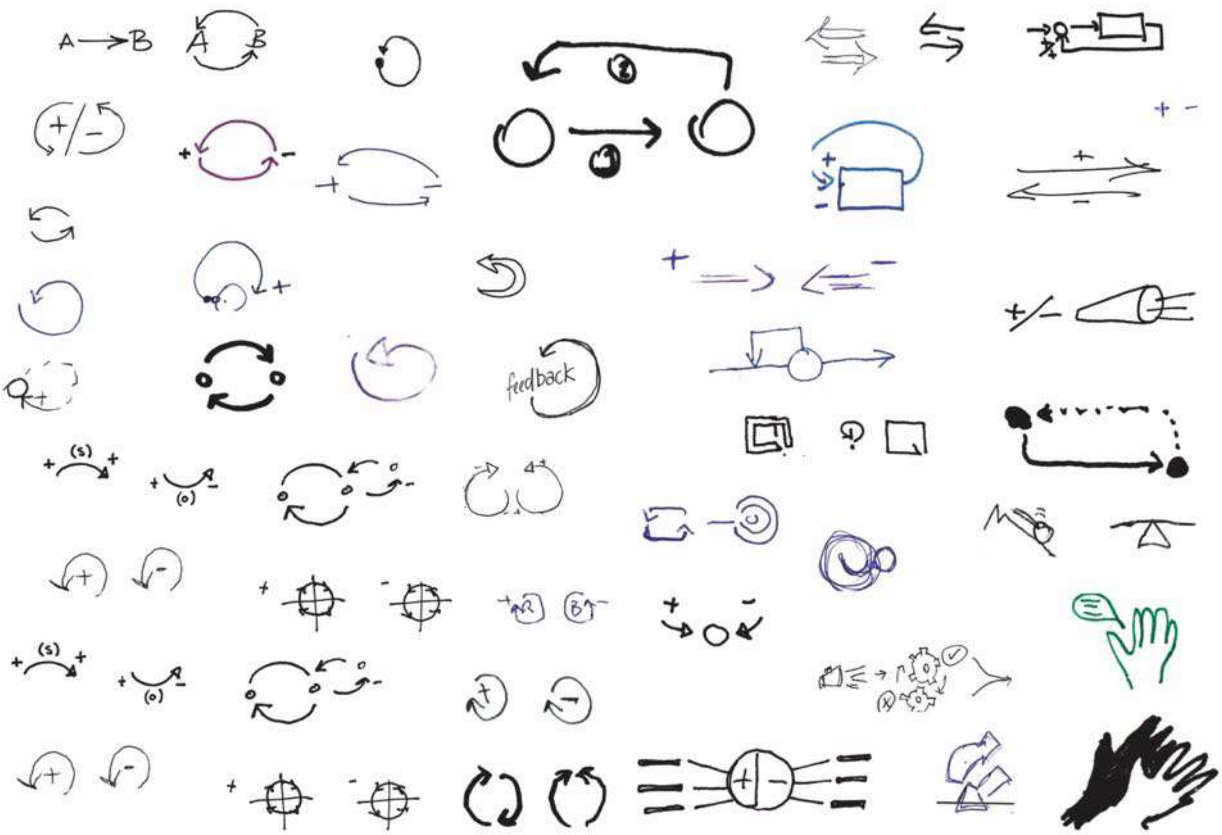


Figure 2. Feedback (positive + negative). Characteristic sheet - collection of RSD6 survey responses.

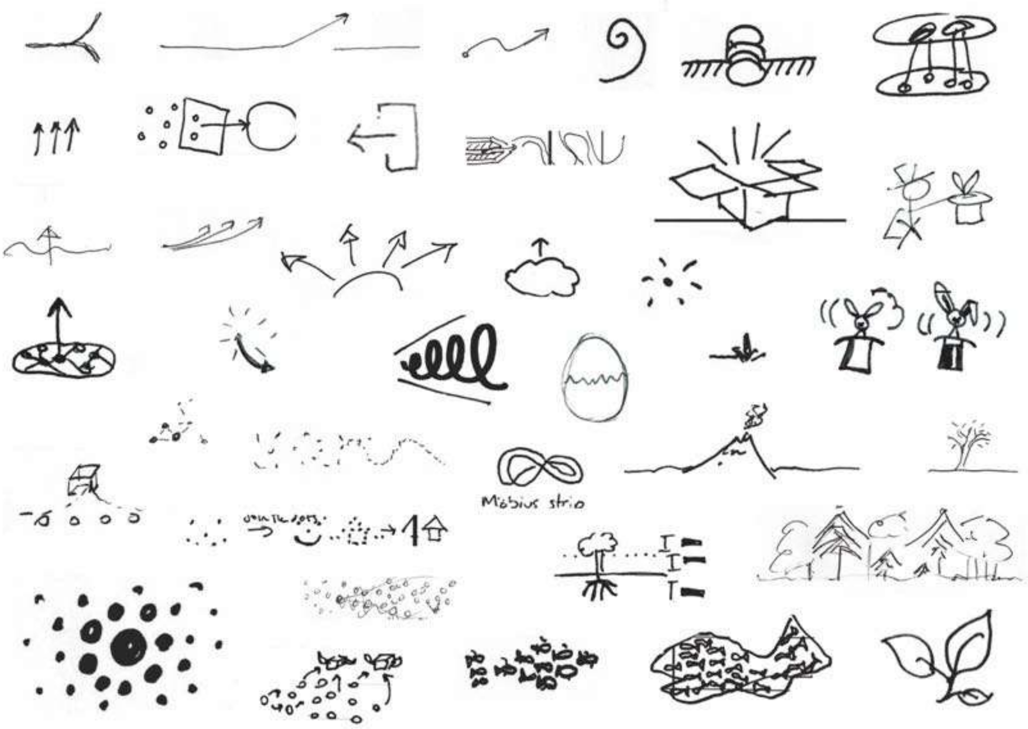


Figure 3. Emergence

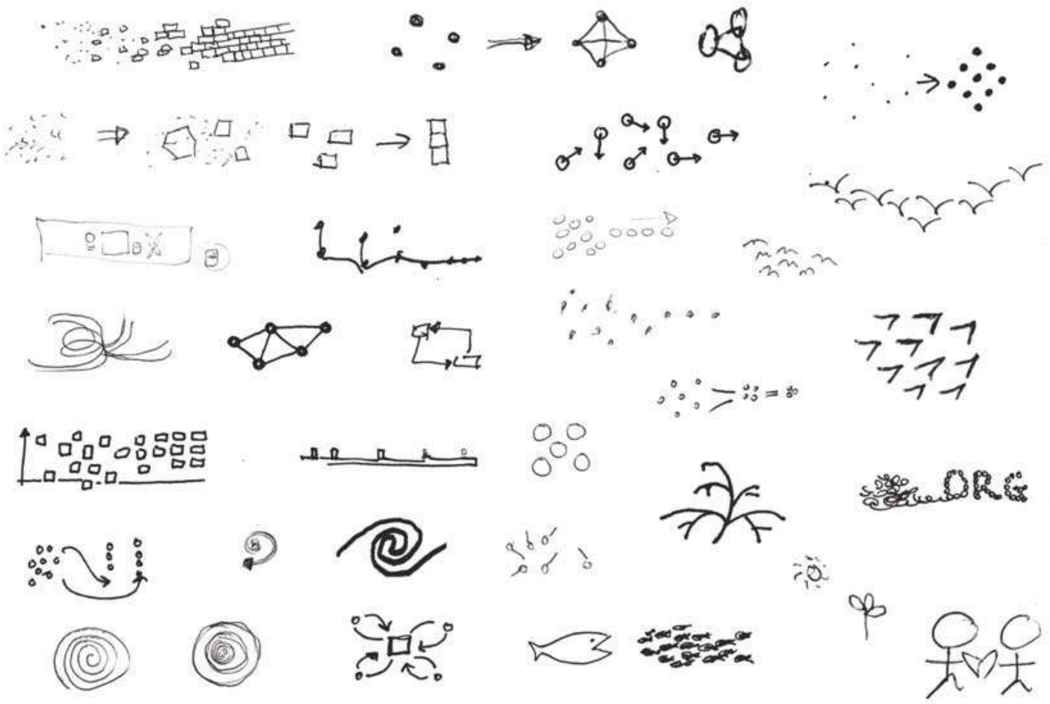


Figure 4. Self-organisation. Characteristic sheet - collection of RSD6 survey responses.

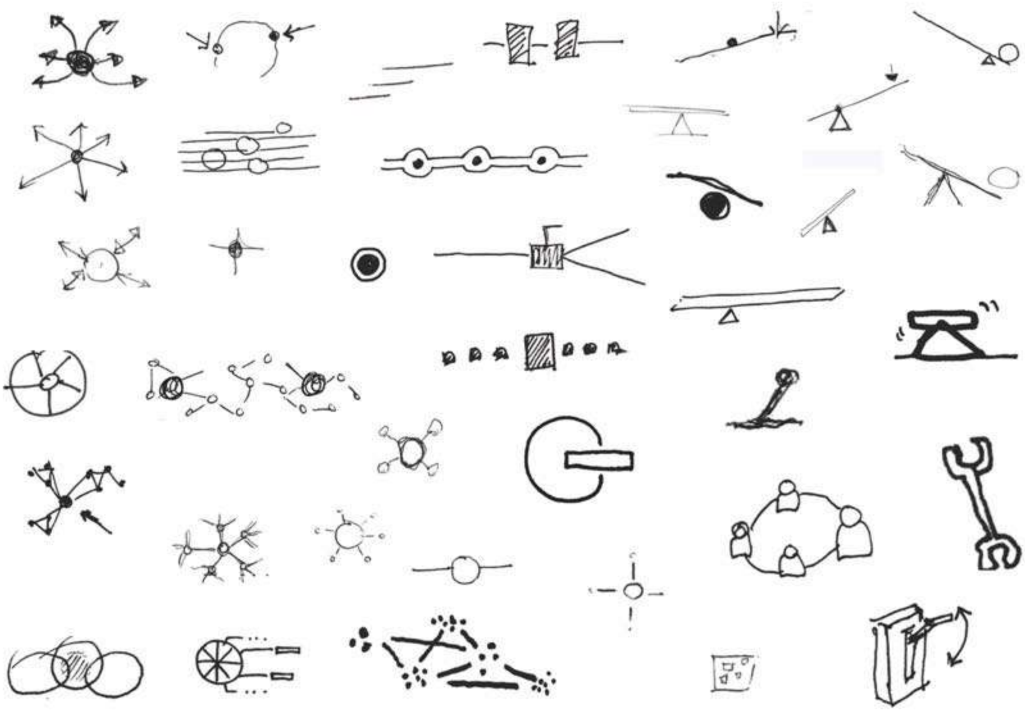


Figure 5. Levers and hubs. Characteristic sheet - collection of RSD6 survey responses.

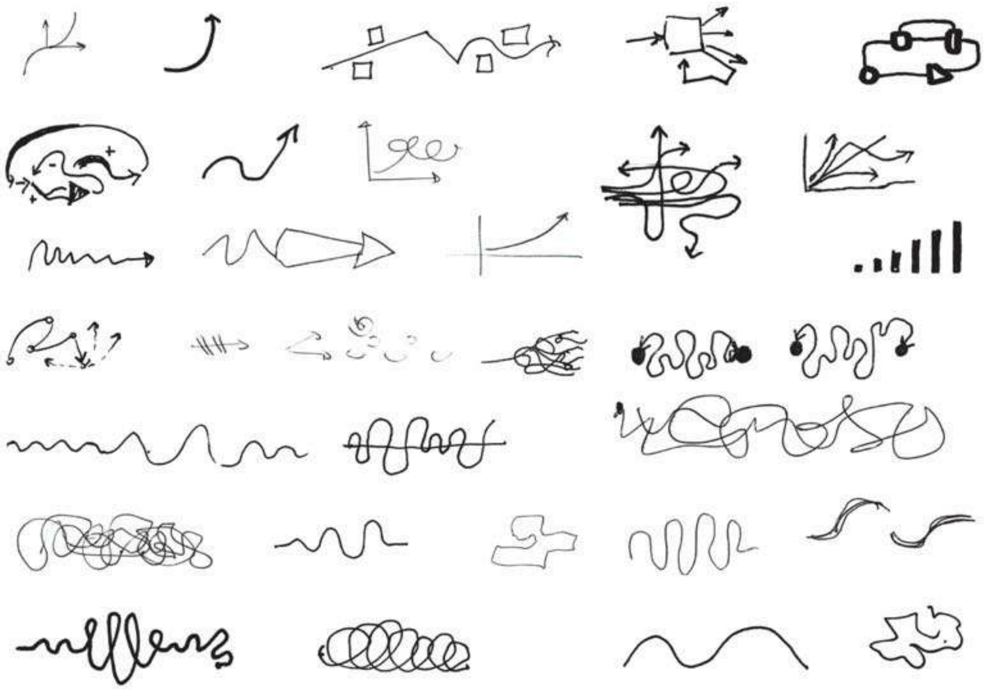


Figure 6. Property non-linearity. Characteristic sheet - collection of RSD6 survey responses.

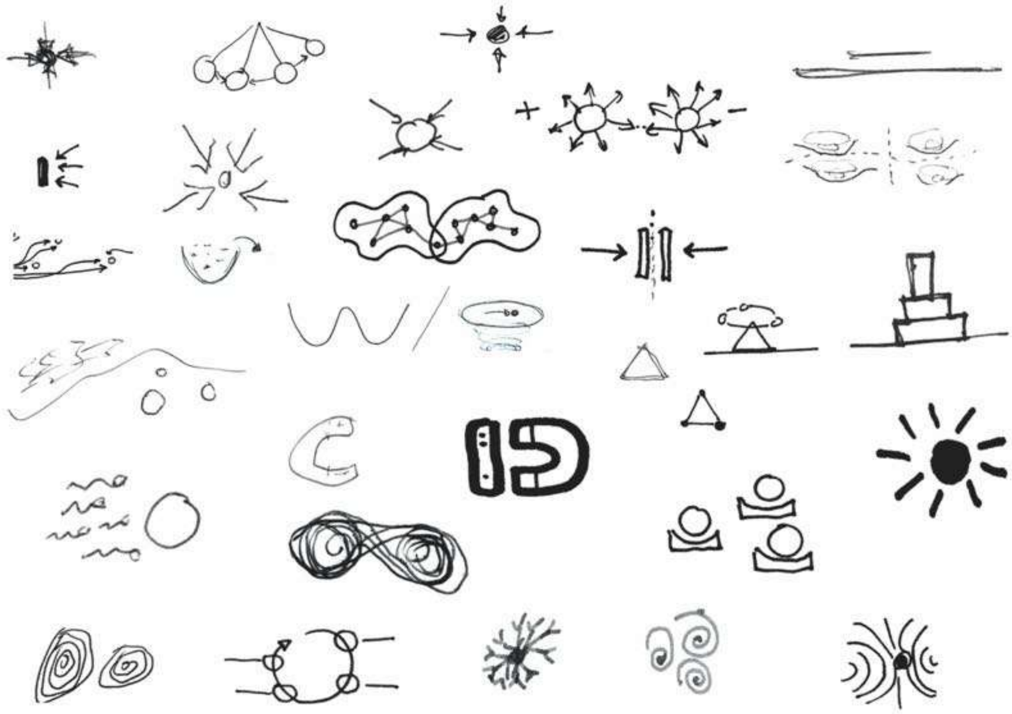


Figure 7. Domains of stability / attractors. Characteristic sheet - collection of RSD6 survey responses.

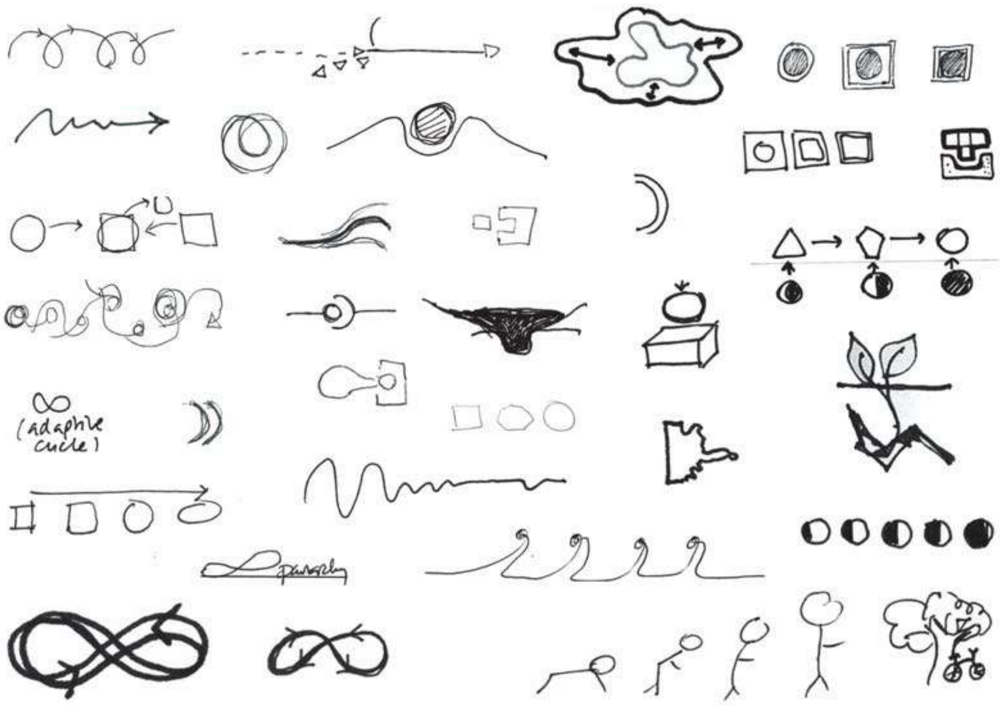


Figure 8. Adaptation. Characteristic sheet - collection of RSD6 survey responses.

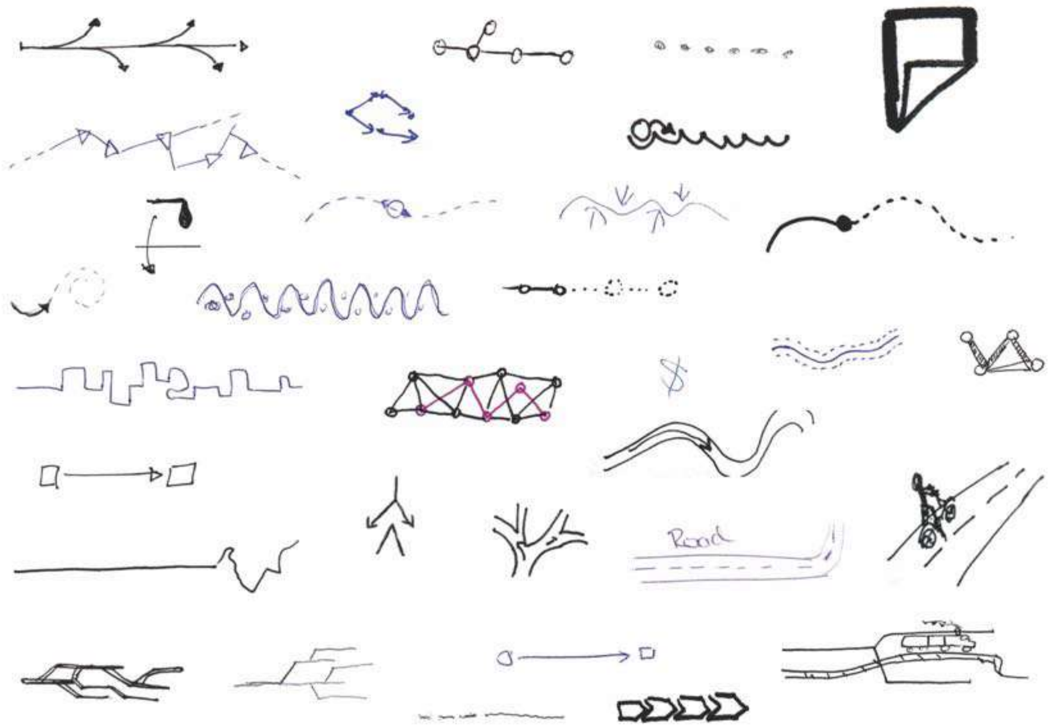


Figure 9. Path + path dependency. Characteristic sheet - collection of RSD6 survey responses.

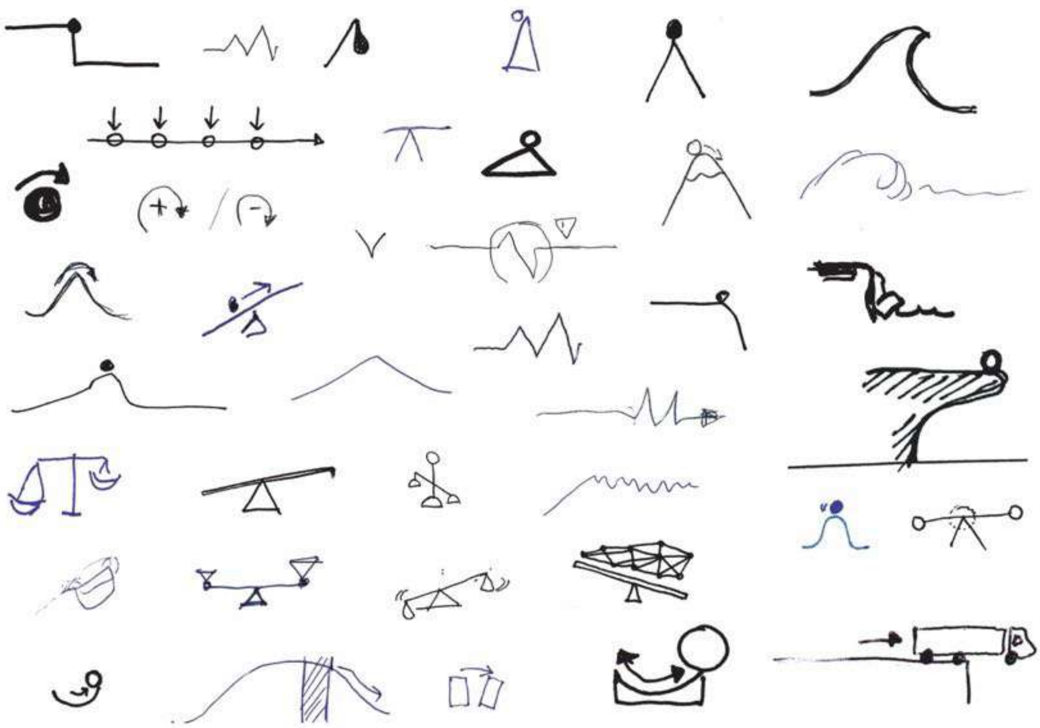


Figure 10. Tipping points. Characteristic sheet - collection of RSD6 survey responses.

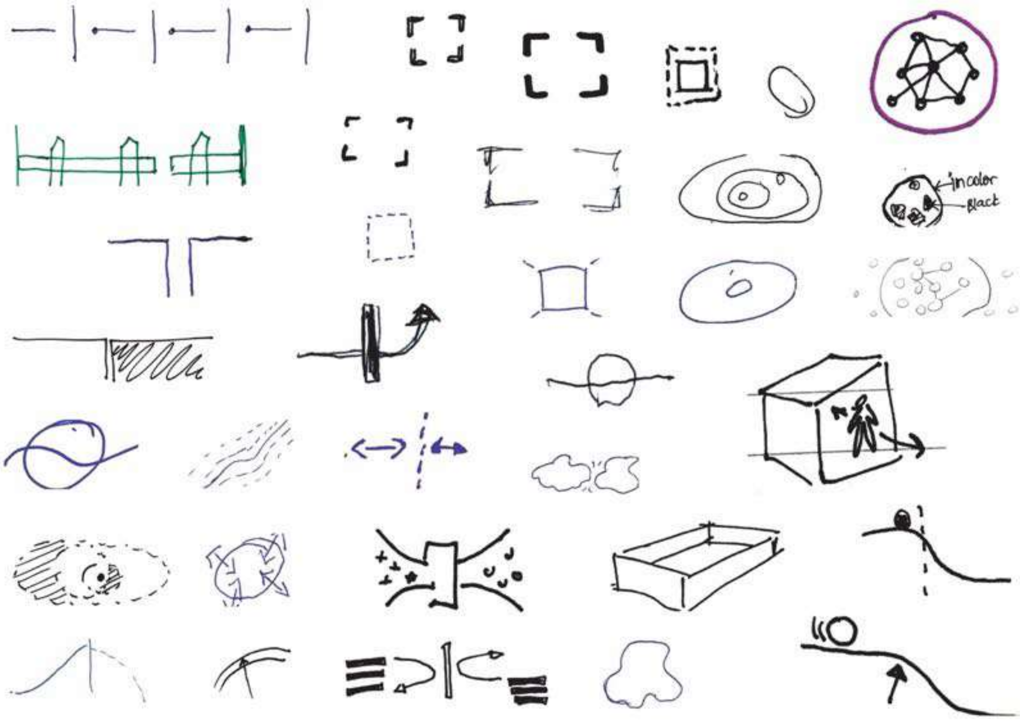


Figure 11. Boundary / Threshold. Characteristic sheet - collection of RSD6 survey responses.

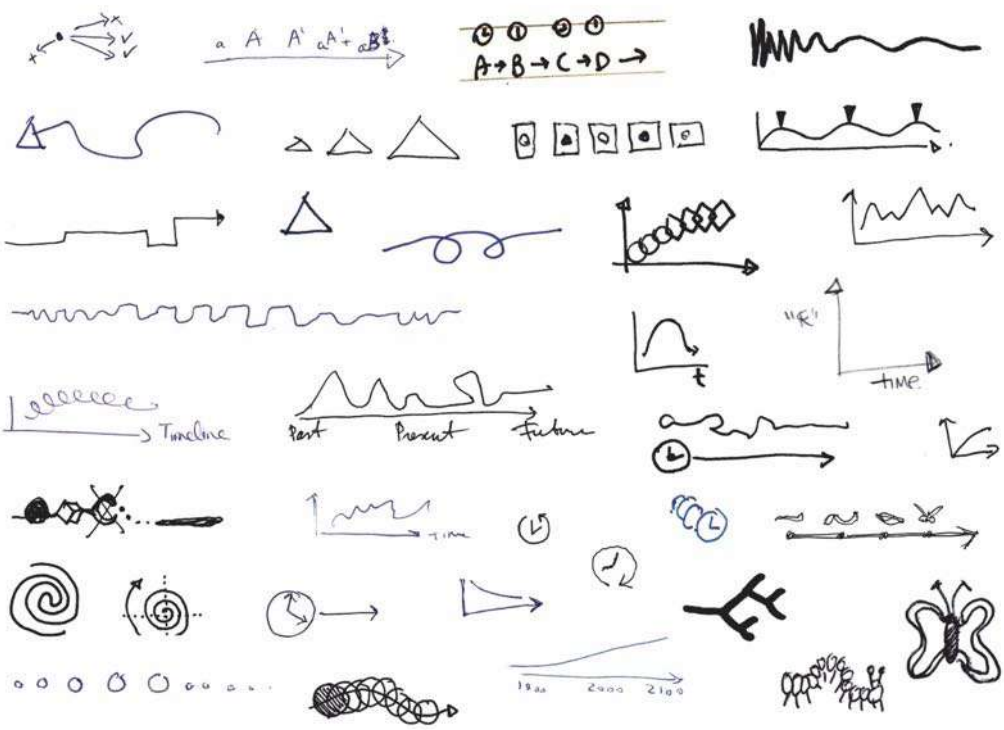


Figure 12. Change over time. Characteristic sheet - collection of RSD6 survey responses.

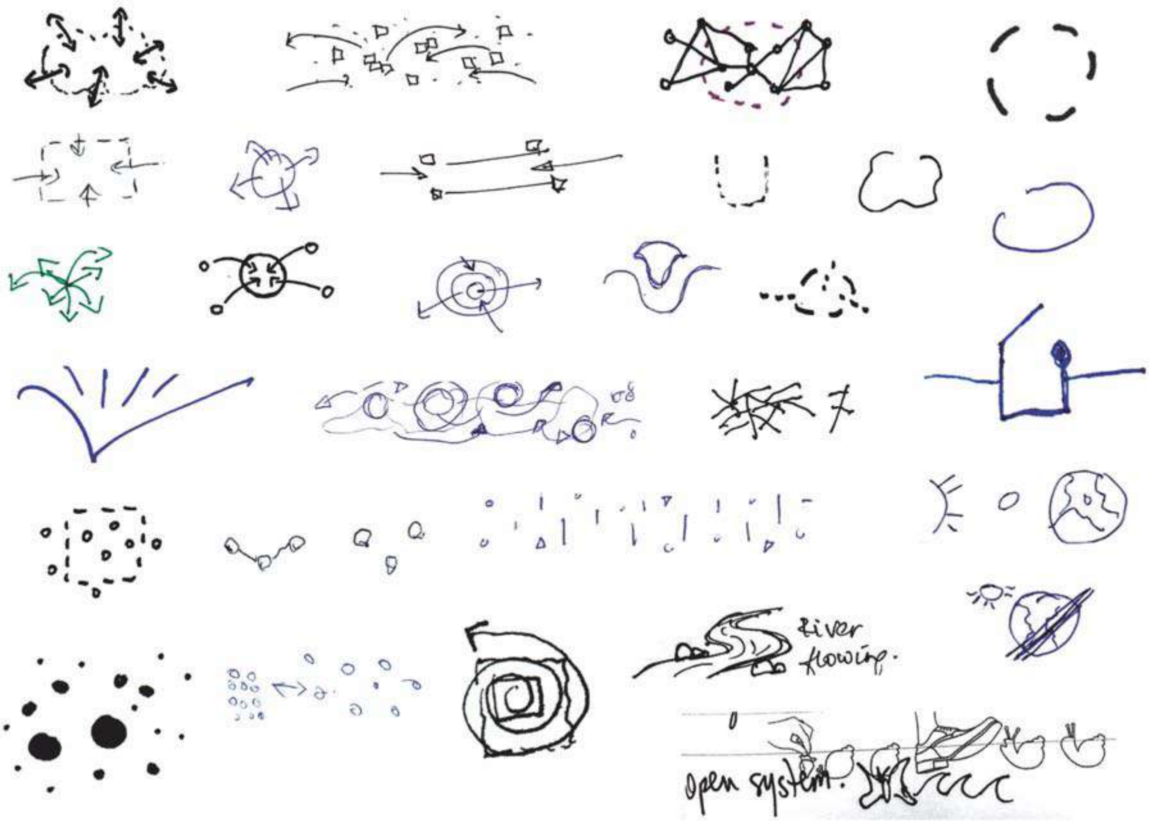


Figure 13. Open system. Characteristic sheet - collection of RSD6 survey responses.

The new characteristic sheets were a basis for the two participatory concept mapping design workshops at the University of Westminster in London with the CECAN research group (November 17 & December 15, 2017). These three-hour workshops gave the research group an opportunity to view results of the survey, deliberate on the results and create new visual outcomes based on new knowledge generated in the discussions. We conducted a design crit on each characteristic sheet. The most popular visual representations were identified and discussed in detail although the group made an explicit decision not to rely on popularity as the basis on which a final graphic would be designed, but rather sought images that captured the essential characteristics of each concept according to group discussions.

The CECAN research group brought their own ideas and images to the project. Everyone contributed sketches and together we developed a variety of visual strategies. In some instances (emergence, adaptation) none of the images collected by the survey results were used as the research group aspired to generate entirely new visual metaphor to capture specific meanings that were insufficiently embodied by any of the images collected in the surveys.

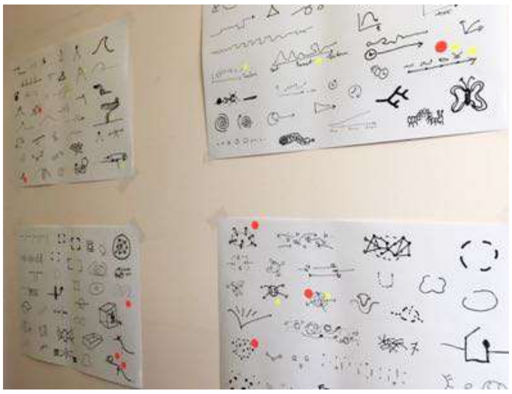


Figure 14. Characteristic sheets at the CECAN workshop, 17 November 2017, University of Westminster.

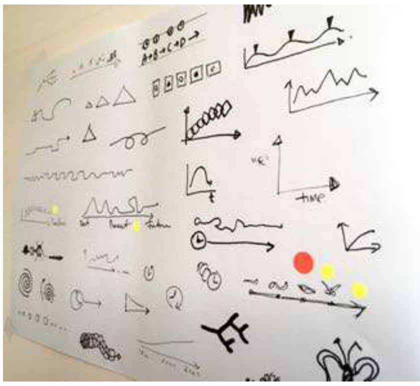


Figure 15. Change over time sheets at the CECAN workshop, 17 November 2017, University of Westminster.

During the two workshops five more characteristics were identified to make a total of sixteen. The boundary / threshold concept was dropped and five new characteristics were added at this stage (unpredictability, unknowns, distributed control, nested systems and multiple scales). The ideas generated in these workshops were the basis for the generation of the final outcomes over the following three months.

3.4 Representation of Ideas: Design of Visual Outcomes

I was responsible for designing all 16 images as the CECAN research group developed new definitions, examples and learning points over the following months. The sixteen features of complexity visualised by this project are: feedback, emergence, self-organization, levers / hubs, non-linearity, domains of stability, adaptation, path dependency, tipping points, change over time, unpredictability, unknowns, distributed control, nested systems and multiple scales.

3.5 Interpretation of Ideas: Re-Design of Visual Outcomes

As the visualisations for each feature took form, each visualisation was further interpreted by the CECAN research group. Feedback was taken and the visualisations were refined. The design research process was completed in April 2018. The final visual outcomes for each feature are below embedded in the poster (figure 16) which is also available online.

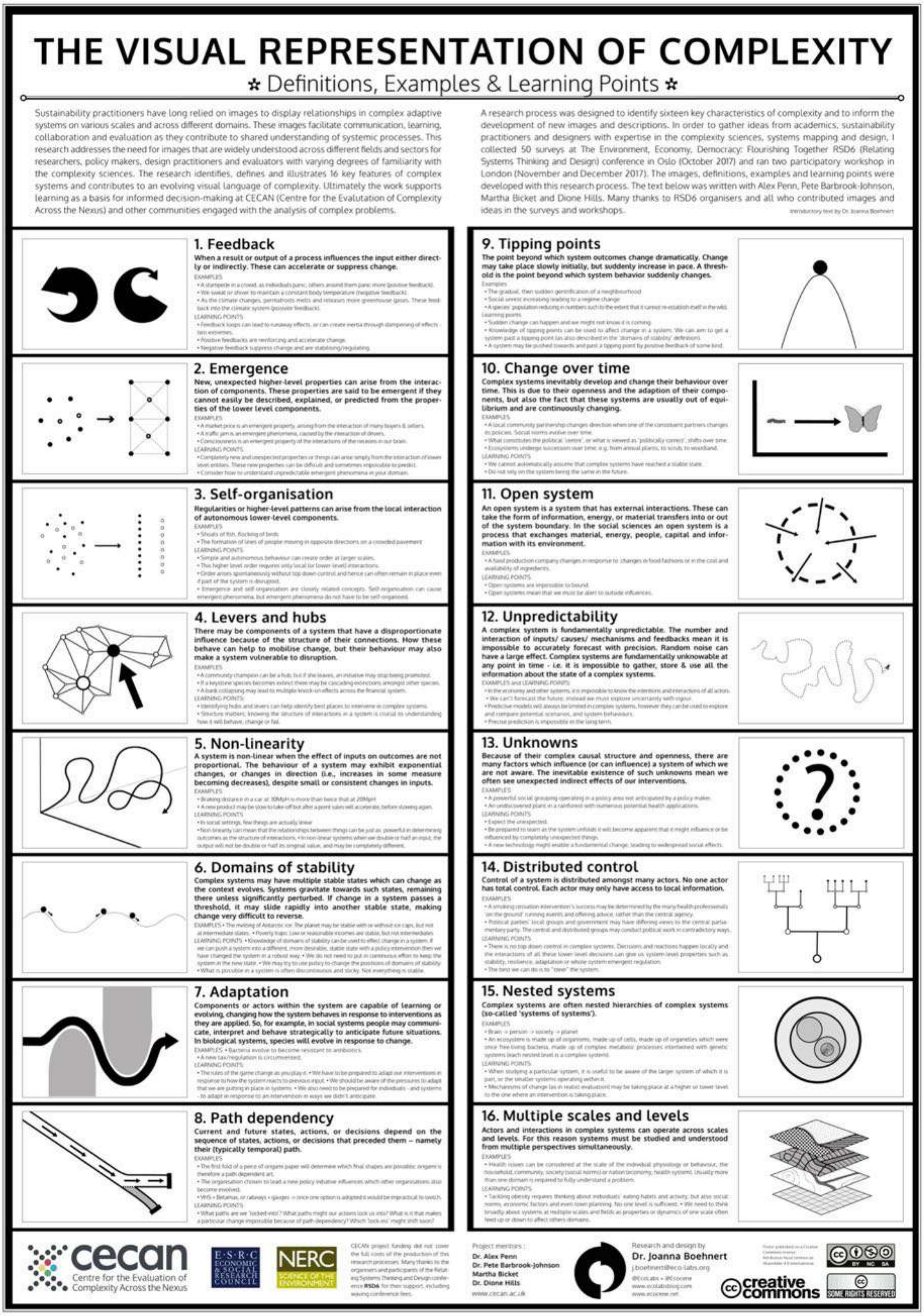


Figure 16. The Visual Representation Of Complexity: Definitions, Examples & Learning Points. A1 poster.

3.7 Ultilisation of Ideas: RSD7 and Beyond

I presented earlier version of this paper at the RSD7 symposium (Challenging Complexity By Systemic Design Towards Sustainability, Turin, October 24-26, 2018) along with the poster (figure 17) at the RSD7 “Visualizing Complex Systems” exhibition. The collection of images from the 50 RSD6 surveys were made available online for other designers and researchers to use for their own purposes. This work has over two hundred interactions on Twitter over the past year.

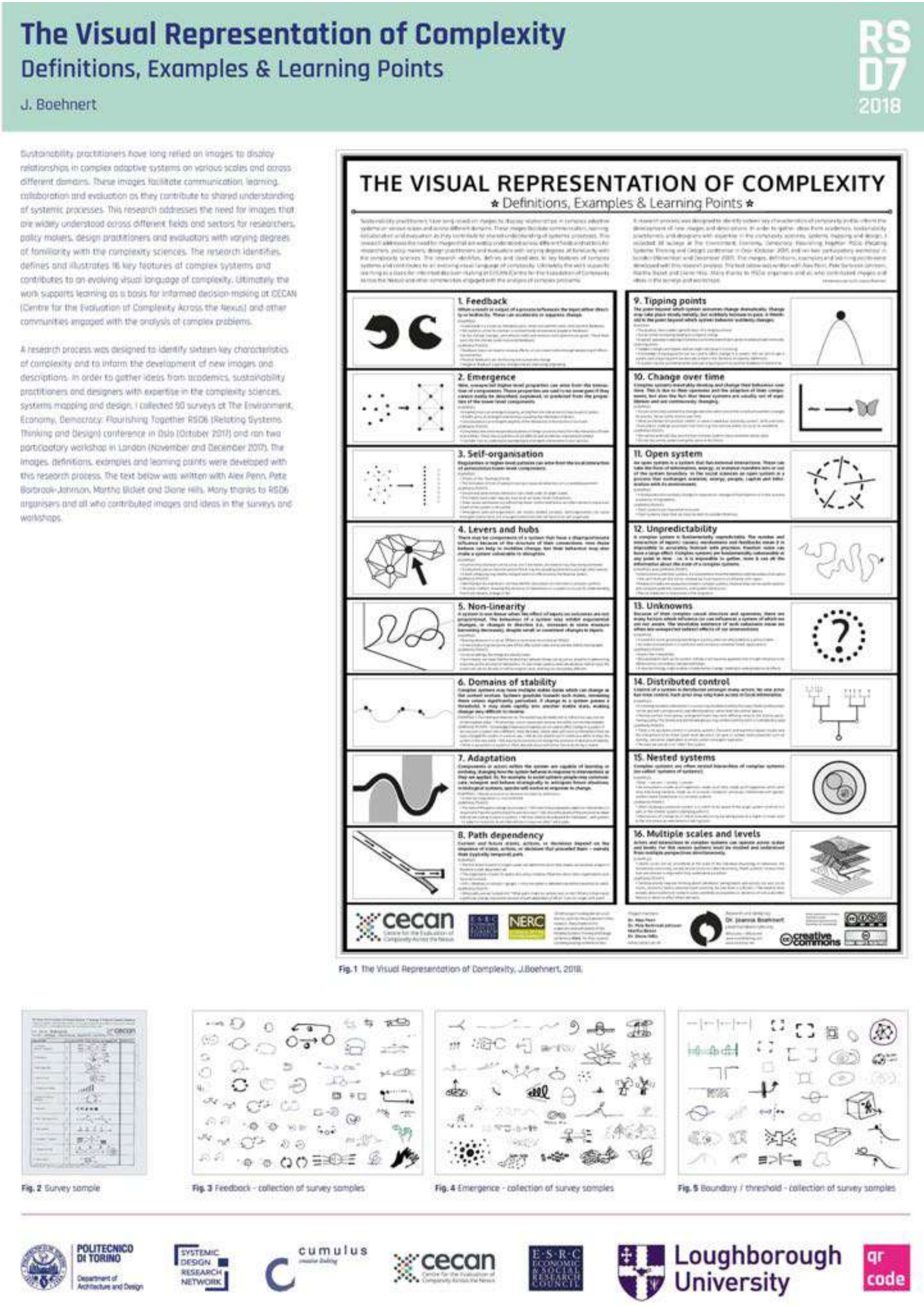


Figure 17. The Visual Representation Of Complexity. RSD7 poster.

4. Reflections

This short research project created space to examine, critically assess and redesign visual representations of some of the key features of complexity with an interdisciplinary research team using a participatory design research process. It brought design knowledge to the CECAN community and expertise from the CECAN research group to the systemic design community engaged with this research. Over the past decade systemic designers have sought to develop visualisation practices to capture complex systemic processes. Images can provide a nuanced understanding of systemic processes and serve to nurture relational ways of understanding complex phenomenon by displaying information about the features and types of relationships (Sevaldson 2016; Boehnert 2014, 2018). This visual representation of relationships as a means of supporting relational perception and ecological perception (Sewall 1995, 1999; Boehnert 2014, 2018). Since complexity is often characterized by relationships, i.e. it is the dynamics between different actors that determines how system functions, relational perception can a means of understanding complexity.

This research project was made significantly more difficult by the way CECAN management engaged with the design research process. Participatory design processes often face the common problem of scope creep as work expands with the involvement of people pulling in different directions, accelerated by the power imbalances between participants. The initial research proposal for this research was very different from the ideas that were developed for the outcomes once participatory processes were initiated. The additional work generated by requests for new illustrative icons (not codes) and then entirely new visualisations were not supported by CECAN management despite my request to be paid for the work of attending to new objectives.

Despite these difficulties, this research was completed to inform decision-making at CECAN and other communities engaged with the analysis of complex problems. The identification of 16 key characteristics with definitions, learning points, examples and illustrations can be used as a learning resources for practitioners, academics and students alike. The work supports learning, collaboration and decision-making for interdisciplinary researchers, policy makers, design practitioners and evaluators as we develop a shared understanding of systemic processes. The research contributes new definitions and visual representation of key features of complexity.

Acknowledgements

Many thanks to the organisers and participants of RSD6 Oslo and the CECAN research group (Alex Penn, Pete Barbrook-Johnson, Martha Bicket and Dione Hills) for their contributions to this work. This research project was completed with the support of Loughborough University.

References

Boehnert, J. (2014). Ecological Perception: Seeing Systems. In Proceedings of DRS 2014: Design's Big Debates, Umea, Sweden, 16–19 June.

Boehnert, J. (2017). CECAN Fellowship application form (unpublished).

Boehnert, J. (2018). *Design, Ecology, Politics: Towards the Ecocene*. London: Bloomsbury Academic.

Cabrera, D. & Trochim, W.M.K. (2006). A Theory of Systems Evaluation, in *Systems Evaluation and Evaluation Systems Whitepaper Series*. Ithaca, NY: Cornell University Dspace Open Access Repository.

Cabrera, D. (2008). Distinctions, Systems, Relationships, Perspectives: The Simple Rules of Complex Conceptual Systems: Proceedings of the 52nd Annual Meeting of the ISSS, Jan 1, 2008.

Gell-Mann, M. (1995/96). Let's Call It Plectics. *Complexity*, 1 (5), John Wiley and Sons, Inc.

Greene, J. C., & Caracelli, V. J. (1997). Advances in mixed-method evaluation: The challenges and benefits of integrating diverse paradigms. In J. C. Greene & V. J. Caracelli (Eds.), *New directions for program evaluation* (Vol. 74). San Francisco, CA: Jossey-Bass.

Jones, P.H. (2014). Systemic design principles for complex social systems. In G. Metcalf (ed.), *Social Systems and Design,* Volume 1 of the Translational Systems Science Series, pp 91-128. Springer.

Jones, P. (2014) RSD3/ Relating Systems Thinking and Design 2014. Design Research Methods in Systemic Design In Proceedings of RSD3, Third Symposium of Relating Systems Thinking to Design.

Masud, L., Valsecchi, F., Ciuccarelli, P., Ricci, D., & Caviglia, G. (2010). From Data to Knowledge Visualizations as Transformation Processes Within the Data-Information-Knowledge Continuum. 14th International Conference Information Visualisation (26-29 July) London, United Kingdom.

Sevaldson, B. (2013). "Systems Oriented Design: The Emergence and Development of a Designerly Approach to Address Complexity." In Proceedings of DRS/Cumulus Oslo 2013: 2nd International Conference for Design Research Education Researchers. Oslo: DRS/Cumulus (May 2013): 1-22.

Sevaldson, B. (2016). A Library of Systemic Relations. SOD. Accessed online: http://www.systemsorienteddesign.net/index.php/giga-mapping/types-of-systemic-relations

Sewall, L. (1995). The Skills of Ecological Perception. In T Roszak, M Gomes, & A Kanner (eds.) *Ecopsychology.* San Francisco, CA: Sierra Club Books, 201–215.

Sewall, L. (1999). *Sight and Sensibility: The Ecopsychology of Perception*. New York, NY: Putnam.

Trochim, W. (1989). An introduction to concept mapping for planning and evaluation. *Evaluation and Program Planning*, 12(1), 1-16.

Trochim, W. & Cabrera, D. (2005). The Complexity of Concept Mapping for Policy Analysis. Prepared for the 1st International Workshop on Complexity and Policy Analysis, Cork Ireland, 22-24 June 2005.

Co-Designing a Social Innovation Model for Changemakers

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Abstract As design educators we believe that continuous innovation in education is necessary if we are to imagine new ways for young people to realize their potential. It is critical to rethink our education system and ensure that it is reflective of our current, complex realities. We are especially interested in co-designing learning processes that encourage social innovation and recognize young people as active changemakers. To do this, we developed a research program titled INNOCO (**Inno**vation **Co**-designed). With support from Zayed University in Dubai, UAE we developed a humanistic research framework, an adaptable set of activities including an innovation bootcamp and a supportive community network that continues to grow. INNOCO was delivered with youth in the UAE and in Nepal and has achieved considerable impacts tracked through both quantitative and qualitative narratives. Our core work is about co-creating pathways for youth to engage in and grow social innovation in their communities.

Keywords: Empathy-Driven, Social Innovation, Changemakers, Co-Design, Transdisciplinary, Youth Empowerment, Education systems

1. Introduction

As design educators at Zayed University in Dubai, UAE, we believe in using social innovation to explore new systems of education that are relevant to the evolving needs of our communities. Particularly in the field of education, continuous innovation is both necessary and possible if we are to imagine new ways for young people to realize their full potential.

The current education system in practise in most parts of the world often represents a socially narrow and dated curriculum that is limited in its ability to cultivate empathetic, driven and holistic young leaders and changemakers. In a report titled 'Reimagining Education' by the Centre for Public Impact, the foundation wing of the Boston Consulting Group, the argument for new ways of thinking about education is made clear "*while education is our greatest lever for social change, the current system is increasingly falling short. Unacceptable gaps in academic attainment, poor social mobility, rising mental health issues and a failure to provide young people with the skills they need for life in the 21st century are just some of the consequences of a system rooted in the needs of a bygone era." (*Big Change and Centre for Public Impact, 2013). There is a strong need to rethink education and socially innovate a system that is relevant and responsive to the complex realities youth experience in today's world. We were especially interested in how to encourage creative youth engagement in social innovation as a means to enable young people to realize their potential as changemakers.

The term 'social innovation' has enjoyed increased popularity in recent years and is often used to distinguish between the more traditional understanding of technological or market-based innovation that has failed to address rising social inequalities. According to the Centre for Social Innovation at Standford University, it speaks to a paradigm shift for how we collectively understand innovation and requires projects to consider and tackle significant societal issues such as poverty, unemployment, degrading environments and education. Agnes Hubert's 'Empowering People, Driving Change' report defines social innovation as "*new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society but also enhance society's capacity to act*" (Hubert et.al., 2010).

Considering the changing needs of education and our commitment to social innovation, the central question we explored was ***'How might we co-design an immersive, educational, transformative, and sustainable changemaker pathway for social innovation?'*** To do this, we leveraged community initiative and institutional support from Zayed University to build a platform to social innovation named INNOCO (Innovation Co-designed). Simply put, INNOCO actively supports young people interested in building their capacities as changemakers. Hence, it strives to disrupt linear educational approaches and builds on the need for a paradigm shift in education in the region. The INNOCO program is based on humanistic principles of co-design, meaningful participation and how the 'self' is inherently tied to the 'collective.' This foundational principle is visualized as a model titled ME=WE discussed in detail in later sections. The program activities include a set of versatile and adaptable workshops, readings and interactive exercises that marry relevant content with engaging learning methodologies. These activities enable participants to consider changemaking capacities on an individual (micro), community (meso) and systemic (macro) level. Our core work is about co-creating pathways for youth to engage in and grow social innovation in their communities.

In three years INNOCO has developed a successfully implemented research framework that has already been modeled for a partner project at Zayed University; has facilitated a youth engagement program with participants in UAE and Nepal; and, has chronicled the changemaker journeys of program participants through quantitative and qualitative narratives. Through these cumulative processes, youth explored ways in which they could connect, collaborate and contribute to their larger communities. Critical aspects of our work are detailed below with the hope that an engaged audience of educators and systems thinkers may learn from our shared experiences and enrich our collective knowledge.

2. Values of Co-design

INNOCO is a strong example of an initiative that benefits from a convergence of bottom-up and top-down approaches. The value we assigned to co-design was instrumental in deepening our understanding of social innovation and ensured that the learning process we developed would be informed by multiple perspectives. The co-design process was crucial in forming a common language of understanding to unify opinions and direction. Our foundation for co-design was inspired by Margaret Mead's famous words *"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has."*

2.1. Leadership and Vision

The meaningful participation of diverse voices is critical to furthering social innovation, additionally, so is the presence of strong leadership. Good leaders are imperative to the success of co-design as they steer collective dialogue and facilitate the identification of a common vision. INNOCO's principal leads were able to articulate their vision for social change with transparency and passion which enabled the multiple collaborators, partners, mentors and participants involved in this work to leverage their unique expertise to further a collective vision for change.

2.2. Inclusivity and Participation

Through strategic outreach, preliminary exploratory sessions and surveys with our immediate and international communities, we initiated dialogues about reimagining education and learning that helped nurture our direction and actions. The formation of an organic team included the perspectives, knowledge, skill and guidance from students, educators, CEO's, industry experts, existing changemakers and storytellers to name a few. The elements that were generated through the co-designing process were adaptive and responsive to the interests of youth participants and collaborators to cultivate and expand our collective capacity. For example, youth who expressed an interest in facilitation were invited to co-host sessions with lead facilitators.

Although the processes for co-design can be slow, complex and highly iterative, we believe it to be a promising pathway to social change allowing community participation. From 2015-2018 our co-design process involved approximately 116 experts, facilitators and collaborators from diverse and multidisciplinary backgrounds. Understanding limitations and levels of commitment from participation is highly important in the co-design process. When done right, co-design can yield lasting, meaningful impact that permeate through individual, community and systemic levels.

2.3. Impactful Ownership and Achievement

Ideas that are collectively imagined, designed, developed and implemented, we believe this creates a lasting change because of the diverse voices that are engaged. Individuals who were able to provide meaningful input into existing areas or foresee new areas of development and could take ownership proved to be valuable to the overall growth and progress of INNOCO. The collective actions of co-design has to meet individual ownership and community driven purpose to be impactful towards systemic changes.

Through these collective contributions, acknowledging achievements and appreciative celebration creates milestones in the growth of social innovation work. Challenges and setbacks are always part of the tapestry but when on-the-ground action and team effort leads to successes it brings us closer to the realization of a collective vision as changemakers.

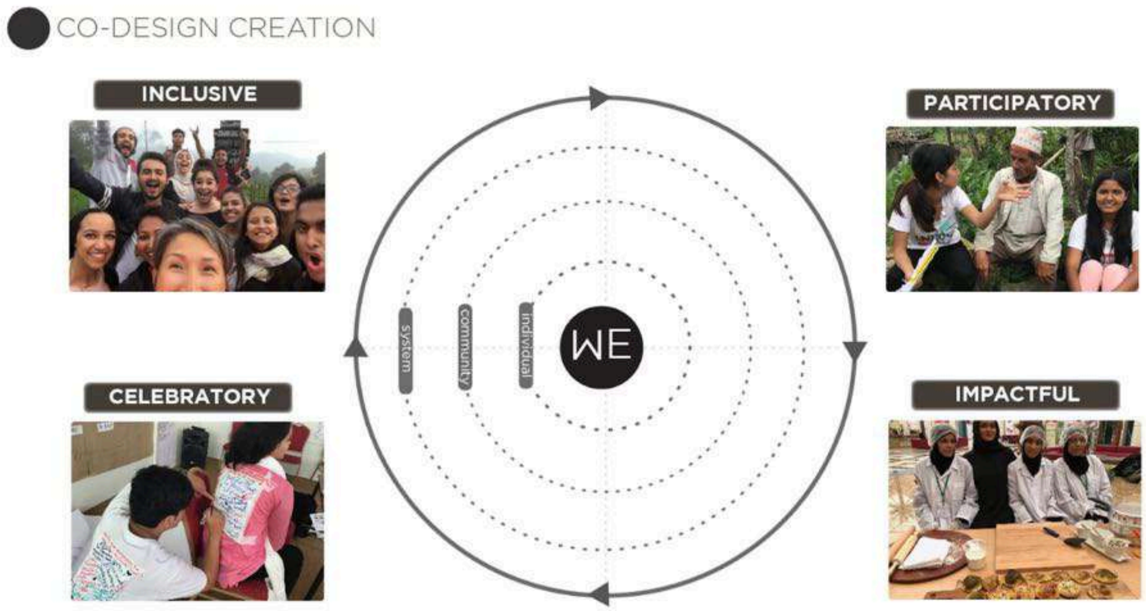

Figure 1. INNOCO's principles of Co-Design

3. Research Framework

Our research model is a human-centered and evidence-informed one titled 'ME=WE' that resonates with the Panarchy Theory to understand the systemic and symbiotic relationships between self (ME) and society (WE). **ANA=NAHNU (أنا=نحن) as translated in Arabic** is a core humanistic concept of empathetic understanding between the self and society. It acknowledges how personal growth can lead to creative confidence and empowerment that ultimately contributes to society.

ME=WE attaches significant value to the symbiotic relationship between an individual and the larger societies and systems he/she/they inhabit. The framework focuses on 'action and reflection' contributing to social change that one can affect at an individual (micro), community (meso) and systemic (macro) levels.

Wise and diverse communities across our world adopt this simple philosophy. In 'The Origin of Values', Fredrik Barth discusses the Balinese principle of 'tattwa-masi', which translates to '*you are we and we are you*'. Similarly, Jacoba Mugumbate and Andrew Nyanguru explore the South African philosophy of "Ubuntu" in the African Journal of Social Work, it teaches that our humanity is reflected in the achievements and humanity of others, intrinsically connecting the 'self' with the collective. This framework also manifests in the Mobius strip, a mathematical phenomena that demonstrates infinite and continuous movement and sprouting growth.

At INNOCO the ME=WE framework was developed as a pathway that begins with the individual as a changemaker who engages with their community and systemic change through a continuous cycle of growth, action and reflection. The individual journey mirrors the expansive and moving structure of this framework as they engage in activities grounded in empathy, trust, creative confidence and communication. Through this work, the individual experiences growth points between action and reflection allowing for enriching their knowledge and capacities and deepening appreciative inquiry mode as continuously leaping from ME to WE and WE to ME.

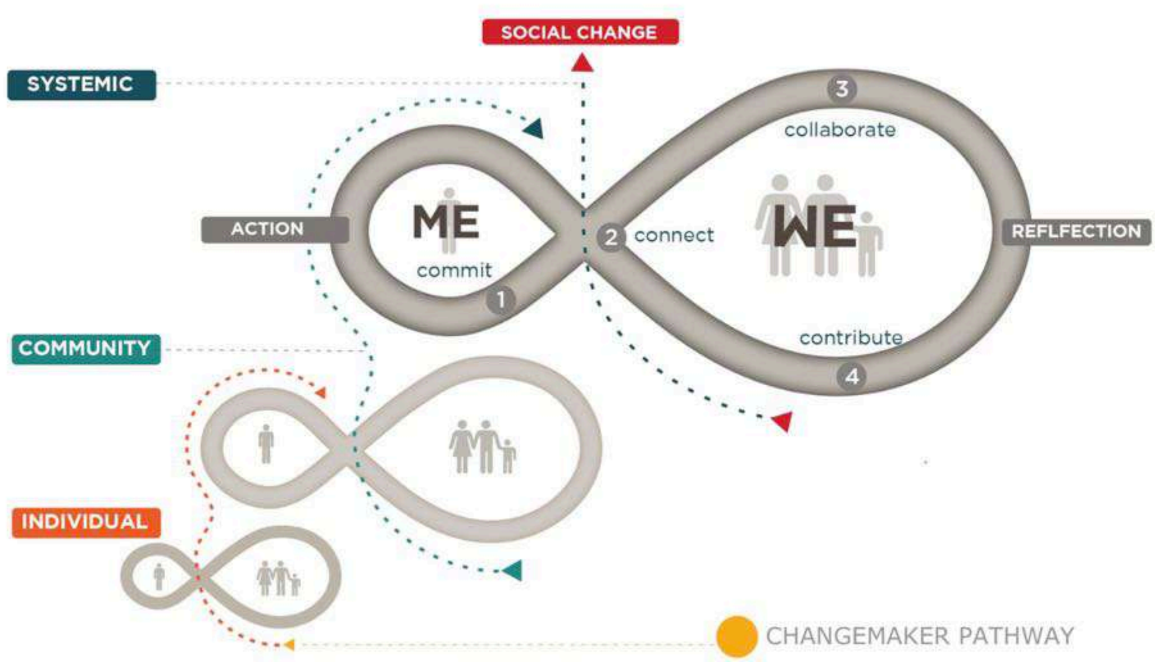

Figure 2. ME=WE framework guiding a changemaker's pathway

4. Program Tools

A flexible and imaginative program as a series of independent workshops and an intensive 9-day bootcamp was developed to facilitate socially minded youth engagement. The program objective was to build collective capacity in planning and developing entrepreneurial and/or community-driven service projects and contribute to tangible change-making.

4.1. Immersive Program

The immersive program was co-designed considering changemaker character building, experiential learning, empathy driven practice and community/industry integration. Through phase one of the program, we focused on the individual changemaker and in identifying their pathway. The program consisted of four main workshop styled sessions:

- **Building Creative Confidence** focuses on the individual's paradigm shift to a confident space by considering the meaning of empathy, trust, identity and passion. It builds upon the participants identified strengths and perspectives to re-think self to society and vice-versa (ME=WE). The session ends with the participant envisioning their hero journey as changemakers and commitment to moving forward.
- **Design Thinking Practice** initiates the conversation of value creation by using empathy driven tools, establishing needs finding and point of view processes, visualizing and ideating through storytelling techniques and quick prototyping to assess assumptions towards social problems.
- **Social Innovation Space** begins with what social entrepreneurship might look like so participants can define it. This workshop introduces the Value Proposition Design (VPD), Social Business Model Canvas (SBMC) and how experience innovation stands on the pillars of desirability, viability and feasibility. These aspects are applied to the participants selected social issues to realize sustainable solutions.
- **Pitching Social Innovation Ideas** builds the participants confidence to pitch their social innovation ideas through a meaningful story, convincing and structured vision and engaging storytelling. The program concludes with the pitch presentations evaluated by a panelist from the community, for relevant feedback to action and possible connections for the changemaker to further their learning and begin to establish their ecosystem.

The INNOCO program was piloted with youth in UAE and in Nepal in varying forms. In UAE (2016-2017) a six-month workshop series was implemented where 20 youth experienced learning and collaboration towards 3 pitched ideas, participants were not ready to move forward with their social enterprise or community service projects. In Nepal (2016 – 2018) during the UAE Nepal Connect (UNC) project, the program was initially piloted with select youth and evolved into a 9-day innovation residential bootcamp with 18 youth. At the end of the Nepal bootcamp, nine ideas were pitched to a panel of community panelists, out of which seven have emerged as viable projects in ongoing development.

4.2. Cluster Development

INNOCO's next phase of programming was to mobilize youth who participated in the program to form a support and networking system to assist each other and motivate growth of project or service ideas. The aspect to further facilitation of the program and learning in the changemaker communities was also an objective. The Nepal bootcamps lead to the development of the Nepal Youth Cluster (NYC), initiated by the participating youth in 2016. Core members of NYC assisted in co-designing the 2017 bootcamp and created the conversation with new participants to establish their own not-for-profit organization in August 2018, Nepal Youth Innovators (NYI).

4.3. Ecosystem Mapping

This area of the program was to consider the changemakers' journey on a systems scale to affect social change at the macro-level. Taking into consideration the ME=WE framework, an 'Ecosystem Mapping' tool was co-created by the INNOCO team and paired with a mentorship component to strengthen the changemakers' self-growth and the scalability of their project. Seven mentors were identified and recruited from Nepal and internationally, matched with seven NYI changemakers to foster learning and expansion of their projects pitched during the bootcamp. This is an ongoing relationship and supports the growing needs of the changemakers.

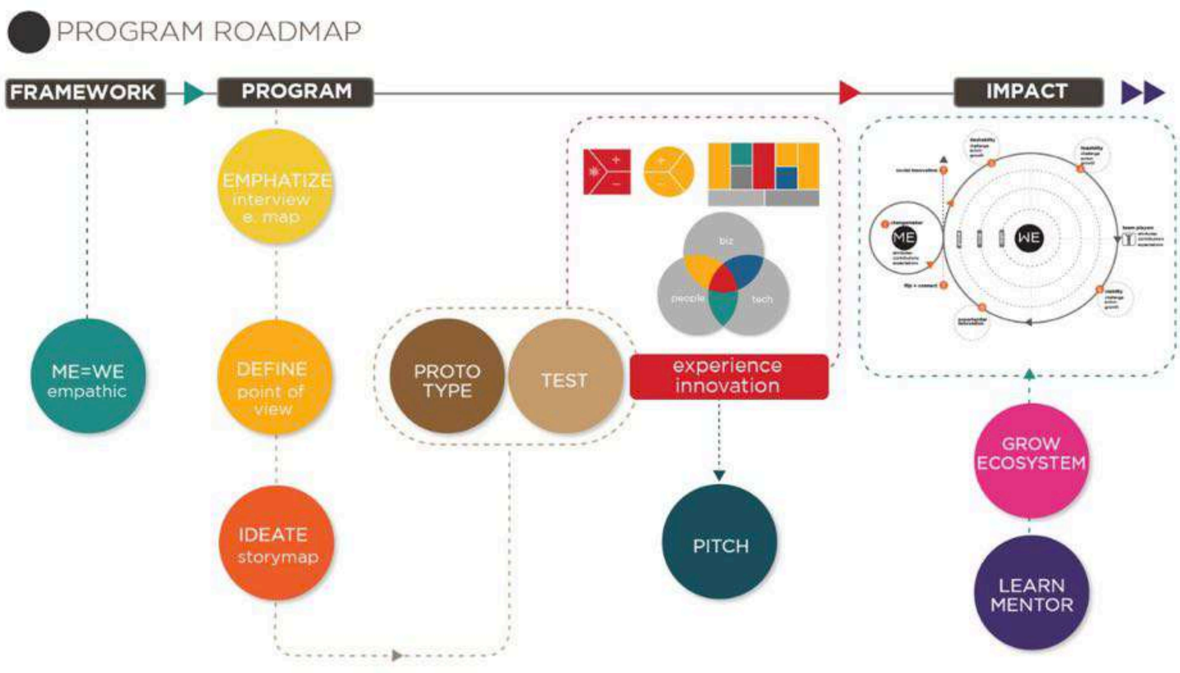

Figure 3. INNOCO program roadmap

5. Impact Stories

INNOCO emerged as an exploration of how we might reimagine education as a meaningful pathway for youth to changemaking and community building. This exploration evolved into an immersive, transformative, and sustainable educational program wherein youth could realize their potential as changemakers and active players in society. The program underwent multiple renditions that consisted of pilot modules, workshops, bootcamps and co-design sessions in both UAE and Nepal and therefore the impact data gathered is fairly vast. To determine INNOCO's key impacts we considered the original objective and structured a mixed-methods data collection plan that allowed us to gather rich qualitative narratives of change from youth participants along with quantitative measures of program effectiveness. Data was collected following the pilot program delivered to local youth in the UAE, the first phase of the program in Nepal, and the second phase or innovation bootcamp. The impacts of our work are illustrated through these sets of data and by the stories they tell.

5.1. Local Impact

The INNOCO program was initially piloted with youth in the U.A.E. and consisted of a series of workshops and talks that introduced youth to key concepts of social innovation, co-design, community collaboration and creative confidence. 20 participants were asked to complete feedback forms at the end of the sessions and were also interviewed for added input. Data indicated that young people found the concepts of social innovation useful but the current environment they found themselves in did not enable them to translate their understanding into actionable change-making projects.

While youth in the pilot program did not build social innovation projects themselves their feedback allowed us to build on the program and create a more nuanced and detailed program which evolved into the innovation bootcamp offered in Nepal. Pilot participants were also actively involved in planning and facilitating the next phase of the program. They even travelled with the team to Nepal to deliver the new series of innovation workshops; the value of this exchange has manifested in meaningful cross-cultural relationships, mentorships and understanding.

5.2. International Impact

Following our experience in UAE, the team decided to pilot the program in an international setting and leveraged a partnership in Nepal to deliver the program with diverse youth based in Kathmandu. This resulted in the UAE Nepal Connect (UNC) program.

While our impact assessment data is primarily qualitative gathered through transcribed one-on-one in-depth interviews, quantitative data was also collected through post program surveys. Analysis of the quantitative narratives shows that the program was highly rated by participants especially in the areas of *bootcamp environment and cultivating culture*. These were critical areas for us as we attempted to create an unconventional learning environment and culture that valued co-design where youth could contribute to the process in fulsome ways. On a scale of 1-5 (5 is very satisfied; 1is unsatisfied) participants rated key areas of their experience, A snapshot of average rating scores demonstrate the following: *Workshop Quality: 4.1 / 5; Content Relevance: 4 / 5; Culture & Space: 4.6 / 5; Expectations Met: 4 / 5; Interaction: 4.2 / 5; Creative confidence: 4 / 5.* These scores indicate key strengths of the program and point to the need for innovative content and learning spaces for youth that prioritize community and change-making.

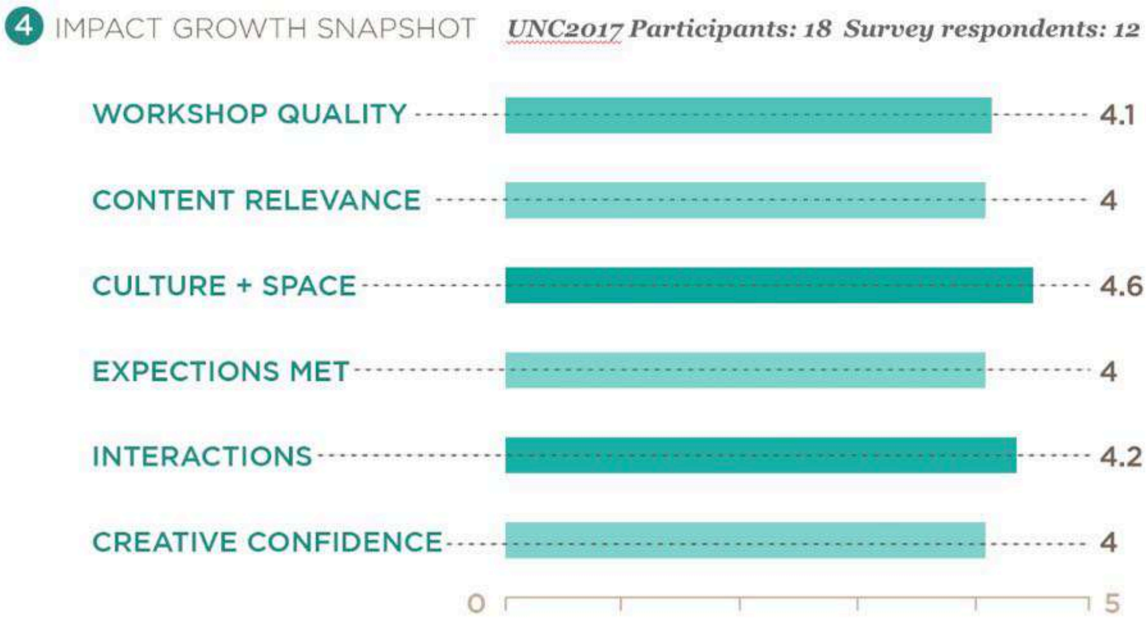

Figure 4. Impact growth with UNC 2017 Program participants (0=low standard / 5= high standard)

The qualitative data collected through in-depth interviews was used to develop a set of illustrated changemaker stories to further our Knowledge Translation and Exchange (KTE) efforts. The stories follow youth participants who completed the INNOCO program and demonstrate the transformative change they experienced that led to actions on individual, community and systemic levels. While many discussed viable social enterprise projects that either resulted from or was fueled by their participation at INNOCO, many also identified key life skills they attributed to the program. These included resiliency and the tools to adapt to changing needs or project directions; confidence and the ability to present and/or communicate their creative vision; and, an understanding of the language of social enterprise along with stronger familiarity with tools such as the empathy engine and value proposition canvas. Here is what some of the participants had to say:

“I got chance to work on projects ... Take survey about different topics ... Visit the farm ... And most importantly present myself and my ideas in front of everyone which gave me confidence ... It gave me worthy lessons for life ... I feel happy about all this”

“I was a bit shy girl but now when I come front for the presentation I just cannot stop myself from giving my best. Once I got the title of 'presenter of the day" as well and it has been possible due to the strength that I got throughout those 9 days of UNC. I am much thankful for those motivating and inspiring days.”

“UNC 2017 means a lot for me. It has always been a milestone for the leadership development and execution. Furthermore, it has bolstered confidence in me to take leadership initiative in different situations. I have emerged as the problem solving, inspiring and energetic, enthusiastic leader at my work.”

"UNC 2017 acted like a fuel to turn my thoughts into action. I am able to witness the impact of boot camp both in my thinking process as well as my courage towards any contingent action that I have to take in my work life. The most powerful thing I have been practically applying in my life is the Value Proposition canvas and the essence of teamwork."

Additionally, there were seven viable projects that emerged from the Nepal bootcamp. All are in their initial developmental and/or operational phases. This includes a literacy and reading program in a rural community; a homestay for women facing domestic violence; a hydroponic farm; and a kiwi farm and waste management system. The Nepal youth group also realized their vision by registering as the Nepal Youth Innovators (NYI), a space for young people to connect to like minded changemakers and cultivate meaningful connections and collaborations to better contribute to social change.

5.3. Added Benefits

From 2015-2018 INNOCO's co-design process involved approximately 116 multidisciplinary experts, facilitators from diverse backgrounds and collaborators across sectors of work. Sparking this flourishing and supportive network of people passionate about social innovation is one of the program's strongest impacts. This network has elevated on-campus learning opportunities at Zayed University by introducing students to expert speakers in social innovation and social enterprise. Many of these collaborators have also supported the program by being mentors for youth participants and actively encouraging their social enterprise projects.

The ME=WE research framework and changemaker pathway developed by INNOCO has also been modeled for a partner project at Zayed University that connects communities to co-designing systems of sustainability and at Impact Hub at Georgian University in the USA. Learning from and having the ability to build on the lessons learnt from INNOCO's research and program experience has been invaluable in sustaining new ways in which to engage young people in becoming active changemakers.

6. Conclusion

INNOCO's journey is a strong example of communities co-designing systemic solutions in the field of education. Our central goal when we began this journey was to reimagine education and learning as a way for youth to further their capacity as changemakers. What we learnt is that new systemic methods of learning and driving social change are not only viable but are being actively sought out by youth and adults alike. People are ready and vested in change. The failings of our current systems in meeting social challenges are increasingly being recognized in communities across the globe and the time is ripe for an overhaul in our thinking and institutions.

A key finding through INNOCO's work has also been the understanding that people are just as committed to social change outcomes are they are to community-based processes. INNOCO's values of co-design, commitment to social innovation and humanistic research framework of ME=WE truly resonated with people who engaged in this work. This understanding allowed for a common language that allowed for stakeholders to buy-in to the vision of a changemaker pathway. Our comprehensive and flexible set of program tools for youth engagement were positively received and the impacts have been significant. The skills, mindset and confidence gained on the individual participant level coupled with the social enterprise project levied on the community level combine to steer a path towards meaningful systemic change. Through these cumulative processes, youth explored ways in which they could connect, collaborate and contribute to their larger communities.

INNOCO's social innovation model in its entirety is both powerful and promising for future work. To continue this journey, an online hub of program tools, research framework, principles and impact stories will soon be shared as a platform for youth, educators and/or academics to easily access and adapt this model for their local communities. We believe that INNOCO is a strong example of a social innovation pathway that cultivates young changemakers and a study in co-designing alternative forms of learning that disrupt linear models. As one of the INNOCO youth participants in Nepal so aptly states "*What we learn in schools is not everything, I want kids and young adults to learn life skills that will bring out the best person that they can be*"

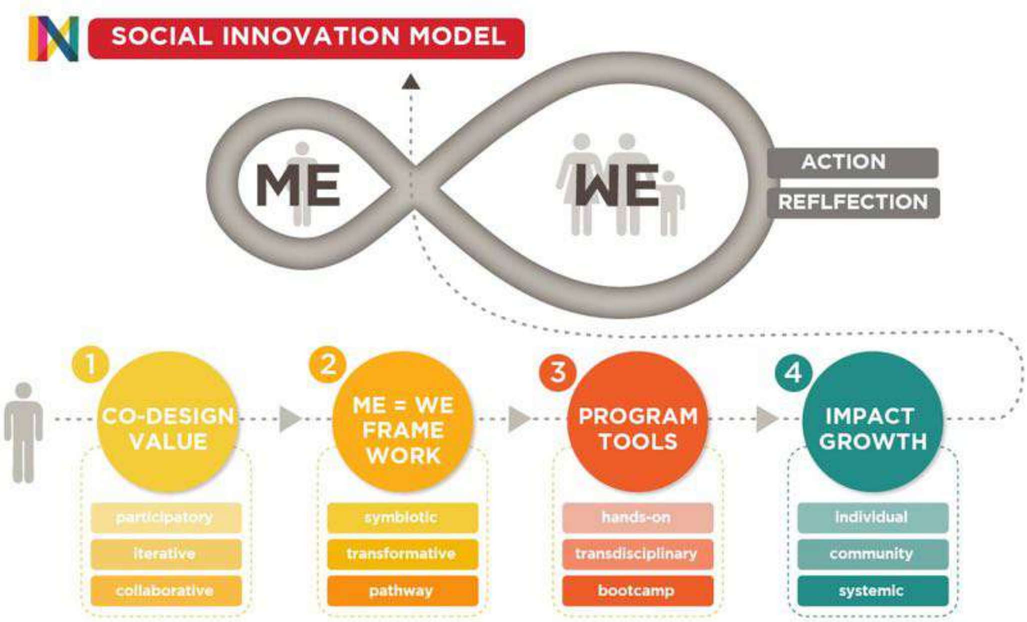

Figure 5. INNOCO Social Innovation Model

References

Agnes Hubert et al., (2010) Empowering people, driving change Social Innovation in the European Union. *The Bureau for European Policy Advisors*, Pg 09

Big Change Organization, 'Reimagining Education,' Centre for Public Impact; pg 05

Centre for Social Innovation ; Stanford University

Moore, Michele-Lee, and Frances Westley. (2011) "Surmountable Chasms: Networks and Social Innovation for Resilient Systems." *Ecology and Society*, vol. 16, no. 1,

Gunderson and Holling, 'Panarchy: Understanding Transformations in Human and Natural Systems' (2012)

Hechter, Michael et al, (editors), (1993) '*The Origin of Values*', Are Values Real?. The Enigma of Naturalism in the Anthropological Imputation of Values, pg 40

Jacoba Mugumbate and Andrew Nyanguru, *African Journal of Social Work*, Exploring African Philosophy: The Value of Ubuntu in Social Work, Vol 3, no 1, 2013, pg 84, https://www.ajol.info/index.php/ajsw/article/viewFile/127543/117068

Perspectives on Systemic Design: examining heterogeneous relevant literature to provide a historical and 'systemically inspired' review

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Abstract This paper lays out a plan of action for literature review on Systemic Design. It argues that despite the newness of systemic design, there is scope for such work, especially if it departs from the typical styles of literature review, and a) takes a historical perspective, b) pulls in a range of heterogenous literature, and c) if, in doing this, it takes its cue from systems itself, and uses systems thinking based methodologies to establish the interrelationships between systemic design and its influences and directions. Thus the goal of this paper is to explain the rationale for this review style and to call for it to become a strand of research that offers interested scholars a place to stand to examine the antecedents of the turn to systems by designers, to learn about the rich heritage of the systemic design and to help develop further themes within this design paradigm that are newly emerging.

Keywords: Literature review, systemic design, heterogenous resources, historical perspective, emergent themes,

1. Introduction

As the ideas of systemic thinking become more familiar and found in many disciplinary discourses, so there is an increase in work reviewing systemic thought. Existing literature reviews are often conducted from a particular disciplinary standpoint, for instance, management (Mele, Pels and Polese, 2010); engineering (Monat and Gannon, 2015). It is as yet too early to carry out a literature review on systemic design. Therefore, although this paper is in the tradition of a literature review, it differs in two respects. The first difference is in the emphasis on giving a sense of a historical perspective (Peruccio, 2017). This allows us to move from the type of literature review whose primary purpose is to draw out key concepts. Rather, we wish to add to the 'key concepts' review, a narrative that builds on timelines and contemporary reactions to relevant discourse in the period under study. The second difference is to use a review methodology based on a systems-inspired literature review (Sylvester, Tate and Johnstone, 2013). This encourages drawing in a range of literature and lends support to narrative inferences by making explicit the interrelationships between ideas, timelines and contemporary discourse. The rationale for making these departures from traditional review methodologies is that, since systemic design is relatively new, grounding it within a historical perspective is an important contribution to establishing a background. Also, systemic design's 'newness' means that resources are not discoverable using traditional literature review search techniques which rely on pre-defining search terms. However, we believe that a review based on 'sweeping in' (Nelson, 2003) heterogeneous relevant research literature will offer a richer set of materials. In short, this review would seek to map the trajectory of ideas that have been influential in systemic design and related themes 'entangled' with systemic design, and by doing this, generate fresh insights into the philosophy, theory and praxis of systemic design.

2. From a traditional to a 'systemically inspired' review'

Typically, a descriptive literature review will use a number of search terms, and choose a number of publication outlets, to seek and obtain a good coverage of source material. When a collection of resources is made, they are studied, and the reviewers synthesize previous research and conceptualise the research themes. From this, reviewers will build a picture of what is happening in that particular discipline with regard to a particular topic. The main purpose of this type of review is to draw out the key concepts. Our claim is that for Systemic Design it is too early to have such a review, and that a narrative literature review based on historical perspective will be more conducive to offering useful insights. Also, it will not be possible to be neutral, but the interpretative approach will be open and thus available for inspection and debate.

We propose to use a systems thinking inspired approach (following Sylvester, Tate and Johnstone, 2013) who look for the narratives and uses soft systems methodology to better understand those narratives and frame them, giving interpretations that do not need to follow the positivist style with the emphasis on progression common to most typical literature reviews. Although this approach was adopted for studying concepts in Information Systems, it can be adapted to be used with systemic design. This is because it is primarily a narrative, as opposed to a descriptive, approach. The narrative approach in this case, makes use of a historical perspective, which is helpful for grounding a new emergent design paradigm such as that of systemic design. It does this by placing it in context, showing how it relates with the various schools of systems-based work, where different groups of researchers are working with the 'same' theory, but in different ways for different purposes.

Such an approach was taken by Greenhalgh, Robert, Macfarlane et al., (2005). They proposed that a 'meta-narrative' review can help make sense of heterogeneous bodies of literature, in which different groups of scientists have conceptualised and investigated the 'same' problem in different ways, in their case the theory of the diffusion of information. .Although this is not the kind of question we are dealing with here, still there is value in the idea of a meta-narrative that may offer explanations for various phenomena we observe and help us to interpret them. We agree with Sylvester et al. in challenging the assumption that scholarly knowledge accumulates in a linear fashion over time. They present evidence that sometimes, because of the popularity of some schools of thought, they seem to create more and more studies following established models and methodologies, such that research, rather than building up, is 'piling up', and not creating new insights or advances. When literature reviews of such schools of thought are carried out, they are necessarily inward looking, even though a traditional descriptive review may point to a continuous progression. By combining thematic and historical context to the literature, it is possible to "identify turning points, changes and disconnects […] distinguishing advocacy from enquiry […] provide a nuanced and heterogeneous understanding of a complex real-world phenomenon." (Sylvester, Tate and Johnstone, 2013, p.1213).

Finally, our approach also draws from Cameron and Mengler (2009), who worked on a problem that we see as similar ours, although with a starting point that is based on heterogeneity of meaning. Working in the context of museums, they noted that many museums share the problem that their objects in their collection are too many to be displayed at any one time. However, with the advent of the internet, it is possible for interested parties to experience virtual objects. The problem then becomes that both "digitization and networked access enable […] gathering a broader range of associations around collections, intimately connected to cultural, social and political formations, debates and events." (Cameron and Mengler, 2009, p. 190) and the question arises of how to catalogue the objects to take account of these associations. The classification systems previously established are no longer relevant, as they are too closed to be of wider use. Yet online databases provide access to those objects that cannot be displayed, so the information about them needs to be as rich as possible.

In addition, as part of the modern conceptualization of museums, they are no longer to be conceived as 'mausoleums' but as collections enhancing public education and awareness, meaning that they should be as open, but also as relevant, as possible for the public. The dichotomy between the expert museum curator and the casual visitor is also breaking down, as the meanings assigned to objects move into the realm of the 'networked' object. This refers to the object, whether virtual or real, that is the subject of debate over the internet. Such network objects can be artefacts that have not been seen in the museum setting, in real life, but are the main protagonist in online debates. Thus, the researchers sought to understand how the museum might moves from a closed system to one that attempts to match its lived environment with all its incumbent contradictions, uncertainties and variabilities. Their response was to use the metaphor of complexity and acknowledge that on the one hand the heritage of classifications are valued, but that in addition, meanings are fluid. Of course, this is well known internally within the museum curators and cataloguers, but the custom has been to ‘force’ objects into classification, as a means to foster clarity and rationality, and to maintain the authority of the museum. This is in spite of much research demonstrating that the way the museum cataloguers understand the objects differs greatly from the way members of the general public do.

Accepting that there is room for alternatives, and that this should be a source of richness, and an opportunity to authorise more meanings, without compromising the authority of the museum, is akin to what we propose in our literature review approach. We propose that the heterogenous literature can contain different narratives that can foster different meanings, meanings that are not available if practices such as selection processes or pre-assigned meanings predominate.

Thus, Sylvester et al. see the problem of the traditional literature review as pre-imposing a selection process that narrows down the collection of documents to be studied, and also assumes positivist progression, and Cameron and Mengler see the objects in the museum collection as being forced into a rigid classification system that denies their existence as ‘networked’ objects. Sylvester et al. suggest a historical perspective and derives narratives in which to foster new interpretations. Cameron and Mengler suggest the notion of “knowledgescapes” and of using complexity as a metaphor that rejects dualistic, hierarchical and linear approaches. Such an approach will incur ‘uncomfortable’ but real-world aspects that we all operate under, such as interlinkages, unpredictability, ambiguity and heterodoxy. In both the traditional literature review, and the traditional documenting systems of libraries, real life is being confined to conform to well delineated ‘systems’ which ignores complexity and with it the richness of stories that do not conform to the accounts that fit within the norms of those systems.

A systems thinking based approach can provide a more holistic picture of the topic under study because it is conducted within the context of surrounding environments. It includes the researcher as an active part of the research setting, facilitating dynamic dialogue among different perspectives of the things and participants (Jung, 2017). Such an approach searches for the influences and looks for the meaning, as illustrated in the two photos below:

Figure 1. Illustrating “Documenting the influences and searching for the meaning”

The review work seeks to both to map the trajectory of ideas that have been influential in systemic design as well as to follow back related themes that are ‘entangled’ with systemic design, e.g. healthcare or eco-sustainability, etc.

Figure 2. Illustrating both “trajectory of ideas” and “themes entangled with systemic design”

3. Entanglement

Figure 3. Illustrating "Engtanglement"

Since both systems thinking and design have highly inter-disciplinary traditions, it is natural that both should be bound up with many types of work, and that sometimes valuable pieces of research are located in publication outlets that would not normally be directly associated with design or systems, such as with a collection of resources about sustainability (Systemic learning for Sustainability, n.d.) or healthcare (Clarkson et al., 2017). Moreover, it may be that the perspective, which may be for example, the collection in which the resource is located conceals viewpoints relevant to systemic design. For instance, we know that participatory approaches are a bedrock of systemic design, yet foundational research on the notion of co-design as collective creativity, leading possible "transformation toward more sustainable ways of living in the future" (Sanders and Stappers, 2008) does not mention systems, although it might be argued that it appears to have absorbed it. Another example is when systems thinking is applied to an area contingent to design, such as creativity: Csikszentmihalyi, a psychologist, claims systemic implications on creativity (Csikszentmihalyi,1999).

Therefore, following relevant themes and topics and also research groups (e.g. Barbero, 2017) is important. This is not done with a primary aim of discovering search terms, - although this can be useful at a later stage for seeking out more resources, - rather, it is mapping themes to an overall emerging picture, so that interrelationships can be reflected upon. This, in turn, leads to more discoveries until a 'saturation' point is reached, sufficient for a well-grounded narrative accounting for how certain themes are related and how developments have emerged. This narrative can then give some basis to make assumptions about how they might continue to develop.

Furthermore, by laying open to scrutiny the ways by which the observer (in this case the authors of this paper) 'interpret' what they see, other observers are able to follow the reasoning and draw their own conclusions, for as Midgley (2003) emphasises, it is not possible to present a neutral account.

3.1. As an example…

The trajectory of systems thinking and systems oriented design offered by Peruccio (2017) shows how a historical perspective can be illuminating. Between the 1972 publication of the *Limits to Growth* (Meadows el al.,1972) and the Buchanan's 1992 paper noting an area of design "concerned with complex systems or environments" (Buchanan, 1992, p.10) there is a gap of two decades. Previous to this, we know that systems thinking was taught in the now famous design education establishment that was the Ulm school, (1953-68). Also, we know that in this period Design was pre-occupied with self-reflection on the nature of design e.g. 'designing designing' (Jones, 1979); with debates about intuition versus positivism, with 'designerly ways of knowing' (Cross, 1982). It is strange that systems thinking does not seem to have infiltrated to produce 'systemic design' earlier.

We might speculate, that perhaps it was because of an association between positivism and system dynamics (Coyne and Snodgrass 1991: Cross, 1993)? On a parallel note, in a different discipline, Collopy notes that systems thinking did not implant itself in management (Collopy, 2009) although he attributes this to need to acquire literacy in systems. The question of systems literacy is also part of other discourses around systems thinking, with claims that systems literacy is essential to all research endeavours (Bosch, King, Herbohn et al., 2007; Dubberly, 2014).

Figure 4 below represents an attempt to show how a visualization of this speculation can lead to more thoughts. Of course, visualizing has been shown to be a good tool for exploring 'data' as Tufte (1990) advocates, based on examples from the past.

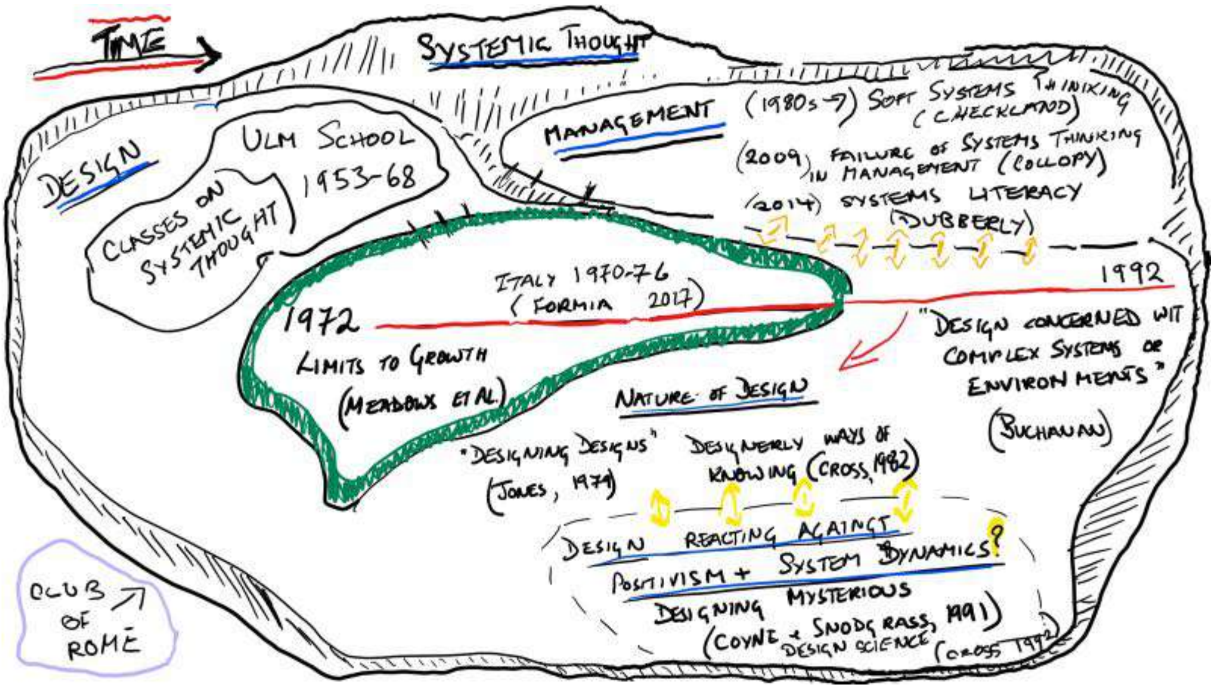

Figure 4. Systemic thought and how it did not take root in Design despite antecedents -rich picture

4. The contributions of Design History and Literature Reviews

Design historians are the acknowledged experts in answering these kinds of questions posed above (Formia, 2017). However, we maintain that literature reviews, especially those framed as we have described, could also be helpful. For instance, within design oriented academic journals, there is an emergence of concern with incorporating wider issues into design. Examples are papers on 'whole system design' integrating social, economic and environmental phenomena (Blizzard and Klotz, 2012; Charnley, Lemon and Evans, 2011) and the linking of 'design for sustainability' (DfS) as design for 'system innovations and transitions' (Ceschin and Gaziulusoy, 2016). Many of these papers evolve their systems thinking discourse from exposure to interests in sustainability (stewardship of the planet), or to 'bumping up against' complexity in their design work. This correlates the claim that, "design studies today tend to follow an ambiguous version of complexity theory, rendered without citations or methodological influence" (Jones, 2014, p.123). If this is the case, is design simply responding to the pervasiveness of calls for the need for systems thinking, apparent in all kinds of settings from agriculture to 3rd sector work (Bland and Bell, 2007; Vexler, 2017)? In order to try to answer these questions, we need a blend of both a historical perspective, literature reviews that follow the narrative method, and heterogenous literature encompassing various types of resources, coming from various disciplines, not to mention different regions of the world, and where literature may not ordinarily be available to researchers because of language or other barriers.

5. Current work and future directions

The plan for our work, is to continue to map out themes and timelines, with the aim of also creating a set of resources that can be added to, interpreted (and re-interpreted) to explore the interrelationships of timelines with themes that are found both in and around systemic design. A number of such themes have already presented themselves in our work so far, such as the relationships between service design and systemic design which call for both more grounding and more exploration (Darzentas and Darzentas, 2014, 2016). Another theme is to examine the antecedents of recent work on systems thinking as a psychological construct (Davis, Leppanen, Mularczyk, et al., 2018, Randle and Stroink, 2018), and speculate what this might mean for designing with neurodiversity. More immediately, the suggested synthesis of Design Thinking and Systems Thinking (Pourdehnad, Wexler and Wilson, 2011; Ryan, 2014) is a fertile ground for more nuanced investigations as evidenced by (Jones, 2014: Sevaldson, 2017)

It is our hope that we can also engage with the emerging systemic design community, via the new Systemic Design Association, to create a special interest group of like-minded researchers, in order to, for instance, bring in impactful literature from sources that are unknown to the wider community, because of not being published outside of national boundaries, or inaccessible due to language barriers, or being published in non-indexed resources. In this way, we hope our review work will not only lead to publications, but also to the establishment of a background prompting fresh research questions.

References

Barbero, S. (Ed.) (2017) *Systemic Design Method Guide for Policymaking: a Circular Europe on the Way*, Allemandi, (output of the EU funded Interreg RETRACE project)

Bland W. L. &. Bell M. M. (2007) A holon approach to agroecology *International Journal of Agricultural Sustainability* 5(4) 280-294

Blizzard, J. L. & Klotz, L. E. (2012). A framework for sustainable whole systems design. *Design Studies*, 33(5), 456–479.

Bosch, O. J. H. King, C. A. Herbohn, J. L. Russell I. W. & Smith, C. S (2007) Getting the Big Picture in Natural Resource Management—Systems Thinking as 'Method' for Scientists, Policy Makers and Other Stakeholders *Systems Research and Behavioral Science* 24, 217-32

Buchanan, R. (1992). Wicked Problems in Design Thinking *Design Issues*, 8(2), 5–21.

Cameron, F. & Mengler, S. (2009). Complexity, Transdisciplinarity and Museum Collections Documentation: Emergent Metaphors for a Complex World. Journal of Material Culture, 14(2), 189–218.

Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies*, 47, 118–163

Charnley, F., Lemon, M. & Evans, S. (2011). Exploring the process of whole system design *Design Studies*, 32(2), 156–179

Clarkson, P. J. et al (2017) *Engineering Better Care: a systems approach to health and care design and continuous improvement,* Royal Academy of Engineering, ISBN: 978-1-1909327-35-1.

Collopy, F. (2009). Lessons Learned — Why the Failure of Systems Thinking Should Inform Future Design Thinking Retrieved from: https://www.fastcompany.com/1291598/lessons-learned-why-failure-systems-thinking-should-inform-future-design-thinking

Coyne, R. & Snodgrass, A. (1991). Is designing mysterious? challenging the dual knowledge thesis. *Design Studies*, 12(3), 124–131.

Cross, N. (1982). Designerly ways of knowing *Design Studies*, 3(4), 221–227.

Cross N. (1993) A History of Design Methodology. In: de Vries M.J., Cross N., Grant D.P. (eds) *Design Methodology and Relationships with Science.* NATO ASI Series (Series D: Behavioural and Social Sciences), vol 71. Springer, Dordrecht

Csikszentmihalyi, M (1999). Implications of a Systems Perspective for the Study of Creativity. In Sternberg, R. (ed.) *Handbook of Creativity*. New York: Cambridge University Press, 313-338.

Darzentas, J. & Darzentas, J.S. (2014) Systems thinking for service design: A natural partnership. In: *Proceedings of RSD3, Third Symposium of Relating Systems Thinking to Design*, 15-17 Oct 2014, Oslo, Norway. Retrieved from:http://openresearch.ocadu.ca/id/eprint/2080/

Darzentas, J. & Darzentas, J.S. (2016) Product-Service Systems or Service Design 'By-Products'? A Systems Thinking Approach *Proceedings of the Conference of the Design Research Society DRS2016* http://www.drs2016.org/506/

Davis, A. C., Leppanen, W., Mularczyk, K. P., Bedard, T., & Stroink, M. L. (2018). Systems Thinkers Express an Elevated Capacity for the Allocentric Components of Cognitive and Affective Empathy. *Systems Research and Behavioral Science*, 35(2), 216–229

Dubberly, H. (2014) A Systems Literacy Manifesto RSD3 2014 Symposium — Relating Systems Thinking and Design Retrieved from http://www.dubberly.com/wp-content/uploads/2016/02/systems_literacy.pdf

Formia, E. (2017). Mediating an Ecological Awareness in Italy: Shared Visions of Sustainability Between the Environmental Movement and Radical Design Cultures (1970–1976*). Journal of Design History*, 30(2), 192–211.

Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., Kyriakidou, O. & Peacock, R. Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review, Social Science & *Medicine*, 61, (2) 2005, pp 417-430,

Jones, J. C. (1979) Designing Designing, *Design Studies*. Vol. 1, No. 1. July 1979. pp. 31 – 35

Jones, P. H. (2014). Systemic Design Principles for Complex Social Systems. In Metcalf, G. (Ed) *Social Systems and Design* (pp. 91–128). Springer, Tokyo.

Jung, Y. (2017). Systems thinking in organizations: Applying it to study arts and educational settings. *The Journal of Art for Life*. 9(1) Retrieved from http://journals.fcla.edu/jafl/issue/view/4774

Meadows, D. el al. (1972). The Limits to Growth • Club of Rome. Universe Books. Retrieved from https://www.clubofrome.org/report/the-limits-to-growth/

Mele, C., Pels, J. & Polese, F. (2010). A Brief Review of Systems Theories and Their Managerial Applications *Service Science*, 2(1–2), 126–135

Midgley, G. (Ed) (2003) *Systems Thinking* Sage London, Thousand Oaks, New Dehli

Monat, J. P. & Gannon, T. F. (2015). What is Systems Thinking? A Review of Selected Literature Plus Recommendations. *American Journal of Systems Science*, 4(1), 11–26.

Nelson, H. G. (2003). The legacy of C. West Churchman: a framework for social systems assessments. Systems Research and Behavioral Science, 20(6), 463–473.

Peruccio, P. P. (2017). Systemic Design: A Historical Perspective. in Barbero, S. (Ed.) *Systemic Design Method Guide for Policymaking: a Circular Europe on the Way*, Allemandi, pp 68-74 (output of the EU funded Interreg RETRACE project)

Pourdehnad, J., Wexler, E.R & Wilson, D.V. (2011) Systems & Design Thinking: A Conceptual Framework for Their Integration. *Organizational Dynamics Working Papers. 10*., also *Proceedings of the 55th Annual Meeting of the International Society for the Systems Sciences*

Randle, J. M. & Stroink, M. L. (2018). The Development and Initial Validation of the Paradigm of Systems Thinking. *Systems Research and Behavioral Science*, 35(6), 645-657

Ryan, A. (2014): A Framework for Systemic Design, *FormAkademisk* Vol 7 No 4

Sanders E. B.-N. & Stappers P. J.(2008) Co-creation and the new landscapes of design, *CoDesign*, 4:1, 5-18

Sevaldson, B. Redesigning Systems Thinking *FormAkademisk*, Vol 10 No 1 (2017) https://doi.org/10.7577/formakademisk.1755

Sylvester, A., Tate, M., & Johnstone, D. (2013). Beyond synthesis: re-presenting heterogeneous research literature. *Behaviour & Information Technology*, 32(12), 1199–1215

Systemic Learning for Sustainability http://learningforsustainability.net/systemic-design/

Tufte, E. (1990) *Envisioning Information* Graphics Press, Connecticut, USA,

Ulm School (1953-1968) Retrieved from https://en.wikipedia.org/wiki/Ulm_School_of_Design

Vexler, D. (2017, June). What Exactly Do We Mean by Systems? (SSIR). *Stanford Social Innovation Review* Retrieved from https://ssir.org/articles/entry/what_exactly_do_we_mean_by_systems

Trans-Co-Design in Systemic Approach to Architectural Performance: The Multi-Layered Media and Agency in Creative Design and Its Processes

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Abstract: Based on several research by design cases illustrations, the paper aims to conclude a mix of diverse media in reference to diverse generative agency in Systemic Approach to Architectural Performance design field. In this field, the design processes and design's performances in time are seen as the 'resulting design objects'. Therefore, the agency involved in both is merged and proceeds parallel within one co-performative and co-living eco-system in its fight for Post-Anthropocene in built environment. SAAP is a fusion of several process based fields and their media, involving namely: a) 'Systems Oriented Design'; b) 'Performance Oriented Architecture'; 3) 'Prototypical Urban Interventions'; d) 'Time-Based Design'; e) 'Service Design'; f) 'Co-Design, Co-Creation and DIY'. The paper separately investigates SAAP's relations to these fields and concludes with their integration and synergy.

Keywords: trans-co-design; systemic approach to architectural performance; eco-systemic agency; systems oriented design; time-based design; performance-oriented design; eco-systemic urban interventions; co-design; co-creation; DIY, non-anthropocentric eco-systemic services

1. Introduction

Figure 1: The sharp division of human built up environment and the environment covering other than human ecosystem in the city centre of Cardiff. Such distinction is still representing the prevailing tendencies of current urbanism that is in opposition with current landscape ecology. (photo: Davidová 2018)

The discussed field of Systemic Approach to Architectural Performance is focusing on landscape, social and cultural ecology in built environment for eco-systemic co-living co-performance. With Joachim's statement that looking forward to a future that shines is not a platitude but an absolute imperative that empowers designers to speculate about the near future (Joachim, 2015), this research by design is targeting on its shift from Anthropocene for biodiversity support and climate change adaptation (Davidová, 2018; Davidová, Pánek, & Pánková, 2018; Davidová & Zímová, 2018). SAAP represents holistic approach through so called *'real life co-design laboratory'*, which, as opposed to the concept of regular laboratory, engages with the complexity of 'real life in real time' (Davidová et al., 2018). This concept evolved from Sevaldson's concept of *'Rich Design Research Space'* (Sevaldson, 2008) that is integrating to it real life performance of- and within- the eco-system of built environment which historically tended to be distinguished (see Figure 1) (Davidová & Raková, 2018; Davidová & Zímová, 2017, 2018; Hensel, 2019).

The direction of media mix and time-based design was suggested in reference to creative digital design techniques by Sevaldson already in 2005 (Sevaldson, 2005). However, this new approach contributes to the field by assigning the diverse media to particular biotic and abiotic agency, including trans-disciplinary human and non-human co-design participation in 'real time and life'. The biotic and abiotic generative agency is here used to express actions of living and non-living interactors covering their agendas, which through their cross-interaction co-create evolutive performance. The media involve: a) the complexity diagramming - a manual analogue and digital tool from Systems Oriented Design (SOD) called gigamapping, which is the most designerly way to deal with systems (Sevaldson, 2013); b) digital modelling; c) its full scale prototyping and namely: d) all the integral performances and cross-interactions of all the above mentioned, generated in time. The last ones appear through i.e. airflow, relative humidity, temperature; species such as algae, lichen, butterflies or bumblebees; material properties; or through human trans-disciplinary co-designers, such as general public, landscape ecologists, coders, architects, etc. Therefore, there is a shift from what architectural profession used to be perceived. As a designer, you can only interact with the system, not designing it. Through this interaction, you can co-design and therefore re-design the (eco)system (Davidová & Zímová, 2018).

Through the properties of the active agency within the co-design are also defined its creative design tools. Therefore, the performances take multiple layers, such as synergy of natural, social and cultural environment defined in Performance Oriented Architecture by Hensel (Hensel, 2010). Here it involves creative trans-disciplinary and trans-social, biological, material, climatic, mechanical or digital performances. These are achieved through *'prototypical urban interventions'* (Doherty, 2005) established as generative urban design tool at the start of millennium by CHORA office (CHORA, 2017). Such generativeness and co-performances are grounded within its *'time-based design approach'* (Sevaldson, 2004) discussed by Sevaldson around the same time period . Within SAAP this also involves hands on studies on historical references, that were tested and developed over generations. Through the generative interventions, the projects are co-creating eco-systemic services in built environment. This is supported by another layer of generative co-designing agency whilst marking the prototypes with QR codes. The QR codes are leading to recipes for 'do it yourself' (DIY) locally specific adaptations. The paper exemplifies these processes on several different cases of *'responsive wood'* (Hensel & Menges, 2006) projects that form and ratify the *'Systemic Approach to Architectural Performance'* (Davidová, 2017b) design field.

2. The Integrated Fields

Systemic Approach to Architectural Performance is integrating several process-based fields for eco-systemic real time life co-performance in living environment. The key fields in this are: a) Systems Oriented Design; b) Performance Oriented Architecture; 3) Prototypical Urban Interventions; d) Time-Based Design; e) Service Design and f) Co-Design, Co-Creation and DIY. These fields are through interventions co-providing synergetic co-performing processes of urban and cultural landscape.

2.1. Systems Oriented Design

Systems Oriented Design (SOD) is looking beyond object to access a *'rich picture'* (Checkland, 2000) of complexity serving as a generative design tool. It is holistically looking at vast fields of relations and patterns of interactions (Sevaldson, 2013). SOD is framed in media rich *'Rich Design Research Space'* which takes into account the physical, social, and cultural spaces, and the virtual and visual media spaces in which the research-by-design takes place (Sevaldson, 2008). In our case, this space takes place in the building site's public space (see Figure 2) or in adjacent publically accessible refreshment spaces (see Figure 3 and Figure 4) whilst both are being accompanied by social events such as EnviroCity Festivals (Davidová & Kernová, 2016) (see Figure 5). Such spaces cover co-design with communities and diverse trans-disciplinary team members and stakeholders.

Figure 2: Rich Design Research Public Space gigamapping and conceptual modelling on building site targeting on community co-design (photo: Davidová 2018)

Figure 3: COLridor II Project Rich Design Research Space covering stakeholders' gigamapping that is engaging sketching, work with referential images and conceptual model making (photo: Gönulf 2018).

Diverse actors in the Rich Design Research Space require diverse media. For example, within human speculative co-design some disciplines or public relate better to drawing or image relations' connections, the others to physical modelling or prototyping or combinations of all (see Figure 2 and Figure 3). This needs to be at first point grounded by physical gigamapping to find the relations of the natural, social and cultural data, thoughts, collective understandings and speculations. The physical maps can be further on translated to digital maps and digital modelling simulations. This can be afterwards printed and fabricated to meet physical interaction again (see Figure 4). Such feedback looping interaction is however, simultaneously co-designed with the other kinds of agency. The prototype's performance is co-generated by i.e. relative humidity, temperature, their material properties and organisms that appear in its adjacent environment or directly settles on prototypes. Therefore, the design processes appear to be cross- and multi-layered in relation with multiple agency and mixing digital with analogue, biotic with abiotic – living with non-living.

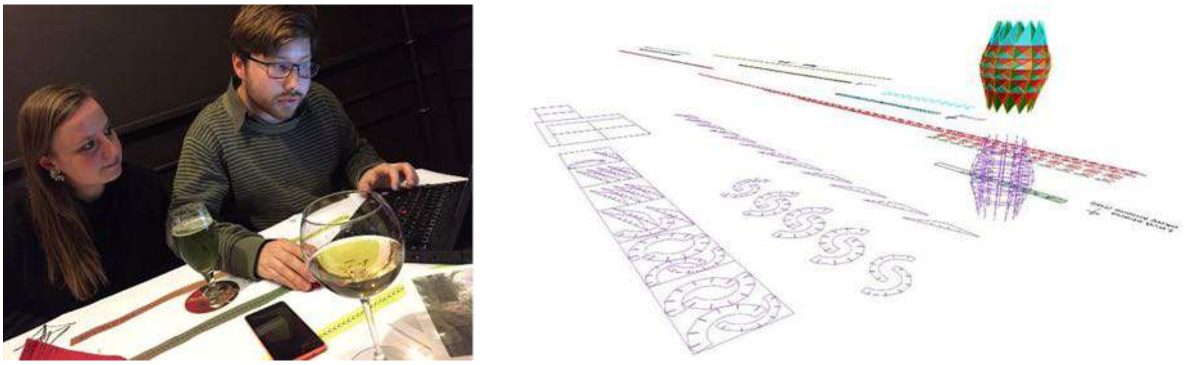

Figure 4: Combining gigamapping and computing whilst co-designing with local community and trans-disciplinary team in project COLridor I (photo: Zímová, digital model and print screen: Prokop 2017)

Figure 5: Selection of the events of EnviroCity 2017 festival (Photos: Carrithers 2017)

2.2. Performance Oriented Architecture

Performance Oriented Architecture is explained by Hensel as non-anthropocentric, requiring integration of core concepts in architecture and biology. This is to be approached so as to inform the integrated spatial and material organisation of architecture and its interaction with the physical environments towards the production of heterogeneous provisions that can help sustain ecosystems and biodiversity (Hensel, 2012). Within such framework, the SAAP research by design cases have been mainly developing and applying non-anthropocentric responsive solid wood concept on its full-scale prototypes in built environment. This research by design has been focusing on hygroscopic co-performance of living and non-living biological matter and abiotic agency of relative humidity and temperature (see Figure 6 and Figure 7). These prototypes take direct active agency within the natural, social and cultural environment, co-performing and co-designing its edible, habitable, transferable, exchangeable and micro-climatic eco-systemic services.

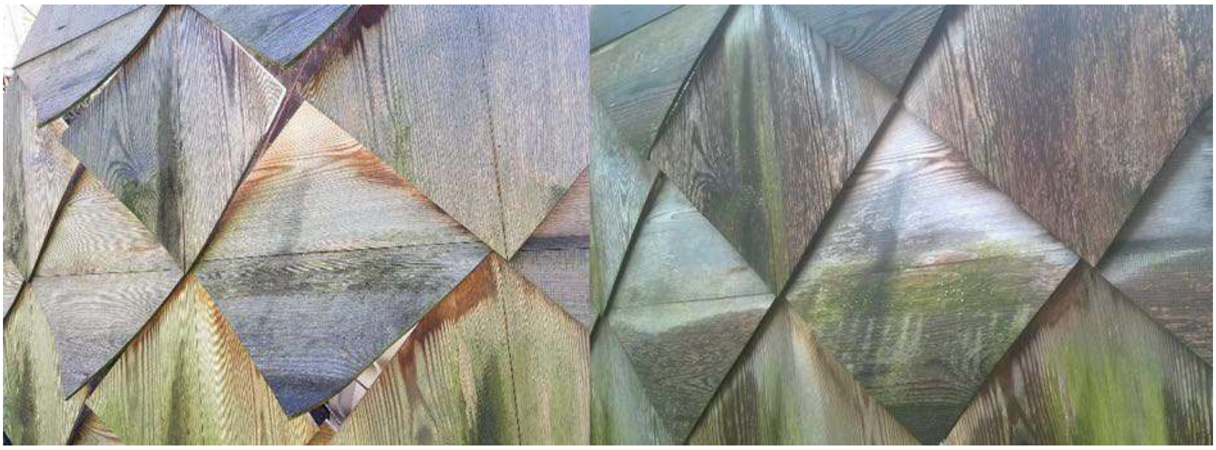

Figure 6: Ray 2*2013 Responsive Wood Envelope Prototype a) in semi-dry June 2018 weather when the screen is open for boundary exchange between exterior and semi-interior; b) after April light rain in 2017 when the system is closed, not allowing the humid and cold air to pass through the boundary; both after five and four years respectively of being exposed to weather and biotic conditions. The prototype got inhabited by Blue Stein Fungi, Algae and Lichen. These, namely the algae, are regulating the moisture content of wood, thus co-causing its warping. Notice also the organisation of algae habitation caused by the material's fibre direction and position within the design that is affected by material performance and form. Thus it is organised through its moisture and the organism's abundance and distribution interaction (Davidová, 2017a). (photos: Davidová 2017 - 2018)

Figure 7: COLridor II project that is using hygroscopicity of wood for planting flowers for coming spring pollinators in otherwise fully build up environment. The outdoor and its indoor extensive installation generates micro biotopes of edible landscape, covering dwellings and nutrients opportunities for various species, including, but not limited to honey producing plants and local edible and sprout seeds. These eco-topes secure a transition and an exchange on a biocorridor connecting central urban with semi-urban areas of historical city of Třebíč (photos: Davidová 2018 and Zímová 2019).

2.3. Eco-Systemic Prototypical Urban Interventions

Figure 8: TreeHugger CY together with exhibited design gigamaps and QR code leading to Systemic Approach to Architectural Performance blog with recipe for its creation for generating its iterations. The TreeHugger prototypes serve as hotels for insect as well as fast-food restaurants for bats and birds. This one was built by the United Nations Buffer Zone – the non-human bio-corridor that is, thanks to the difficult political situation, passing through the otherwise very human oriented urbanised city centre of Nicosia. The prototype is questioning the linearity and separation of this concept, suggesting its crossing for both the non-human spread to urbanised areas as well as the human spread of community built iterations on both sides of the city. Therefore it engages with food chains; transfers and exchange of nutrients, genetic, biological, biotic as well as abiotic materials, cross-species cultural, social and political interaction; co-habitats and co-dwellings, etc. (photo: Davidová 2018)

From an urban and landscape perspective, prototypes are explained by Doherty as architectural and programmatic interventions that are open to changing political, economic, ecological and social dynamics over time and space. They present a more strategic, canny and fluid approach rather than determinate strategies like master planning. Prototypes perform with uncertainty by creating and maintaining a spatial dialogue of sorts over time (Doherty, 2005). In other words, prototypes act as generative force that is engaging its surrounding environment. Therefore, with the bottom up approach of rather small and simple input, prototypes can grow into an expansive and complex time-based outputs. Our prototypes have non-anthropocentric character and focus on engagement of overall eco-system through its systemic interactions. Therefore, they are called eco-systemic prototypical urban interventions that engage with food chains; transfers and exchange of nutrients, genetic, biological, biotic as well as abiotic material, cross-species cultural, social and political interaction; co-habitats and co-dwellings, etc. (see Figure 7, Figure 8 and Figure 9).

2.4. Time-Based Design

Figure 9: TreeHugger CZ performing over time from being build in spring 2017 to winter 2019. Please, note also the inhabitation by algae after the autumn 2017. (photos: Davidová and Carrithers 2017 - 2019)

Figure 10: Café in an Open Air Museum in Aarhus, Denmark. The traditional house was most likely not meant to offer an extra dwelling layer for the family of titmice within its structure. However, as opposed to current civil engineering agendas tendency, this structure is offering such opportunistic use and has developed into cross-species co-living situation over time. (photo: Davidová 2018)

Sevaldson explains framework of development of time-based projects as a) observation; b) analyses and c) intervention. The explained observations develop there along several paths of: 1) movement in the spirit of Mareys experiments (Braun, 1992); 2) the performance of singular objects with emphasis on the relations to other objects or environments over time; 3) complex situation with emphasis on the discovery and analyses of patterns in the interaction between entities and environments (Sevaldson, 2004). Systemic Approach to Architectural Performance is intersecting these layers and feed-back looping these stages and paths. The intervention is not seen as a final object but as a performing generative input for co-design and co-living that is to be further observed, analysed, inhabited, eaten, iterated and of course re-designed (see Figure 9).

Systemic Approach to Architectural Performance also covers analysis of historical prototypes that developed and were tested over generations. Within performance field the pioneering work in this sense is covered by Fathy with focus on abiotic performance of traditional architectures in arid climates (Fathy, 1986). The biotic performance investigation was added and developed by Hensels (Hensel & Sunguroğlu Hensel, 2015). This has however focused purely on speculative computer simulations or theory, not investigating the complexity of hands on real life experience over time such as Systemic Approach to Architectural Performance (Davidová, 2016a, 2018; Davidová & Raková, 2018; Davidová & Uygan, 2017) (see Figure 10 and Figure 17).

2.5. Service Design

Today environmental science talks about Anthropocene Extinction, or 6th Mass Extinction, that is defined as an ongoing current event in which a large number of living species are threatened with extinction or are going extinct because of environmentally destructive human activities (Wagler, 2017). About 80% of insects by biomass disappeared in regions around central and western Europe since the end of eighties (Vogel, 2017). Similar pattern is followed by agricultural birds in example in Czechia (Czech Ornithologists Association, 2016) but most likely other regions as well. Zeithaml et al. describe Service Design as *'a form of architecture that involves processes rather than bricks and mortar'* (Zeithaml, Parasuraman, & Berry, 1990). These processes can be neither performed nor received purely by humans as well as they cannot be designed with purely human orientation.

This research is oriented towards the shift to Post-Anthropocene of urban and cultural environment through claiming that cities and other humanised landscape have to cover not only human oriented eco-systemic services – means processes. The shift from Anthropocene however cannot emerge without human involvement unless we consider a total humanitarian catastrophe. Therefore, we cannot reach environmental justice without social justice and vice versa (Davidová & Zímová, 2018; Haase, 2017; McIntyre-Mills, 2014). The commonly used term of ecosystem services is by definition designed to bring benefits to the ones involved. However, in this notion, the involved ones are traditionally targeted to be purely humans (Pauleit, Zölch, Hansen, & Randrup, 2017). The non-anthropocentric eco-systemic services are process based to distribute benefits of: a) culture and sociality (see i.e. Figure 2, Figure 3, Figure 4, Figure 5 and Figure 11); b) heathy nutrients (see i.e. Figure 7, Figure 8, Figure 11 and Figure 12); c) healthy habitats (see i.e. Figure 6, Figure 7, Figure 8 and Figure 10) and d) safe transition and exchange paths across the eco-system and all the other above mentioned services (see Figure 13). This is also including human beneficiaries as well as human agency, amongst the other biotic and abiotic participation.

Figure 11: Experience the City Other Way Festival 2018 – Collaborative Collective's stand with hands on teaching services on DIY bird food production services for the coming autumn. (photo: Horák Goryczka 2018)

Figure 12: This restaurant in the city centre of Cardiff, Wales serves as a refreshment station for both, for the humans as well as for the bumblebees, generating more feasible paths across the city. (photo: Davidová 2018)

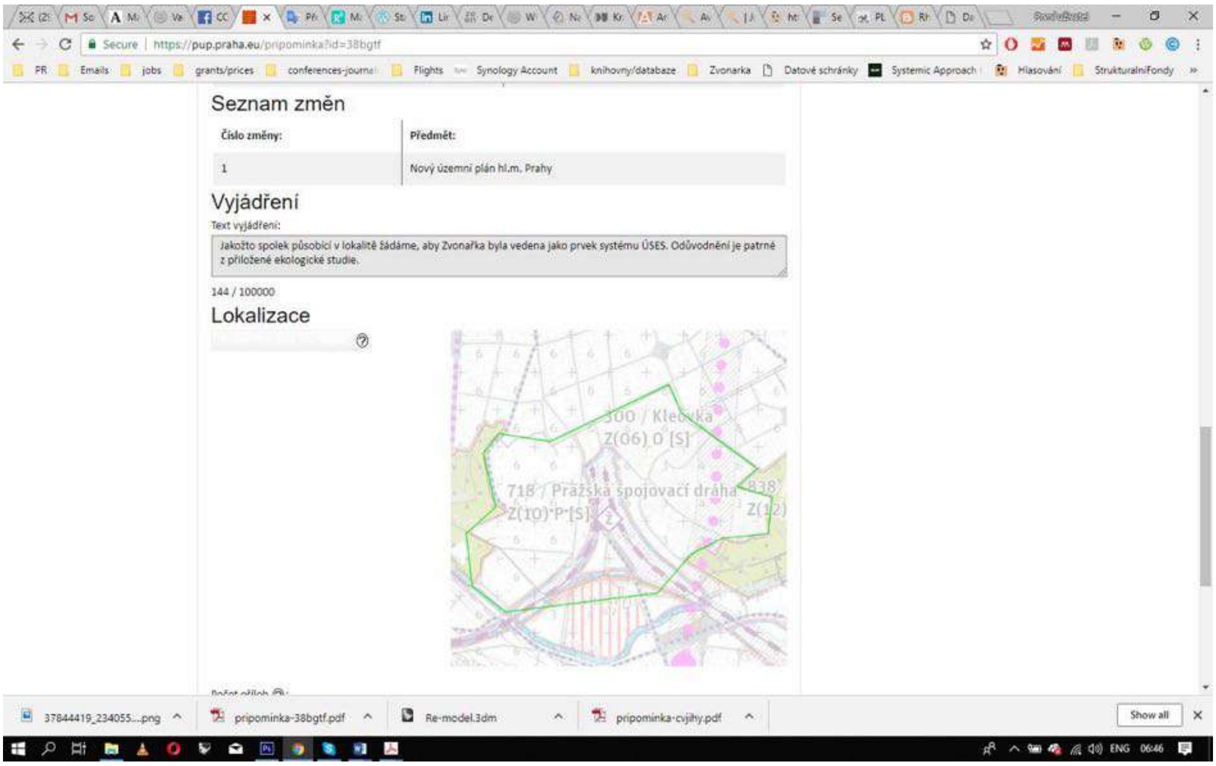

Figure 13: Questioning bio-corridorial barriers of too little planned land protection on an investigated site of COLridor I project in Metropolitan Plan proposal as remarks from Collaborative Collective NGO to the Municipality of Prague. (screenshot and marking: Davidová 2018)

2.6. Co-Design, Co-Creation and DIY

Figure 14: SpiralTreeHouse with self-standing flexible structure that is co-designed with wind and the tree to which it is attached. The platform on the right is being co-designed by the habitation of moss, providing comfortable flooring and mattress for humans and other species, thus extending present landscape. (photos: Zapletal 2014, Davidová 2012).

Figure 15: The construction site of Co-oCo-oNest prototype being built, used and re-designed by its users in the same time in Slavutych by Chernobyl, Ukraine. The project was to bring new futures speculations to, though by peoples' world attention abandoned, very rich developing new eco-system that is competitive to other ecological treasures of the world. The aim was to redirect the attention to the dead previously glowing past of the local community to the new opportunities of what the today's world issues bring. (photo: Davidová 2018)

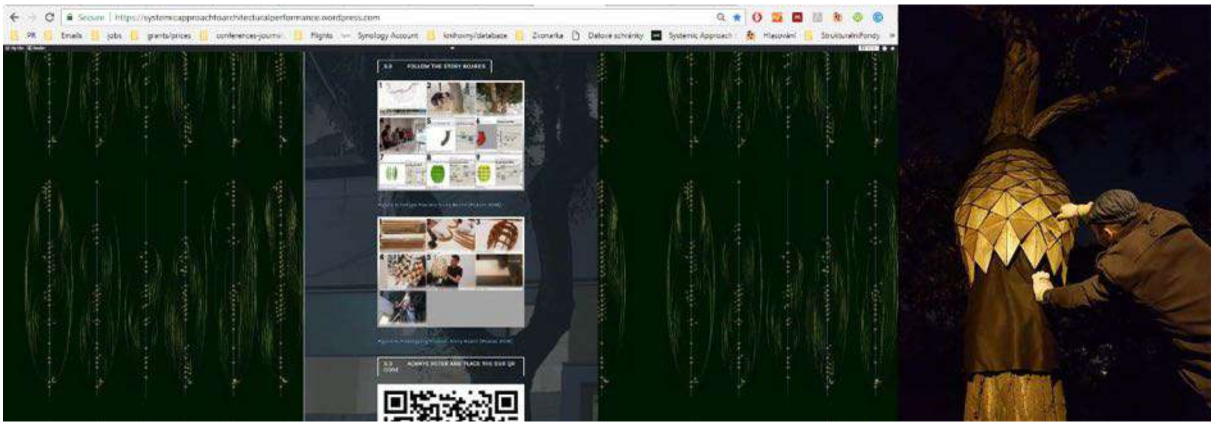

Figure 16: DIY recipe with downloadable parametric code of TreeHugger CY on SAAP blog (Davidová, 2016b) and updating of the Prague TreeHugger CZ prototype with a QR code that leads to that site (photo: Davidová 2018)

The next new thing in the changing landscape of design research has become co-designing with the users (Sanders & Stappers, 2008). There is a difference between being an activist or the facilitator, offering generative service and adaptation, rather than revolution. Interaction, through engagement of and with others and of and with food chain can for example generate large time based change across the social, cultural, economic, political and ecological systems (Govera & Evans, 2018).

This all can be achieved across multiple stakeholders and disciplines through more ways. These would be for example: a) when planning (see Figure 2); b) within the production process, on the go in real time and real life (see i.e. Figure 9, Figure 14 and Figure 15) or c) through non-commercial Creative Commons licenced DIY iterations (Creative Commons, 2017) by other communities under other local specific parameters (see Figure 8 and Figure 16). These multiple stakeholders and disciplines should cover both, the biotic and abiotic agents and agency communicated by those who cannot be represented like explained by Sevaldson for gigamapping (Sevaldson, 2018). Systemic Approach to Architectural Performance is multi-layering and cross-referencing these media and agency layers. Such multi-agency co-creative co-design process is generating the integral design's co-performance over time that in traditional terminology would be called the 'design result'

3. Integral Summary, Discussion and Conclusions

The illustrated projects focus on trans-disciplinary multi-layered, analogue and digital, collaborative co-design processes grounded in gigamapping for co-performance prototypes' generation. They are placed within public and natural environment complexity for its interaction. This interaction is engaging co-living and co-creation across the particular urban and/or cultural landscape eco-system and interpretation of such through multi-genre performers or agents. While doing so, the real time performance and its reflection for future project's stages is co-designed. Though the gigamap serves as a complexity and present prototype's observation generative and reflective discussion board, the prototypes serve for environmental material embodied tacit interaction, experience, observation and generation of new alterations. Being inside these design processes, this design-research represents

Sweeting's discussion on what can design research practice give to second order cybernetics (Sweeting, 2016).

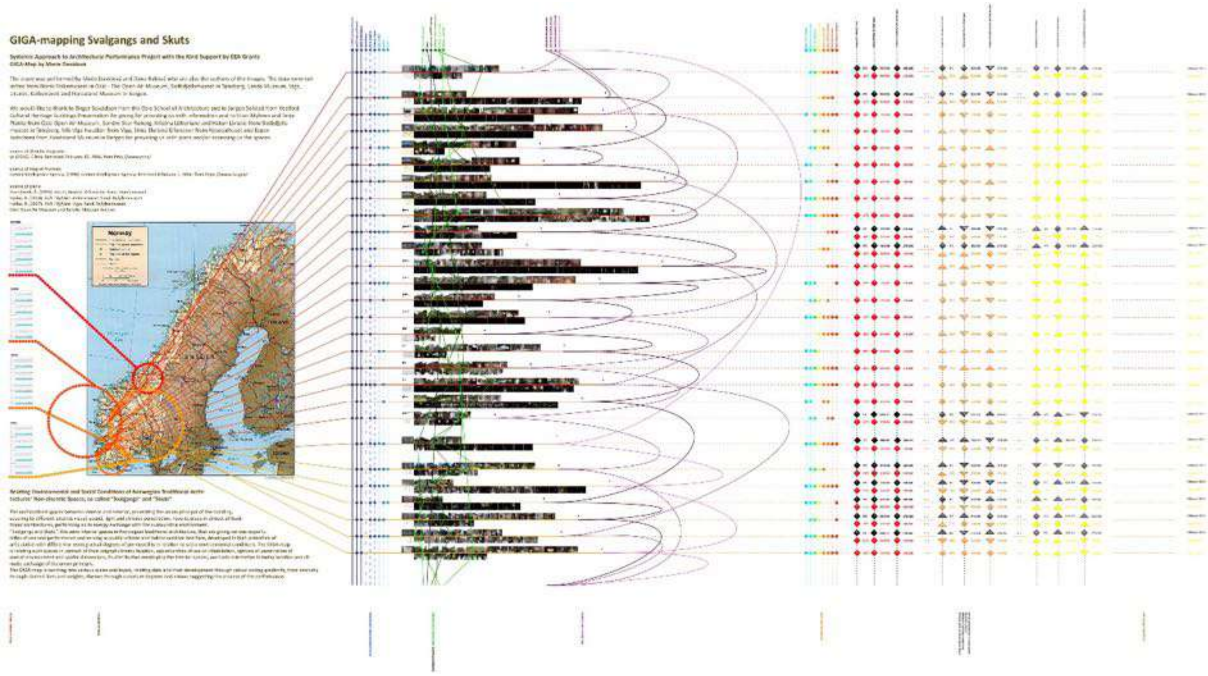

Figure 17: Traditional Architectures Observations and Registering Gigamapping: Gigamapping Svalgangs and Skuts (Davidová 2017, photos used: Davidová and Raková 2016 and 2017): The gigamap is relating such spaces in context of their original climatic location, opportunities of use or inhabitation, options of penetration of overall environment and spatial dimensions, its distribution enveloping the interior spaces, world axis orientation in today location and climatic Exchange of the onion principle. The gigamap is zooming into various scales and layers, relating data and their development through colour coding gradients, their intensity through dashed lines and weights, themes through curvature degrees and arrows suggesting the process of the performance. - the map of Norway is a public source from: Central Intelligence Agency (Central Intelligence Agency, 1998); the macro climatic diagrams (yr, 2016) are used with the courtesy of yr.no

Many of the prototyping and mapping projects focus more on detailed, other than human, environmental interaction development and its prototypical observation. This is followed by architectural application speculations and its referential studies on traditional architectures (see Figure 17). While the development of the first and very early research stage prototype is followed by gigamapping of its environmental interactions speculations supported by sampling, the prototyping research takes several feedback-looping paths that are however interconnected with the other subprojects:

a) long term first prototype observations when exposed to environmental settings;

b) observations of related traditional architectures;

c) various local specific fast iterations;

d) the new prototype development based on condemned weaknesses of the first prototype;

e) observations of related traditional architectures and both of the prototypes for planned practice application;

f) various local specific fast iterations;

….

Through the long-term prototypical observation, the development of climate-material interaction and related biotic agency is taking place in time when it is co-designed by the mentioned. In the same time, the new prototype that is trying to answer firstly observed weaknesses is built and observed again. This is within the same time confronted with related historical references of possible applications (see Figure 17) to lead to the planned use in practice. The iteration paths test different local specific applications and variations. This ‘bottom up approach’ of prototyping is followed by ‘top down’ practice applications speculations and traditional architecture references from extreme climates observations mainly in reference to *‘adaptation to climate change in Czech Regions location’* (Czech Republic Ministry of the Environment & Czech Hydrometeorological Institute, 2015).

Figure 18: The TreeHugger CZ Responsive Insect Hotel Prototype after its Biotic and Abiotic Interaction over one and half year: The prototype applies Ray 2 panelling (see Figure 6) adjusted to double curved surfaces (Ray 4 (Davidová & Prokop, 2018)) and is a result of transdisciplinary co-design – the Trans-Co-Design. (photo: Davidová 2018)

The studies lead to focus on eco-systemic service design through performative eco-systemic *'prototypical urban interventions'* (Doherty, 2005). Such approach is gaining from collective trans-disciplinary and trans-agency knowledge gathered through multiple stakeholders. One of the key intervention, the responsive wood insect hotel TreeHugger (see Figure 18), is parasitting on a tree trunk in the middle of a central urban eco-top. TreeHugger is a small object. However, it is applying detailed climate moderation solution through responsive wood concept for variety of insect species' needs to create their liveable and/or preferred environment. These, in reference to the larger eco-systemic chain are to generate *'edible landscape'* (Creasy, 2004) for i.e. bats and birds, while another fast food of blossoming plants seed bombs is generated for feeding these insects. All this is integrated through i.e. the multi-genre festival EnviroCity, representing the synergy of natural, social and cultural environment with its generative agendas of recipes for DIY. Therefore, these initial projects on architectural sustainable solution have transformed to the sustainable solution for eco-systems covering and crossing multi-species and multi-non-living forces, multi-cultural, multi-political and multi-social environment agendas. They are not only bringing solutions through habitation but also through sustainable eco-system of co-living with nutrients, genetic and other material resources, societies, cultures and collaborative political agendas; the environment of *'flourishing for all'* (Ehrenfeld & Hoffman, 2013).

The full scale prototyping in reference to co-design process was largely discussed by Capjon (Capjon, 2005). However here, these processes are perceived as a 'results' that are co-designed with overall eco-system in time. This field calls for the shift from *'Cities for People'* (Gehl, 2010) towards the participation of both, biotic and abiotic agency within one co-performative eco-system, the *'Real Life Laboratory'* (Davidová et al., 2018). This is supported through using the key concept SOD tools such as *'Rich Design Research Space',* discussing the social and spatial parameters (Sevaldson, 2008) and gigamapping, that in this case, serves as a co-design communication and complexity relations mapping tool that is indivisible from prototypical co-performance and 'resulting' observations, reflections and co-design. The paper concludes with that there is a necessity of mixing and integrating living and non-living, human and non-human, analogue and digital processes based on the involved agency and its position in time and these need to be cross- and multi-layered. This can be mainly achieved through hands on reflective Research by Design, investigating the *'eco-systemic prototypical urban interventions'* (Davidová & Prokop, 2018), their related historical prototypes studies and their DIY iterations in *'real life and time – the real life co-design laboratory'*. Such 'laboratory' cannot be and should not ever attempt to be engineered (Davidová, 2017b) but intervened. Within the field of *'Systemic Approach to Architectural Performance'*, the design management, the methodology, the collaborative design processes, the design's physical results and their collaborative co-performances are fused in one Time Based Eco-systemic Trans-Co-Design in real time. Therefore this research by design aims to reformulate the notion of *'Nature in Design'* (Joachim, 2016) into a *'living nature co-design'*. And whilst attempting this, such research by design's processes real time co-generate the concept of *'ecological urbanism'* that was defined by Mostafavi and Doherty (Mostafavi & Doherty, 2016).

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4.1. Spiral TreeHouse (Cholín's adjacent forests, Czechia 2010)

- Authors: Marie Davidová, Prokop Závada
- Building Team: Prokop Závada, Marie Davidová, Barbora Peterková, Anežka Závadová, Filip Dioszegi, Michal Vedral, Jan Hradilek

4.2. Co-oCo-oNest – 86' Festival's Workshop (Slavutych, Ukraine 2018)

- Workshop Tutors: Marie Davidová, Šimon Prokop
- Workshop Participants: Nataliia Neshevets, Oleksandr Rezen, Olivia Dimitrishina, Andrii Zabolotnyi, Slavutych local community

4.3. COLridor II – installation for Czech National Heritage Institute Exhibition (Třebíč, Czechia 2018)

- Design and Realisation Lead: Marie Davidová, Kateřina Zímová, Ondřej Michálek, Jan Zatloukal, Kateřina Gazdová, Arif Gönulf, Jan David
- Building Team: Michal Stasiak, Tereza Čapková, Roman Čapka, Matěj Nejedlý, Vojtěch Viceník, Kamil Belán, Tomáš Novotný, Vladislav Větrovec, Tomáš Veselý, Ondřej Herzán
- Client - Exhibition Theme and Concept: Kateřina Horák Goryczka

4.4. TreeHugger CZ and COLridor I Project (Prague, Czechia 2017)

- Authors: Marie Davidová, Šimon Prokop, Kateřina Zímová, Ondřej Michálek, Kateřina Horák Goryczka, Krištof Hanzlík, Kamil Trgala, Eliška Oberhofnerová, the Local Biotic and Abiotic Community of Prague 2 District (Co-Design)

4.5. TreeHugger CY – eCAADe RIS 6 at the University of Cyprus Workshop (Nicosia, Cyprus 2018)

- Workshop Tutors: Marie Davidová, Šimon Prokop
- 6th eCAADe RIS Organisation: Odysseas Kontovourkis
- Site Analysis for Tree Pre-Selection and Permission Negotiation: Panagiota Konatzii, Michalis Psaras
- Prototyping Worksop Participants: Panagiota Konatzii, Michalis Psaras, Stefanos Kyprianou, Marko Vucic, the Local Biotic and Abiotic Community of Nicosia Centre (Co-Design)

References

Braun, M. (1992). *Picturing Time*. Chicago: Chicago University Press.

Capjon, J. (2005). Engaged Collaborative Ideation supported through Material Catalysation. In *Nordes 2005 - In the Making* (pp. 1–6). Copenhagen: Royal Danish Academy of Fine Arts, School of Architecture. Retrieved from http://nordes.org/opj/index.php/n13/article/viewFile/231/214

Central Intelligence Agency. (1998). Central Intelligence Agency. Retrieved February 1, 2016, from https://www.cia.gov/

Checkland, P. (2000). *Systems Thinking, Systems Practice*. Chichester: John Wiley & Sons LTD.

CHORA. (2017). CHORA – conscious city. Retrieved December 11, 2017, from http://chora.org/

Creasy, R. (2004). *Edible Landscaping*. Gainesville.

Creative Commons. (2017). Creative Commons — Attribution-NonCommercial 4.0 International — CC BY-NC 4.0. Retrieved December 9, 2017, from https://creativecommons.org/licenses/by-nc/4.0/

Czech Ornithologists Association. (2016). *The Annual Report of the Czech Ornithologists Association / Výroční zpráva České společnosti ornitologické 2016 birdlife.cz*. Prague. Retrieved from http://bigfiles.birdlife.cz/Vyrocni_zprava_CSO_2016.pdf

Czech Republic Ministry of the Environment, & Czech Hydrometeorological Institute. (2015). *Strategie přizpůsobení se změně klimatu v podmínkách ČR / Strategy on Adaptation to Climate Change in the Czech Republic*. (Centre for Environment at Charles University & Prague, Eds.) (1st ed.). Prague: Czech Republic Ministry of the Environment. Retrieved from http://www.mzp.cz/C1257458002F0DC7/cz/zmena_klimatu_adaptacni_strategie/$FILE/OEOK-Adaptacni_strategie-20151029.pdf

Davidová, M. (2016a). Socio-Environmental Relations of Non-Discrete Spaces and Architectures: Systemic Approach to Performative Wood. In P. Jones (Ed.), *Relating Systems Thinking and Design 2016 Symposium Proceedings* (pp. 1–17). Toronto: Systemic Design Research Network. Retrieved from https://www.researchgate.net/publication/312501181_Socio-Environmental_Relations_of_Non-Discrete_Spaces_and_Architectures_Systemic_Approach_to_Performative_Wood

Davidová, M. (2016b). Systemic Approach to Architectural Performance. Retrieved March 29, 2016, from https://systemicapproachtoarchitecturalperformance.wordpress.com/

Davidová, M. (2017a). Co-Habited, Co-Lived, Co-Designed and Co-Created Eco-Systemic Responsiveness in Systemic Approach to Architectural Performance: A Case Study on Interaction of Performative Solid Wood Envelope Ray and Algae. In M. João de Oliveira & F. Crespo Osório (Eds.), *KINE[SIS]TEM: From Nature to Architectural Matter* (pp. 36–45). Lisbon: DINÂMIA'CET-IUL ISCTE - Instituto Universitário de Lisboa. Retrieved from https://www.researchgate.net/publication/317819704_Co-Habited_Co-Lived_Co-Designed_and_Co-Created_Eco-Systemic_Responsiveness_in_Systemic_Approach_to_Architectural_Performance_A_Case_Study_on_Interaction_of_Performative_Solid_Wood_Envelope_Ray_and_Alg

Davidová, M. (2017b). *Wood as a Primary Medium to Eco-Systemic Performance: A Case Study in Systemic Approach to Architectural Performance*. Czech Technical University in Prague. https://doi.org/10.13140/RG.2.2.17123.45607

Davidová, M. (2018). Roles, Agency and Relations of GIGA-Maps in Systemic Approach to Architectural Performance: The Special Prototypes of Post-Anthropocene. In J. Bean, S. Dickinson, & A. Ida (Eds.), *AMPS Proceedings Series 12. Critical Practice in an Age of Complexity* (pp. 114–132). Tucson: University of Arizona. Retrieved from http://architecturemps.com/wp-content/uploads/2018/11/AMPS-Proceedings-12-Critical-Practice-in-an-Age-of-Complexity.pdf

Davidová, M., & Kernová, M. (2016). EnviroCity - Facebook. Retrieved April 1, 2016, from https://www.facebook.com/envirocity/

Davidová, M., Pánek, K., & Pánková, M. (2018). Spiralling Slope as a Real Life Co-Design Laboratory. In J. Bean, S. Dickinson, & A. Ida (Eds.), *AMPS Proceedings Series 12. Critical Practice in an Age of Complexity* (pp. 133–142). Tucson: University of Arizona. Retrieved from http://architecturemps.com/wp-content/uploads/2018/11/AMPS-Proceedings-12-Critical-Practice-in-an-Age-of-Complexity.pdf

Davidová, M., & Prokop, Š. (2018). TreeHugger: The Eco-Systemic Prototypical Urban Intervention. In O. Kontovourkis (Ed.), *6th eCAADe RIS 2018 Proceedings* (pp. 75–85). Nicosia: University of Cyprus. Retrieved from http://papers.cumincad.org/cgi-bin/works/paper/ecaaderis2018_103

Davidová, M., & Raková, D. (2018). Biodiversity and Climate Change Adaptation through Non-Discrete Architectural Spaces and Architectures: Systemic Approach to Traditions for Sustainable Futures. *FormAkademisk - Research Journal of Design and Design Education*, *11*(4), 1–31. https://doi.org/https://doi.org/10.7577/formakademisk.2287

Davidová, M., & Uygan, E. (2017). Living in Bio-Climatic Layers: An Investigation of Cappadocian Caves in Relation to Today's Design and Its Futures. In F. Mahbub, S. Uddin, & A. M. Khan (Eds.), *International Design Conference: DESIGN EVOLUTION [Education and Practice]* (pp. 1–12). Karachi: Indus Valley School of Art and Architecture. Retrieved from https://www.researchgate.net/publication/313759290_Living_in_Bio-Climatic_Layers_An_Investigation_of_Cappadocian_Caves_in_Relation_to_Today%27s_Design_and_Its_Futures

Davidová, M., & Zímová, K. (2017). COLridor: Co-Design and Co-Living for Sustainable Futures. In B. Sevaldson (Ed.), *Relating Systems Thinking and Design 6: Environment, Economy, Democracy: Flourishing Together* (pp. 1–20). Oslo: Systemic Design Research Network. Retrieved from https://systemic-design.net/rsd6/systemic-design-cases/#davidova

Davidová, M., & Zímová, K. (2018). COLridor: Co-Design and Co-Living Urban Adaptation. *FormAkademisk - Research Journal of Design and Design Education*, *11*(4), 1–30. https://doi.org/https://doi.org/10.7577/formakademisk.2647

Doherty, G. (2005). Prototypes in Pinkenba. In *Nordes 2005 - In the Making* (Vol. 1, pp. 1–5). Copenhagen: Royal Danish Academy of Fine Arts, School of Architecture. Retrieved from http://www.nordes.org/opj/index.php/n13/article/view/262/245

Ehrenfeld, J., & Hoffman, A. J. (2013). *Flourishing : a frank conversation about sustainability* (1st ed.). Stanford: Stanford University Press. Retrieved from https://www.researchgate.net/publication/274250501_Flourishing_A_Frank_Conversation_on_Sustainability

Fathy, H. (1986). *Natural Energy and Vernacular Architecture: Principles and Examples with Reference to Hot Arid Climates. Chicago and London: The University of Chicago Press*. Chicago and London: The University of Chicago Press. Retrieved from http://archive.unu.edu/unupress/unupbooks/80a01e/80A01E00.htm

Gehl, J. (2010). *Cities for People* (Vol. 1). Washington, Covelo, London: Island Press. https://doi.org/10.1017/CBO9781107415324.004

Govera, C., & Evans, J. (2018). Thinking Edibility Otherwise. *Journal of Design and Science*, (4). Retrieved from https://jods.mitpress.mit.edu/pub/issue4-evans-govera

Haase, A. (2017). The Contribution of Nature-Based Solutions to Socially Inclusive Urban Development– Some Reflections from a Social-environmental Perspective (pp. 221–236). Springer, Cham. https://doi.org/10.1007/978-3-319-56091-5_13

Hensel, M. (2010). Performance-oriented Architecture: Towards Biological Paradigm for Architectural Design and the Built Environment. *FORMakademisk*, *3*(1), 36–56. Retrieved from http://www.formakademisk.org/index.php/formakademisk/article/view/65

Hensel, M. (2012). *Performance-oriented architecture: An integrated discourse and theoretical framework for architectural design and sustainability towards non-discrete and non-anthropocentric architectures*. University of Reading. Retrieved from https://www.researchgate.net/publication/282856733_Performance-oriented_Architecture_-_An_integrated_discourse_and_theoretical_framework_for_architectural_design_and_sustainability_towards_non-discrete_and_non-anthropocentric_architectures

Hensel, M. (2019). The rights to ground: integrating human and non-human perspectives in an inclusive approach to sustainability. *Sustainable Development*, 1–7. https://doi.org/10.1002/sd.1883

Hensel, M., & Menges, A. (2006). *Morpho-Ecologies* (1st ed.). London: AA Publications.

Hensel, M., & Sunguroğlu Hensel, D. (2015). Architectural History from a Performance Perspective – The Latent Potential of Knowledge embedded in the Built Environment. In La Scuola di Pitagora (Ed.), *Teritage and Technology: Mind, Knowledge, Experience - Le Vie dei Mercanti XIII International* (pp. 794–802). Naples: La Scuola di Pitagora. https://doi.org/10.13140/RG.2.1.3409.7365

Joachim, M. (2015). A Century of Ecological Innovation. *Architectural Design*, *85*(4), 68–73. https://doi.org/10.1002/ad.1928

Joachim, M. (2016). Ten archetypes of nature in design. *Technoetic Arts*, *14*(1), 127–130. https://doi.org/10.1386/tear.14.1-2.127_1

McIntyre-Mills, J. (2014). Systemic Ethics for Social and Environmental Justice. In J. McIntyre-Mills (Ed.), *Systemic Ethics and Non-Anthropocentric Stewardship* (pp. 121–153). Cham: Springer. https://doi.org/10.1007/978-3-319-07656-0_6

Mostafavi, M., & Doherty, G. (2016). *Ecological Urbanism*. (M. Mostafavi & G. Doherty, Eds.), *Ecological Urbanism* (revised). Cambridge: Lars Müller Publishers. Retrieved from https://www.academia.edu/25491739/Ecological_Urbanism_Revised_Edition

Pauleit, S., Zölch, T., Hansen, R., & Randrup, T. B. (2017). Nature-Based Solutions and Climate Change – Four Shades of Green. In N. Kabisch, H. Korn, J. Stadler, & A. Bonn (Eds.), *Nature-Based Solutions to Climate Change Adaptation in Urban Areas* (pp. 29–49). Cham: Springer. https://doi.org/10.1007/978-3-319-56091-5

Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*, *4*(1), 5–18. https://doi.org/10.1080/15710880701875068

Sevaldson, B. (2004). Designing Time: A Laboratory for Time Based Design. In *Future Ground* (pp. 1–13). Melbourne: Monash University. Retrieved from http://www.futureground.monash.edu.au/.

Sevaldson, B. (2005). *Developing Digital Design Techniques: Investigations on Creative Design Computing* (1st ed.). Oslo: Oslo School of Architecture and Design.

Sevaldson, B. (2008). Rich Design Research Space. *Form Akademisk*, *1*(1), 28–44. Retrieved from http://journals.hioa.no/index.php/formakademisk/article/view/119/108

Sevaldson, B. (2013). Systems Oriented Design: The emergence and development of a designerly approach to address complexity. In J. B. Reitan, P. Lloyd, E. Bohemia, L. M. Nielsen, I. Digranes, & E. Lutnaes (Eds.), *DRS // CUMULUS 2013* (pp. 14–17). Oslo: HIOA. https://doi.org/ISBN 978-82-93298-00-7

Sevaldson, B. (2018). *Systems Oriented Design*. in preparation.

Sweeting, B. (2016). Design research as a variety of second-order Cybernetic practice. *Constructivist Foundations*, *11*(3), 572–579. Retrieved from https://www.researchgate.net/publication/305317834_Design_Research_as_a_Variety_of_Second-Order_Cybernetic_Practice

Vogel, G. (2017). Where have all the insects gone? *Science*, *5*(6355), 1–4. https://doi.org/10.1126/science.aal1160

Wagler, R. (2017). Anthropocene extinction. *Access Science*. https://doi.org/10.1036/1097-8542.039350

yr. (2016). Clima. Retrieved February 15, 2016, from http://www.yr.no/

Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1990). *Delivering quality service: Balancing customer perceptions and expectations*. New York - London: Free Press.

Evolutionary Stakeholder Discovery: Requisite System Sampling for Co-Creation

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Abstract A significant source of both power and error in social system design is found in the selection of stakeholders for participation in design and planning engagements. When stakeholders are selected to participate in sessions conceived as co-creation practices, where participants are the "designers of the system," then the entire onus of design decisions falls on the selection of participants. Stakeholder selection can be significantly biased by default and unreflective practices common in design engagements. A discovery process of evolutionary stakeholder sampling resolves this concern by adapting multiple dimensions of ontological and social identification, commensurate with the requisite variety in the defined problem or social system of interest to participating stakeholders. This process provides a justified basis for democratic engagement of multiple stakeholders associated with a social system, across a number of inclusive spectra.

Keywords: Requisite variety, Stakeholder discovery, Co-creation, Third-order cybernetics, Sampling

1. Introduction

As increasingly complex domains are addressed in design studies, from healthcare to smart city planning, methodological accounts are published on engagement practices and group interventions for co-creation and design facilitation (Aguirre, Agudelo & Romm, 2017, Donetto, et al., 2015, Jones, 2019). As predicted by Sanders and Stappers (2008) a decade ago, design practices have indeed moved from design for product and service owners to "design with" participants in their own lifeworlds.

However, as the level of complexity moves higher along a notional scale from products to organizations to multiple coordinating organizations, the inclusion of participants and their role in design decision making changes dramatically. The role of a participant in sketching a preferred app interface entails nowhere near the multifactorial complexity or power relations involved in system, policy, or governance decision-making programs. Yet these programs and their workshops are calling on design practitioners for process support, and these engagements are frequently facilitated with similar participatory and generative methods. The stakes are significantly different between user participation and multi-stakeholder consensus on critical issues or wicked problem systems, and the methods for professing to consensus and design decisions differ not only by style but epistemology and disciplinary integration. An underinformed user's contributions to a service prototype would not have authoritative outcomes. A stakeholder group determining the community's climate adaptation policy ought to require knowledge, personal or professional stake, and the capability to sustain action according to collective decisions.

There may be many systemic design methods considered pragmatically effective in their consultative or engagement settings. Yet in any design process requiring participant decisionmaking, especially with consensus on binding actions, the commitment of the participant to the outcome becomes a critical factor.

Many design scholars have proffered frameworks distinguishing different designing contexts and the skills and mindsets associated with satisfying their felicity conditions. Perhaps the best known is Buchanan's (1991) four orders of design associated with wicked problems in design thinking. Rather than levels associated with problem scale, they are considered four "placements" for design action that can evolve in a design process: symbolic communications, 2) material objects, 3) activities and services, and 4) complex systems and environments. The doctrine of placements regarded the skilled designer as a mediator between these contexts for design. A comprehensive design project might entail production in and across all four placements, such as a multi-branch library system or the multiple functions of a hospital.

The increasing complexity of problem systems engaged by design practice requires a rethinking of the skills and education associated with problems in similar contexts. In Van Patter and Jones (2013) four domains of design were considered to be additive but incommensurable with each other. Skills appropriate to creative production remain necessary, but are completely insufficient to address complex social domains. When multidisciplinary teams Referred to as Design 1.0 – 4.0, the determining factor for each domain was the degree of social (non-design) or ecological complexity entailed in design research and decisionmaking. The first two orders, 1.0 (design as craft) and 2.0 (products and services) are client or brief-driven, typically commercial domains where the parameters for production are well-established or can be set through requirements. Design 3.0 (organizational) and 4.0 (social policy or multi-stakeholder) are both non-parametric design contexts that require methods commensurate with the social complexity (e.g. requisite variety) and ambiguity of outcome. In Design 3.0 and 4.0 we face complexity that does not exist in client projects with a clear user orientation, where appropriate research can settle most design questions. In non-parametric design contexts a practical concern with stakeholder representation arises immediately, with the necessity to represent values and futures across one or many continuing social systems. Unlike product or service design (Design 2.0) we cannot merely sample from a user base to inform design decisions targeting future product releases. A design team may not know the target domain(s) well enough to even identify and represent relevant stakeholders and commensurate methods to facilitate their interaction.

In Design 3.0 and 4.0, the "users" are the system. We treat users as experts in their own experience, not as representatives of a social system of users. We can reliably sample from user populations or market participants, and can identify relevant characteristics of use behaviours to assumed product/service needs. In design research, high deviation from the norm informs design decisions, as research exploring the extremes of use and application signal the emergence of new options in a product or offering.

But in Design 3.0-4.0 contexts, the signifying tasks manage complex scenarios and decisions for which designers cannot be held to understand as domain participants. The facilitating design activities are much more “abstract” than in product/service design research, and primarily include problem finding and framing, discovering common ground between levels of power and knowledge, and across contexts, constructing credible proposals for action, and facilitating a durable consensus for decisions.

These activities require high-credibility and neutral facilitation of stakeholders, who may be seen as committed expert participants in practices, as genuine “system members.” Real stakeholders are not merely representatives of a social system in which they hold titular membership, they are committed co-producers of the social system of concern. In organizational and policy contexts, stakeholders can be seen as political participants in an arena of debate (Renn, 1993). Therefore, one of the most overlooked design choices, stakeholder selection, may be one of the most critical risks and blind spot we face in systemic and policy design.

2. Getting the Whole System in the Room

In the Western knowledge society we have “centred” users and stakeholders as sources of knowledge and veridiction. Human-centring in design is often presented as evidence of ethical practice, or at least, a necessary sensitivity to multivocalism in design process. However, in many if not most design-led participatory workshops, the situated placement of self-selecting participants as representative “voices of the system” can slip into an unreflective (but efficient) process that evades responsibility of future consequences of design decisions. We would not decide a consensus for actual social system participants. Yet how are we disclosing ourselves as lifeworld-sensitive designers, when we decide for a systemic decision, perhaps an even more consequential outcome, of who will be the system participants?

Design problematics in the many domains we now touch involve social complexity and the complex multiplicity of stakeholders. If we recognize stakeholder co-creation as a context for design facilitation for critical decision and planning events (Jones, 2018), we bring forth skills for different roles than product or service designers. As with other design skills, systemic designers are neither authentically domain experts or visionaries in the complex sociotechnical systems we may serve, such as urban planning, healthcare, ecological community design, and advanced technology.

A common phrase among facilitators of large-group interventions is “getting the whole system in the room.” Group processes such as Future Search (Weisbord, 1992) have relied on this principle. Such practices (based on the original search conference concept) rely on the assumption that large group workshops increase the points of view and diffuse the power levels among members of a group and raise the likelihood of their learning from each other and making durable decisions together. This practice has been reported as successful within organizations. However, as a social system is expanded to its larger social boundary (as across an industry or community), achieving understanding and decisions across widely disparate organizations and its stakeholders requires more than just large group workshops and arranging for occasions to meet. We might question the heuristic of the large group intervention, that relies on inclusion of greater numbers of participants rather than targeted compositions of stakeholders and their expected contributions. How could we ever know whether we had acquired the appropriate social variety representative of a given social system, without modelling the system of interest in detail and its interactions? When the very identity of a social system is defined by its members, we would have to involve some quorum of its stakeholders that other members would agree have defined its boundary conditions and inclusions.

Stakeholder selection is itself a wicked problem. As in a wicked problem (Rittel and Webber, 1973) each selection of stakeholder matters, each inclusion of a participant excludes another possible choice. The consequences of participation and non-participation are unknown at the time of selection, but each person's perspective counts and can be seen as a potential representative. Stakeholders as a collective share a context (even if solely due to their invitation to an engagement) and co-create a framing (a reference system) that becomes path-dependent, that cannot be undone. The participant sample defines the problem space. Vision, context and direction setting are extremely sensitive to initial conditions, and – especially when performed well - may create a lock-in effect with confirmation of beliefs among actors that their choices represent desirable preferences for future system participants.

On this logical position we might propose that the selection of stakeholders make more difference to achieving a durable consensus than our choice of design methodology. A carefully-tuned participatory design workshop with attention to co-creation process and designerly practices makes little enduring difference if the participants have no continuing stake in the outcome. When the design team is left to interpret for themselves the meaning of sticky notes pulled off the wall, the workshop has not intervened in the future system.

In systemic design we face a changing problem frame with each selection of participants. We can see shifts between each stage of a progressive design process, sustaining an essentially artificial co-creation engagement. A typical co-creation engagement proceeds from visioning and problem framing, through system intervention or concept formulation, and toward consensus on collective action. All of these activities require stakeholder insight and validation, and much less design guidance and content compared to D2.0 product/service contexts.

A design process becomes irrelevant if stakeholder selection does not represent the variety in the exogenous social system and fails to enrol authentic commitment from selected stakeholders. As design disciplines are predicated on a tradition of creative problem solving, and not social science research, these critical functions are often underdeveloped, especially for workshop-type engagements. When we under-conceptualize the exogenous (external, socially constructed) system we risk failures in outcome, even when co-creation has been deemed highly satisfactory, by failing to select and enrol sufficiently well enough to enable an effective future result in the social system.

2. A Social Science of Cybernetics

Stakeholder selection in systemic design co-creation can be considered an interdisciplinary social science problem, intersecting social science research methodology, sociological analysis of social groups, organizational theory, and action research. In its more rigorous expression, sampling appropriate stakeholders involves non-probability population estimation, and the development of models representing assumptions about the social systems from which inferences about the "whole system" can be justified. The purpose of sampling models or frames in estimating population characteristics becomes critical when policies or decisions are constructed, in design or planning contexts as well as sociopolitical arenas, that affect an entire group's future outcomes. In some respects, every urban planning problem or public policy can be posited as a multi-stakeholder social system. When design teams are given responsibility for convening complex multi-community engagements we require an ethically supportable, transparent process that reveals our criteria, assumptions and system modeling involved in sampling and recruiting.

The method of selecting specific types or even persons meeting necessary criteria to serve as research participants is a well-established method in qualitative research, known as purposive or theoretical sampling. For social systems design, the purposive sample is the most appropriate sampling method. When a group of participants self-selects to participate in an engagement we can determine that some measure of agency bias (personal interest in outcome) could be involved. These implicit biases are difficult to detect, and even harder to balance as their effects are unknown in a session. The so-called random sample of participants, often considered a fair approach in public sector consultations, neglects to identify participants who may be deeply informed and representative of organizations or classes of interest. The purposive sample selects individuals associated with the core purpose of the engagement or study, and is referred to as "theoretical" in that participants match the theoretical issues or constructs of the problem area, which in this case would be a "theory of the system" or a sampling model.2

Evolutionary stakeholder discovery is typically not conducted for well-established groups or defined subsets of organizations, such as a project team, even if users or external stakeholder are involved. This fairly elaborate process is not done for reasons of academic rigor, although increasing rigor without inefficient overhead is usually a desirable practice. Evolutionary stakeholder sampling becomes necessary for ensuring breadth of perspective across the social system and its various constituencies. The process is evolutionary in the sense of the multiple iterations necessary to learn and gain feedback from subsets of the total sample. An evolving process of "discovery" is followed, where the appropriate sample is constructed by evaluating actual stakeholders against models and testing the sampling models against criteria. Such a process protects fairness, neutrality of position, and aims to mitigate power relations within engagements where multiple competing perspectives are expected, and a shared reference outcome, such as a plan or decision, is required.

2.1. Multiple Stakeholder Varieties

Ross Ashby's (1958) principle of requisite variety establishes the primary principle by which stakeholders are selected for a given social system. Ashby also articulated requisite variety with respect to organizations and social systems, as well as the familiar (engineering) control systems with which his theory was applied. With respect to organization, Ashby (1962) revealed the conditions of variety in self-organizing systems, and the consequent uncertainty and conditionality of such systems. Of central concern was the way the "parts" of a dynamic social system change under conditions of the observer's viewpoint. This perspective became known as second order cybernetics (or the cybernetics of cybernetics) by Margaret Mead and von Foerster (2003), a perspective that evolved from the early 1960's and has become a well-established term of art in cybernetics.

The process and purpose of stakeholder *discovery* can also be seen as explicitly cybernetic. Participants are selected for the purposes of the issue of concern. The formulation of stakeholder observations for feedback, feedforward and future control of a social system meets the definition of first-order control. However, since human observers are themselves making observations about systems of concern, this control system of observations serves as a second-order cybernetic system. The *selection* of participating observers charged with formulating observations about their social system's future options adds another layer of control, the management of process and recruiting of relevant participants requires the proposal of a suitable model or conceptual simulation of the process and its outcomes. This executive modeling process becomes a third-order control system. Figure 1 shows a simple representation of these levels of social system observation.

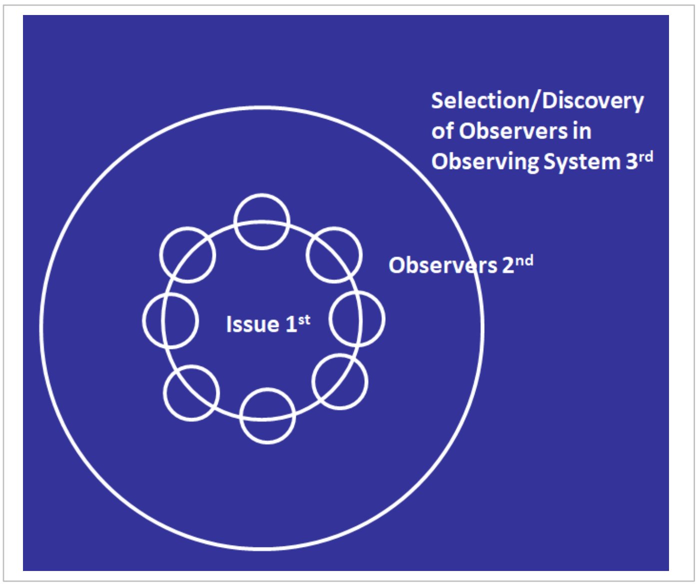

Figure 1. First, Second and Third-Order Observations in a Multi-Stakeholder Design Engagement.

Figure 1 presents a third-order cybernetics frame, an evolution of cybernetic orders developed in the disciplinary discourse for over a decade (c.f. Mancilla, 2011). Here the concept shows the social cybernetics of feedback/feedforward of a 3rd order observing system (e.g., a design team) forming an observing system of participants (2nd order) who engage directly in the facilitated observations regarding the issue (1st order). The third-order design team, typically the steering committee or core group of an engagement, has responsibility for the identification, selection, and recruiting of stakeholders in the observing system that we refer to as the co-creation engagement.

To summarize, we might describe the multiple configurations of social requisite variety potentially influential in the systemic design stakeholder encounter.

- Multiple perspectives associated with the issue of concern
- Multiple perspectives associated with the Triggering Question (the framing of inquiry as presented to all participants)
- Multiple stakeholders and their organizations holding a commitment to the issue or question (domains in the Arena of debate)
- Multiple stakeholder communities that care about the decision or design outcome
- Variety of sociopolitical diversity criteria to ensure appropriate distribution across age range, career stage or type, gender, ethnicity, geography, and meaningful political spectra.

These varieties are expressed in terms of perspective or representation, which are first described in a sampling model. Criteria from the model are then allocated to stakeholder selection, based on inference and validated by interview or survey questions. Following both research and systems principles, primarily requisite variety, we become ethically obligated to employ a sampling and selection process commensurate with the problem complexity. Social systems are not product marketing, and they require a careful analysis of the entailed social dimensions as a first step. Concurrently the framing of a triggering question shared as critical by the participants must be done and communicated in recruiting. Finally, a complete process requires a dialogic engagement methodology that “absorbs” varieties commensurate to the social complexity of the entire balance of dimensions and their ranges. Preferably such process is sufficiently contained by facilitation to enable dialogue, dissension and agreement to emerge.

3. Evolutionary Sampling for Stakeholder Discovery

The requisite stakeholder variety model for stakeholder discovery was designed to address the necessary variety in high-stakes foresight for long-term R&D strategies and as a reference model for anticipatory policy research. We propose an approach called evolutionary sampling, that iteratively samples stakeholders from across sets of covarying dimensions identified within the social system being designed. This method also effectively enables planners and sponsors to reveal biases and risks and to trade-off potential leaders, dominant voices, and under-represented minority views within the social system of concern.

A pragmatic methodology has been developed with several methods consistently associated with the process. The process of evolutionary sampling refers to the stakeholder reference model developed by a core group to map social system characteristics to possible stakeholder varieties. Several category sets are defined to consider stakeholder influence and power, and to expose risks and blind spots where oversampling subgroups could express systematic biases in an engagement.

3.1. Multi-dimensional sampling by multi-category

An iterative sampling process was developed for Dialogic Design methodology (Christakis & Bausch, 2006) and other foresight practices, where the undersampling of variety leads to insufficient knowledge and gaps within critical areas of social representation. Based on two design action research cases performed with a large US government research lab (Weigand, et al., 2014) and Canadian foresight studies, a sampling reference model was developed that integrates three dimensions ((Fig. 2):

- Ontological commitment, or worldview perspectives, based on Latour's (2013) Modes of Existence ontological typology as a social theory of orthogonal perspectives,
- Foresight trend categories based on STEEP categories (selection of core expertise),
- Social variety (diversity) and demographic characteristics associated with the system.

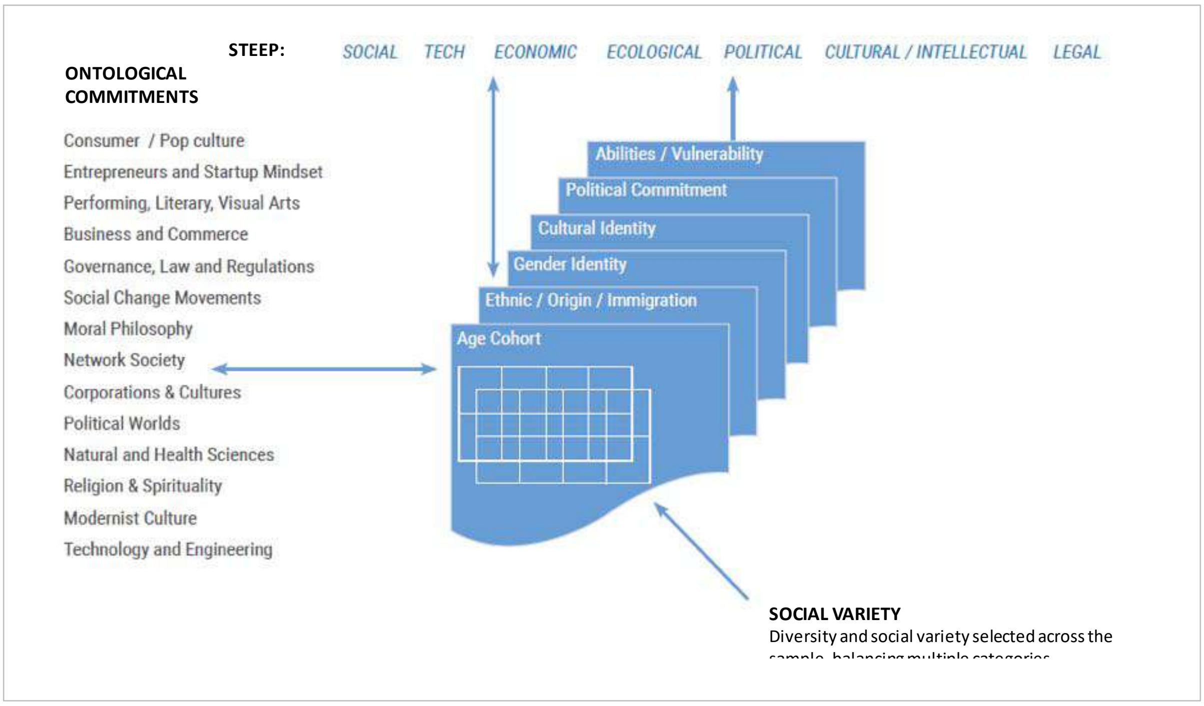

Figure 2. Model Sampling Frame for Evolutionary Stakeholder Discovery.

A model for requisite stakeholder variety enables robust sampling for ontological representation, variety, biases and diversity of knowledge, and exogenous representation of commitment (e.g. *skin in the game*, Taleb & Sandis, 2015). This canonical stakeholder model maps selected domain categories (e.g., STEEP) to worldview ontological domains (Modes), and further diversifies by variety attributes including age, culture, gender, and experience. This mapping identifies significant relationships of knowledge and trends across domains and disciplines. At minimum the stakeholder sampling model provides a checklist that exposes possible risks and blind spots in the available composition of stakeholders or experts. It further provides a schema for identifying values conflicts between worldviews and other attributes associated with known stakeholder interests (such as strategic preferences that planners wish to include).

The evolutionary sampling process requires several stages of mapping from inquiry to social system. I have described the sampling frame, which is essentially the formation of a framework of dimensions that reflect the exogenous social system of interest. The sampling frame consists of a matrix composed by mapping selected categories from the framework to not only the social system, but a question of interest to participants in that system qualified to act in the future as a result of the engagement or its consensus.

A continuing dialectic is created between the sample and the emerging question that become resolved through the process of recruiting appropriate stakeholders. The dialectic is between the envisioned participants within categories and their match to the question. The process starts with the initial issue framing, the analysis of categories, identifying participants matching those categories, and reframing the question of interest (triggering question) to best fit the emerging interest patterns of the committed participants.

4. Conclusion

The outcomes of any design or strategy engagement can result in conclusive decisions. The interactions of participants are indeterminate, probabilistic and potentially influential of future outcomes. We cannot and do not wish to control or influence the outcomes and decisions of multistakeholder groups. But we cannot know how knowledge and power influences will propagate within a session, especially in high complexity contexts. Since we know that many group process dysfunctions exist, and process facilitation is not a perfect science, it become an ethical imperative to manage the outcome risk for which we have some control. If we can develop better models of the social system of interest in a planning or decision contexts, much of the risk of an unwanted outcome can be mitigated.

The object of evolutionary stakeholder discovery is the best-fit match between participants in a design engagement associated with the requisite variety commensurate with an exogenous social system or crossing of systems. The formation of such a microsystem of macrosystems forms a context for a strong democracy in miniature whereby committed participants, the stakeholders owning the social system design, agree to balance or distribute agency and risk across the system.

References

Aguirre, M., Agudelo, N., & Romm, J. (2017). Design facilitation as emerging practice: Analyzing how designers support multi-stakeholder co-creation. *She Ji: The Journal of Design, Economics, and Innovation, 3*(3), 198-209.

Ashby, W. R. (1958). Requisite variety and its implications for the control of complex systems. *Cybernetica, 1*, 83–89.

Ashby, W. R. (1962). Principles of the Self-organizing System. In von Foerster, H. and GW Zopf, Jr., *Principles of Self-organization*. University of Illinois Symposium on Self-Organization, pp. 255-278. Pergamon Press.

Christakis, A.N. & Bausch, K. C. (2006). *How people harness their collective wisdom and power to construct the future in Co-laboratories of Democracy*. Information Age Publishing.

Donetto, S., Pierri, P., Tsianakas, V., & Robert, G. (2015). Experience-based co-design and healthcare improvement: realizing participatory design in the public sector. *The Design Journal, 18*(2), 227-248.

Jones, P.H. (2018). Contexts of co-creation: Designing with system stakeholders. In P. Jones and K. Kijima (eds.), *Systemic Design: Theory, Methods and Practice*, pp. 3-52. Volume 8 in Translational Systems Sciences Series. Springer Japan.

Latour, B. (2013). *An inquiry into modes of existence*. Cambridge, MA: Harvard University Press.

Mancilla, R. (2011). Introduction to sociocybernetics (Part 1): Third order cybernetics and a basic framework for society. *Journal of Sociocybernetics, 42*(9), 35-56.

Renn, O. (1993). The social arena concept of risk debates. In S. Krimsky (Ed.), *Social theories of Risk* (pp. 179–196). Westport, CN: Praeger.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155-169.

Sanders, E.B.N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *Co-design, 4*(1), 5-18.

Taleb, N. N., & Sandis, C. (2015). The skin in the game as a risk filter. In *Future Perspectives in Risk Models and Finance.* Springer, pp. 125-136.

Van Patter, GK & Jones, P. (2013). Understanding Design 1,2,3,4: The rise of visual sensemaking. In T. Poldma (ed.), *Meanings of Designed Spaces*. New York: Fairchild Books, pp. 331-342.

Von Foerster, H. (2003). Cybernetics of cybernetics. In H. von Foerster (Ed.), *Understanding Understanding,* pp. 283–286. New York: Springer.

Weigand, K., Flanagan, TR, Dye, KMC, and Jones, P. (2014). Collaborative foresight: Complementing long-horizon strategic planning. *Technological Forecasting & Social Change, 85*, 134–152.

Weisbord, M. R. (1992). *Discovering common ground*. San Francisco: Berrett-Koehler Publishers.

Exploring R.D. Laing's Knots in Systemic Design

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Abstract *Knots*, a 1970 book by the Scottish psychiatrist R.D. Laing, is based around a collection of patterns of human thinking, metacognition, and theory of mind, drawn from real experience with patients but turned into abstracted examples. The approach has the potential to be adapted into a range of formats which enable systemic design phenomena such as recursion, reflexivity, theory of mind, and second-order effects in systems to be explored, as a way of thinking about systems for design students and adding to their conceptual vocabulary, but potentially also as a method for doing research with people. This paper illustrates example 'new knots' around topics including sharing data, social media, clickbait, and 'smart' homes.

Keywords: systems, knots, double bind, methods

1. Introduction

Bringing systemic thinking into design education—and practice—takes many forms. Work described at previous RSD conferences (e.g. Sevaldson, 2017), and in the wider community around systemic design, cybernetics, and related fields such as transition design, has emphasized the value and importance of particular systems concepts and approaches, from the leverage points and stocks, flows, and buffers of Donella Meadows (2008), to the conversation models of Dubberly and Pangaro (e.g. 2015a), the materials mapping of Aguirre Ulloa and Paulsen (2017), and the visual approaches of Boehnert (2018). There is, taking a systemic perspective, probably no 'right' set of concepts to teach or learn, only a repertoire or vocabulary (Lockton & Candy, 2018)—a requisite variety—of methods, tools, or lenses for examining and exploring systems at different levels of resolution and with different purposes and goals in mind; "All models are wrong, but some are useful" (Box & Draper, 1987).

A resurgence in attention to the history of methods and developments in systems research and cybernetics (e.g. Pickering, 2010), the evolution of the design methods movement, and their intersections with interaction design (Steenson, 2017; Dubberly & Pangaro, 2015b) and practical application within current technological contexts (Fantini van Ditmar, 2016) has inspired re-examination of some tools and concepts from a related area: the systems and psychiatry milieu of the 1960s and 70s.

In particular, in this paper, I explore a few examples of ways in which R.D. Laing's concept of *knots* (1970) has proved applicable in provoking design students to consider systemic effects in relation to aspects of interaction with digital technology in everyday life, and enabling new kinds of analyses. We also touch on Gregory Bateson's related notion of the *double bind* (1972).

Although originally developed and presented in very different circumstances, the two concepts have certain synergies that make them valuable 'tools for thinking' about systems, and can be applied practically to people's role in contemporary technological examples including issues of data protection, social media, 'smart' homes, behavioural targeting, and design for behaviour change, as well as other topics within design practice such as contextual research with participants, and participatory design.

2. Some contemporary examples of knots and double binds

Laing's *Knots* is a curious 1970 publication, a slim book formatted in the form of a volume of poetry, which contains a collection of patterns of human thinking, metacognition, and theory of mind that Laing had noticed in his work as a psychiatrist, and turned into abstracted (but still often poignant) examples. Many of them involve one person reasoning about how another person thinks, or trying to unravel the complexity of, or causalities within, a situation, and there is a good deal of 'second-order' thinking present which is immediately (superficially at least) reminiscent of the kinds of cybernetic discussions of relations and conversations in the work of researchers such as Pask, Glanville, Pangaro, and Dubberly.

These knots are essentially about people trying to understand what someone else understands about them, or in our terms, how someone understands their relationship with a system. But that understanding changes how they relate to the system, and the system in turn then changes the relationship, and a tangle or knot emerges. For instance, the book starts with:

> *"They are playing a game. They are playing at not playing a game. If I show them I see they are, I shall break the rules and they will punish me. I must play their game, of not seeing I see the game." (Laing, 1970:1)*

Some later patterns verge into forms of concrete poetry which are essentially systems diagrams (e.g. Figure 1), and it is this way into using the concept of 'knots' which has proven useful in exploratory design classes, with students introduced to knots through extracts from the book, and challenged to find (and construct) examples of analogous situations in people's everyday interactions with technology.

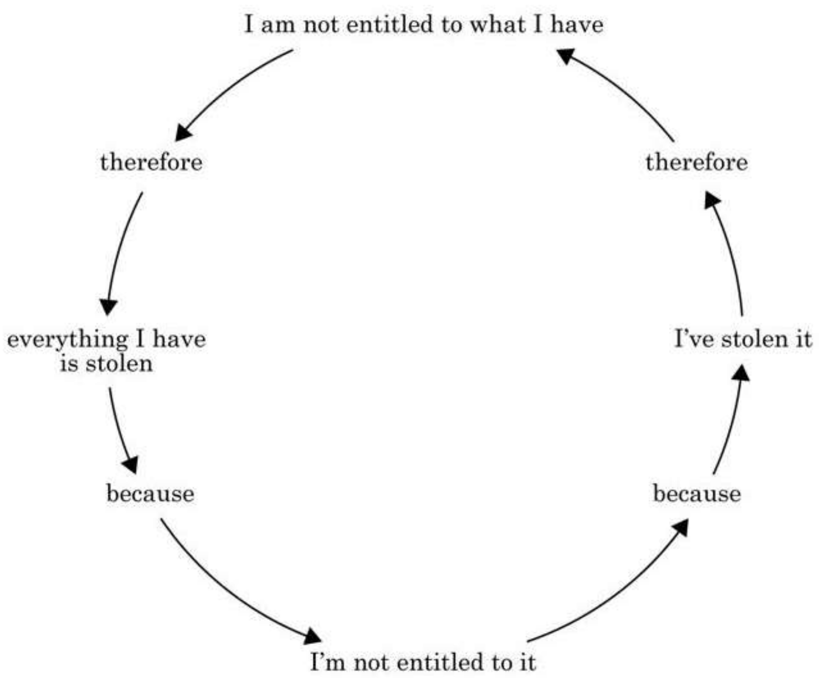

Figure 1: A knot redrawn from Laing (1970:35)

2.1. Knots in sharing data

For example, in Figure 2, a 'new knot' around data sharing and personalization in smart homes is presented (building on ideas from Fantini van Ditmar & Lockton, 2015, and originally presented as part of a workshop at NORDES 2015 (Dutson et al, 2015)).

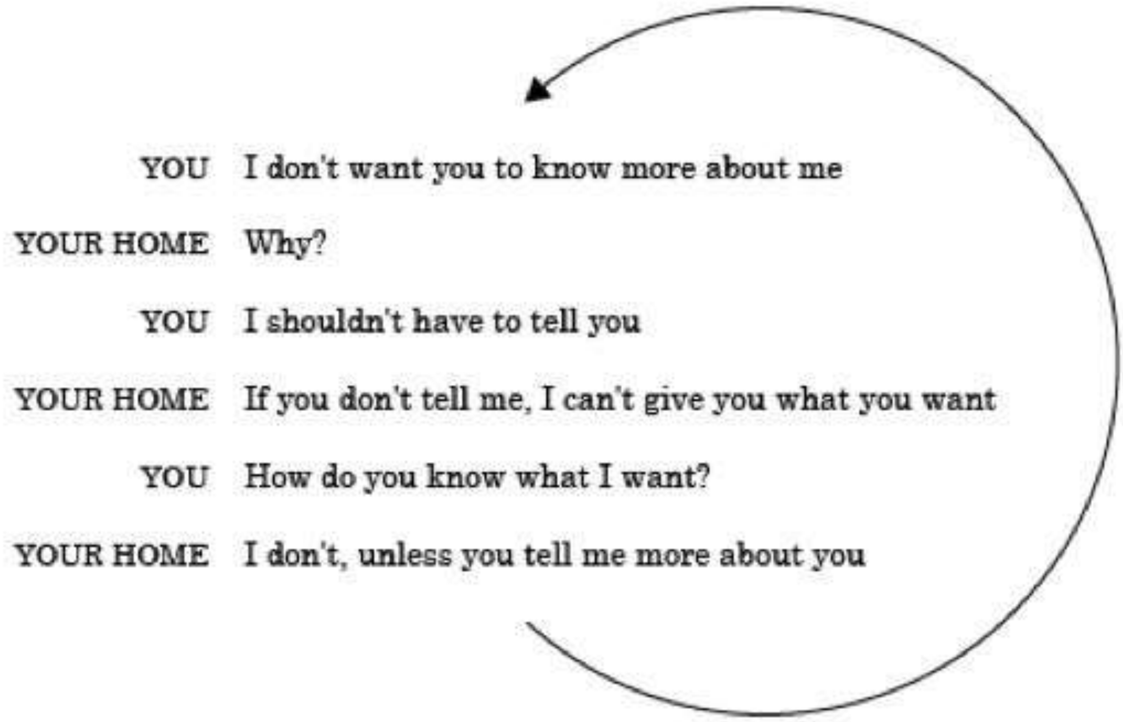

Figure 2: A 'new knot' in a smart home context

A similar model might also be applicable to behavioural profiling in advertising and algorithmic feed curation in social media. People (at least according to advertisers) express a desire for 'relevant' content, but also don't wish to give up any data to enable the content to be tailored.

One student's project around this issue involved asking others "What do you think Facebook thinks about how you think?", based on extracting data from the advertising 'audiences' that Facebook had placed them into (Figure 3), finding that this tension, or flip-flopping, between being annoyed by perceived inaccuracies in the categories, but also feeling annoyed by categories which were *too* accurate (hence indicating too-successful profiling), was a common feeling.

Figure 3: Extracts from research done by Annisa Prasetyanto into students' feelings on learning how they had been categorized for advertising purposes by Facebook.

2.2. Knots in design for behaviour change

In design for behaviour change (e.g. Tromp & Hekkert, 2018; Lockton et al 2009), the relationships between attitudes and behaviours are often a matter for investigation, as different models presume different starting points. Figure 4 starts with this, in a 'knot' form, and then also mentions a perceived collective action problem—a common framing particularly in relation to influencing more sustainable behavior, where it may seem 'not worth' doing unless everyone else does it too.

My attitude must be wrong

because my behaviour is wrong

because my attitude is wrong

How can I change?

I want to change

does that mean my attitude is right?

then I don't need to change

but I want to

I will change my behaviour

when everyone else does

otherwise there's no point

Figure 4: An attitude/behaviour 'new knot'

2.3. Double binds in student wellbeing

When we introduce the idea of knots to students, the principle often works in conjunction with Bateson’s concept of the double bind, in this context referring to dilemmas or situations where someone feels—or *experiences*—being pulled or pushed (metaphorically) in two contradictory directions at once (causing stress, unhappiness, or decision paralysis).

More precisely, the double bind describes situations where the ‘rules’ of how to act within a system seem to be mutually self-contradictory and any action taken in one direction causes more problems in the other (paralleling aspects of wicked problems, particularly Conklin’s (2006) interpretation). To use an example that students raised, they know they ‘should’ eat more healthily (taking time to prepare), but they also know they ‘should’ spend as much time as possible working. Often the contradiction occurs because each framing of ‘the problem’ is operating at different level of the system, and so uncovering double binds as experienced by people living ‘within the system’ can be a route into understanding how to intervene, or at the very least to map a system from the perspectives of the participants.

Figure 5: Streblessful: an extract from *Lexicon of Feelings* by Aisha Dev, Kailin Dong, Katie Glass, Zhiye Jin, Soonho Kwon, and Jessica Nip (Luria et al, 2019)

One recent project (Luria et al, 2019) includes students examining ‘contradictory injunctions’ in relation to mental health and pressures on student life (work hard but also get enough sleep; be successful but don’t work too hard; be sociable but also concentrate on studying; etc) through creating new compound words which capture the contradictory states in a single expression, e.g. ‘Streblessful’ (Figure 5) to signify feeling stressed, but also thankful and blessed.

2.4. Knots and overthinking in messaging and social media

Social media and other contemporary forms of communication offer a variety of 'overthinking' situations which can be modelled using a 'knot'-like approach. Figure 6 shows a (simulated) conversation in which the attention someone believes a friend is paying to their updates is not matched by reality (perhaps through genuinely not paying attention, or perhaps through an algorithmic decision to hide/de-emphasise the updates, unbeknownst to either party). Figure 7 shows a meme example around Snapchat responses, embodying consideration of theory of mind.

Figure 6: A (perhaps unrealistically stilted) text message conversation embodying a variant of Laing's "I'm upset you're upset" knot (Laing, 1970:21).

Figure 7: An 'expanding brain' meme (collected on Reddit's me_irl subreddit) dealing with a knot-like escalating sequence of approaches to dealing with a Snapchat snap. By the fourth panel, the "thinking about how the other person will think you think" level has become complex and employs a particular affordance of the messaging system (the 'typing' notification) in a strategic way. Original author unknown.

In a potentially more formal communication format, such as replying to email, responding to a telephone message, or even replying to a letter, a somewhat similar knot can play out (Figure 8) around a delay in replying, and how that is believed to be perceived by the other person. A slow reply can signal a lack of care about the correspondent, but a fast, perfunctory reply can signal that the sender has not thought deeply (enough) about them. In general, many of these kinds of knot encompass a recognition that, as Laing had earlier noted, “Your experience of me is invisible to me and my experience of you is invisible to you... [but] I cannot avoid trying to understand your experience, because although I do not experience your experience... I experience you as experiencing.” (Laing, 1967:4). As we enter into systems, we are aware that other people within the system will also be experiencing it, just as we are; we are aware that their experience may not be the same as ours, and we are aware that they may interpret our behaviour in different ways, and make inferences about us and our intentions (and personality) from observing our behaviour (Ross & Nisbett, 1991), whether or not those inferences are correct.

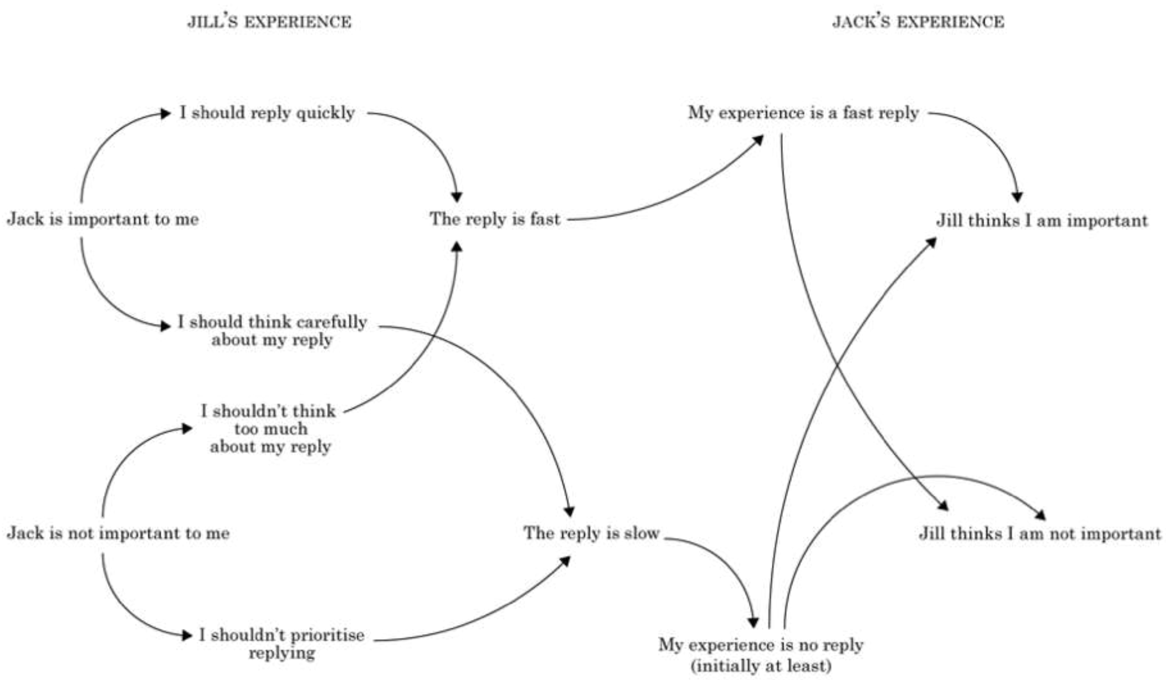

Figure 8: A knot in reply etiquette (e.g. replying to emails) contrasting the possible experience of each party (Jack and Jill).

Some of these are essentially variants of classic dilemmas around unrequited (or not) love, or attention in general (e.g. Figure 9) which are relatively easy to put into a ‘knot’ format.

Jill likes Jack
Jill *hopes* Jack likes Jill
Jill hopes Jack thinks Jill likes Jack
Jill *worries* Jack thinks Jill doesn't like Jack
Jill worries Jack thinks Jill likes Jack too much

Jack doesn't like Jill
Jack hopes Jill doesn't like Jack

Jack hopes that Jill likes Jack
even though he doesn't like her

Jack doesn't like Jack

Figure 9: An old story, of thinks, hopes, and worries.

2.5. The real reasons that knots and clickbait relate. #2 will shock you!

The phenomenon of clickbait—often sensational 'news' stories created primarily to attract readers to click, thus enabling increased advertising revenue—has been modelled from a system dynamics perspective by Nicky Case, creator of the wonderful Loopy "tool for thinking in systems" (Case, n.d.), primarily in terms of how trust in journalism is eroded. But it's worth highlighting the basic knot-like systemic relationship: the more people click on 'shocking' things, the less 'shocking' they become, and so an escalation or runaway race to the bottom might be a consequence. Figure 10 is an attempt to illustrate part of this process.

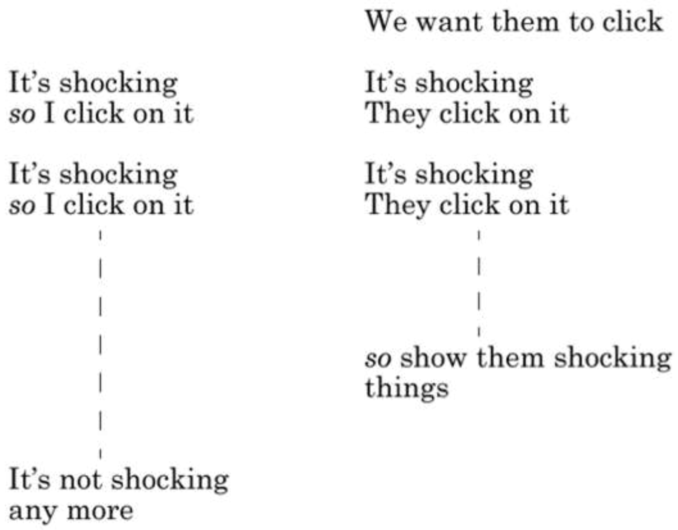

Figure 10: Eventually the system 'optimises' for clickbait: what starts off as an accidental side-effect with certain stories quickly becomes the default way to write stories, but loses its effect.

2.6. Knots, machine learning, and other intelligences

KNOTS AND THE SMART FRIDGE, OR THE OLD SAUSAGE*

I am vegetarian
I don't like sausage
My friend is not
She came to stay
She brought sausage
She left some

My fridge has sausage in it I don't eat it	Your fridge has sausage in it
My fridge has sausage in it I don't eat it	Your fridge has sausage in it
My fridge has sausage in it I don't like sausage	Your fridge *always* has sausage in it You must really like sausage
	Let me order you some more

Based on a case in Delfina Fantini van Ditmar's PhD, *IdIoT: Second-order cybernetics in the 'smart' home*, 2016

Figure 11: Based on a case in Delfina Fantini van Ditmar's PhD, IdIoT: Second-order cybernetics in the 'smart' home (2016), in this example the 'learning' system of a smart fridge makes an incorrect inference about the reason for there always being sausage in the fridge.

Many of Laing's knots are essentially about people trying to understand what someone else understands about them. We might extend that to covering how someone understands their relationship with a system—but of course, that understanding changes how they relate to the system. In this vein, one application of knots as a 'format' could be in doing user research around people's understandings of artificial intelligence, particularly systems using machine learning. We are used to thinking about how other people think about how we think (and mentally simulating that, perhaps adjusting our behaviour as a result), but what does it look like when we start having these kinds of thoughts about other actors—not just humans? And when 'they' start having these kinds of 'thoughts' about us? What 'models of how people' are being encoded into algorithms (quite apart from the structural biases)? What new knots could emerge from our interactions with systems which are learning about us just as we learn about them (Figure 11)?

3. Conclusion: What do knots offer?

This working paper has provided a brief, shallow, and quite cursory tour of just a few examples of how formats inspired by, or based on, aspects of R.D. Laing's *Knots* can provide a systems-ish perspective on different, mainly technology-mediated, phenomena in contemporary design research. While it is hard to define an exact specification for a knot format—Laing himself notes that the patterns he has "delineated… have not yet been classified by a Linnaeus of human bondage" (Laing, 1970:v)—I hope the reader will be able to see some commonalities of structure and ways of thinking among the examples.

Knots offer a way of enabling recursion, reflexivity, theory of mind, and second-order effects in systems to be explored through a variety of narrative formats. Introducing this as a way of thinking or exploring systems to design students serves to add to their conceptual vocabulary, but perhaps a more expansive way forward is to use elements of the format as a method for doing research with people. How could we use knots (and double binds) as a concept to help people explore their relationships with systems? What could it look like to turn knots into a form of probe or interview tool? Could we help people identify knots in their own lives (and help them untangle them?) Is it even possible to untangle these? Do they describe problems that have a wickedness to them which means attempting to untangle creates a whole new problem? (Is it inherently 'wicked'?)

Through a series of projects with colleagues over the last few years, I have become increasingly fascinated by how we, as designers, can apply methods from design practice as a form of enquiry into the imaginaries, mental imagery, intangible and invisible aspects of people's understanding and personal, subjective experience of concepts and ideas which are otherwise hidden or only describable through spoken or written language. What started in 2011 as an attempt to get people to draw their mental models of heating systems using Post-It notes led through various modes including asking people to create instructions for others (Phillips et al, 2013) and to draw or paint their mental imagery around energy (Bowden et al, 2015) or build model landscapes to represent career paths or life journeys (Ricketts & Lockton, 2019). But an investigative format based around knots, perhaps actually physicalized (Fass, 2016) as a system of string or thread which can be tangled and looped and connected, seems to offer a particularly exciting and rich set of possibilities, enabling people to model relationships in a more nuanced format than a static diagram, and facilitating prompts for discussion about the specifics of the knotted situations that emerge, as part of a participatory design process. This is the direction I intend to take this work in future projects.

References

Aguirre Ulloa, M., & Paulsen, A. (2017). Co-designing with relationships in mind: Introducing relational material mapping. *Form Akademisk,* 10(1), pp.1–14.

Bateson, G. (1972). 'Double Bind, 1969'. In: *Steps to an Ecology of Mind*, pp.271–278. Chicago: University of Chicago Press

Boehnert, J. (2018). *Design, Ecology, Politics: Towards the Ecocene*. London: Bloomsbury Academic.

Bowden, F., Lockton, D., Gheerawo, R. and Brass, C. (2015). *Drawing Energy: Exploring perceptions of the invisible*. London: Royal College of Art, London.

Box, G.E.P., and Draper, N.R. (1987). *Empirical model-building and response surfaces*. New Jersey: Wiley.

Case, N. (n.d.). Loopy (v.1.0): A tool for thinking in systems. Available at: https://ncase.me/loopy/v1/

Conklin, J. (2006). *Dialogue Mapping: Building Shared Understanding of Wicked Problems*. New Jersey: Wiley.

Dubberly, H. and Pangaro, P. (2015a). 'Cybernetics and Design: Conversations for Action'*. Cybernetics and Human Knowing* 22(2‑3), pp.73-82.

Dubberly, H. and Pangaro, P. (2015b). 'How cybernetics connects computing, counterculture, and design'. In: Blauvelt, A. (ed.), *Hippie Modernism: The Struggle for Utopia*. Minneapolis: Walker Art Center.

Dutson, C., Fantini van Ditmar, D. and Lockton, D. (2015). 'The Performance of Nonhuman Behaviour'. Workshop at *NORDES 2015: Design Ecologies: Challenging anthropocentrism in the design of sustainable futures*, 7-10 June 2015, Stockholm, Sweden.

Fantini van Ditmar, D. (2016). *IdIOT: second-order cybernetics in the 'smart' home*. PhD thesis. London: Royal College of Art.

Fantini van Ditmar, D. and Lockton, D. (2015). 'Taking the code for a walk'. *Interactions* 23(1), pp.68–71.

Fass, J. (2016). 'Self Constructed Representations: Design Research in Participatory Situations'. In Proceedings of *Cumulus 2016*, 21–24 November 2016, Hong Kong.

Laing, R.D. (1967). *The Politics of Experience*. London: Penguin

Laing, R.D. (1970). *Knots*. London: Penguin

Lockton, D., Harrison, D. and Stanton, N.A. (2009). ‘Choice Architecture and Design with Intent’. In Wong, W & Stanton, N.A. (eds.), *NDM9 – 9th Bi-annual International Conference on Naturalistic Decision Making*, June 23-26, 2009, London, UK, Doctoral Consortium Proceedings, British Computer Society, Swindon

Lockton, D. and Candy, S. (2018). ‘A Vocabulary for Visions in Designing for Transitions’. *Proceedings of DRS 2018: Design Research Society conference*, Limerick, 25–28 June 2018.

Luria, M., Brown, J., Herzog, K., Rodriguez, L., Vitoorakaporn, S., LeFevre, J., Mills, S., Guilfoile, C., Kahle, N., Dong, K., Nip, J., Dev, A., Glass, K., Jin, Z., Kwon, S., Wolf A., and Lockton, D. (2019). ‘Potions, Rocks, Models, and Lexicons: Materializing Mental Health Using Design Methods’. Under review.

Meadows, D.H. (2008). *Thinking In Systems: A Primer*. Vermont: Chelsea Green.

Phillips, R., Lockton, D., Baurley, S. and Silve, S. (2013). ‘Making instructions for others: exploring mental models through a simple exercise’. *Interactions* 20(5).

Pickering, A. (2010). *The Cybernetic Brain: Sketches of Another Future*. Chicago: University of Chicago Press.

Ricketts, D. and Lockton, D. (2019). ‘Mental Landscapes: Externalizing Mental Models Through Metaphors’. *Interactions* 26(2).

Ross, L. and Nisbett, R.E. (1991). *The Personal and the Situation*. McGraw-Hill.

Sevaldson, B. (ed.) (2017). *Proceedings of Relating Systems Thinking and Design (RSD6) 2017 Symposium*. Oslo, Norway, October 18‐20, 2017.

Steenson, M.W. (2017). *Architectural Intelligence: How Designers and Architects Created the Digital Landscape*. Cambridge, MA: MIT Press.

Tromp, N. and Hekkert, P. (2018). *Designing for Society: Products and Services for a Better World*. London: Bloomsbury.

Mapping disciplinary mobility for tackling complex problems

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Abstract: This working paper aims to explore the value of spatial metaphors and collective mapping as a conceptual and methodological framework to facilitate the understanding of cross-disciplinary interactions within heterogeneous working groups tackling complex problems. This kind of problems requires the formulation of systems-oriented approaches that are not always easy to communicate or assimilate while working with a team with mixed knowledge backgrounds and expertise, so there is an opportunity space to improve the way groups comprehend their problems' level of complexity and the nature of their own profiles, workflows and processes. Spatial metaphors and collective mapping can serve as a common ground for teams to represent those interactions. This paper presents the results of several workshop-led activities held with multidisciplinary teams utilizing a systems-oriented set of tools supported on visual thinking and spatial metaphors such as nationality, territory and mobility.

Keywords: *complex problems, cross-disciplinarity, knowmadism, systemic design, collective mapping*

1. Introduction

According to Midgley (2003), the way we understand problems cannot be separated from the way they are intervened and investigated. Complexity does not show explicit boundaries or divisions and its structure does not always match with the disciplinary approaches that we have crafted through the different levels of human knowledge. Therefore, since observers are also part of the system they are trying to frame, systemic intervention processes should be designed taking under consideration the nature and configuration of the actants that are looking to create changes within the system.

Mostly in academic and professional interventions, disciplines work as strategic points of departure where agency is self-regulated by the actants shared interests and the methods and processes that are better known for them, either individually or collectively. This kind of organization leads to the classification and distribution of tasks in a workflow, which implicitly defines the division of labor and the departmentalization of knowledge

However, our contemporary world keeps asking us to solve highly complex issues that cannot be addressed only by isolated specialists but require collective approaches that integrate diverse kinds of knowledge, such as systems thinking. The need for this kind of approaches is also a consequence of the increasing effects of information decentralization, the ambiguity on academic legitimization systems, the disciplinary flexibilization of expertise areas, and the lack of manageability of knowledge in terms of possession (Quaggiotto, 2008).

In order to understand the complexity of knowledge exchange processes that a team requires while addressing equally complex issues, this paper explores diverse possibilities to represent and communicate cross-disciplinary interactions among team members, specifically regarding to human beings with a formal disciplinary background and expertise.

2. Working groups and self-organization processes

Francis Heylighen (2013) considers that collaboration in human working groups depends on the degree of coordination achieved during self-organization processes, when individual agency and strategies are aligned to a range of collective objectives. When agency is not obstructed but complemented by each agent’s action, the kind of collaboration is called synergy. Thus, coordination is “the structuring of actions in time and (social) space so as to minimize friction and maximize synergy between these actions” (Ibid., p. 123).

One of the main problems in self-organization processes of human working groups is the fact that individuals’ interventions respond to a shared framework of paradigms, interests, specialized language, methods and ideologies that were historically built through disciplinary practices. Discordances between disciplinary practices and the group’s collective objectives result into a lower coordination degree.

2.1. How coordination works

Heylighen describes four elemental mechanisms that ensure coordination within a group and constitute a complex branched network of mutually dependent processes [Figure 1]:

- **Alignment:** The orientation of multiple agents' actions towards a shared direction or objective in order to generate a low friction degree among agents and strategies. The loss of alignment can be a consequence of the agents' dispersion or segmentation over the working space.
- **Division of labor:** The development of different tasks according to the compatibility and complementarity of each agent's capabilities.
- **Workflow:** Coordination of activities that have place one after another in a sequence of actions. Its realization depends on the agents' availability and capacity (in terms of how diverse and reciprocal their capabilities are).
- **Aggregation:** Simultaneous collection of all the agents' contributions in order to synthesize them towards a coherent final product or outcome.

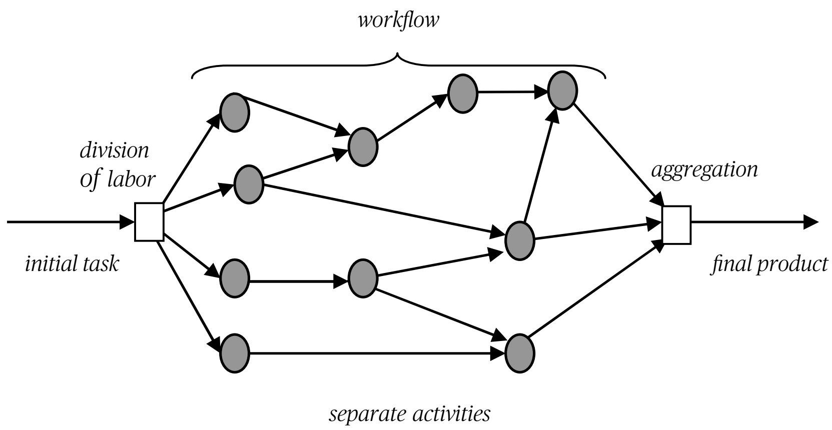


Figure 1. Coordination in which an initial task is split up in separate activities performed by different agents (division of labor), which are followed by other activities (workflow), and whose results are assembled into a final product (aggregation). Grey circles represent individual agents performing activities. Arrows represent the "flow" of work from one agent to the next. (Heylighen, 2013)

Heylighen points out that problem solving requires intelligence (either it is individual of collective, according to agents' distribution over the working space). Collective intelligence is only achieved by the integration of diverse agents with different forms of expertise (knowledge, information and skills) and it represents by itself a cognitive coordination problem that could be analyzed by evaluating Surowiecki's requirements for a group to exhibit collective intelligence (2005), which are:

- **Diversity:** In terms of the knowledge and expertise possessed by each agent.
- **Independence:** In order to avoid influence or premature alignment.
- **Decentralization:** Information gathering and processing in a parallel and collective way.
- **Aggregation:** Discussion mechanisms and collective decision-making processes.

2.2. Disciplinary orientation according to complexity

According to Heylighen's perspective on coordination, we could say that academic disciplines play a key role for collaborative processes as they set the ground for the division of labor and the decentralization of tasks through the segmentation of different activities. We can see results of this segmentation not only in academic production, but also in how knowledge has been traditionally managed in business around the world. However, it is well known from knowledge economy (Gibbons et al., 2010) that, even though the Mode 1 production of knowledge (monodisciplinarity) has brought highly specialized outcomes for industrial and social development, the Mode 2 (multi/inter/transdisciplinarity) is valued by its potential to resolve complex and uncertain problems, mostly due its need of enabling a more open, iterative and heterogenous process of knowledge production.

In an attempt to understand the sequence of actions performed by heterogenous working groups where there is a high influence from the agents' disciplinary backgrounds, cross-disciplinary interaction has been schematized in many different ways as a coordination process which interactions complexify according to the nature of the addressed issue [See Figure 2] and the number of involved agents (Carbone & Crowder, 2011; Godemann, 2008; González-Castillo, 2016; Mumuni, Kaliannan, & O'Reilly, 2016). However, this kind of theoretical approaches result highly complicated to comprehend or replicate for non-scientific practitioners, thus they fail as a hands-on framework for groups to evaluate or design their cross-disciplinary interactions.

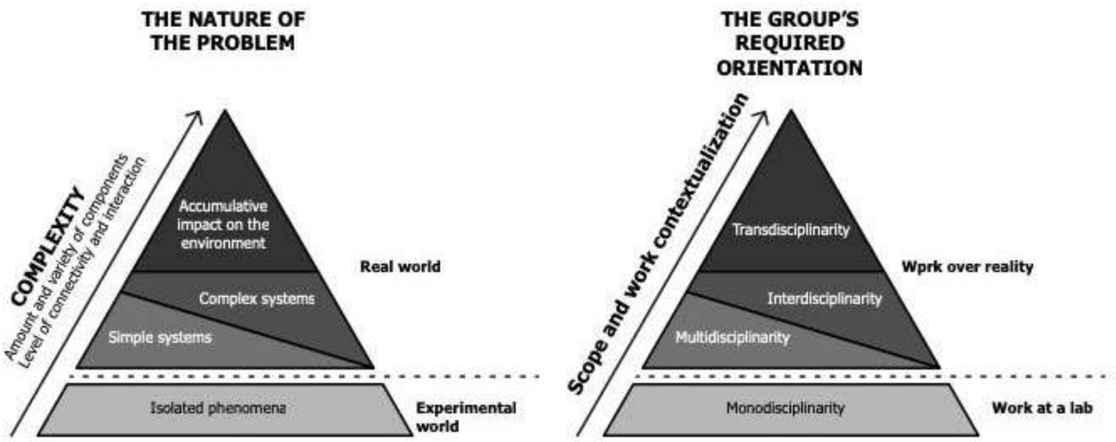


Figure 2. Adaptation of situations/problems and disciplinary orientations pyramids. (González-Castillo, 2015)

Since, as argued above, agents addressing complex issues are inherent parts of the systems they are working with, a systemic design approach might be useful to bridge the gap between problem framing and self-organizing processes such as team building and group coordination. This would mean helping teams understand themselves before (or while) understanding their problems. Joi Ito claims "we need a paradigm shift that allow us to understand, design and deploy interventions in complex systems, (a paradigm that requires) a post-disciplinary approach; a new "participant design" process in which the participants in the system are the designers" (2018, p. 31).

3. Disciplinary mobility

With a constructivist point of view over knowledge, Oliva-Figueroa, Koch-Ewertz, and Quintero-Tapia (2014) offer an interesting approach to understand migratory processes among diverse disciplinary areas within the academic realm. In this context, the usage of the term "disciplinary mobility" was planned to serve as an evaluation metric to measure quantitative regularities referring to processes of displacement and disciplinary interactivity among students of different careers according to the totality of undergraduate and graduate students of academic institutions. Even though they do not deepen into the conceptual construction of this term, it still serves as a rich concept to link with other conceptualizations such as "knowmads"[1], an term inspired by Peter Drucker's concept of "knowledge workers" and coined by John Moravec to refer to an emerging class of borderless workers who apply what they know into new contexts to create value within different organizational and social configurations, regardless their former disciplinary backgrounds (Moravec, 2013; Moravec & van den Hoff, 2015).

There seems to be a tendency to utilize concepts such as "mobility" or "nomadism" as a metaphorical way to represent contemporary dynamics of interactivity in terms of identity, consumption and production of information (Gaggiotti, et al. 2015) —which actually makes sense, considering the possible meanings that those concepts would imply if looked by a systemic point of view—. Metaphor is an essential linguistic resource to understand and represent a concept in terms of another (Lakoff & Johnson, 2008) and has been constantly used as a cognitive tool to explain how humans experience the world, translating complex phenomena to "a much more human scale" (Fauconnier & Turner, 2008) in order to enable a higher sense of understanding of a situation.

Following the metaphor of "disciplinary mobility" as the possibility of moving across different fields of knowledge, I would like to propose an extent to the concept so it can be understood as the capacity of agents to flow across institutionalized systems of knowledge, oriented by their interests of agency, and regulated by diverse exchange dynamics that enable their organization and linkage with other agents through the consumption, production, and application of knowledge.

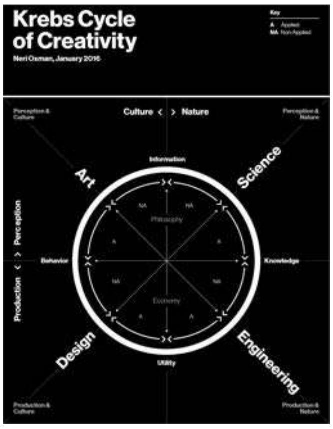
This metaphor made even more sense for me while reading Neri Oxman's "Age of Entanglement" (2016), where she states the following:

> "But how can we become constant travelers within a border-free, and lingo-legible 'intellectual Pangea?' How can we traverse a cerebral supercontinent, where the analog of world citizenship governs our identity as thinking—and creating—beings? How can we navigate an atlas that is charted not for four hats, but for one pair of shoes, and with which we can—including some luck and a quantum leap-of-faith—inhabit multiple places at once? Can a scientist invent better solutions than an engineer? Is an artist's mindset really all that different from a scientist's? Are they simply two ways of operating in the world that are

[1] Also described by the author as a combination of "knowledge nomad" and "mad for knowledge".

> complementary and intertwined? Or, when practicing art, is perhaps what truly counts less the art form and more one's (way of) being? Ultimately: is there a way to understand the culture of making which transcends a two-dimensional Euclidean geometry—four plots to match four hats—to a more holistic, integrative and globe-like approach?"

In the same article, Oxman presents the "Krebs Cycle of Creativity (KCC)" [Figure 3], based on Rich Gold's four hats of creativity matrix (2007) [Figure 4]. This diagram works as a framework to identify the flows of human creativity across four disciplinary dimensions (Art, Science, Design and Engineering). As a speculative map, the KCC is intentionally abstract and can be understood as a clock, a microscope, a compass and a gyroscope.



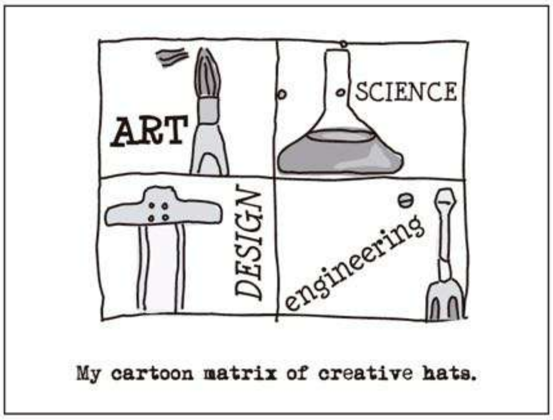


Figure 3 (left). Krebs Cycle of Creativity (Oxman, 2016)
Figure 4 (right). Four hats of creativity matrix (Gold, 2007)

Based on the above, as part of a thesis dissertation for the undergraduate program of Graphic Communication Design at Universidad Autónoma Metropolitana (UAM) in Mexico, a team of product and graphic designers were challenged in 2017 to develop innovative theoretical and methodological approaches that enabled "disciplinary mobility" for working groups using systemic design as foundation, since it was a possibility space (Sevaldson, 2017) to create intersections between systems thinking and practice (regarding self-organization processes for working groups and complex problems framing), design thinking (as a mode of reflection and process implementation) and design practice (as a preferred outcome supported by visual thinking and communication design).

4. The Knowmap Workshop

The main outcome of this research-through-design project was the experience design and facilitation of several workshops under the name of "Knowmap[2]". The workshops gathered a diverse range of participants from different disciplines that organized themselves in teams in order to use a set of

[2] Clearly inspired by the term "knowmad" but referring in this case to the act of mapping knowledge interactions as the workshop's main activity.

tools and techniques particularly designed to reflect on how disciplines shape the way we approach to complex problems and how we interact with other agents while working in a group. The workshop helped participants making those interactions explicit through visual thinking and interactive dynamics that used spatial metaphors to understand the journey of collaboration (e.g. their disciplinary profiles were depicted as nationalities and knowledge areas as territories of action). Both tools and techniques were inspired by diverse strategic and systemic design methods that such as management and planning applications of Gigamaps (Sevaldson, 2018) and multiplans approaches on collective mapping (Ares & Risler, 2016). These techniques were oriented to identify Heylighen's mechanisms of coordination within each team (alignment, division of labor, workflow and aggregation) utilizing Oxman's KCC as a framework (disciplinary dimensions and flows) and Moravec's concept of "knowmadism" to describe each participant's disciplinary mobility (e.g. we framed their disciplinary specialization and willingness to collaborate referring to them as a traveler's profile; i.e. a local, a tourist or a knowmad). The usage of the migration metaphor helped participants understand the flexibility of their knowledge and expertise and how it was perceived by others in terms of identity and practice.

4.1. Disciplinary interaction as rite of passage

In previous research (Marines, 2015a, 2015b), cross-disciplinary interaction was proposed to be understood as a rite of passage (van Gennep, 1909) that represented the changes of an individual's way of being/working through the experimentation and collaboration with other academic and professional disciplines (from monodisciplinarity to inter/multi/transdisciplinarity). Rites of passage where used as a way to understand these processes since they served as a micro-sociological approach to study small groups and were also compatible with several soft systems approaches. As van Gennep's rites of passage, the Knowmap Workshop was facilitated through three separated stages: Separation, Margin and Aggregation. Each stage provided theoretical and practical approaches to systems thinking and disciplinary collaboration to enable the full understanding of each tool and technique.

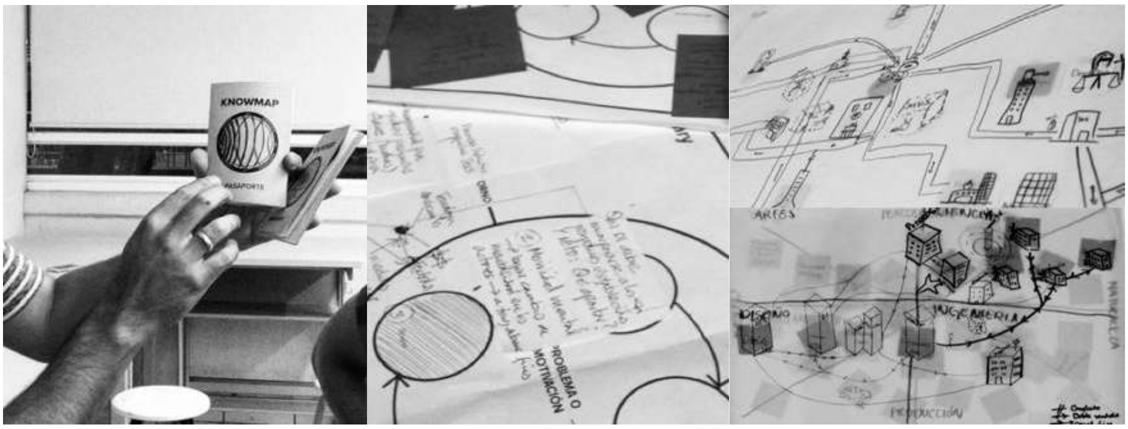


Figure 5. Tools designed for the three different stages of the "Knowmap Workshop" (from left to right: Separation - Disciplinary passport, Margin - Disciplinary canvas, and Aggregation - KnowMAP canvas)

4.1.1. Separation (Disciplinary Passport)

The workshop begins with an ice-breaker activity inspired on the moment when a migrant arrives to a new country and interacts with an immigration officer. This activity introduces participants to the metaphor of a voyage that is constantly reinforced during the workshop in order to enable the conversation about how disciplinary specialization shapes our identity and the way we think, understand and respond to our complex world.

4.1.2. Margin (Disciplinary Canvas)

This phase is designed to help participants to move forward from a monodisciplinary to a cross-disciplinary way of thinking and understanding of their problems.

The activity starts with filling a "Disciplinary canvas", a tool created to develop hypotheses around a random complex problem that is built collaboratively, in order to enable a horizontal conversation about the participants' thoughts and perspectives about different problematic scenarios.

4.1.3. Aggregation (KnowMAP Canvas)

During this very last phase, the workshop participants build a self-organized team to map their own-crafted complex problem through the usage of the KnowMAP Canvas (a mapping tool based on the layers of Neri Oxman's KCC.

At the end of this activity, teams develop their own version of a KnowMAP journey, a Gigamap variant that helps visualizing their interactions with spatial metaphors, identifying buildings (disciplines), paths (workflows), roadblocks (conflicts) and vehicles (time-based strategies).

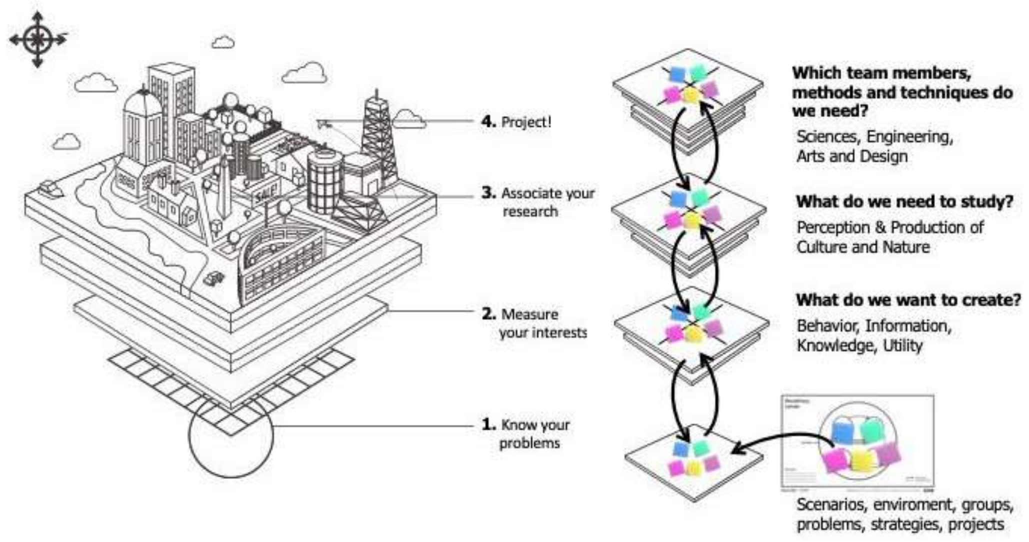


Figure 6. Visualization of the Knowmap Canvas techcnique, during the last workshop stage when all the tools are integrated into a single Gigamap.

5. Learnings and next steps

5.1. Foucault's disciplinary power

It is relevant to acknowledge that another theoretical inspiration for the workshop design was Michel Foucault's philosophical understanding of disciplines. Bolaños (2010) argues that many philosophers of science ignore the fact that the concept of scientific discipline is not a epistemological or political neutral term, highlighting Foucault's approach to the term "discipline" that was framed as a discursive form of knowledge production and regulation, but also as a set of techniques to achieve individuals standardization and control over their behavior (Foucault, 1990). Foucault argued that "disciplinary power" aimed to distribute and organize individual forces in order to increase their economic strength at the same time as their political force was reduced.

Foucault utilized several spatial metaphors to represent this kind of domination over individual behavior, such as field, position, region, and territory. He strongly believed that spatial metaphors served to explain the dynamics of disciplinary power and made explicit the relations between power and knowledge. This is why strategic thinking (highly related to war and military strategy) is usually communicated through spatial metaphors, since they are a hint of a combative thinking that uses geographic vocabulary in order to represent the use of knowledge as a political element.

Exploring the relations between the concepts of space, knowledge and power as understood by Michel Foucault, helped participants to reflect on the way academic disciplines have been historically and culturally constructed, in the same way that the idea of nations was created to regulate individuals with the distribution and classification of space and identity. This happens as well with human knowledge and the way institutions created frontiers to separate and reproduce modes of knowledge production. This phenomenon has direct impact in the way human agents assimilate these modes as a way of being and doing.

5.2. Visualizing complex disciplinary interactions

This exploratory research on systemic design and disciplinary interaction served to test the value of utilizing spatial metaphors as a shared vocabulary while mapping complex relations between disciplines and agents. Workshop results proved that visual and systems thinking tools can facilitate the understanding of those interactions through a rhetoric process that visualizes strategic flows, interests, barriers and leverage points. There was also good feedback regarding how the workshop includes the observer (individual and collective) as a part of the system and starts mapping their profiles before mapping the problems.

From Plato's allegory of the cave to Foucault's disciplinary space and Oxman's KCC, humans have made use of diverse spatial metaphors to refer to knowledge perception, construction and appropriation. This subject seems to be relevant for future reflections on how the concept of space serves as a linguistic vehicle to facilitate systems-oriented approaches.

5.3. Future applications

The set of tools and techniques developed for the Knowmap Workshop will be constantly iterated and improved during future sessions. However, they can already serve as a reference for systemic design practitioners. The workshop contents still require to be tested in more practical applications in order to create evaluation metrics and turn them into an integrated toolkit.

In recent sessions, the workshop techniques have been replicated for several projects related to organizational innovation and team building. The tools have been perceived as useful for teams that aim to diagnose and improve their collaborative processes and knowledge exchange. "Disciplinary mobility" extended concept also made sense for participants as a way to describe their professional and academic future orientations. The concept will be explored to discover other applications for career design and professional evaluation for human productivity.

References

Ares, P., & Risler, J. (2016). *Manual of Collective Mapping. Critical cartographic resources for territorial processes of collaborative creation*. Buenos Aires: Tinta Limón.

Bolaños, B. (2010). *Más allá y más acá de las disciplinas. De las capacidades cognitivas a los estilos de razonamiento científico. (Beyond disciplines. From cognitive capacity to styles of scientific reasoning*). In A. Peláez & R. Suárez (Eds.), *Observaciones filosóficas en torno a la transdisciplinariedad (Philosophical observations on transdisciplinarity)* (pp. 13-40). Mexico City: Anthropos - Universidad Autónoma Metropolitana, Cuajimalpa.

Carbone, J. N., & Crowder, J. A. (2011). Transdisciplinary synthesis and cognition frameworks. *Journal of Integrated Design & Process Science, 15*(1), 35-57.

Fauconnier, G., & Turner, M. (2008). Rethinking metaphor. *The Cambridge handbook of metaphor and thought*, 53–66.

Foucault, M. (1990). *Vigilar y castigar: nacimiento de la prisión* (*Discipline and Punish: The Birth of the Prison)*. Buenos Aires: Siglo XXI.

Gaggiotti, H., Kostera, M., Bresler, R., & San Román, B. (2015). *El nomadismo y el movimiento como epistemologías del mundo contemporáneo (Nomadism and movement as epistemologies of the contemporary world)*. *Scripta Nova: revista electrónica de geografía y ciencias sociales, 19*.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (2010). *The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies.* London: SAGE Publications Ltd.

Godemann, J. (2008). Knowledge integration: a key challenge for transdisciplinary cooperation. *Environmental Education Research, 14*(6), 625-641. doi:10.1080/13504620802469188

Gold, R., & Maeda, J. (2007). *The Plenitude : Creativity, Innovation, and Making Stuff*. Cambridge, US: MIT Press.

González-Castillo, O. (2016). *Sustentabilidad y la Universidad del siglo XXI: Aproximaciones al conocimiento y al trabajo colaborativo (Sustainability and the University of 21st Century: Approaches to knowledge and co-working)*. In G. Laguna, R. Marcelín, G. Patrick, & G. Vázquez (Eds.), *Complejidad y sistemas complejos: un acercamiento multidimensional (Complexity and complex systems: a multidimensional approach)*. Mexico City: CopIt-arXives & EditoraC3.

Heylighen, F. (2013). Self-organization in Communicating Groups: the emergence of coordination, shared references and collective intelligence. In *Complexity Perspectives on Language, Communication and Society* (pp. 117-149): Springer.
Ito, J. (2018). *The Practice of Change, How I survived being interested in everything.* (Doctoral Dissertation), Keio University, Retrieved from https://web.media.mit.edu/~joi/files/ito_phd_diss_v1.11.pdf
Lakoff, G., & Johnson, M. (2008). *Metaphors we live by*: University of Chicago press.
Marines, L. (2015a). El diseñador: ser liminal entre disciplinas (The designer: liminal being between disciplines. In Soto. L. (ed.), *Trans e interdisciplina, ejes para una formación integral de los Diseñadores (Trandiscipline and interdiscipline: axes for designers' integral training)* (pp. 181-190). Mexico City: Universidad Autónoma Metropolitana, Unidad Azcapotzalco. DOI: http://doi.org/10.13140/RG.2.1.3309.8004
Marines, L. (2015b). *Influencia y oportunidades del diseño en los procesos de interacción entre disciplinas*. Paper presented at the 1st Transdisciplinary Colloquium of Sociology Students, Universidad Autónoma Metropolitana, Unidad Azcapotzalco.
Midgley, G. (2003). Science as systemic intervention: Some implications of systems thinking and complexity for the philosophy of science. *Systemic Practice and Action Research, 16*(2), 77-97.
Moravec, J. (2013). Knowmad society: the “new” work and education. *On the Horizon, 21*(2), 79-83. DOI: http://doi.org/10.1108/10748121311322978
Moravec, J., & van den Hoff, R. (2015). Higher Education 3.0: Knowmads Create Their Own Value! In A. Dailey-Hebert & K. S. Dennis (Eds.), *Transformative Perspectives and Processes in Higher Education* (pp. 233-239). Cham: Springer International Publishing.
Mumuni, E., Kaliannan, M., & O'Reilly, P. (2016). Approaches for scientific collaboration and interactions in complex research projects under disciplinary influence. *The Journal of Developing Areas, 50*(5), 383-391.
Oliva-Figueroa, I., Koch-Ewertz, T., & Quintero-Tapia, J. (2014). Inter/transdisciplinariedad y universidad: patrones de desplazamiento e interactividad disciplinar (Interdisciplinary/Transdisciplinary and the University: Patterns of Disciplinary Mobility and Interactivity). *2014, 6*(13), 14.
Oxman, N. (2016). The Age of Entanglement. *Journal of Design and Science.* Retrieved from https://www.pubpub.org/pub/ageofentanglement
Quaggiotto, M. (2008). *Knowledge cartographies: Tools for the social structures of knowledge.* Paper presented at the Changing the Change. Design. Visions, Proposals and Tools. Proceedings, Turin.
Sevaldson, B. (2017). Redesigning Systems Thinking. *FormAkademisk - Research Journal of Design and Design Education, 10*(1). DOI: https://doi.org/10.7577/formakademisk.1755
Sevaldson, B. (2018). Visualizing Complex Design: The Evolution of Gigamaps. In P. Jones & K. Kijima (Eds.), *Systemic Design: Theory, Methods, and Practice* (pp. 243-269). Tokyo: Springer Japan.
Surowiecki, J. (2005). *The wisdom of crowds*. New York: Anchor Books.
van Gennep, A. (1909). *Los ritos de paso (The rites of passage)*. Madrid: Alianza Editorial.

Design for Emergence – Enabling Stakeholder Liminal Transitions and Innovation Value Pivoting through Complex Systemic Transformations

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Abstract Emerging sustainable innovation value is increasingly being recognized as a key challenge – and one increasingly considered from the perspectives of complex systemic transformations that require iterative learning processes, awareness of complex-adaptive systems, collaboration in multi–stakeholder environments and competencies in meaning *and* value co–creation. Innovating within complex social systems can be challenged by the stakeholder buy-in processes, affective team climate and the multi–dimensional aspects of organizational adoption. We introduce *Design for Emergence* – a meta-design framework to increase innovation community resilience by orienting towards human psycho-social factors, while building social coherence across the systemic micro, mezzo and macro scales of analysis – with the goal of easing stressors within 'liminal space' transitions to *enable* desirable future outcomes, *by facilitating* individual and organizational transformational journeys.

Introduction

Researchers observe that “innovation occurs through the combination and recombination of information and knowledge that are old and new” where “innovation is thus an emergent process” (Cooke, 2013). However, emerging innovation in a sustainable manner within markets, communities and organizations is still viewed as a challenge – and one increasingly related to the processes of learning (Harkema, 2003) within complex–adaptive systems (Carlisle & McMillan, 2006), that require collaboration in multi–stakeholder environments (Sørensen & Torfing, 2011), and are dependent on value co–creation outcomes (Romero & Molina, 2011).

A survey of the research literature suggests that innovation initiatives are faced with a surprising lack of adoption by the key stakeholders across diverse industry contexts and organizational settings – including natural resource management practices (Shiferaw, Okello, & Reddy, 2009), healthcare organizations (Cresswell & Sheikh, 2013), and policy environments (Douthwaite, Keatinge, & Park, 2001). Stakeholder buy-in challenges are posited to be complex and affected by a multiplicity of factors – including impacts of team climate on performance (González-Romá, Fortes-Ferreira, & Peiró, 2009), team-member creativity (Somech & Drach-Zahavy, 2013) and the multi–dimensional aspects of enabling adoption (Pichlak, 2016).

In and of itself, stakeholder adoption is not considered as sufficient for enabling sustainable innovation initiatives. Even when the ‘innovation buy-in’ has occurred – and the key stakeholders are ready to undergo the innovation journey, further challenges are observed – including maintaining individual well-being (Dackert, 2010), managing affective events (Pirola-Merlo, Härtel, Mann, & Hirst, 2002), and adapting to the new ‘boundary roles’ described as “complex, contested, and nonlinear” that require a “nonlinear perspective on innovation” (Ferlie, Fitzgerald, Wood, & Hawkins, 2005), and which “occur at several organizational boundaries” (Tushman, 1977).

Nearing the end of innovation initiatives – for those that manage to break through the barriers of stakeholder adoption while staying the course of an innovation journey – researchers observe that the anticipated value is often reduced through challenges in delivering innovation outcomes (Martin & Scott, 2000; Klein Woolthuis, Lankhuizen, & Gilsing, 2005) and lack of new value realization (Chesbrough & Rosenbloom, 2002) – often as the result of insufficient post-implementation usage (Cresswell & Sheikh, 2013).

We posit a research gap in translating the current innovation theories into effective practices capable of delivering sustainable innovation value – when enacted in complex environments, and in a manner optimized for stakeholder participation and innovation outcomes adoption.

Design for Emergence

To respond to the outlined concerns around the feasibility of effectively emerging new value through innovation processes, we introduce the *Design for Emergence* – a practical, applied design methodology intended for multidisciplinary teams and practitioners – to enable flourishing futures and increased resilience across systemic scales (Bergström & Dekker, 2014), human psychosocial contexts (Matin & Taylor, 2015) and social support systems (Sippel et al., 2015; Almedom, 2015).

We introduce approaches for building social coherence (Antonovsky, 1987; Keyes 1998) across systemic scales and levels of analysis (Marr, 1982), with the goal of easing stressors within the 'liminal spaces' (Van Gennep, 1906; Turner, 1987) to impact desirable future outcomes and enable individual and organizational transformational journeys.

The *Design for Emergence* is positioned as a meta–design framework comprised of three core modalities: 1) *Design for Adoption*, 2) *Design for Resilience*, and 3) *Design for Transience*. Each component is a general-purpose meta-design modality with specific design goals and engagement guidelines – intended to simplify practical use of theoretical concepts within diverse, complex innovation environments that require multi–stakeholder collaboration and delivery of broad cross–scale impacts.

The *Design for Emergence* meta-design framework provides a generative design space to 'plug-in' existing systemic design methodologies, implementation tools and innovation best-practices – with the goal of enabling sustainable innovation in complex ecosystemic scenarios, while simplifying the design processes and delivering enhanced stakeholder, organizational and community value.

Design for Adoption

Recognizing that the intrinsic and continued participation of the key stakeholders is essential for the success of innovation initiatives, as exemplified in co-innovation (Lee, Olson, & Trimi, 2012), the *Design for Adoption* eases participation by leveraging motivational theory to support both initial and ongoing stakeholder engagements (Pink, 2009).

Adoption is a critical success factor in multiple industries and community contexts that are increasingly experiencing rapid transformation amid complex systemic challenges, that often mandate a successful integration of conflicting goals (Bledow, Frese, Anderson, Erez, & Farr, 2009). At the same time, many industries are experiencing escalating environmental complexity pressures (Blau & McKinley, 1979; Damanpour & Gopalakrishnan, 1998). In healthcare, this can be manifested as a rapid growth in the number of people requesting access to the health system complexified by an increase in the total number of systemic diseases such as the Alzheimer's, obesity and diabetes, while simultaneously attempting to adapt to the emerging technologies that enable competition from the adjacent market-spaces.

Intense innovation pressures are experienced in key areas such as governance, energy development, banking, insurance, not-for-profit and the corporate innovation sectors – that increasingly need to manage shrinking operational budgets, respond to changes in regulatory environments, and anticipate shifts in the competitive and community landscapes; while responding to growing pressures of market adaptation and sustainable innovation.

Interacting innovation pressures emerge a complex environment. For instance, in health care a common view is that “systems are under increasing pressure to cope with shifting demographics” where meeting the challenges of advancing medicine and health care delivery are “not as rapid as the pace of change” (Keown et al., 2014). In education, the “rapid and far-reaching economic and social changes, driven particularly by the impact of accelerating globalization, increased economic modernization, and transition toward a knowledge-based society” have “transformed higher education systems in many countries from elite to mass, placing colleges and universities under considerable strain regarding infrastructure, resources, and expertise” (Dunrong, 2015). In the public sector services, a common views is that “there are general trends that place great stress", where the "changing demographics mean ageing populations are placing greater demands on health and social services while a smaller proportion of working people are being required to finance the additional expenditure", and where there are "bottlenecks in focusing attention on particular areas of innovation" (Windrum & Koch, 2008, p. 230).

The shifting demographics challenges are also exacerbated by the emergence of disruptive technologies – where the “innovative success is dependent upon the ability of firms to acquire and assimilate new knowledge without disrupting value chain members such as suppliers, customers and complementary innovators” with comparatively “little advice on how to deal with radical, controversial innovations that may also introduce new undesirable environmental, health, and social side affects”. This is posited to be further complexified when “in addition to technological, commercial and organisational uncertainties, the developers of such technology typically must resolve social uncertainties”, which is viewed as challenging due to the “added complexities and often conflicting and/or difficult-to-reconcile concerns from secondary stakeholders” (Hall & Martin, 2005).

Managing shifting community demographics while adapting to an array of disruptive technologies does not seem to slow-down expectations to innovate quickly – with a paradoxical effect of creating acceleration pressures. For instance, researchers note that China now “centers on what we call accelerated innovation” in a way that’s focusing on “reengineering research and development and innovation processes to make new product development dramatically faster and less costly” (Williamson & Yin, 2014) – creating further pressures on the global institutions and multi-national enterprises (MNEs) to enhance “their managerial ability to cope with the accelerating pace of innovation” (Buckley & Casson, 2010).

Innovating for sustainability within such a complex environment – while creating innovations that are sustainable – is viewed as an additionally challenging proposition. Leading researchers explore the “links between agency, institutions, and innovation in navigating shifts and large-scale transformations toward global sustainability" – in order to identify conditions that might help to "reverse the trends that are challenging critical thresholds and creating tipping points in the earth system"; while attempting to contend with the key identified issues, such as the "lack of incentives for the private sector to innovate for sustainability" and the "lags inherent in the path dependent nature of innovation", which is viewed as compounded by our "incapacity to easily grasp the interactions implicit in complex problems" (Westley et al., 2011).

We posit that the socio-cognitive experiences of the individual stakeholders are integral to enabling complex innovation and ecosystemic transformations – and that, designers must take this individual experience into consideration when designing for complexity.

The process of integrating an individual into the innovation process is a not a new idea. For instance, the transformation of the Finnish innovation system was in part considered from the perspectives of "integrating the individual and the organisational levels", where a key innovation challenge was identified as "how tacit knowledge can be transformed to be useful for the whole organisation, and on the other hand, how explicit knowledge can be transformed into personal 'know-how'" – referencing the SECI 'spiral of organisational knowledge creation' model (Nonaka, 1994) described as consisting of four main modes of conversion – "(1) socialisation (from tacit knowledge to tacit knowledge; (2) externalisation (from tacit knowledge to explicit knowledge); (3) combination (from explicit knowledge to explicit knowledge); and (4) internalisation (from explicit knowledge to tacit knowledge)" (Schienstock & Hämäläinen, 2001).

A key argument that "a knowledge-based organisation is able to generate knowledge and innovation if it manages to transform the very difficult and demanding exchange processes between the two forms of knowledge into routine organisational processes" is viewed as predicated on the "following factors: knowledge vision, organisation forms, incentive system, corporate culture and organisation routines, and leadership" - that, in turn, hinge on the ability of the organizational and innovation ecosystem stakeholders to successfully traverse the 'socialisation phase'; which "creates common understanding and generates trust among group members", and where the "knowledge vision needs to transcend the boundaries of existing products, divisions, organisations, and markets to allow for extensive knowledge exchange even among units with different interests" (Schienstock and Hämäläinen, 2001, p. 63).

We argue that such social traversals are indeed at the crux of any innovation challenge – whether in the knowledge creation phase, or in the other innovation processes. While the innovation literature outlines many formative solution approaches – such as the Accelerated Radical Innovation (ARI) project, with the 'accelerated innovation prototyping' method (Bers, Dismukes, Miller, & Dubrovensky, 2009) – we propose to augment and further enable the existing methodologies with a meta-design framework capable of describing the human psycho-social factors necessary for traversing the innovation spaces of uncertainty and transformation, that can be considered from a liminal transition perspective.

To further understand such social traversal challenges, we posit that a confluence of innovation pressures creates a complex environment of active tensions between the current ('needed for success now') and the emerging ('necessary for succeeding in complex systems') competencies, that include:

CURRENT COMPETENCY	EMERGING COMPETENCY
respond to well-defined challenges	manage continuously emerging issues
master known practices	create new capabilities
compete in familiar marketspaces	identify / enable novel opportunities
leverage existing knowledge	create conditions to 'explore the new'
manage personal achievement	facilitate group success

When unresolved, such innovation tensions can overwhelm the individual psycho-cognitive adaptation and organizational change abilities – exerting a counter-effect of innovation resistance that might act as an inhibitor in enabling sustainable innovation value. Researchers posit that this can be seen in areas such as education reform – where "efforts to reform schools stall" and "educators resist change because they feel burdened or conflicted by the process", and where it's important to "reviews standard conceptualizations of change" while analyzing the "psychology of individuals and the culture of institutions" (Evans, 1996).

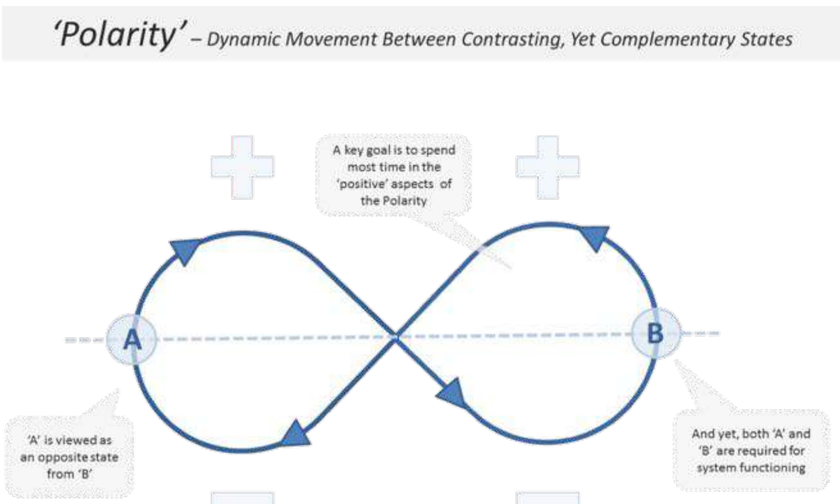
Early on, researchers attempted to normalize this apparent resistance to change, and make it more understandable – arguing that, "the vast majority of people who have no *a priori* desire to change may be more typical and even more rational than a small minority of individuals who seek change", even when considering "the intrinsic value of the innovation" – urging to focus on "individuals who resist change" in order to "understand their psychology of resistance", and "utilize this knowledge in the development and promotion of innovation" (Sheth, 1979, p. 274).

As such, researchers posit that indications of innovation resistance include escalating perceptions of risk aversion, low tolerance to failure, insistence on 'patching the problem' with 'quick fixes' and non-systemic linear approaches, engagement structures that impede effective transformation, and mismatches in organizational culture that attempt to measure progress with performance indicators rooted in the perceptions of the 'current state' – instead of orienting towards enabling the new desirable outcomes.

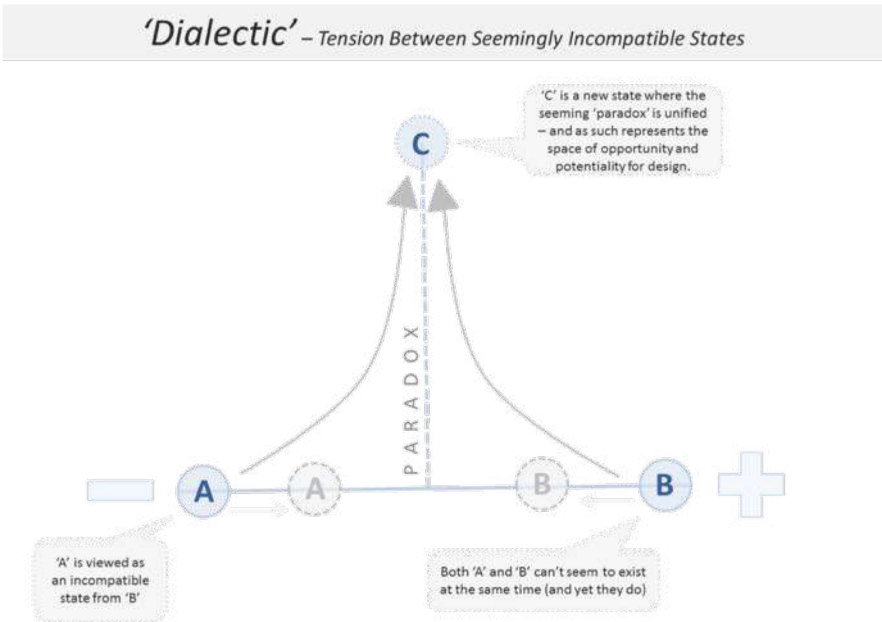
Designing for adoption is further complexified in the presence of multi-organizational teams with different skills, approaches and values – engaging different parts of a shared challenge without full awareness of the relevant capabilities and perspectives. This can contribute to a lack of ability to effectively align collaboration capabilities across organizational and community contexts – resulting in a 'competition of views', 'action paralysis' and appearance of underlying systemic loops capable of impeding significant progress in innovation initiatives. When the adoption tensions are not actively managed, they can create an environment where key stakeholders are engaged in attempting to deliver complex innovation initiatives while addressing internal mobilization challenges – that can impact an overall readiness to enact innovation.

To mitigate these challenges, we propose to detect, identify and consider the key emerging tensions within innovation journeys as either 'polarities' (Johnson, 1992) or 'dialectics' (Deci & Ryan, 2004), where institutional change is viewed as a "dialectical process", and where "actors espousing conflicting views confront each other and engage in political behaviors to create and change institutions" (Hargrave & Van De Ven, 2006). We content that the 'dialectical' and 'polarity-based' challenges can be best addressed with very different design strategies and management approaches.

With 'polarities', a key managing strategy is to minimize the 'downside' of traversing the negative aspects of each polarity – and to move as quickly as possible to the 'upside'. This strategy works since polarities can not be beneficially 'resolved' in a real sense – and must instead be balanced. Examples include 'individual work' vs. 'teamwork', and 'rest' vs. 'activity' polarities – where, overemphasizing either state does not generally lead to preferred outcomes. In a business context, an example might be a polarity of 'organizational acquisitions' (that can be exciting and energizing, and yet eventually exhausting when prolongued), versus 'process optimizations' (that can lead to efficiencies and be organizationally enabling – and yet often be experienced as stifling when over-emphasised).



In contrast, managing 'dialectical' tensions is profoundly different – with seemingly incompatible states that are in apparent opposition to one another, at the root of which there might be a perceived paradox. An example might be a healthcare organization that is already over capacitated and under-resourced, and yet expected to serve additional patients and communities with an enhanced level of care. These seemingly opposing systemic states might appear as mutually exclusive and incompatible with each other – yet allowing for the possibility of innovation convergence through the generation of new options. A key design strategy for managing dialectical tensions is to synthesize new options that have not existed before – out of the common ground of shared yet opposing perspectives, as per the diagram below:



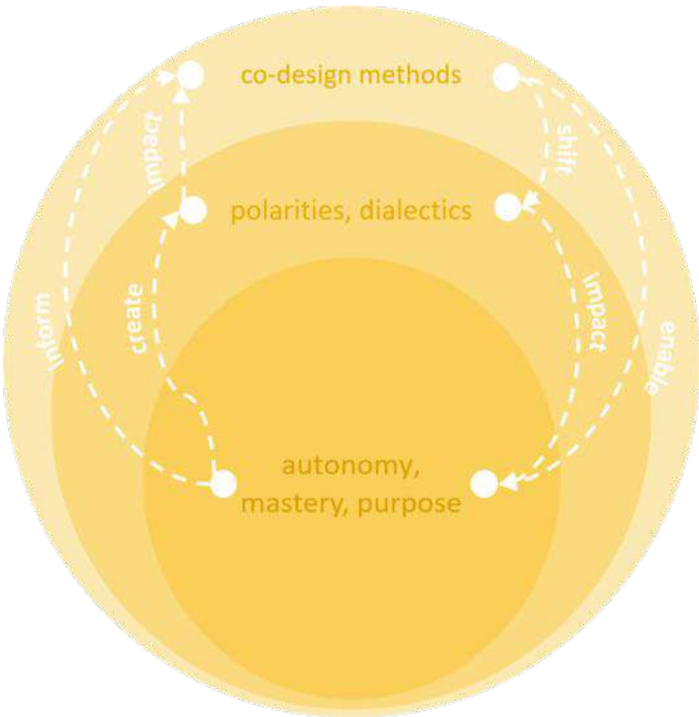
To positively impact the internal mobilization challenges and associated dialectical and polarity-based innovation space tensions, we propose a meta-design modality entitled *Design for Adoption* – informed by the following key design goals:

1) **help build trust**: leveraging 'autonomy', 'mastery' and 'purpose' to strengthen the individual ability to engage the innovation potentials in a generative manner

2) **enable facilitative strategies**: to engage multiple stakeholders with diverse perspectives and create conducive group dynamics

3) **leverage group co-design**: to enable creation of insights capable of achieving positive systemic impacts

To define key criteria capable of emerging a 'minimal design grammar' that can enable such goals, we consider the systemic diagram as per below:



Here, the ability to enact effective ‘co-design methods’ with the key stakeholder communities is supported by the intentional identification and management of ‘polarities’ and ‘dialectics’ – that inevitably emerge through the innovation design process. The identified polarities and dialectics are not avoided – and are instead utilized in a generative fashion to help strengthen and build group trust as well as the stakeholder buy-in.

Simultaneously, the key innovation participants and engaged communities are considered from the standpoints of ‘autonomy, mastery and purpose’ (Pink, 2009) – where, the iterative changes in the environment are parsed in terms of what they might mean, and how they might impact, the engaged stakeholder contexts.

We posit that the relationships between these three levels of design reveal complex networks and an active space of interaction – that can be further considered from the perspectives of simultaneity (how interactions in one level of design might have immediate correspondences in others), resonance (how nodal points might form between multiple levels of design, and have disproportionate impacts), moving forward-and-backward (how behaviours or artifacts are more or less visible throughout the experience lifecycles, becoming increasingly observable or less measurable), and engagement (identifying inflection points where it might be possible to more or less successfully involve the key stakeholders).

When enacted, the *Design for Adoption* meta-design modality enables successful stakeholder engagements during innovation journeys – by making it possible to build on shared insights (by leveraging trust relationships evolved in psychological safe-spaces), emerge complexity awareness (by iteratively exposing underlying systemic complexities), and to start building conditions for perceiving preferential ‘future worlds’ (by aggregating current assumptions and emergent expectations into perceptions of possible futures).

While helping to build initial trust and enabling co-design through the dynamic management of emerging innovation tensions – and starting to align key stakeholders around shared perceptions of the future – the *Design for Adoption* also requires the next meta-design modality, the *Design for Resilience*, to help innovation initiatives deliver sustainable value.

4. Design for Transience

As an innovation initiative nears completion, researchers observe that a change in the underlying value perceptions acts as a stressor (Cullen, Edwards, Casper, & Gue, 2014). To help re-imagine and re-orient value propositions within the enclosed ecosystem, the *Design for Transience* maps how the stakeholder perceptions of value change throughout the levels of analysis (Marr & Poggio, 1982), and suggests to leverage a formal foresight method – such as the ‘three horizons’ (Curry & Hodgson, 2008) – to explore the evolution of value perceptions from the experienced present to a possible perceived future.

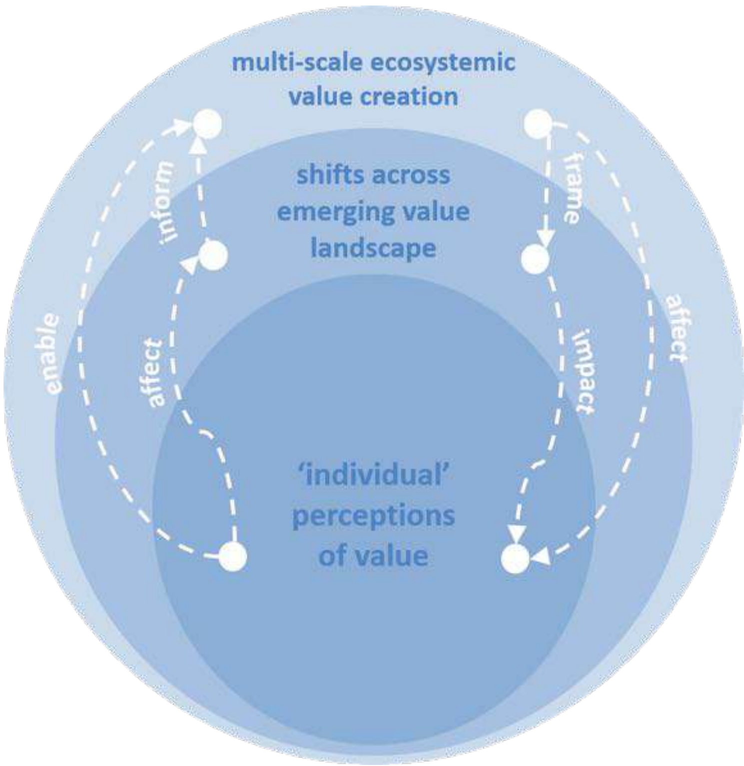
To positively inflect the key ‘transience’ challenges, the *Design for Transience* is informed by the following key design goals:

1) **build individual awareness of shifts in value-perceptions**: outline perceived value transitions across temporal scales, translating narratives to the individual (‘micro’) context

2) **map intermediate shifts in value**: correlate ‘current’ and ‘emerging’ perceptions of value through the lens of the ‘intermediate’ (mezzo) organizational, institutional and community stakeholders

3) **map ecosystemic value-changes**: outline relational changes in value through the highest level of ecosystemic analysis – utilizing models such as ‘panarchy’ (Gunderson, 2001) – to share meaningful narratives with the innovation stakeholders

To explore the systemic relationships between the stated design goals in some further depth, we consider the systemic diagram as per below:



Here, a key meta-design objective is to actively manage the evolution of value perceptions from the experienced present towards the perceived or anticipated futures – with the capacity of creating positive feedback loops when the emergent narratives are connected back to the *Design for Resilience* and *Design for Adoption* modalities.

As such, the *Design for Emergence* is a meta-design framework that articulates value propositions, enhances collaborative potentials and creates an intrinsic resilience by aligning stakeholder perceptions within participating communities – in a way capable of enabling emergent innovation.

References

Almedom, A. (2015). Understanding human resilience in the context of interconnected health and social systems: Whose understanding matters most? *Ecology and Society*, *20*(4). https://doi.org/10.5751/ES-08195-200440

Antonovsky, A. (1987). *Unraveling the mystery of health: How people manage stress and stay well*. San Francisco, CA, US: Jossey-Bass.

Bergström, J., & Dekker, S. W. A. (2014). Bridging the Macro and the Micro by Considering the Meso: Reflections on the Fractal Nature of Resilience. *Ecology and Society*, *19*(4). Retrieved from http://www.jstor.org/stable/26269699

Blau, J. R., & McKinley, W. (1979). Ideas, Complexity, and Innovation. *Administrative Science Quarterly*, *24*(2), 200–219. https://doi.org/10.2307/2392494

Buckley, P. J., & Casson, M. (2010). Organising for Innovation: The Multinational Enterprise in the Twenty-First Century. In P. J. Buckley & M. Casson (Eds.), The Multinational Enterprise Revisited: The Essential Buckley and Casson (pp. 96–117). London: Palgrave Macmillan UK. https://doi.org/10.1057/9780230250468_5

Carlisle, Y., & McMillan, E. (2006). Innovation in organization from a complex adaptive systems perspective. *E:CO*, *8*.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. https://doi.org/10.1093/icc/11.3.529

Cooke, P. (2013). *Complex Adaptive Innovation Systems: Relatedness and Transversality in the Evolving Region*. Routledge.

Cresswell, K., & Sheikh, A. (2013). Organizational issues in the implementation and adoption of health information technology innovations: An interpretative review. *International Journal of Medical Informatics*, *82*(5), e73–e86. https://doi.org/10.1016/j.ijmedinf.2012.10.007

Cullen, K. L., Edwards, B. D., Casper, W. C., & Gue, K. R. (2014). Employees' Adaptability and Perceptions of Change-Related Uncertainty: Implications for Perceived Organizational Support, Job Satisfaction, and Performance. *Journal of Business and Psychology*, *29*(2), 269–280. https://doi.org/10.1007/s10869-013-9312-y

Dackert, I. (2010). The impact of team climate for innovation on well-being and stress in elderly care. *Journal of Nursing Management*, *18*(3), 302–310. https://doi.org/10.1111/j.1365-2834.2010.01079.x

Damanpour, F., & Gopalakrishnan, S. (1998). Theories of organizational structure and innovation adoption: the role of environmental change. *Journal of Engineering and Technology Management*, *15*(1), 1–24. https://doi.org/10.1016/S0923-4748(97)00029-5

Deci, E. L., & Ryan, R. M. (2004). Handbook of Self-determination Research. University Rochester Press.

Douthwaite, B., Keatinge, J. D. H., & Park, J. R. (2001). Why promising technologies fail: the neglected role of user innovation during adoption. *Research Policy*, *30*(5), 819–836. https://doi.org/10.1016/S0048-7333(00)00124-4

Dunrong, B. (2015). Shifting Demographics in Higher Education in Asia. *International Higher Education*, (47). https://doi.org/10.6017/ihe.2007.47.7957

Ferlie, E., Fitzgerald, L., Wood, M., & Hawkins, C. (2005). The Nonspread of Innovations: the Mediating Role of Professionals. *Academy of Management Journal*, *48*(1), 117–134. https://doi.org/10.5465/amj.2005.15993150

Gennep, A. van. (1906). *Mythes et légendes d'Australie: études d'ethnographie et de sociologie*. E. Guilmoto.

González-Romá, V., Fortes-Ferreira, L., & Peiró, J. M. (2009). Team climate, climate strength and team performance. A longitudinal study. *Journal of Occupational and Organizational Psychology*, *82*(3), 511–536. https://doi.org/10.1348/096317908X370025

Gunderson, L. H. (2001). *Panarchy: Understanding Transformations in Human and Natural Systems*. Island Press.

Hall, J. K., & Martin, M. J. C. (2005). Disruptive technologies, stakeholders and the innovation value-added chain: a framework for evaluating radical technology development. R&D Management, 35(3), 273–284. https://doi.org/10.1111/j.1467-9310.2005.00389.x

Hargrave, T. J., & Van De Ven, A. H. (2006). A Collective Action Model of Institutional Innovation. *Academy of Management Review*, *31*(4), 864–888. https://doi.org/10.5465/amr.2006.22527458

Harkema, S. (2003). A complex adaptive perspective on learning within innovation projects. *The Learning Organization*, *10*(6), 340–346. https://doi.org/10.1108/09696470310497177

Johnson, B. (1992). *Polarity Management: Identifying and Managing Unsolvable Problems*. Human Resource Development.

Keown, O. P., Parston, G., Patel, H., Rennie, F., Saoud, F., Al Kuwari, H., & Darzi, A. (2014). Lessons From Eight Countries On Diffusing Innovation In Health Care. *Health Affairs*, *33*(9), 1516–1522. https://doi.org/10.1377/hlthaff.2014.0382

Keyes, C. L. M. (1998). Social Well-Being. *Social Psychology Quarterly*, *61*(2), 121–140. https://doi.org/10.2307/2787065

Klein Woolthuis, R., Lankhuizen, M., & Gilsing, V. (2005). A system failure framework for innovation policy design. *Technovation*, *25*(6), 609–619. https://doi.org/10.1016/j.technovation.2003.11.002

Lee, S. M., Olson, D. L., & Trimi, S. (2012). Co-innovation: convergenomics, collaboration, and co-creation for organizational values. *Management Decision*, *50*(5), 817–831. https://doi.org/10.1108/00251741211227528

Marr, D. (2010). *Vision: A Computational Investigation Into the Human Representation and Processing of Visual Information*. MIT Press.

Martin, S., & Scott, J. T. (2000). The nature of innovation market failure and the design of public support for private innovation. *Research Policy*, *29*(4), 437–447. https://doi.org/10.1016/S0048-7333(99)00084-0

Matin, N., & Taylor, R. (2015). Emergence of human resilience in coastal ecosystems under environmental change. *Ecology and Society*, *20*(2). https://doi.org/10.5751/ES-07321-200243

Pirola-Merlo, A., Härtel, C., Mann, L., & Hirst, G. (2002). How leaders influence the impact of affective events on team climate and performance in R&D teams. *The Leadership Quarterly*, *13*(5), 561–581. https://doi.org/10.1016/S1048-9843(02)00144-3

Pichlak, M. (2016). The innovation adoption process: A multidimensional approach. *Journal of Management & Organization*, *22*(4), 476–494. https://doi.org/10.1017/jmo.2015.52

Romero, D., & Molina, A. (2011). Collaborative networked organisations and customer communities: value co-creation and co-innovation in the networking era. *Production Planning & Control*, *22*(5–6), 447–472. https://doi.org/10.1080/09537287.2010.536619

Sheth, J. N. (1979). *Psychology of Innovation Resistance: The Less Developed Concept (LDC) in Diffusion Research*. College of Commerce and Business Administration, University of Illinois at Urbana-Champaign.

Shiferaw, B. A., Okello, J., & Reddy, R. V. (2009). Adoption and adaptation of natural resource management innovations in smallholder agriculture: reflections on key lessons and best practices. *Environment, Development and Sustainability*, *11*(3), 601–619. https://doi.org/10.1007/s10668-007-9132-1

Sippel, L., Pietrzak, R., Charney, D., Mayes, L., & Southwick, S. (2015). How does social support enhance resilience in the trauma-exposed individual? *Ecology and Society*, *20*(4). https://doi.org/10.5751/ES-07832-200410

Somech, A., & Drach-Zahavy, A. (2013). Translating Team Creativity to Innovation Implementation: The Role of Team Composition and Climate for Innovation. *Journal of Management*, *39*(3), 684–708. https://doi.org/10.1177/0149206310394187

Sørensen, E., & Torfing, J. (2011). Enhancing Collaborative Innovation in the Public Sector. *Administration & Society*, *43*(8), 842–868. https://doi.org/10.1177/0095399711418768

Tushman, M. L. (1977). Special Boundary Roles in the Innovation Process. *Administrative Science Quarterly*, *22*(4), 587–605. https://doi.org/10.2307/2392402

Turner, V. (1987). *The Anthropology of Performance.* PAJ Publications, New York.

Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., … van der Leeuw, S. (2011). Tipping Toward Sustainability: Emerging Pathways of Transformation. AMBIO, 40(7), 762. https://doi.org/10.1007/s13280-011-0186-9

Williamson, P. J., & Yin, E. (2014). Accelerated Innovation: The New Challenge From China. MIT Sloan Management Review.

Windrum, P., & Koch, P. M. (2008). Innovation in Public Sector Services: Entrepreneurship, Creativity and Management. Edward Elgar Publishing.

Finding the *emic* in systemic design: Towards systemic ethnography

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Abstract (150 words) This paper proposes a framework for assessing the emic or etic orientation of a research project and examines the role of etic (from outside) and emic (from within) perspectives in systemic design. I make the case that systemic design projects should be driven from as emic an orientation as possible—that to do otherwise will result in flawed intervention, possibly leading to grave consequences for the stakeholders of the system. Drawing from theory on ethnography and qualitative research, I situate processes and principles of emic understanding to the practice of systemic design in order to establish the research orientation framework. I test this framework in an exploratory assessment of case studies in systemic design, demonstrating how they may be used to show differences in researcher orientation and lead to success or failure.

Keywords: systemic design, emic, etic, research methods, stakeholder perspective

1. Introduction

An under-emphasized dimension of work in systemic design is the research orientation of practitioners: the degree to which practitioners' understand the problem at hand from stakeholders' perspectives. Systemic design processes that are not executed with the direct and explicit engagement of stakeholders—to the extent of achieving an *emic* (or from within) understanding of the system—are potentially flawed at their foundation. While the discipline has roots in empathic methods (especially in recent years; see Kimbell, 2011), it is easy for systemic designers to adopt research methods that do not produce understanding from stakeholder perspectives. By fostering recognition of the importance of an emic perspective, and by providing a framework of principles, practices, and process to accomplish systemic design with this perspective, I hope to ensure that systemic design processes are as accurate and valid as possible with respect to the stakeholders of the system.

This is not to suggest that systemic design practice is "too etic". In fact, with roots in design, systemic design is often deliberately emic. Systemic designers make use of designerly tools that help the researcher to build empathy with system stakeholders (e.g., soft systems methodology, critical systems heuristics, appreciative inquiry; Jones, 2015). They often seek to engage stakeholders in the systemic design process and include reflective analysis of what has been learned in order to assess where deeper engagement with the system is required (Ryan, 2014). That said, with the advent of crowdsourcing (the facilitated involvement of the general public in problem solving, usually using online tools; Lukyanenko & Parsons, 2012) and data science (the use of computational tools to analyze and understand large quantities of data; cf. Provost & Fawcett, 2013), it is likely that data-driven methods will increasingly influence systemic design practice. This data-driven direction presents a powerful opportunity, but it underscores the need to develop principles and best practices for assessing and directing research orientations as we gain more data from these tools.

In section 2, I explain the concept of emic understanding with reference to scholarship from qualitative theorists. I draw from theory to construct a emic research orientation framework including a process and key techniques to help researchers assess and direct their research perspective. In section 3, I test this framework by applying it in a critique of two systemic design case studies, examining the emic orientation of the procedures they use and the results they report in order to understand the role and value of emic efforts in the discipline. The fourth section concludes with a discussion of the contributions and limitations of this work while suggesting next steps for research on this issue.

2. Emic Perspectives

In general, emic research seeks to understand events from the mind of the researched; etic research seeks to understand events from outside, as an observer (Harris, 1976). The emic mode is not necessarily better than the etic mode. At etic approach helps to develop understanding generalizable from the researched domain to other domains. Etic understanding is therefore necessary in the development of theoretical absolutes, and in social research etic understandings are often developed once several emic views have been captured (Fetterman, 2005b). Emic understanding, on the other hand, is relativistic. Emic methods "[…] help the fieldworker understand why members of the social group do what they do, in contrast to a priori assumptions about how systems work from a simple, linear, logical perspective—which might be completely off target […]" (Fetterman, 2005a). As Geertz (1973, p. 28) writes: "The aim is to draw large conclusions from small, but very densely textured facts; to support broad assertions about the role of culture in the construction of collective life by engaging them exactly with complex specifics."

For a hypothetical example, say one wants to develop a theory of consumer behaviour. An etic perspective might at the outset ascribe the behaviour to general economic principles (e.g., "Jeeps are durable vehicles, thereby consumers who buy them value saving money"). Emic research may then reveal important cultural aspects of the consumer behaviour unique to jeep purchasers—something about the experience of using the jeep. As those emic units of understanding are gathered and combined, the researcher may develop a new etic theory of consumption that can be abstracted and applied to other consumer subcultures.

In many social research domains, then, both etic and emic modes of study can be necessary in order to develop accurate theory. Recall, however, that practitioners of systemic design attempt to make progress on wicked problems (see Rittel & Webber, 1973)—and that a cardinal attribute of wicked problems is that the understanding of one wicked problem cannot be generalized to others. In other words, entering a systemic design challenge with an etic understanding of the problem risks immediate irrelevance—and the practitioner may be ignorant of their irrelevance. In systemic design, then, an emic approach must be essential to developing an accurate understanding. The question becomes: in a given project, how might we construct a more emic perspective?

2.1. How are emic perspectives constructed?

A process for emic research

To this end, Clifford Geertz' seminal "Thick Description: Toward an Interpretive Theory of Culture" (found in *The Interpretation of Cultures*, 1973, chapter 1) is essential reading. Geertz presents a thorough if meandering articulation of the significance of emic interpretation, but one phrase arguably sums up the key takeaway: emic research must be executed "with a great deal of care" (Geertz, 1973, p. 14). Through the chapter, Geertz (1973) makes the argument that emic understanding is obtained through the thick description of the researched. This means "understanding … normalness without reducing particularity. It renders them accessible; setting them in the frame of their own banalities, it dissolves their opacity" (p. 14). This involves, in a rough and repeating order:

1. acknowledgement and systematized capture of our initial interpretations of the research domain (p. 15, paragraph 1);

2. capturing the flow of symbols (including speech), behaviours, events, and artifacts, along with the attribution of meaning or roles (or uses, in the case of artifacts) to these phenomena in relation to the actors who engage with them, if possible (p. 17, paragraphs 2-3);
3. constructing coherent meaning from these observations (p. 18, paragraph 2)—"tracing the curve of a social discourse; fixing it into an inspectable form" (p. 19, paragraph 1); and
4. appraising captured perceptions and constructed meaning as to whether they are thick enough to effectively achieve our goals (p. 16, paragraph 3).

How do we know we're making progress in emic understanding? "A study is an advance if it is more incisive—whatever that may mean—than those that preceded it; but it less stands on their shoulders than, challenged and challenging, runs by their side" (Geertz, 1973, p. 25, paragraph 2). How about when to end? "Every serious cultural analysis starts from a sheer beginning and ends where it manages to get before exhausting its intellectual impulse" (Geertz, 1973, p. 25, paragraph 3) as "cultural analysis is intrinsically incomplete, […] the more deeply it goes, the less complete it is" (Geertz, 1973, p. 29, paragraph 2). In other words: we make progress by adding to what we already know, developing a deeper internal perspective of the study domain, and we stop when we have to.

Procedures of emic research

So we know roughly what emic research should look like (the four steps above, plus the kinds of progress we should observe when executing them), but we do not have a good handle on what emic research consists *of*. Geertz (1973) himself does not prescribe precise principles for these four steps; indeed, one can assume that any activity that allows the researcher to achieve steps 1 through 5 above will help advance an emic understanding of the studied domain. However, Creswell & Miller (2000) provide a highly cited framework used to assess the validity of qualitative inquiry that may translate here. They highlight nine procedures across three research paradigms (postpositivist, constructivist, and critical) that foster the perception of validity across three stakeholders: the researcher themselves, the participants, and the audience of the research (Creswell & Miller, 2000, page 126, table 1). The nine procedures are described briefly below.

Triangulation

Does the described understanding come from the convergence of multiple sources of information? Triangulation suggests that researchers examine a given concept from multiple angles in order to confirm their understanding of the concept from several of those angles. As reported by Creswell & Miller (2000, p. 126-127), Denzin (1978) "identified four types of triangulation: across data sources (i.e., participants), theories, methods (i.e., interview, observations, documents), and among different investigators".

Disconfirming evidence

Researchers should strive to invalidate their interpretation of a concept by seeking out evidence that opposes their conclusions. Unfulfilled effort to disconfirm a concept is validating.

Researcher reflexivity

Researcher reflexivity involves making explicit the researcher's own assumptions and biases, critiquing these beliefs, and doing so early. In doing so, a researcher makes transparent their approach (for external evaluation and critique) and may be able to suspend these influences throughout the research.

Member checking

This simply means involving the research participants in the study by presenting data and conclusions to them for feedback. By, say, convening a focus group or providing participants with a copy of the raw data and analysis, participants themselves have an opportunity to critique the researcher's interpretations and confirm (or disconfirm) their concepts.

Prolonged engagement

Prolonged engagement is self-descriptive: it means to engage in the research within the context and with the participants for a prolonged period of time. To do so is to build rapport with participants, gaining increasing access to the domain and to the opportunity to study longer term trends/to see phenomena that may otherwise have been missed.

Collaboration

Participants may be involved in qualitative inquiry as co-researchers. Creswell and Miller (2000) give some examples: involve participants in the formation of research questions, in the collection and analysis of data, or in the writing of the research narrative. To do so is to construct the research with the participants view as well as your own.

The audit trail

Another approach to establishing validity is the creation of an audit trail through transparent documentation of the research process and the decisions made therein. A reviewer can then assess the trail and attest to the credibility of the process, or the researcher can make the audit available to readers.

Thick, rich description

Creswell & Miller (2000) suggest that thick descriptions of the research objects (e.g., the setting, the participants, or other themes) provide credibility. Such thick descriptions contextualize the research and help readers transport themselves into the process of the research, too.

Peer debriefing

An example of peer debriefing is the peer review process. When fellow researchers critique a study, they offer new perspectives, challenge assumptions, offer additional methodologies, and so on. Passing through a peer review or debrief process suggests that the research was robust enough to survive these critiques and still be accepted by other researchers.

2.2. Developing a framework

These nine procedures provide several routes through which a researcher may check and establish the validity of a given qualitative research project. Not all of them directly support emic understanding, however. **Triangulation**, for instance, would only validate emic research if the researcher is triangulating concepts obtained from within the studied domain. In other words, triangulation is important—but only if the data triangulated includes some that has been obtained from an emic perspective. Likewise, **disconfirming evidence** is an important technique, but evidence invoked from outside of the studied domain has little bearing on an emic phenomena, by definition. Thus, to validate an emic perspective, evidence that disconfirms an interpretation should be found within the studied domain. **Researcher reflexivity** has some value, too. By articulating their assumptions in advance of a study, a researcher can literally establish the etic concepts they bring to the project. The other techniques can then be used to integrate or disregard these concepts in the emic perspective of the domain. **Member checking and collaboration** have obvious value in the construction of emic interpretations, as they involve the perspectives of those internal to the domain in the creation of the research product. **Prolonged engagement** further adds emic value; as suggested above, longer exposure generally leads to greater access and exposure to the studied domain, making it more likely that the researcher will observe something they would otherwise have missed (or have been prevented from seeing).

The remaining three techniques: the audit trail; thick, rich description; and peer review have little emic value—except that they may be used to reinforce the validation garnered from the other six techniques. Member checking, for instance, may be augmented by giving the participants "thicker" descriptions to critique. Likewise those participants may be more likely to engage in authentic critique if rapport has been built through prolonged engagement. So, these techniques feed into one another, but it is not necessary to seek the above three techniques in every emic research project.

The six techniques bolded in the paragraph immediately above provide us with a framework with which to assess the emic validity of a given project. This analysis finds intuitive credibility in the organizing framework of Creswell and Miller (2000). They suggested that triangulation, disconfirming evidence, and researcher reflexivity are each techniques for validating research *from the perspective of the researcher*, while member checking, collaboration, and prolonged engagement are each techniques that foster validation *from the perspective of the researched*. Note that emic research in systemic design focuses on both the researcher and the researched, as both actors are key stakeholders ensconced in a project domain.

Thus, Geertz (1973) provides a well-known conceptualization of the task of generating emic understanding which I have synthesized into a four-step process model. To this model I have added six techniques from Creswell and Miller (2000) as techniques for validation in emic inquiry. Taken together, we have a framework for emic research. This framework is visualized in figure 1.

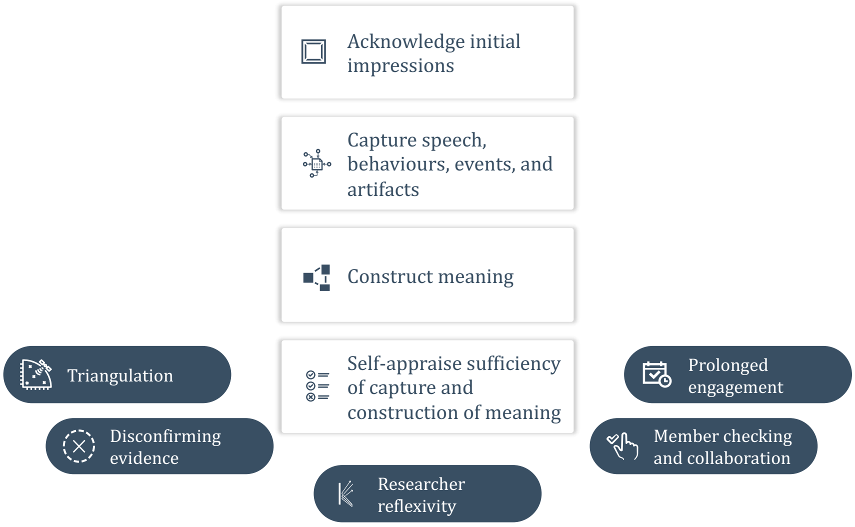

Figure 1. A framework for assessing the emic orientation of systemic design research. An emic project should iterate over the process (the white boxes) and maximize use of the procedures (the teal boxes).

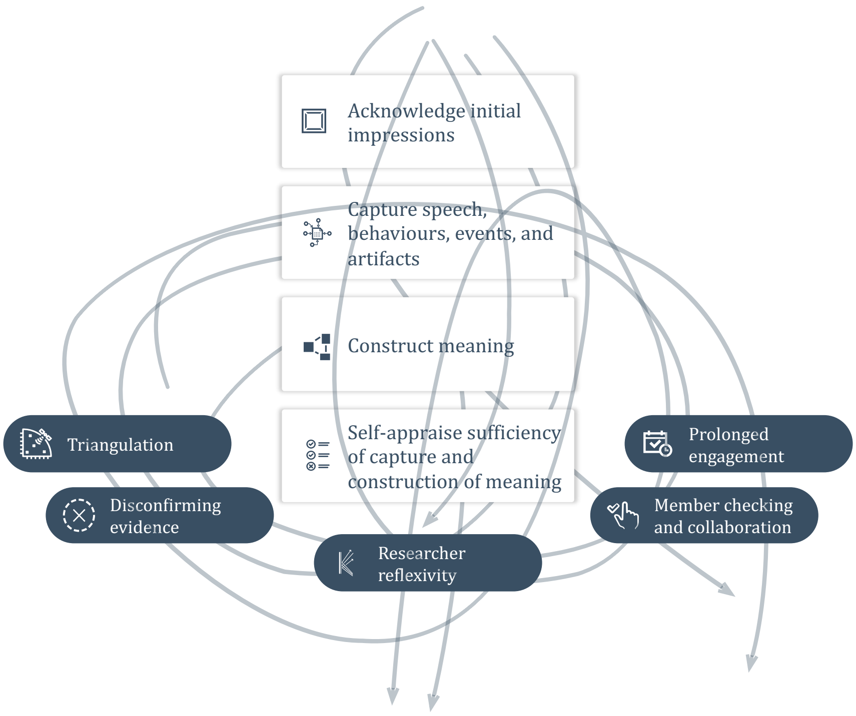

Figure 2. Pathways for emic research. The researcher approaches emic understanding by iterating through the process, using the techniques to further check and enrich their stakeholder-oriented understanding of the problem system.

2.3. Relating the framework to systemic design

As discussed above, a systemic designer searches for ways to make progress on wicked problems. These problems—eradicating homelessness in St. John's, Newfoundland & Labrador; reforming gun law in the USA; and changing global industry to prevent climate change are all examples—are defined by their inability to be universally defined and understood. In other words, these challenges look different in different places and from the views of different stakeholders. They may only be understood *emically*. A systemic design project is therefore an emic research project, and—as suggested by Geertz (1973)—they must be executed with a great deal of care.

The model described immediately above, then, provides us with a framework for syst*emic* design as a structure with which we can check whether sufficient care was taken. Systemic design projects should show evidence of methods that invoke the "four steps" of Geertz' (1973) ethnography, and they should likewise search for validation with at least some of the nine techniques provided by Creswell & Miller (2000).

I propose that a project that follows the steps (to demonstrate depth of emic understanding) and/or invokes the validation techniques (to demonstrate qualitative validity) will be more likely to reflect an accurate emic understanding of the problem domain than one that does not. This understanding should translate into greater efficacy of the interventions identified by the project, and ultimately into more powerful impact according to the goals of the project.

3. Applying the framework: A pilot study

In this pilot study, I applied the framework to two case studies selected via a purposive, paradigmatic sampling strategy (Stake, 2005; Flyvbjerg, 2006). I used phenomenological hermeneutics to analyze the chosen case studies (Eberle, 2014, p. 196; cf. Wernet, 2014). In plain words, this simply means a careful reading and interpretation of the phenomena observed in a given research case. By reviewing the outputs and results of systemic design projects as they relate to etic and emic understandings, I may be able to judge the value of etic vs. emic meaning in these projects.

The first case study (the National Youth Leadership and Innovation Strategy Summit; MaRS Studio Y, 2017; see also Stauch & Cornelisse, 2016) served as inspiration for this research. I was present for the summit and personally authored the case; it is available but could not be included in the present submission due to length restrictions. This example consisted of a two-day systemic design workshop involving hundreds of representatives for across the country—the goal of which was to develop national policy. The second case study was chosen from Ryan and Leung's (2014) cases. It describes a redesign of public procurement processes at a Canadian university. It was selected as an explicit demonstration of systemic design and one of the earliest such cases available in the literature. By examining and comparing this case I may find important contrasts to the experience described in the NYLIS case. Thus, while I explore NYLIS as a potentially flawed systemic design project (as that is what sparked my interest to begin with), the Ryan and Leung (2014) case is supposedly an exemplar of a successful systemic design practice. Across both cases, then, we have a good sample of the systemic design paradigm.

In each case, I examined the step-by-step procedure and any associated notes about the experience of the researchers and participants involved. In each step or experience, I looked for evidence of the four steps of emic understanding or the six techniques of emic validation reported above. Figure 3 summarizes the resulting analysis; a full discussion is available but outside the scope of this paper.

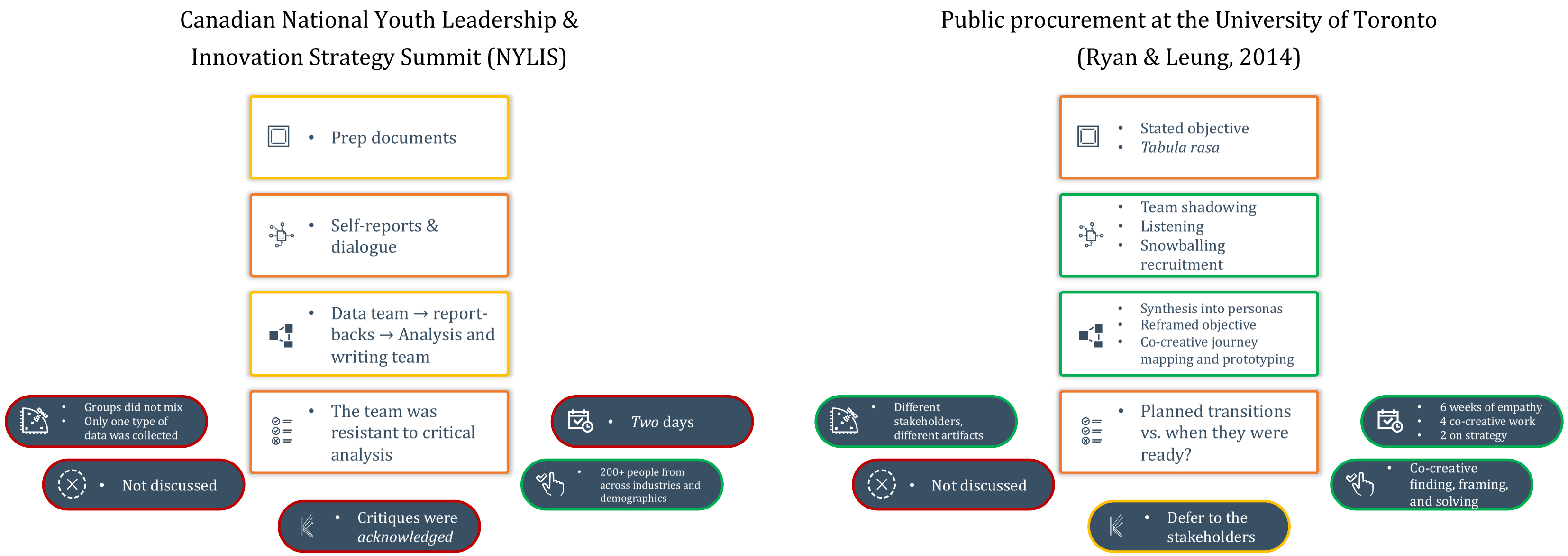

Figure 3. A summary visualization of the analysis of the two case studies. Adherence to the process and techniques of emic research is indicated via colour-coding from red (poor evidence) to green (strong evidence), and observations of each component is commented on in the relevant boxes.

4. Discussion

4.1. Contributions

Intensivist and Extensivist Systemic Design

One thing is obvious: these two cases illustrate two profoundly different approaches to systemic design. In one approach, systemic designers attempt to bring the system to them. Stakeholders are gathered as participants in isolation, and the systemic designers use a lot of facilitation and tools of systemics and design to attempt to understand the system and to identify opportunities for innovation. I call this the "intensivist" approach. Like the type of physician that shares the term, intensivist systemic design uses technical procedures and facilitating machinery to suspend the system in place. While the system is suspended, the intensivist systemic designer pokes, prods, and prompts, developing a hyper-clear picture of how it works and where the problems lie. They may even develop and start interventions while they have the system artificially in their grasp. The intensivist approach is fast, controlled, and scales easily.

In the second approach, systemic designers go to the system itself. They use ethnographic methods to engage with stakeholders, observing the behaviour of the system as it unfolds. They involve the stakeholders of the system in the work, sharing their insights with them for feedback and co-creating models and innovations. I call this the "extensivist" approach. Extensivist systemic designers extend throughout the system as much as possible. For the duration of the study, at least, they become part of the system—foreign, yes, but purposefully so. By growing into the system, the extensivist learns about its structure, because they must in order to keep participating. They begin to recognize deeply rooted issues and what sustains those issues. The extensivist approach is slow, adaptive, and difficult to scale.

Intensivist systemic design provides the researchers with an immense sense of power over the system—but that power can be artificial, like the suspended system from which it is obtained. Extensivist systemic design provides the researchers with a sense of the power of the system, and the dependencies that exist between the stakeholders that comprise it—but that sense can be difficult to wield; it must be communicated to the stakeholders in order to make change.

If it isn't obvious, this is not to suggest that one approach is better than the other. If the present case studies are any indication, the extensivist approach (demonstrated by case 2) generates a more emic understanding of the system than the intensivist approach (demonstrated by cases 1 and 3). Depending on available timing, however, an intensivist approach may be the only chance an organization has in order to understand a system, as a full intensivist can be organized and executed at immense scale with little time. Nonetheless, case 2 appeared to have greater success at creating systemic change than cases 1 or 3. This may be a weak indication that the extensivist approach is more likely to achieve impact if the systemic designer has the time and access to make it work.

Assessing emic understanding is important

As the analysis of the cases show, it is possible to examine the level of emic research of a given systemic design project. An emic understanding is crucial in the domain of systemic design challenges; etic understandings are simply insufficient to be able to develop deep, changemaking innovations. That means that assessing emic understanding is an important aspect in evaluating the success of a systemic design project.

At face value the proposed framework provide a useful way of comparing the otherwise incomparable. The emic understanding (already uniquely contextual) generated by different researchers using different methods in different domains with different stakeholders can still be judged by whether or not the author sought to observe phenomena, triangulate their observations, and so on. Now that this issue has been raised and a basic methodology has been provided, it should become an imperative component of evaluating systemic design.

5. Next steps and further research

5.1. Refine the criteria for emic understanding

As the results of the case analysis show, performance on different emic criteria matters less than others (e.g., none of the cases showed a search for disconfirming evidence). This reveals a problem with the criteria. Some are necessary but not sufficient to demonstrate that an emic understanding has been achieved. Others—e.g., prolonged engagement—may be sufficient to show that a significant degree of emic understanding has been achieved, but it is not necessary that a study use prolonged engagement to establish emic understanding. Or is it? These criteria are proposed here as a starting point, but they must be further scrutinized and refined.

5.2. A test of the criteria with fieldwork

Hypocritically, the present research is an etic critique of emic studies. A stronger proof-of-concept would come from a test of these criteria on a real, in-field systemic design project. It should be possible to follow a systemic design team as they undertake a project, studying their behaviour with ethnographic methods to assess the use of etic or emic approaches. Such a study would be able to observe phenomenologically when, with precision, etic versus emic knowledge is collected, interpreted, synthesized into the project's models, and used to generate systemic innovations. It is an obvious extension of the current study, but it is necessary—if for nothing else than to avoid being called out for sanctimony.

6. Conclusion

The point is that while emic understanding is important, it does not have to be hard. Each of the criteria hint at ways for systemic designers to integrate emic perspectives into their understanding of their systems. Simple tweaks and additions to method—from self-report to observation, checking the accuracy of a systems model with stakeholders—can make a rich difference in the contextual understanding we are able to achieve. In turn, our contextualized insights may be more powerful than any we are otherwise able to grasp.

References

Creswell, J. W., & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice*, *39*(3), 124–130. https://doi.org/10.1207/s15430421tip3903_2

Denzin, N. (1978). *The Research Act: A Theoretical Introduction to Sociological Methods*. New York, NY: McGraw-Hill.

Eberle, T. S. (2014). Phenomenology as a Research Method. In U. Flick (Ed.), *The SAGE Handbook of Qualitative Data Analysis* (pp. 184–202). Los Angeles, Calif. [u.a.]: Sage. Retrieved from https://www.alexandria.unisg.ch/228374/

Fetterman, D. M. (2005a). Emic Perspective. In *Encyclopedia of Evaluation* (pp. 124–124). Thousand Oaks: SAGE Publications, Inc. https://doi.org/10.4135/9781412950558

Fetterman, D. M. (2005b). Etic Perspective. In *Encyclopedia of Evaluation* (pp. 136–136). Thousand Oaks: SAGE Publications, Inc. https://doi.org/10.4135/9781412950558

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, *12*(2), 219–245. https://doi.org/10.1177/1077800405284363

Geertz, C. (1973). *The interpretation of cultures: Selected essays* (Vol. 5019). Basic books.

Harris, M. (1976). History and Significance of the Emic/Etic Distinction. *Annual Review of Anthropology*, *5*(1), 329–350. https://doi.org/10.1146/annurev.an.05.100176.001553

Jones, P. (2015). Design Research Methods for Systemic Design: Perspectives from Design Education and Practice. *Proceedings of the 58th Annual Meeting of the ISSS - 2014 United States*, *1*(1). Retrieved from http://journals.isss.org/index.php/proceedings58th/article/view/2353

Kimbell, L. (2011). Rethinking Design Thinking: Part I. *Design and Culture*, *3*(3), 285–306. https://doi.org/10.2752/175470811X13071166525216

Lukyanenko, R., & Parsons, J. (2012). Conceptual modeling principles for crowdsourcing (pp. 3–6). ACM. https://doi.org/10.1145/2390034.2390038

MaRS Studio Y. (2017). *A strategic framework for youth leadership & innovation in Canada: Insights from the 2016 National Youth Leadership and Innovation Strategy Summit*. Toronto, ON. Retrieved from http://www.studioy.marsdd.com/wp-content/uploads/2016/12/MaRS_NYLIS-strategic_framework_Final.pdf

Provost, F., & Fawcett, T. (2013). *Data Science for Business*. USA: O'Reilly Media.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. Retrieved from http://link.springer.com/article/10.1007/BF01405730

Ryan, A. (2014). A Framework for Systemic Design. *FORMakademisk–Research Journal for Design and Design Education*, *7*(4). Retrieved from https://journals.hioa.no/index.php/formakademisk/article/view/787

Ryan, A., & Leung, M. (2014). Systemic Design: Two Canadian Case Studies. *FormAkademisk - Research Journal of Design and Design Education*, *7*(3). Retrieved from https://journals.hioa.no/index.php/formakademisk/article/view/794

Stake, R. (2005). Qualitative Case Studies. In *The SAGE Handbook of Qualitative Research* (3rd edition, pp. 443–466). Thousand Oaks, Calif.: SAGE Publications.

Stauch, J., & Cornelisse, L. (2016). *Canada Next: Learning for Youth Leadership and Innovation*. Calgary, AB: Institute for Community Prosperity, Mount Royal University, and MaRS.

Wernet, A. (2014). Hermeneutics and Objective Hermeneutics. In U. Flick, *The SAGE Handbook of Qualitative Data Analysis* (pp. 234–246). 1 Oliver's Yard, 55 City Road London EC1Y 1SP: SAGE Publications, Inc. https://doi.org/10.4135/9781446282243.n16

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WORKING PAPER

Leverage analysis in systemic design: Using centrality and structural analysis to understand complexity

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Abstract A key component of many systemic design processes is the development and analysis of systems models that represent the issue(s) at hand. Models often take the form of Causal Loop Diagrams in which phenomena are graphed as nodes with connections between them indicating an influencing relationship. Models provide systemic designers with a mechanism for stakeholder collaboration, problem finding, and generative insight, becoming powerful resources for use in visual argument. These functions are valorized in design thinking, but the potential of these models may yet be unfulfilled. We propose the exaptation of techniques from social network analysis and systems dynamics to uncover key structures, relationships, and latent leverage positions of modelled phenomena. We reframe these measures for systemic design and demonstrate their utility in a pilot study. By rethinking logics of leverage, we might make better arguments for change, finding the place to stand from which to move the world.

Keywords: systemic design, leverage, centrality analysis, structural analysis, methodology

1. Introduction

1.1. Systemic design and leverage points

The practice of systemic design offers tools and approaches that can help find leverage in complex systems. Complex systems often produce emergent, counterintuitive behaviour that is difficult to predict by looking at the individual phenomena (Gharajedaghi, 2011). By capturing and illustrating how these phenomena interdepend through models, we may gain the ability to grasp this emergent behaviour. More importantly, we may be able to identify leverage points: places within a system in which a small shift produces big change (Meadows, 1997).

The properties of complex systems (and of how people engage with them) present a number of issues that introduce bias and chance into the process of intervening on systems (Norman & Stappers, 2015). Given a model, systemic designers work through what they observe and interpret, engage in dialogue about what is important, and look for patterns. While some principles and processes exist (cf. Jones, 2014), developing models, identifying leverage points, and designing solutions tends to happen by "muddling through" a problem (Norman & Stappers, 2015; see also Simon, 2008, chapter 2).

Systemic design models vary in type. Designers may create systems thinking or soft operations research (soft OR) models, whose purpose is to describe the system as comprehensively as possible (Forrester, 1994; Checkland, 1985). Models of so-called "soft" systems often take the form of causal loop diagrams (CLDs) in which phenomena are graphed as nodes with connections between them indicating an influencing relationship. Alternatively, designers may quantify the phenomena of a system's variables through systems *dynamics* (Forrester, 1994). These approaches to modelling come with important trade-offs yet to be reconciled in modern methods. Systems thinking models are representative, but their insights may be invalid or inaccurate (Forrester, 1994). On the other hand, systems dynamics models are robustly analytical, but we may be analyzing an ill-developed representation of the problem system (Checkland, 1985). Further, in order to develop representative models, systemic designers must draw on diverse stakeholders (Jones, 2014; Stroh, 2015). The development of recent technologies and practices such as crowdsourcing (participatory systems that involve publics in a collaborative project; Lukyanenko & Parsons, 2012) and data science (a set of techniques and theories that help distill insight from data; Provost & Fawcett, 2013), the collection and organizing of large amounts of data becomes ever easier. This brings us to an important tension (cf. Maass, Parsons, Purao, Storey, & Woo, 2018). Larger, more complex, data-driven models are likely more representative, as they capture more perspectives and nuances than simpler models and as their representations can be tested through the simulations and analysis of systems dynamics. However, these models are also harder to learn, understand, and use (Rossi & Brinkkemper, 1996).

Systemic designers must find ways of balancing the trade-offs between complex representativeness and ease-of-insight. In this paper we illustrate how techniques from graph theory and systems dynamics can be used to take advantage of the structural properties of these models of elements and connections to algorithmically identify leverage points in these models. These techniques promise to help take advantage of big data in systemic design and advance our capacity to muddle through progress on wicked problems (Rittel & Weber, 1973).

In the next subsection, we briefly introduce graph theory. In section 2, we introduce the concepts and metrics of centrality analysis and of structural analysis. In section 3, we relate the metrics from each of these methodologies to applications in systemic design and demonstrate their utility in a pilot study. Section 4 discusses the implications of these ideas, and section 5 concludes the paper.

1.2. The potential of graph theory

A graph is formally defined as a set of vertices and edges. An edge is defined as a pair of vertices, where each vertex in the pair terminates the edge (Ruohonen, 2013, chapter 1). In network analysis vertices correspond with members of the social network and edges with connections between them. In using these concepts in *systems*, we call vertices *elements* (the phenomena of the system) and their edges *connections (how those phenomena influence one another)*. In graph theory, a walk (or a path) is a sequence of elements and their connections that begins at a given element and traverses a given connection to the next element, continuing until a given end element is identified. A walk that returns to the starting element is considered a closed walk and is called a cycle. In systems work, however, this is called a *feedback loop*.

How may we use these concepts to analyze CLDs? Beck, Schoenenberger, and Schenker-Wicki (2012) advance four matrix-based approaches to analyzing systems *dynamics* phenomena as sets of variables. They define four variants of matrices that evaluate the relationships between variables and the system they are structured within. Schoenenberger, Schenker-Wicki, & Beck (2014) return to these methods to examine a systems model of terrorism. Le Blanc (2015) examines the indicators of the United Nations' Sustainable Development Goals as a network of interconnected phenomena, and uses some simple network measures to analyze how these indicators relate to one another. Mohr (2016) builds on Le Blanc's work to introduce several additional measures from social network analysis. Earlier work by the present author (Murphy, 2016) used some social network analysis measures on a CLD as a proof-of-concept to elevate the discussion of leverage points in a systemic design project. Potts, Sartor, Johnson, and Bullock (2017) introduce graph theory analysis methods in their exploration of system of systems engineering architectures. Finally, in a separate line of research, Oliva and other researchers have examined the graph structure of systems dynamics in terms of levels of causality and the nesting of loops (Duggan & Oliva, 2013; Kampmann & Oliva, 2006, 2008; Oliva, 2003, 2004, 2018; Saleh, Oliva, Kampmann, & Davidsen, 2010).

These papers serve as inspiration for the current project. However, none of these projects contextualize the analysis within the discipline of systemic design, nor do they relate their ideas to the search for leverage points. They also leave gaps between centrality and structural analysis. This paper presents three contributions: it brings these methods together for the first time, links this approach to systemic design, and relates the use of these analyses to the search for leverage points.

2. Measures of graph centrality and structure

2.1. Centrality analysis

Social network analysis involves the modelling and measurement of the connections between people and organizations in a directed graph, where people and organizations are represented by nodes and connections are represented by vertices (Carrington & Scott, 2011). By measuring the structure of these networks—say, how densely coupled they are, or how central a given node may be—we can learn important things about the nature of the network as a whole such as who is the "most important" member of the network (though the interpretation of "importance" is something of debate; cf. Freeman, 1979).

We can likewise treat a CLD representing a modelled system as a directed graph of phenomena and their connections, using the algorithms of social network analysis to measure the centrality of the phenomena. This analysis can allow a systemic designer to identify important phenomena quickly and objectively (relative to the structure of the graph) regardless of the size or complexity of the map.

A caveat is that these measures do not supplant one another; researchers in centrality analysis have not determined that there is, say, a *most-central* measure. They examine different—but related—aspects of network structure and therefore offer different utility. It is up to the user of the metrics to examine the measures, the models they are analyzing, and to interpret the results.

2.2. Structural analysis

In addition to centrality, another school of analysis examines the structure of the cycles found in graphs. Known as structural dominance analysis or simply structural analysis, these methods were developed to help analysts partition and test system dynamics models (Oliva, 2004). However, these techniques seem to have been constrained to systems dynamics; their utility to help analyze systems thinking models is therefore untapped.

Structural analysis involves identifying and measuring the structure of feedback loops of the systems as cycles in the model (Oliva, 2004; see also Kampmann, 1996 and Warfield, 1989). By doing so, analysts can develop partitions of the levels and cycles of the graph. Analysis of the level partitions results in a hierarchy of the causal structure of model's phenomena. Analysis of the cycle partition allows the analyst to identify a hierarchical structure of the model’s feedback loops. Both enable the analyst to isolate and understand the causal nature of the model's subsystems (Oliva, 2004). In other words, we may be able to use these measures to illustrate a hierarchy of causality in systemic phenomena.

3. Leverage analysis

3.1. Leverage measures

Table 1 illustrates proposed translations of the techniques of centrality and structural analysis into what we have called "leverage measures" for systemic design.

Table 1. Centrality and structural measures mapped to leverage measures.

	Detail	Original meaning	Leverage measures in systemic design
Degree	The number of connections	Higher connectivity to the rest of the network; influence, access, prestige (Newman, 2010)	Immediate impact, sensitivity, resilience
Indegree	The number of incoming connections	High inward connectivity to the rest of the network; sensitivity to information, influence (Newman, 2010)	Receives change from many other elements; may be highly volatile or highly stable
Outdegree	The number of outgoing connections	High outward connectivity to the rest of the network; rapid communication/high access to the rest of the network, highly infectious (Newman, 2010)	Change in the given phenomena is felt by many other elements; impact, power
Betweenness	Frequency of participation in the shortest path between two other elements	Member has a high degree of control; the network is dependent on the member; bottlenecking, control, influence (Freeman, 1979)	Phenomena is a gateway or bottleneck for change; change strategies must consider how to prevent blocking
Closeness	Average length of the shortest paths between the given vertex and every other vertex in the graph	High visibility to the rest of the network and information spreads easily from this member; independence from the rest of the graph (Freeman, 1979)	Phenomena is highly powerful; likely to be resistant to change, and therefore a key indicator of success or failure
Eigenvector	Connectedness to other well-connected elements	Influence of highly influential elements; influence (Newman, 2010)	High-impact phenomena; likely key phenomena to change in pursuit of a given strategy
Reach	The number of elements within [x] steps of the given element	Quick propagation of information through the network; widely accessible (Hanneman & Riddle, 2005)	The map is highly sensitive to these elements
Reach efficiency	The reach divided by the degree of a given node	Efficient (non-redundant) information spreading; high exposure with limited influence on the given element (Hanneman & Riddle, 2005)	Quickly and efficiently propagate change throughout the rest of the network; is not likely to be highly influenced by the rest of the system
Eccentricity	The distance away of the furthest node	Minimal eccentricity indicates the centre of the graph (Hanneman & Riddle, 2005; Oliva, 2004)	Localization of outcome or intervention; target phenomena "neighbourhoods"
Level partition	Which variables are dependent on which?	Hierarchy of causal structure (Oliva, 2004)	Elements at the "bottom" of the hierarchy are uncontrollable within the system; elements at the top are highly dependent on the rest of the system
Cycle partition	Which other variables share the same set of predecessors/successors?	Illustrates cycle set "dominance" → sub-cycles sets must be understood before their "parents" (but not *that* useful as most elements in models sit in the same cycle set; Oliva, 2004)	Sub-cycle set elements dictate the behaviour of supercycles
Shortest Independent Loop Set (SILS)	A decomposition of the cycle partition showing which loops are included in which	- Illustrates a loop hierarchy - With level partitioning, gives an ordering from simple loops to complex loops Shows isolated loop structures (Oliva, 2004)	- Simple loops are easier to experiment with than more complex loops - Inner loops will influence the behaviour of their containing loops - Isolated structures are more easily manipulated

3.2. A pilot study

we we The model is a CLD representing the system of education curricula change in the Canadian province of Newfoundland and Labrador. It can be found and interacted with online at https://kumu.io/systemicdesign/centrality-and-structural-analysis. The model is not overly complex, containing 30 elements and 49 connections between them. Nonetheless this is a sufficient complexity to make the model difficult to interpret at a glance. A good test of the leverage measures is whether the results make sense and reveal insight based on our experience with the system.

The study artifact & materials

The model is built and maintained on Kumu.io, a web application supporting systems mapping and social network analysis. Kumu.io has implemented the centrality analysis metrics discussed above (except for eccentricity, which remains untested in this pilot study).

Procedure

We first used Kumu's built in algorithms to calculate centrality values for each element for the metrics described above. Second, we followed the procedures detailed by Oliva (2004) to examine the level and cycle partitions of the model. Finally, we reviewed the resulting centrality values, level partitions, and cycle partitions. We present our interpretation of the results according to our experience with the problem domain below.

Results

Structural analysis

As suggested by Oliva (2004), the model's initial level partition was not useful. The partitioning resulted in two levels, of which the bottom included only five of the 30 elements in the model. In no particular order, they are:

- Generational shifts in work
- Innovation learning from outside of the public education system
- Accessible and practical models for innovation education
- Other calls for reform
- Low price of oil

Taken with zero interpretation, this analysis implies that these five phenomena are completely independent forces in the world. For most of the phenomena, however, the opposite is true: "Low price of oil", "Other calls for reform", and "Generational shifts in work" are three phenomena that actually have massive systems behind them, and defining those models was simply outside of the scope of the model—a result of boundary drawing. However, the other two phenomena both deal with injecting innovation learning from outside of the extant system. It makes sense that these do not depend on anything within the system. Their independence may make them a useful point from which to implement a change strategy.

The remaining 25 elements can be decomposed into a shortest independent loop set (SILS) containing 18 separate loops. Of these, the loop inclusion graph is presented below (figure 1). It shows that 13 of the loops are independent, sitting at the same bottom-most level. The remaining five loops form the core structure of the model. These loops are illustrated and labelled in figures 3 through 6.

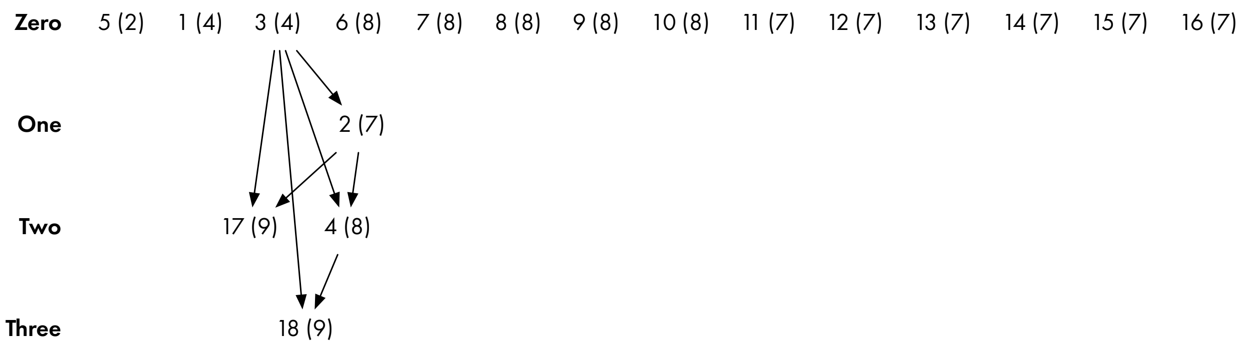

Figure 1. The loop inclusion graph of the innovation education model. Cycle levels are indicated on the left of the diagram.

The core loop of this structure is therefore loop 3—a loop describing how a poor definition of innovation is self-perpetuating. This loop is nested within loops 2, 4, 17, and 18, making it the most contained loop of the model. This is intuitive, as definitions play a major role in how an issue is discussed and, therefore, how policies are made. From a leverage perspective, then, influencing loop 3 means influencing several other key feedback loops of the system.

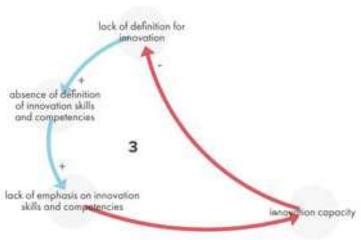

Figure 2. Loop 3: Perpetually poor definition of innovation

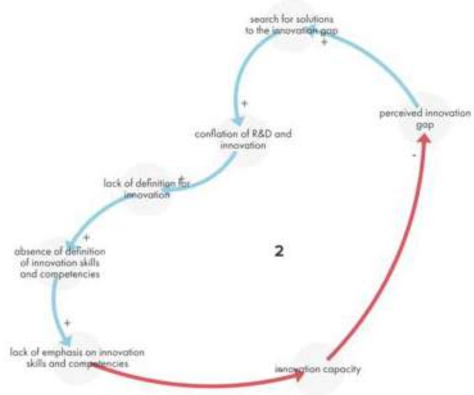

Figure 3. Loop 2: Innovation conflation (with R&D)

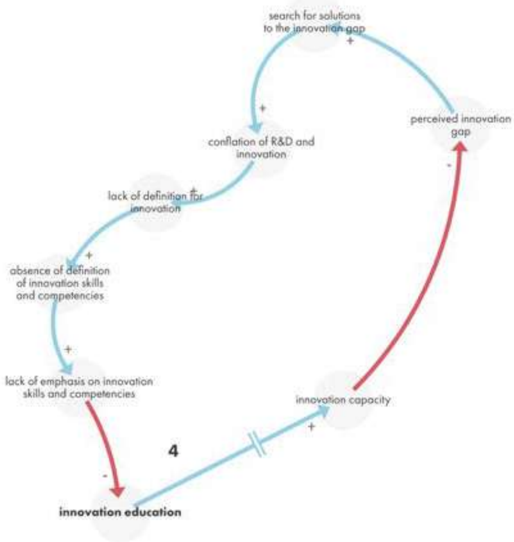

Figure 2. Loop 4: Innovation reinforces innovation

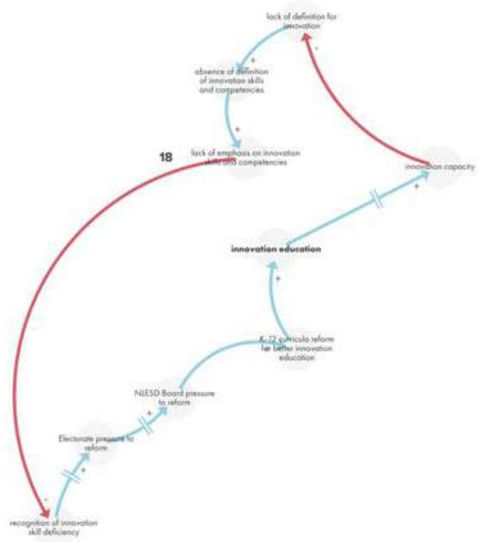

Figure 5. Loop 18: Driving reform

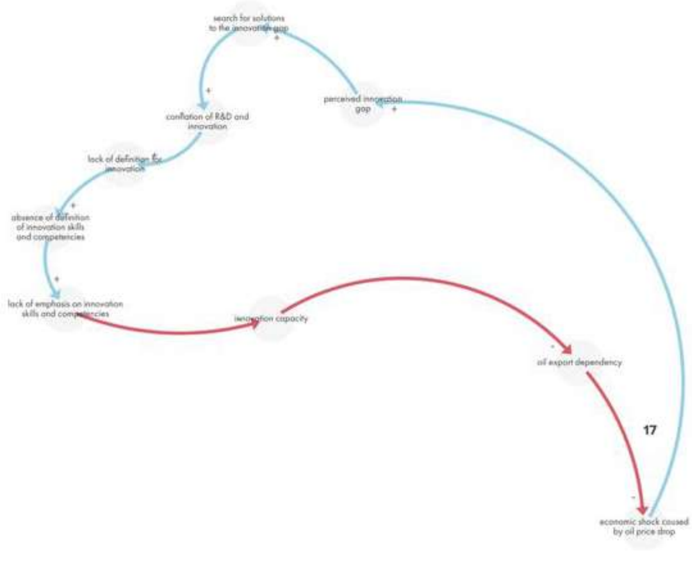

Figure 6. Loop 17: Resource-dependent economy

Centrality analysis

The top three phenomena on each of the centrality indicators is reported in table 2. A full discussion of the implications of these results is outside of the scope of this paper. For now, we provide comment on a few observations on the results of particular metrics below.

Table 2. Ranked results of centrality analysis on phenomena in innovation education, reported in descending order with the highest value items on the left. Values for the respective metric reported in parentheses. Phenomena have been colour-coded for ease of identifying the same phenomena across the table.

Degree	Innovation education (8)	Recognition of innovation skill deficiency (7)	K-12 curricula reform for better innovation education (7)
Indegree	K-12 curricula reform for better innovation education (6)	Innovation education (6)	Recognition of innovation skill deficiency (5)
Outdegree	Innovation capacity (4)	Provincial government pressure to reform (3), Independent actor calls for innovation education reform (3), Austerity limiting new program growth/development (3), Lack of emphasis on innovation skills and competencies (3)	
Betweenness	Innovation capacity (.47)	Innovation education (.454)	Recognition of innovation skill deficiency (.298)
Closeness	Lack of emphasis on innovation skills and competencies (.359)	Innovation capacity (.337)	Innovation learning from outside the public education system (.308)
Eigenvector	Innovation education (.121)	Innovation capacity (.083)	Perceived innovation gap (0.073)
Reach	Lack of emphasis on innovation skills and competencies (0.367)	Innovation capacity (.3)	Recognition of innovation skill deficiency (0.267)
Reach efficiency	Innovation learning from outside the public education system (0.078)	Lack of emphasis on innovation skills and competencies (0.073)	Low price of oil (0.067)

We proposed that high-degree elements would be important indicators of leverage—lead measures of a systemic intervention. Indeed, increased levels of "innovation education", "recognition of innovation skill deficiency", and "K-12 reform for better innovation education" would each be clear signs that change was taking root. Contrast these elements with other components of the system—say, the "need for innovation skills" or the "definition of innovation skills and competencies". These are hand-picked examples, of course, but that the degree measure algorithmically better options is evidence that our proposed definition is appropriate.

We suggested that betweenness indicates a bottleneck. Indeed, "innovation capacity" and "innovation education" reflect bottleneck phenomena in our experience. These phenomena represent our ability to actually practice and teach innovation itself. Since these concepts are fundamental, a change strategy will fail without addressing them. "Recognition of innovation skill deficiency" is third, and it also makes sense that this is a bottleneck. If we knew everything we could about innovation, but fail to notice that we weren't very good at doing it, we would not try to implement reforms to resolve the deficiency.

Last, the eigenvector metric should highlight leverage points in the model. The results here are promising. "Innovation education"—the kernel of the model itself—and "innovation capacity" are the top two results, which are intuitive. The measure also revealed the relative importance of the "perceived innovation gap": whether or not society recognizes that we aren't performing as well on innovation as we should be. This makes sense: alarm that we are failing at innovation is likely to raise awareness and incite change rapidly.

4. Discussion

4.1. Contributions

Leverage analysis is a powerful opportunity for systemic designers. Grafting centrality and structural analysis methods to systemic design is a novel way to gain insight into our wicked or continuous critical problems (Rittel & Webber, 1973; Ozbekhan, 1970). By reframing these techniques using the language of systemic design we hope to motivate more researchers and practitioners to see the potential of these measures for parsing complex systems. Structural analysis adds a rich dimensionality to these otherwise flat and inscrutable diagrams, while centrality analysis offers a quick way of emphasizing structurally important phenomena. Most importantly, these measures help systemic designers do what they are meant to do: interpret the models, with all the experience and domain knowledge they bring, to find strategic opportunities to make change.

A few centrality measures seem especially important. In particular, eigenvector analysis is an intuitive exaptation of the concept of leverage points. It may be that the results of eigenvector analysis should be the first thing that systemic design teams discuss when they move towards strategizing solutions. Identifying potential bottlenecks with the betweenness measure also appears to be a powerful tool in order to ensure that potential bottlenecks are addressed by a change strategy.

The notion of "leverage measures" is a novel concept as a whole. Are there other ways in which we should be measuring the leverage we have on our systems? What principles may be applied in assessing whether a given change strategy has appropriate leverage or not? This is an exciting new idea that deserves further scrutiny and exploration.

4.2. Limitations

First, and most obviously, our proposed metrics deserve further scrutiny than our pilot project. It should be possible to test hypotheses on these ideas. For instance, a modeller or modelling team could examine a domain and develop a model, then assess it with the leverage measures. Expert reviewers could be asked questions (e.g., "What are the key bottlenecks to reform in this issue?") about the domain relating to the proposed leverage measures. After these responses are coded, the reviewers' suggestions could be compared with the results of leverage analysis to see if experts' insights are reflected by the analysis.

Second, the need for interpretation is ever-present. Nonetheless, we can direct what the interpreter interprets. Structural and centrality analysis offers an easy way to provide emphasis, changing what catches the systemic designer's attention.

4.3. Further research

Ontological guidelines for mapping and normalization

The way in which models are researched and designed is not necessarily standardized. Designers may hold different mental models about what is appropriate for a systems model, for the phenomena they are mapping, and for what constitutes a connection between the models. These issues may be alleviated with ontological guidelines or even a strict script for how the real-world problems of systemic design are mapped to systems models.

Explore additional metrics

As discussed earlier in this paper, many more metrics exist dealing with analyzing the structure of graphs. For instance, Borgatti (2005) develops some ideas around how information actually flows in social networks. These ideas may apply to the flows of change between phenomena in systems. Xie, Szymanski, and Liu (2011) profile a set of community detection algorithms used to detect the divisions of social networks into separate social groups. These concepts may relate to new ways to structure and decompose systemic phenomena. Finally, Schoenenberger, Schmid, and Schwaninger (2015) propose a methodology to algorithmically detect different systems archetypes based on the structure of CLDs. This relates directly to the objectives of the current research and should be integrated into the leverage measures framework.

Weighted metrics and algorithms to implement them

It is possible to combine centrality measures. For instance, you can use the Kumu.io algorithms to calculate reach efficiency weighted by eigenvector values. If combined metrics could be clarified and developed with respect to the leverage measures framework, it may be the most powerful way to immediately calculate clear leverage points from a given model. (E.g., eigenvector-weighted reach efficient phenomena may be high-influence high-efficiency intervention points.)

Linking methods

The formal relations and structures emphasized by the methods presented in this paper might be even more useful when embedded in other systemic design methods, such as synthesis maps or Gigamaps (Sevaldson, 2011). Centrality and structural analysis could also find utility in structured dialogic design, where pairwise voting mechanics are already used, providing a semi-quantitative approach to engage stakeholders in modelling complex problems (Jones, 2008).

Systems dynamics vs. systems thinking: from dichotomy to spectrum?

In the introduction, we framed differences between system dynamics and systems thinking as a substantial divide. It may be that these tools can help bridge the gap between the hard, quantitative approaches of systems dynamics and the soft, messy problems of systems thinking. If this is the case, the divide doesn't exist at all—rather work in these two disciplines happens along a spectrum. Choosing the appropriate place on the spectrum to investigate a given problem then becomes a key decision in the systemic design process. This deserves further thought.

5. Conclusion

This paper has served three objectives: to unite different semi-quantitative approaches to analyzing systems, to contextualize these approaches in the discipline of systemic design, and to relate the use of these semi-quantitative methods to the notion of leverage points. Simply by discussing the different aspects structural analysis of systems with respect to systemic design, we hope to have achieved the first and second objectives. By translating different measures from these semi-quantitative approaches into a list of leverage measures, we believe we have achieved the third. Extensive work remains both to critique this work and to extend it. The potential for augmenting the work of systemic design is nonetheless enormous.

References

Beck, M., Schoenenberger, L. K., & Schenker-Wicki, A. (2012). *How Managers Can Deal with Complex Issues: A Semi-Quantitative Analysis Method of Causal Loop Diagrams Based on Matrices* (SSRN Scholarly Paper No. ID 2573718). Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2573718

Box, G. E. P. (1976). Science and Statistics. *Journal of the American Statistical Association*, *71*(356), 791–799. https://doi.org/10.2307/2286841

Carrington, P. J., & Scott, J. (Eds.). (2011). Introduction. In *The SAGE handbook of social network analysis* (pp. 1–8). London ; Thousand Oaks, Calif: SAGE.

Checkland, P. (1985). From Optimizing to Learning: A Development of Systems Thinking for the 1990s. *The Journal of the Operational Research Society*, *36*(9), 757–767. https://doi.org/10.2307/2582164

Duggan, J., & Oliva, R. (2013). Methods for identifying structural dominance. *System Dynamics Review*.

Forrester, J. W. (1994). System dynamics, systems thinking, and soft OR. *System Dynamics Review*, *10*(2–3), 245–256. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/sdr.4260100211/abstract

Freeman, L. C. (1977). A Set of Measures of Centrality Based on Betweenness. *Sociometry*, *40*(1), 35–41. https://doi.org/10.2307/3033543

Freeman, L. C. (1979). Centrality in social networks conceptual clarification. *Social Networks*, *1*(3), 215–239.

Gharajedaghi, J. (2011). *Systems thinking: managing chaos and complexity: a platform for designing business architecture* (3rd ed). Burlington, MA: Morgan Kaufmann.

Hanneman, R. A., & Riddle, M. (2005). Ego Networks. In *Introduction to social network methods*. Riverside, CA, USA: University of California, Riverside. Retrieved from http://faculty.ucr.edu/~hanneman/nettext/C9_Ego_networks.html

Jones, P. H. (2008). Dialogic Design: Harnessing Collective Wisdom for Democratic Design and Action. In *Proceedings of the Tenth Anniversary Conference on Participatory Design 2008* (pp. 307–308). Indianapolis, IN, USA: Indiana University. Retrieved from http://dl.acm.org/citation.cfm?id=1795234.1795315

Jones, P. H. (2014). Systemic Design Principles for Complex Social Systems. In G. S. Metcalf (Ed.), *Social Systems and Design* (pp. 91–128). Springer Japan. https://doi.org/10.1007/978-4-431-54478-4_4

Kampmann, C. E. (1996). Feedback loop gains and system behavior. In *In Proceedings of the 1996 International System Dynamics Conference, System Dynamics Society*.

Kampmann, C. E., & Oliva, R. (2006). Loop eigenvalue elasticity analysis: three case studies. *System Dynamics Review (Wiley)*, *22*(2), 141–162. https://doi.org/10.1002/sdr.333

Kampmann, C. E., & Oliva, R. (2008). Structural dominance analysis and theory building in system dynamics. *Systems Research & Behavioral Science*, *25*(4), 505–519. https://doi.org/10.1002/sres.909

Le Blanc, D. (2015). Towards integration at last? The sustainable development goals as a network of targets. *Sustainable Development*, *23*(3), 176–187.

Lukyanenko, R., & Parsons, J. (2012). Conceptual modeling principles for crowdsourcing (pp. 3–6). ACM. https://doi.org/10.1145/2390034.2390038

Maass, W., Parsons, J., Purao, S., Storey, V. C., & Woo, C. (2018). Data-Driven Meets Theory-Driven Research in the Era of Big Data: Opportunities and Challenges for Information Systems Research. *Journal of the Association for Information Systems*, *19*(12), 1253–1273. https://doi.org/10.17705/1jais.00526

Meadows, D. (1997). Leverage Points: Places to Intervene in a System. Retrieved November 29, 2015, from http://www.donellameadows.org/wp-content/userfiles/Leverage_Points.pdf

Mohr, J. (2016, September 2). A toolkit for mapping relationships among the Sustainable Development Goals (SDGs). Retrieved January 20, 2018, from https://blog.kumu.io/a-toolkit-for-mapping-relationships-among-the-sustainable-development-goals-sdgs-a21b76d4dda0

Murphy, R. J. A. (2016). *Innovation Education* (MRP). OCAD University, Toronto, ON. Retrieved from http://openresearch.ocadu.ca/id/eprint/1344/

Newman, M. (2010). *Networks: An Introduction*. Oxford, New York: Oxford University Press.

Norman, D. A., & Stappers, P. J. (2015). DesignX: Complex Sociotechnical Systems. *She Ji: The Journal of Design, Economics, and Innovation*, *1*(2), 83–106. https://doi.org/10.1016/j.sheji.2016.01.002

Oliva, R. (2003). Model calibration as a testing strategy for system dynamics models. *European Journal of Operational Research*, *151*(3), 552–568. https://doi.org/10.1016/S0377-2217(02)00622-7

Oliva, R. (2004). Model structure analysis through graph theory: partition heuristics and feedback structure decomposition. *System Dynamics Review (Wiley)*, *20*(4), 313–336. https://doi.org/10.1002/sdr.298

Oliva, R. (2018). *Formalization of Model Partition Heuristics through Graph Theory*.

Ozbekhan, H. (1970). *The predicament of mankind: A quest for structured responses to growing world-wide complexities and uncertainties* (Original Proposal to the Club of Rome). Geneva, Switzerland: The Club of Rome. Retrieved from http://quergeist.net/Christakis/predicament.pdf

Potts, M., Sartor, P., Johnson, A., & Bullock, S. (2017). Hidden Structures: Using Graph Theory to Explore Complex System of Systems Architectures. University of Bristol.

Provost, F., & Fawcett, T. (2013). *Data Science for Business*. USA: O'Reilly Media.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*, *4*(2), 155–169. Retrieved from http://link.springer.com/article/10.1007/BF01405730

Rossi, M., & Brinkkemper, S. (1996). Complexity Metrics for Systems Development Methods and Techniques. *Information Systems*, *21*(2), 209–227.

Ruohonen, K. (2013). *Graph Theory*. (J. Tamminen, K.-C. Lee, & R. Piché, Trans.). Retrieved from http://math.tut.fi/~ruohonen/GT_English.pdf

Saleh, M., Oliva, R., Kampmann, C. E., & Davidsen, P. I. (2010). A comprehensive analytical approach for policy analysis of system dynamics models. *European Journal of Operational Research*, *203*(3), 673–683. https://doi.org/10.1016/j.ejor.2009.09.016

Schoenenberger, L., Schenker-Wicki, A., & Beck, M. (2014). Analysing Terrorism from a Systems Thinking Perspective. *Perspectives on Terrorism*, *8*(1). Retrieved from http://www.terrorismanalysts.com/pt/index.php/pot/article/view/323

Sevaldson, B. (2011). GIGA-Mapping: Visualisation for complexity and systems thinking in design. *Nordes*, *0*(4). Retrieved from http://nordes.org/opj/index.php/n13/article/view/104

Simon, H. A. (1996). *The sciences of the artificial* (3. ed., [Nachdr.]). Cambridge, Mass.: MIT Press.

Stroh, D. P. (2015). *Systems Thinking For Social Change: A Practical Guide to Solving Complex Problems, Avoiding Unintended Consequences, and Achieving Lasting Results*. Chelsea Green Publishing.

Warfield, J. N. (1989). *Societal systems: planning, policy, and complexity*. Wiley.

De-coding the possibilities of spatial assemblages: a design methodology of topologizing architectural morphology.

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Abstract (150 words) While the continuous flow of events seems to be a given, we still cannot either perceive or design space which is organized and has the capacity to reorganize itself in order to cope with major changes. In this framework, the research aims to establish a *code* for space, as a semantic system that monitors its sociospatial metabolism while at the same time being directly connected to its material reality. In this framework, the research attempts to establish *a design methodology* aiming at *a generative system for architecture and the city*. The material agency of this productive process is described as a bifold process which constantly informs itself, including a *"convergent phase of selection"* and a *"divergent phase of design"* (Spuybroek 2008: 189). The first one focuses on the *code's organization*, introducing Christopher Alexander's 253 Design Patterns (Alexander et al. 1977) as its elementary units in order to postulate on its topological structure as a network of relations between interacting, active parts. In the next phase, while theorizing the *code's structure*, Design Patterns are substituted by their *A-signifying signs* counterparts, mechanisms able to stabilize or destabilize the assemblage and thus allow for its contingency to remain immanent.

Keywords: design patters, code, design methodology, a-signs, affect theory

0. Introduction

While the continuous flow of events - within the assemblage, complexity and dynamics systems theory - seems to be a given, we still cannot perceive or design space that is organized and has the capacity to reorganize itself so as to cope with major changes. This research aims to establish *a code* for space as a semantic system that monitors its sociospatial metabolism and is directly connected to its material reality. In setting the general schema for its ontology, the research disregards the difference between the observable and the non-observable as well as the anthropocentrism this distinction implies (DeLanda 2013). In this context, space is composed of both the *actual* and the *virtual*, "space as is" and "space as it could be", respectively. As they both inform and enhance its identity, form-production is to be explained through a *process ontology format*.

Space, spatial structures and configurations are here theorized as *assemblages* composed of heterogeneous elements - themselves being parts of larger assemblages - that enter into relations with one another while their components' ability to engage is contingent. In this framework, the research attempts to establish a *design methodology aiming at a generative system for architecture*. To elaborate on the "space as it could be" on one hand, is to speculate on the city's tendencies and capacities not yet manifested or exhibited, both a philosophical and mathematical task. To that end, the concept of *the structure of possibility spaces* is introduced to architecture, a philosophical concept equivalent to or close to a mathematical *manifold* (DeLanda 2013). On the other hand, to conceive of space as being able to self re-produce itself is to postulate on its organization as a system able to differentiate over time according to a set of rules (Spuybroek 2008: 190).

As this information is both actual and virtual, the concept of a *code* is introduced as a processing schema. Chapter 01 deals with the *theoretical framework* needed to think about a code for the city, one that uses the reconstruction of Deleuze's world by Manuel DeLanda as a discursive tool to illuminate the subject of architecture while at the same time drawing from assemblage theory and a-signifying semiotics to set the framework for approaching material contingency. Chapters 02 and 03 explore the *code's organization* and introduce Christopher Alexander's 253 Design Patterns (Alexander et al. 1977) as its elementary units. Chapter 02 focuses on Design Patterns and postulates on their relevancy and ontological status to code space. Chapter 03 focuses on the *intensive processes* and *intensive differences* that produce architecture's spaces of possibilities and sorts Design Patterns into four spaces, pointing them as space's four dimensions. Chapters 04 and 05 deal with the *code's structure* as it transforms its elements to become formative. Chapter 04 focuses on the spatial assemblages' *ability to affect and to be affected* as a precondition to their material contingency. In Chapter 05, the code's dimensional areas acquire their affective capacity by means of *substitution of Design Patterns by their a-signs counterparts*, mechanisms able to increase spatial assemblages' material contingency. The code becomes the space of possible states that space can have, a model of form-production processes that directly connects the design of space to its material reality.

1. Theoretical Framework

Over time, the history of ontologies maps the dominant relationships between the *abstract* and its *concrete actuality*, or in Deleuzian terms between the *virtual* and the *actual*. Moving from one level to the other requires some kind of abstraction as the two are not homologous. (Spuybroek 2008: 190) The history of explanatory schemes notes the shift regarding the *type of abstraction* and the *nature of form*: abstraction evolves from reductive to generative while at the same time form moves from rigid models to more elastic ones. According to Lars Spuybroek: 'There have been four ontological abstractions - idea, schema, diagram and code - that match their concrete actualities - respectively, form, reality, assemblage and being.' (Spuybroek 2008: 190) The first two ontological abstractions, Plato's and Kant's, allow only for the replication of form and not for its generation, therefore implying a metaphysical connection between the abstract and the real. Within the generative theories that follow, Deleuze's diagram accepts a *physical relation between the abstract and the real*, their coexistence within the same continuum, a continuum within the real itself. The last abstraction of code and being is considered to be mapping the ultimate *biologizing of design*.

To better grasp what spaces inhabit the virtual and the actual we draw from Deleuze's distinction between *intensive spaces* on one hand, and *extensive and qualitative spaces* on the other (DeLanda 2013: 63). The virtual is inhabited by the former while the actual is composed by the latter. Extensive and qualitative spaces are bounded by natural and artificial extensive boundaries that extend in space up to a limit marked by a frontier. Intensive spaces or zones of intensity are less familiar but equally well-defined spaces. They are bounded by *critical points of change*, whether in temperature, pressure, gravity, density, tension, connectivity and more and define abrupt transitions for the state of natural and artificial objects that inhabit them. "The intensive, the extensive and the qualitative are intricately related: *zones of intensity* are the site of processes which yield as products the great diversity of extensive and qualitative spaces". (Buchanan and Lambert 2005: 81)

The material agency of this productive process, a key to this ontology, is described as a bifold process which constantly informs itself, including a "*convergent phase* of selection" and a "*divergent phase* of design" (Spuybroek 2008: 189). For the *convergent phase*, one to inhabit the virtual domain, a system is organized by gathering information that is relevant and providing its topological structure, one that concentrates on the relations instead of the components. In this phase, code is established including both the procedure and the rules necessary for the information to be processed over time. *In the divergent phase*, the actualization takes place as the code germinates and transforms into actual spatial structures with geometric and qualitative properties. According to Lars Spuybroek, both phases should be machines in themselves able to connect to one another while their division better describes how an organization turns into a structure. These spatial structures are expected to process information over time and therefore produce variations of oneself. To do that they need to remain structurally open beyond the point of their actualization. (Spuybroek 2008: 189)

To define spatial structures as open systems able to reorganize themselves, the research draws from assemblage theory, an approach to dynamic systems analysis that emphasizes on fluidity, mutability, interchangeability of their constituent components, producing evolving systems that interact between each other. This theory has evolved in order to move away from conceptualizing systems as seamless wholes, and provides "the possibility of analyzing both the contingent interactions between parts as well as the emergent properties of the complex whole". (DeLanda 2006: 10) In assemblage theory, a component may be detached from an assemblage and plugged into another where it forms different interactions. Within this framework, spatial assemblages seem to be specific entities that have been produced in a specific timeframe, and although they have operative capacities they are contingently obliged to function the way they operate.

2. The Convergent Phase _ A Machine of Design Patterns

In this framework, within the convergent phase, Christopher Alexander's 253 *Design Patterns are introduced as the code's *basic units of information* and are rearranged into a new 'table' of spatial relationships, through a population - thinking process (DeLanda 2013: 52). Before delving into establishing the code's spaces of possibilities, we shall elaborate further on Design Patterns pointing to their ontological status and their relevancy as the code's elements. To elaborate on that, we postulate that through DP the code is able to simulate t*he processes of representation and self-organization*, necessary for processing information over time. In terms of the *process of representation*, the code has to be able to gather and store information about the environment. 'The structure of the system cannot consist of a random collection of elements; they must have some meaning.

In traditional philosophical terms, the system must somehow 'represent' the information important to its existence' (Cilliers 1998). In that context, Design Patterns as a collection of pre-structured elements describing space have the capacity to be incorporated in the coding scheme. At the same time, their diagrammatic, rule-based structure is important in terms of their topological plasticity, increasing their capacity for transformation. For the *process of self-organization*, the code is expected to develop organized structure and adapt it to cope with the changing environment. To do that, its elements have to be 'fairly unstructured' (Cilliers 1998: 12) so that the relationships between the distributed elements of the system - under the influence of the environment and the history of the system - can be reevaluated in terms of their patterns of communication. As DP are assemblages themselves of both rules and spatial configurations, we hypothesize that their communicational plasticity will be further enhanced through the communicational capacity of their component parts.

We have by now postulated that the 253 Design Patterns will be the code's basic units of information while at the same time their patterns of communication are assumed to be operative at two distinct spaces. The first space is where the 253 design patterns exhibit their interconnections' possibilities as they communicate with other units, with the units' history, and with their environment. The second space relates to each pattern's internal structure where communications between its parts and rules take place, resulting in the pattern's actualization. (Deleuze 1993: 100). In that respect, Design Patterns are introduced onto *a surface in space* attributed solely to their *communicational possibilities*. [Figure 01]

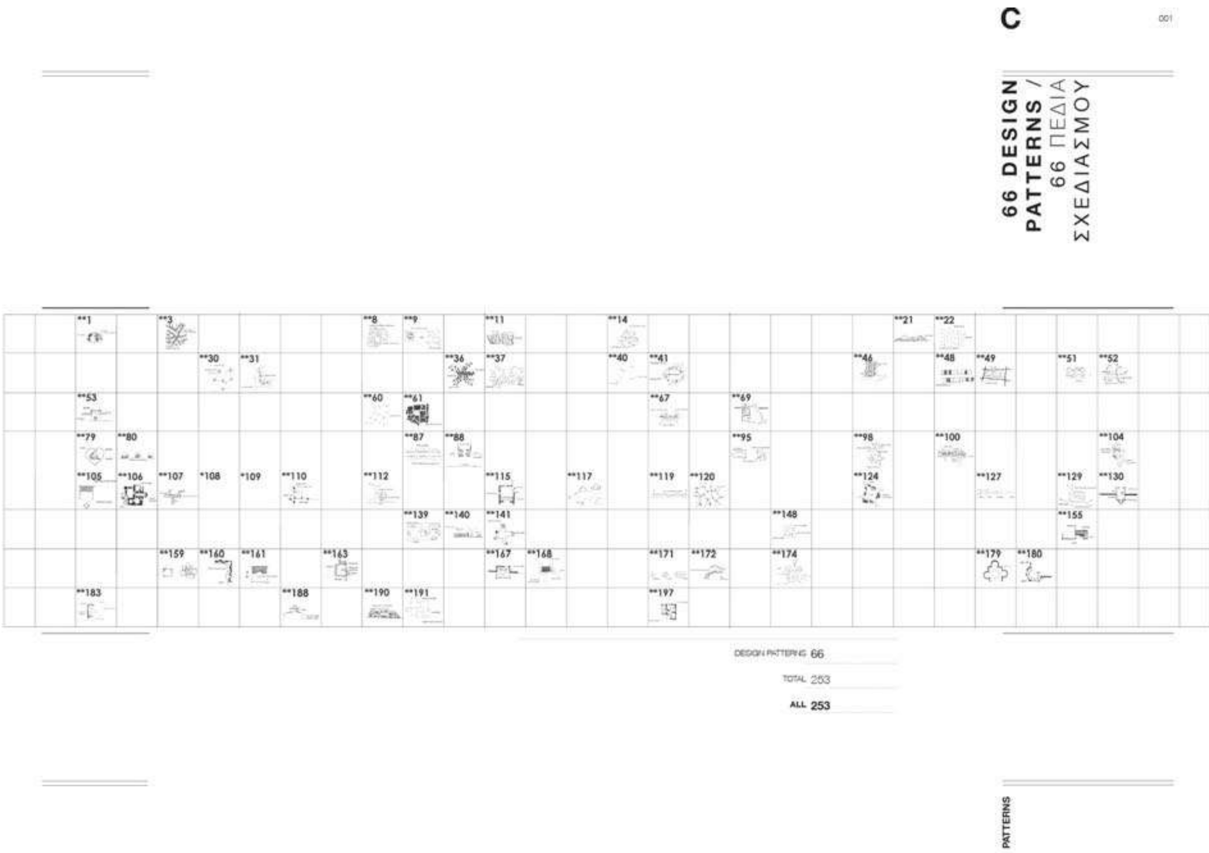

Figure 01 . 66 Design Patterns

On that surface, they are free to assemble and reassemble anew as they use their communication properties, they exhibit their unactualized tendencies and manifest their full range of capacities. This surface is closely related to that of a Riemanian *manifold*, an *N-dimensional surface* or *space* where the number of dimensions may vary while the global embedding system becomes redundant and thus the manifold autonomous. (DeLanda 2013: 5) As the patterns start populating this autonomous surface, the manifold gets activated and energized. In the first part of the population process, Design Patterns are networked in terms of *the intensive processes* that gave rise to them. At the end of the first part of the process, the manifold will have four spaces of possibilities pointing to the city's four dimensions, each inhabited by specific Design Patterns. For the second part, they are interconnected in regards to the *intensive differences* that prompted these processes while each dimensional area. After the second part, each dimensional space will be populated by two contrasting "demes" of Design Patterns, each pointing to *the minima and maxima of their intensive gradient*.

3. The Convergent Phase _ The Code's Organization

In Deleuzian ontology, a species is defined by the morphogenetic process that gave rise to it instead of its essential traits (DeLanda 2013: 2), a principle guiding the first part of the population process. Drawing from dynamical systems theory, we propose a *shift* from 'morphogenetic processes which generate material objects and kinds' (DeLanda 2013: 5) to sociospatial production processes which generate space's material reality. Within the same shift, the dimensions of the manifold are used to represent the relevant ways space may change pointing them as its *intensity zones*, the site where *intensive processes* take place. At the same time, the manifold itself becomes the space of possible states that space can have. To better define and topologically measure space's intensity zones, we map patterns of communication within the full archive of 253 DP by means of networks of interconnected nodes. Each node is used to represent a Design Pattern while a connection between any two such nodes represents some function related to their communication. These networks are controlled by *communication protocols* and set the rules for the *code's organization*. (Passia 2016: 35)

These intensive spaces along with the intensive gradients responsible for their generation are defined in the following six Design Patterns 36, 66, 98, 127, 142, 193. They differ from all others DP in terms of their gradient-like structure as their diagram is a *scale* that maps a spatial relationship defined by a pair of polar terms [opposite in meaning] with specific *scale positions*. These six Design Patterns document the kinds of productive differences that incite form-production processes in the city. Specifically, Design Patterns 66 and 127 define an intensity zone of spatial relations ranging from *interiority to exteriority* in regard to what is public. Patterns 142 and 193 set the intensive boundary within the scale of *integration and separation*. At the same time, pattern 36 sets the limits for what appears to be a zone fostering relations of *concentration and decentralization*. Finally, pattern 98 delimitates an intensive space of spatial configurations aiming at generating circumstances of either *similarity or heterogeneity*. When placed on the manifold's surface, the six gradients start attracting Design Patterns relating to their respective intensity zones while four discrete spaces of possibilities are being generated, four semantic categories. [Figure 02]

interiority Vs exteriority

integration vs separation

concentration Vs decentralization

similarity Vs heterogeneity

In the first part of the population process, a list of *communication protocols* between DP is gradually being established while at the same time the respective topological networks emerge. The intensive spaces of the manifold representing space's four dimensions are the result of each Design Pattern being individuated in terms of the processes responsible for its actualization: the social or spatial relationships they engage in, the design problem they articulate, the context within which they are produced.

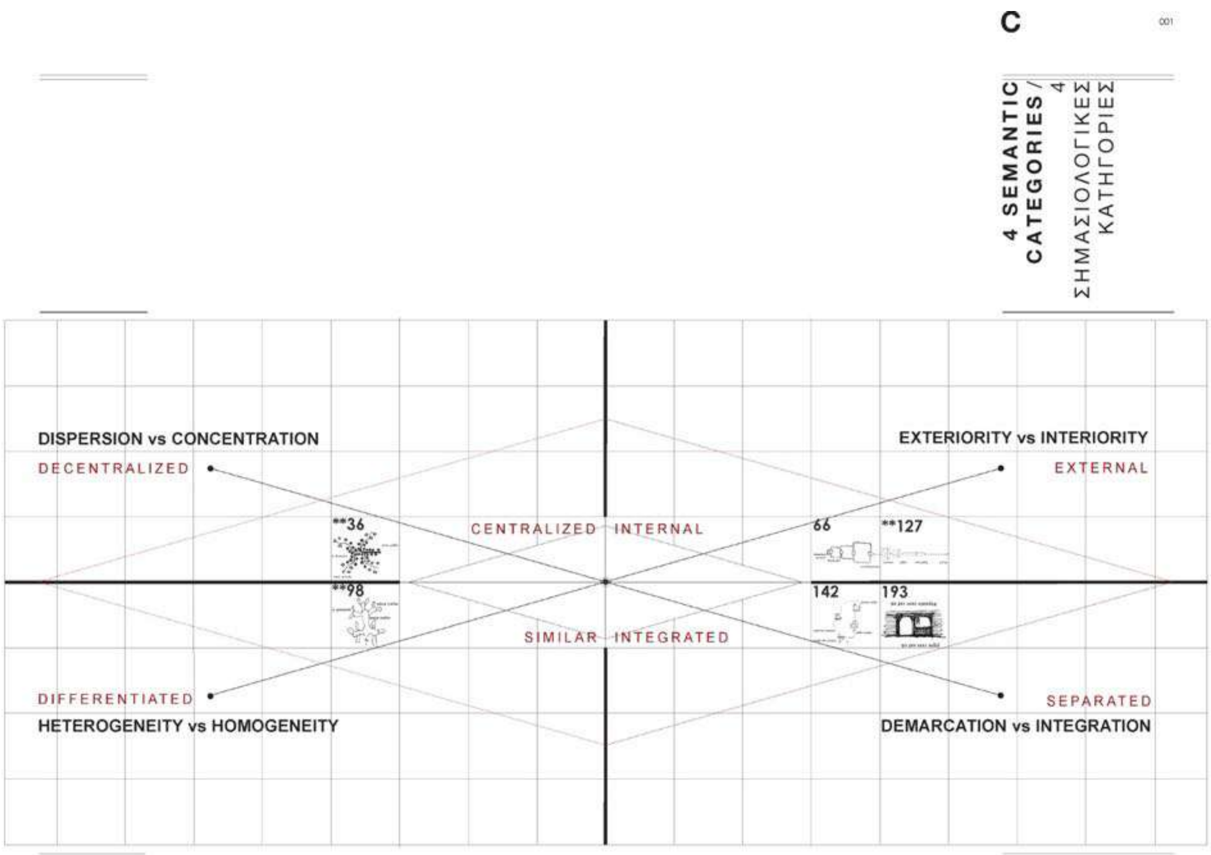

Figure 02. 4 semantic categories with 6 gradients

3.1. Communication protocols_4 and 12-protocols list

Thus, four recurring key concepts within the Design Patterns' archive constitute an initial 4-protocols list: privacy, dispersion, heterogeneity, spatial separation. [Figure 03] These concepts produce four interconnected networks of communication while at the same time four key patterns (Design Patterns 100, 8, 9, 98) take their place on the manifold' s respective areas. Their behavior is that of magnets as they attract new relevant patterns around them, each populating some of the sub-areas of the manifold. The 4-protocols list is enhanced by another 8 new protocols that further broaden the informational substratum of the manifold and better describe the boundaries of their intensive spaces. [Figure 04]

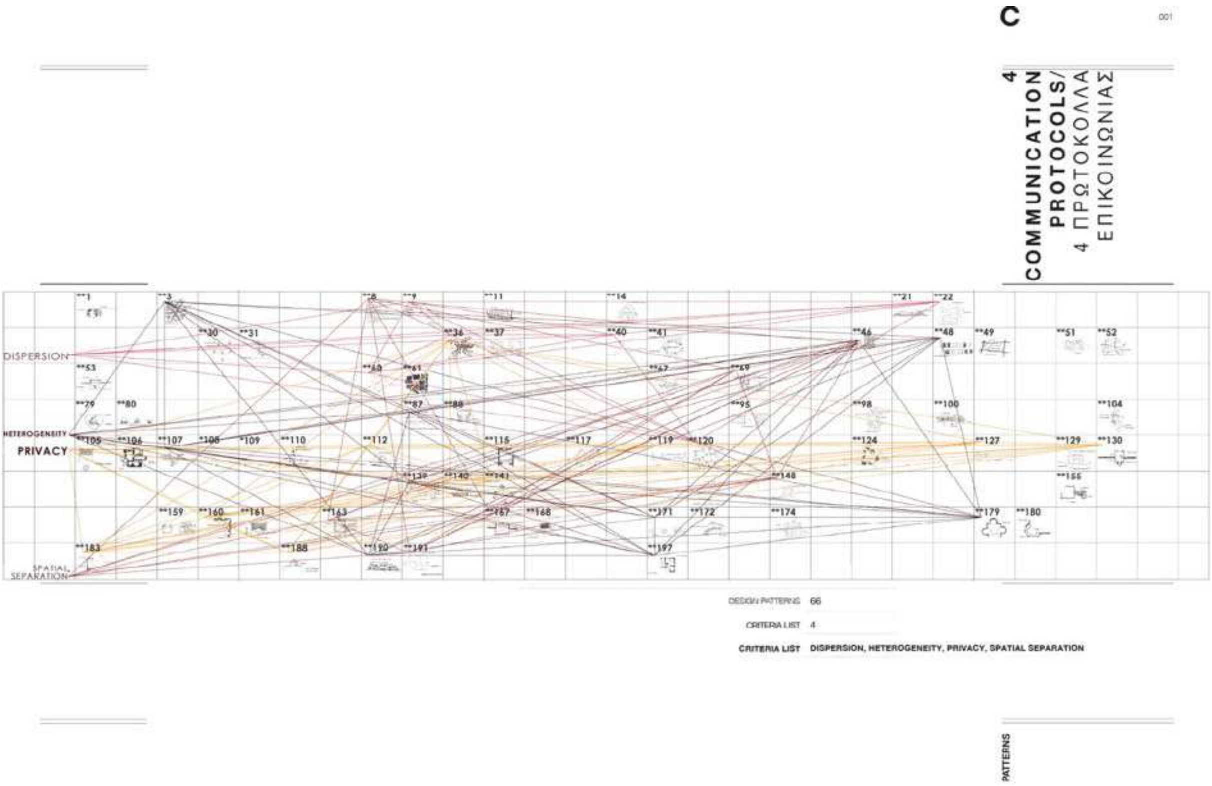

Figure 03. 4 communication protocols

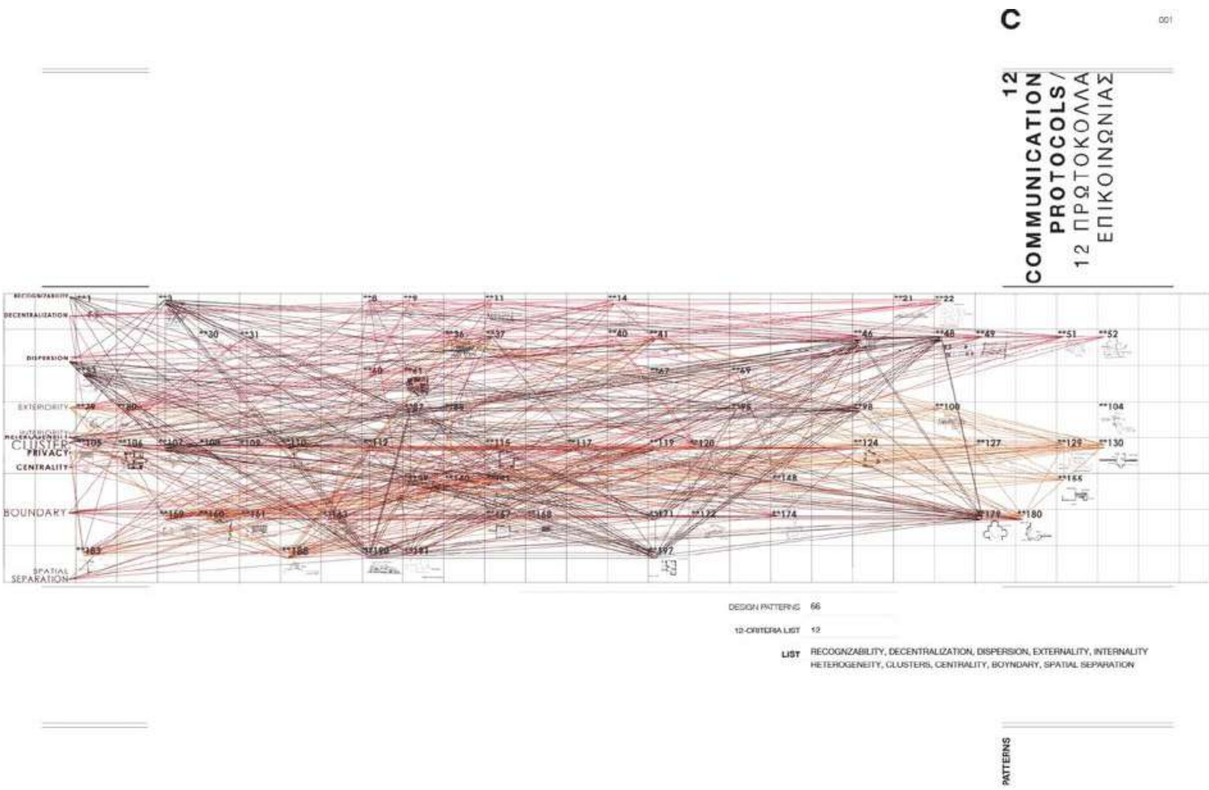

Figure 04. 12 communication protocols

This growing list of protocols organizes new interconnected networks of communication, while at the same time, more significant Design Patterns energize the manifold (Design Patterns 37, 31, 95, 168). Then, the protocol of dispersion appears to be adjacent to those of *decentralization* but also of *centrality*, while heterogeneity seems to be close to both *differentiation* and *recognizability*. The same stands for the protocol of privacy that meets with those of *externality* and *internality*, or the protocol of spatial separation that is closely related to those of *clusters* and *physical boundary*. The new 12-protocols list is populated by concepts both relating and opposing to the initial four, that are also recurrent within the archive and manifest themselves through their respective Design Patterns. These networks, now populating the manifold's space of possibilities are the communicational maps for each dimension. The population process is complete after having assigned all 66 Design Patterns into zones of intensity, space's four dimensions of *Exteriority*, *Cohesion*, *Integration*, and *Differentiation*. [Figure 05]

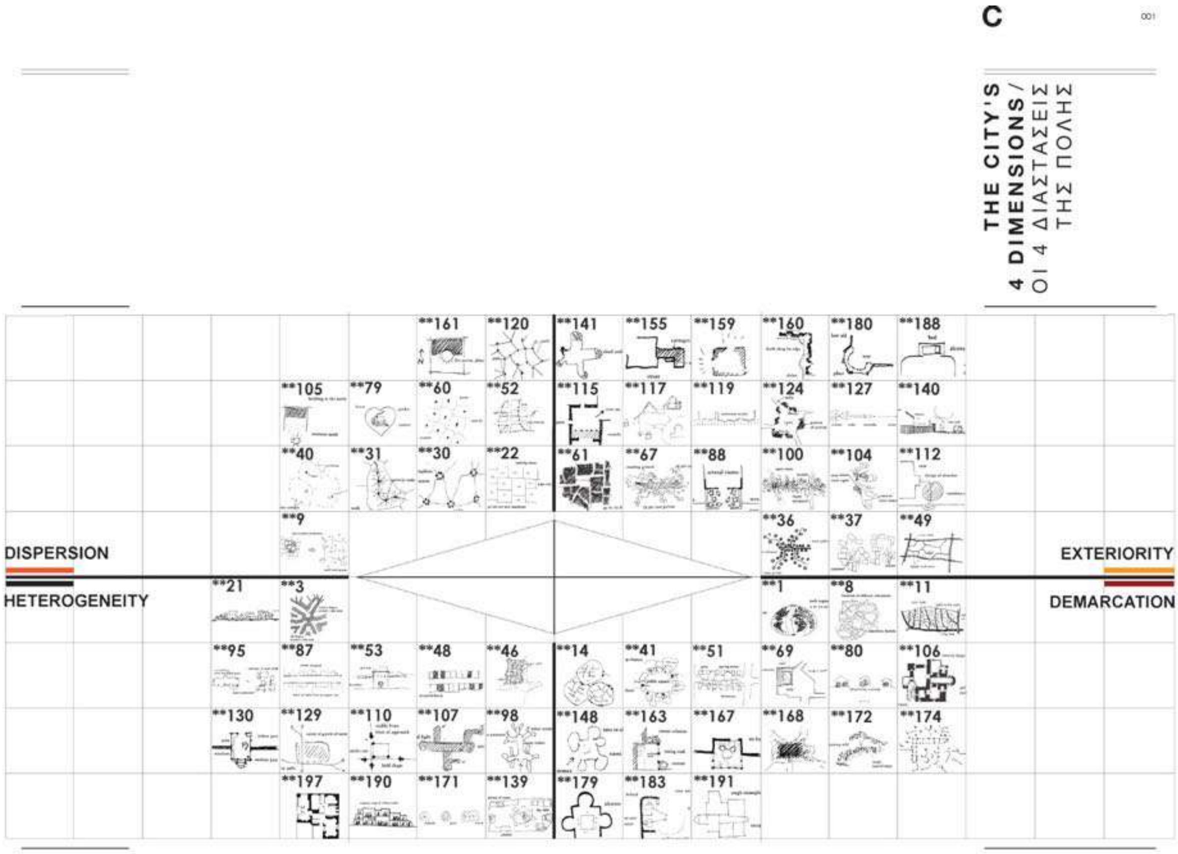

Figure 05. 4 dimensions

3.2. Intensive differences as space's critical points of change

In the second part of the population process, we will take a closer look on each dimensional space and their polarity character trying to establish their internal communicational structure. The notions of *intensive differences* (DeLanda 2013) resurface as the guidelines for this process's second part. As opposing DP are placed on the same areas on the manifold, each area seems to be mapping two extremes of the same spatial relationship e.g. Integration Vs Separation *as the minima and maxima of the dimension of Cohesion*. Each area of the manifold representing a space of possibilities for architectural form is then organized on the basis of continuity between opposites; the space of productive differences that yielded specific Design Patterns as their products. The same guiding principles organize the other three areas of the manifold on the basis of their binary spatial relationships; *Interiority Vs Exteriority, Concentration Vs Decentralization, Similarity Vs Heterogeneity* for the dimensions of Exteriority, Integration and Differentiation, respectively. The informational substratum of each dimension is composed of two contrasting "*demes*" of Design Patterns resulting into two discrete interconnected networks, each setting the *dimension's minima and maxima in the scale of its semantic differentiation*. [Figure 06] These polar patterns are assumed to inhabit two discrete and intensive sub-areas close to the respective poles of each dimension: one towards the origin of space and one towards the periphery inhabited by minima and maxima Design Patterns, respectively. In the city's manifold, each dimension is composed of polar relationships as exhibited by its Design Patterns that map their full gradient. To map each dimension's intensive differences, we postulate there is a semantic scale defined by the dimension's polar patterns with scale positions representing its *critical points of change*. [Figure 07] Through this two-part process, we have assigned four dimensions to our manifold as the code's degrees of freedom and we have established the relevant ways each dimension may change through a set of protocols.

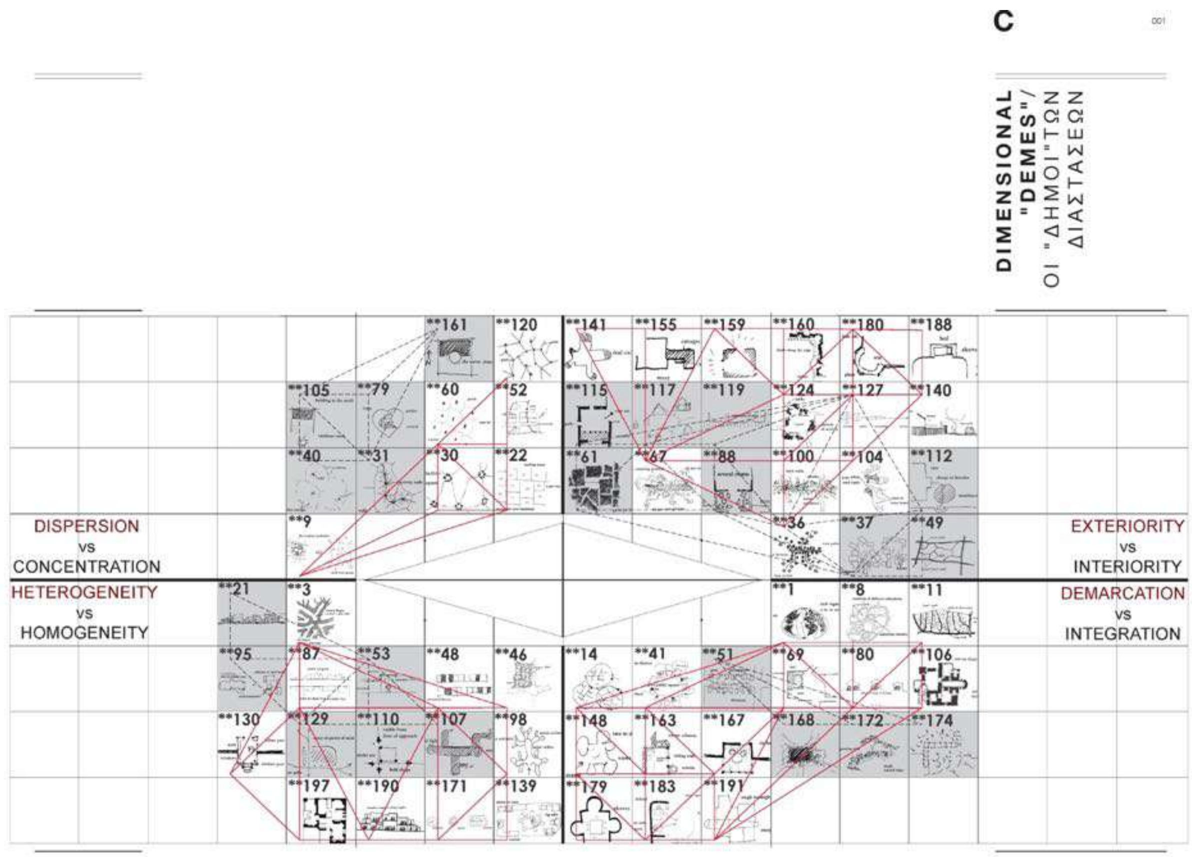

Figure 06. dimensional demes

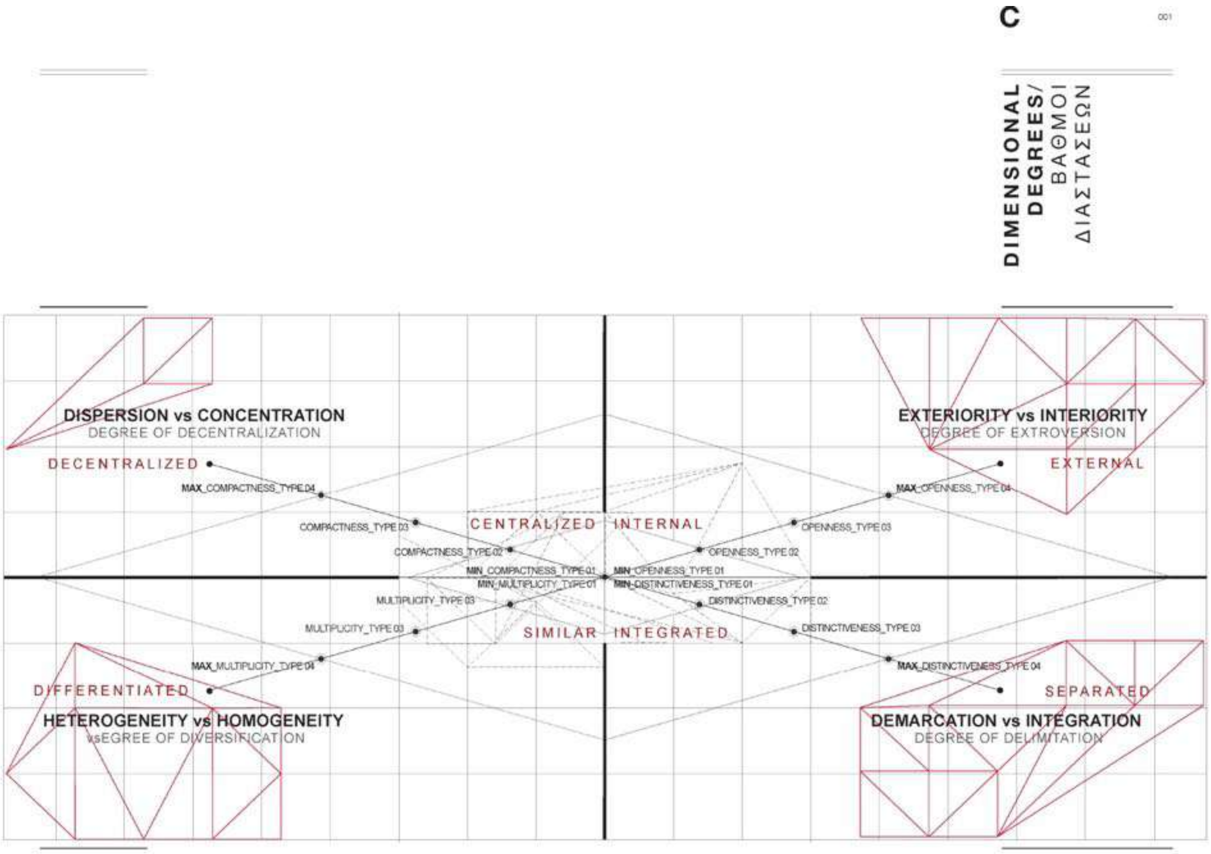

Figure 07. dimensional degrees

4. The Divergent Phase _ A Machine of A-signs

During the convergent phase, Design Patterns have been organized into a *system*, a network of acting and interacting agents that through interaction result in larger-scale patterning effects (Lars Spuybroek: 193). Furthermore, the system can differentiate over time according to *a set of rules*, the agents' communication protocols that continuously organize their dimensions and dimensional degrees. Entering the *divergent phase* and while the code maintains in full its topological organization, it transforms its structure to become formative by replacing its elementary units. To enter the phase of materialization we turn to material structures in order to extract specific *mechanisms* able to interrelate spatial components and thus formulate spatial assemblages. Through Design Patterns we have defined relations between spatial elements through a set of protocols pointing to the dimensional areas they are mostly attracted to as well as their polarity character. We now point to the *affective capacity* these spatial elements and configurations have in order to better define their capacity to assemble and reassemble anew thus allowing for their material contingency. In short, while spatial relations have been defined through communication protocols described by Design Patterns, we now point to the affective capacity of spatial assemblages. This capacity lies in an *excess*, a latent potentiality they contain, not transcendental but immanent in their *pre-subjective* aesthetic power.

In order to analyze and produce spatial assemblages of that kind, we point to their more stable characteristic, their *ability to affect and to be affected*, referred to as *affects*. (Deleuze & Guattari 1987: xvi) Affects are the relations we create with temporary worlds, and by which at the same time we are being created. In mapping the assemblages' affective ability, spatial objects are analyzed in *two axes.* The first axis focuses on the role that the assemblage's components play in order to enter the assemblage, either material or expressive. The second axis records the processes known as *a-signifying signs or a-signs*, (Guattari 1995: 54) which are the triggering mechanisms able to stabilize or destabilize the assemblage and thus allow for its components to assemble anew. These mechanisms are introduced in the spatial object as *intensities* that transform it beyond meaning, beyond fixed or known cognitive procedures. They belong to a molecular level which is populated by modulations, movements, speeds, rhythms, and spasms. (Lazzarato & Melitopoulos 2012: 240) As a-signs cannot be isolated from matter, we thus point to *affects* as the result of the a-signs' capacity to trigger the materialization of one spatial assemblage among many. Theorizing spatial objects as open systems in continual transformation and exchange between its components, affects seems to depict this transformation through "qualities ... as the real world is always a world of effect (events), not quantities". (Kwinter 1998: 60)

A-signs are in this framework the *mechanisms* inherent in spatial objects that allow for the constituent material and expressive parts to perpetually enter into new assemblages. As we have previously mentioned, those spatial structures are theorized as assemblages, that is systems composed of interacting parts. And since all assemblages are parts of larger *assemblages*, their components' ability to engage is *contingent*. (Meillassoux 2012:10). To measure material structures' affective capacity, an *affective mechanisms' index* is created. The index is a map of the affective capacity of spatial configurations at different scales, from design objects to buildings and urban configurations.

5. The Divergent Phase _ The Code's Structure

The *affective mechanisms' index* is composed of approximately 100 a-signs, documented via the analysis of numerous contemporary spatial objects of various scales, including works of art and installations. (Roupas 2016: 63-65) The heuristic mining techniques that were used in order to extract the mechanisms and create this index include but are not limited to the analysis of their descriptive texts, critiques and formal analysis. A-signs are categorized in terms of their aesthetic power to affect and to be affected, themselves material techniques that point directly to the affective capacity of the final design object. Through the index, each a-sign is now connected to specific affects, the material elements it has the capacity to intensify and finally the techniques it uses to that end. Thus, a table for each a-sign is created where the list of affects is noted, along with the paradigms that use the a-sign and an indicative photo. [Figure 08]

Figure 08 . A-signifying signs _ Index Template _ Diagrid

Each a-sign is thus connected - within the premises of this index - with a specific list of affects it triggers and which thoroughly defines it. And vice versa, the same affect is interrelated to the different a-signs that can trigger it. That said we believe that through these mechanisms - a-signs - and the resulting affects we are able to observe design objects as they are allowed to lie in a perpetual state of becoming. Through the affective mechanisms' index [Figure 09], we are now able to analyze and guide the design objects' final form while at the same time establishing the means to measure its contingency.

INDEX/
A-SIGNIFYING SIGNS
AFFECTS
PROJECTS

002

[A]

	A-SIGNS	AFFECTS	PROJECTS
[001]	AFFILIATIONS [FO] [ST] [SC] [SF]	[AMBIGUOUS] [AMORPHOUS] [AXIALITY] [BLURINESS] [COMPLEXITY] [CONTINGENCY] [DIFFERENTIATED] [DISCON-TINUOUS] [DISSIPATION] [DISJUNCTION] [DIVERSITY] [INSTABILITY] [OPENESS] [TONALITY] [VAGUENESS] [VERTICALITY]	1.EASTREN DESIHM OFFICE_ SLIT HOUSE_SHIGA/- JAPAN_2005 2.KENGO KUMA_Z58 OFFICES_ SANGAI, CHINA_2008
[002]	AMBIGUITY [FO] [ST] [SC] [SU]	[ASYMMETRY] [BLURINESS] [COMPLEXITY] [CONTINGENCY] [DEMATERIALISED] [DISCON-TINUOUS] [DISJUNCTION] [DISORIENTATION] [DIVERSI-TY] [FLUIDITY] [INSTABILI-TY] [VAGUENESS]	1.JUN AOKI_LOUIS VUITTON NAGOYA STORE_2004_TOKYO, JAPAN 2.PETER EISENMAN_ HOUSE II_1970_VERMONT, USA
[003]	ANTIGRAVITY [FO] [ST] [SC] [SU]	[DECONSTRUCTION] [DEMATERI-ALISED] [DIFFERENTIATED] [DISCONTINUOUS] [EFFORT-LESS] [INSUBSTANTIALITY] [SCALESS]	1.ATELIER TEKUTO_ MAGRITTE HOUSE_JAPAN_2007
[004]	APPLIED SIGN [FO] [ST] [SC] [SU]	[AFFINITY] [AMBIGUOUS] [COMPLEXITY] [CONTIGENCY] [DIFFERENTIATION] [DISCON-TINOUS] [DISCREPANCY] [DISSIPATION] [DUPLICITY] [MUTATION] [INTSBILITY] [VAGUENESS]	1.TOYO ITO_TAMA ART LIBRARY_JAPAN_2007
[005]	AURAL CONTINUITY [FO] [ST] [SC] [SU]	[AFFINITY] [GRADATION] [FLUIDITY] [INSUBSTANTIALI-TY] [SERIALITY] [TONALITY]	1.TOYO ITO_WHITE U HOUSE_ TOKYO, JAPAN_1976
[006]	AMORPHOUS [FO] [ST] [SC] [SU]	[A-CENTRICITY] [AMBIGUOUS] [ASYMMETRY] [BLURINESS] [DIFFERENTIATED] [DISCON-TINOUS] [GRADATION]	1.KENGO KUMA_HI KAWATANA ONSEN KORYU CENTRE_SHI-MONOSEKI, JAPAN_2009

Figure 09 . Affective Mechanisms' Index _ Extract

As a-signs take their place on the manifold to substitute Design Patterns, they start populating the respective dimensional areas. Using the general categories of *form, structure*, and *surface*, a-signs start to populate code's manifold, taking their place on the dimensional areas that best describe them. In this framework, the dimension of exteriority attracts a-signs on the basis of whether spatial assemblages interact with their context. The a-signs of *[001]_Affiliations [010]_Borrowed Landscapes, [036]_Faciality* and *[079]_Slit Openings* inhabit this dimensional area. The same stands for the dimension of Cohesion composed of a-signs that focus on the materiality and expressiveness of physical boundaries, such as *[011]_Box-Within-Box, [005]_Aural Continuity, [021]_Dematerialization,* or *[100]_Zero Degree*. In the dimension of Integration, a-signs point to how concentrated or decentralized a spatial assemblage's components are, an affect produced by the following a-signs: *[004]_Applied Sign, [024]_Discontinuity, [026]_Disorientation*, and

[037]_Transversality. Finally, within the dimensional area of Differentiation, a-signs aim at creating either homogeneous or heterogeneous spatial assemblages we have enlisted *[013]_Cartesian Grid, [007]_Black Stuff, [015]_Clear Structure Strategy,* and *[022]_Diagrid.* [Figure 10]

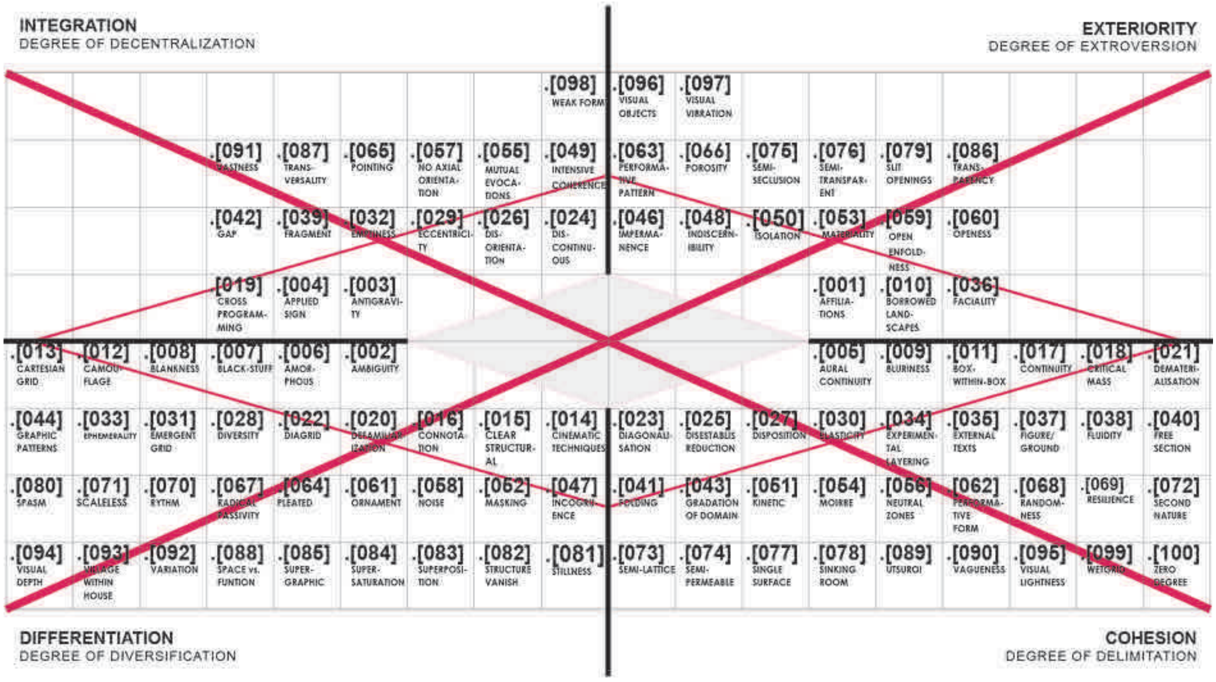

Figure 10 . Code with A-Signs

By replacing Design Patterns with A-signs we introduce affects as material information that is immanent in the spatial object while at the same time they confer no meaning; they only convey some information without semantic content. The affects' ability to merge with the material world without mediation allows them to avoid the realm of representation. With this codification we are able to control the final form of the design object while at the same time establishing the means to measure its continuous transformation as it ceaselessly enters into new assemblages.

6. Conclusions

Through this bifold process, we have defined a number of *attractors* for the code and architectural form: its *four dimensions* as the genera of exteriority, cohesion, integration, and differentiation, and also the *intensive boundaries of their material variation*. During the convergent phase, Design Patterns have been organized into a system, a network of acting and interacting agents that through interaction result in larger-scale patterning effects (Lars Spuybroek: 193). Furthermore, the system can differentiate over time according to a set of rules, the agents' communication protocols that continuously organize their dimensions and dimensional degrees. In the code, we organize for architectural form, the two machines process information through the mobilization of their topologically connected elements thus bridging the virtual and actual space. Transversing from the convergent to the divergent phase, organizations gradually unfold into material structures that have the capacity to be stable but not static thus allowing for material contingency to be theorized, perceived and designed. The code we have organized for the city resembles Deleuze's *abstract machine: 'a map of relations between forces, a map of destiny, or intensity, which proceeds by primary non-localizable relations and at every moment passes through every point, 'or rather in every relation from one point to another".* (Deleuze 2016: 36).

7. References

Bergson, H., Paul N. & Dowson M. (2014). Matter and memory. Kent: Solis Press.

Cilliers, P. (1998). Complexity and Postmodernism: Understanding Complex Systems. London: Routledge, UK.

Deleuze, G., & Guattari, F. (1987). A Thousand Plateaus: Capitalism and Schizophrenia. Minneapolis: University of Minnesota Press.

Deleuze, G., & Hand, S. (2016). Foucault. Minneapolis: University of Minnesota Press.

Delanda, M. (2006). A New Philosophy of Society: Assemblage Theory and Social Complexity. London and New York: Continuum.

DeLanda, M. (2013). Intensive Science and Virtual Philosophy. London and New York: Continuum. USA.

Guattari, F. (1995). Chaosmosis: an ethico-aesthetic paradigm. Trans. Paul Baines and Julian Pefanis. Power Publications: Sydney.

Kwinter, S. (1998). The Genealogy of Models: The Hammer and the Song. ANY: Architecture New York, (23), 57-62. Retrieved from http://www.jstor.org/stable/41856105 accessed 14/02/2019

Lazzarato, M. & Melitopoulos, A. (2012) Machinic Animism. Deleuze and Guatarri Studies 6, 2, 240-249.

Meillassoux, Q. (2012) Iteration, Reiteration, Repetition: A Speculative Analysis of the Meaningless Sign. Lecture at Free University, Berlin, 20 April, 2012. accessed https://cdn.shopify.com/s/files/1/0069/6232/files/Meillassoux_Workshop_Berlin.pdf accessed 13/12/2018

Passia, Y. (2017) Typology of urban circumstances. Diploma project. National Technical University of Athens. Postgraduate courses, Program Architecture - Spatial Design, Division A: Research in Architecture, Architectural Design - Space – Culture. http://dspace.lib.ntua.gr/handle/123456789/45195 accessed 13/12/2018

Roupas, P. (2016). Assemblages: The point of inflection. Diploma Project. National Technical University of Athens. Postgraduate courses, Program Architecture - Spatial Design, Division A: Research in Architecture, Architectural Design - Space - Culture.http://dspace.lib.ntua.gr/handle/123456789/45361 accessed 13/12/2018

Spuybroek, L. (2008) The architecture of continuity essays and conversations, V2_/NAi Publishers, Rotterdam, The Netherlands.

Wilden, A. (2011). System and structure: Essays in communication and exchange. London: Routledge.

Wicked Problems, Wicked Humor: *Fun Machines* as Method

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Abstract

Design methods need to reconsider ways of *not othering* mess (or what appears as nonsense) within wicked problem situations, particularly, crises sites. As such, the paper suggests that fun making (humor) can be utilized as a method for designers to affirmatively work with the paradoxes and contradictions that appear as nonsensical. The paper sets out to map the theoretical framework for a possible *Fun machine*, using the broader methodological discourses on "after method" and "second generation design machine" as a departure point. Simultaneously, the paper discusses some of the concrete implications of the Fun machine via a pilot study (Dessau) and its potential as a coping method. The project is not intended as an end in itself, but instead, a means through which the fun making capacity of the second-generation design machine can be explored further.

Keywords: Crisis, Mess, After method, Coping, Design agency

1. Introduction: Shall We Make Fun of This Mess?

Dessau--a shrinking city--shares many of the common problems faced by former industrial cities of East Germany, since the reunification. Declining job opportunities, mass exodus of the young population and the consequent rise of the aged population, abandonment of built infrastructure are only a number of the complex issues that are an intrinsic part of the everyday reality of these cities (Oswalt et al., 2005). Dessau also provides the backdrop for the famous architectural landmark the Bauhaus designed by Walter Gropius. The entangled history of the Bauhaus and other industrial institutions such as the Junkers factory are reminiscent of the cities industrial past--and better times--in general. Although there have been numerous efforts since the 1990s to integrate cities like Dessau to the economic and growth processes of Germany the results remain primarily conflicted. Many serious proposals both at a national level and state level such as; the conversion of the Stadtpark in the heart of Dessau to an “interkultureller generation park” (Beeck & Bruckner, 2010); the completion of the new Bauhaus museum Dessau (Thöner, et al., 2016); the rebranding of the city using Bauhaus as a cultural landmark; the demolishing of abandoned infrastructure to create extended landscapes through the “city-islands project”(Beeck & Bruckner, 2010), are reflective of some of these admirable efforts. However, the not so serious looking systems in figure 01 also depict Dessau or what it could be.

These alternative constructs of the shrinking city of Dessau are called *Fun machines*. They are different from the existing proposals for the "wicked" questions of the shrinking city. At first glance instead of being serious, they tend to be a bit nonsensical. What can *Poker face Bauhaus, Scram-ball, Old-topia, Social flight simulator, Chic-staining machine, Mind-the-gap* app, contribute to the ongoing design discussion on bringing Dessau out of its messy predicament?

For one thing, instead of negating mess these systems attempt to incorporate it in significant and productive ways, within the design process. They question not only the city's shrinking condition but also the state level and institutional level proposals. For example; *Mind the gap* is questioning the gaps created by the State proposal to create "green islands." The *Bauhaus poker face* and the *Lizard who lost its tail* question the over-emphasis on the Bauhaus as a rebranding strategy. The *Dancing hedgehogs* question the very concept of the "interkultureller generation park." These alternative systems are productions of a unique category of stakeholders of the city-- the architecture students of the Anhalt University. As peripheral stakeholders--aptly depicted in figure 02 as flowing through the city--their chances of partaking in the state level or citizen level approaches to the town are somewhat restricted. But they continue to be one of the stakeholders most affected by the broader conditions of the city. Their position within this site is one that has similarities with designers/architects who are operating at the center of crises sites (slums, refugee camps, tsunami-driven areas, etc.), but feel as though they have very little ability to interfere with the situation.

The Fun machine is a play on design method itself. How would the methods machine operate if optimization or finding the "right" answer were not what it was meant to be doing? How can the methods machine be updated in ways that enable designers to live and work with the confusion in crises sites? What happens to design methods when liberated from a “moralist idea” of methods that suggests that only right methods (right forms of questioning, sampling, mapping) will allow one to know or map a site properly? What happens when one start seeing the methods machine as something that does not describe the reality that is investigated but, instead, constructs it? What if, I was to state that a way to make sense of complexity is by being not so serious? Instead of diligently trying to find a solution, designers should ask themselves and others--shall we make fun of this mess?

Figure 1. Fun machines [sketches by *Studio Fun Machines,* 2018]

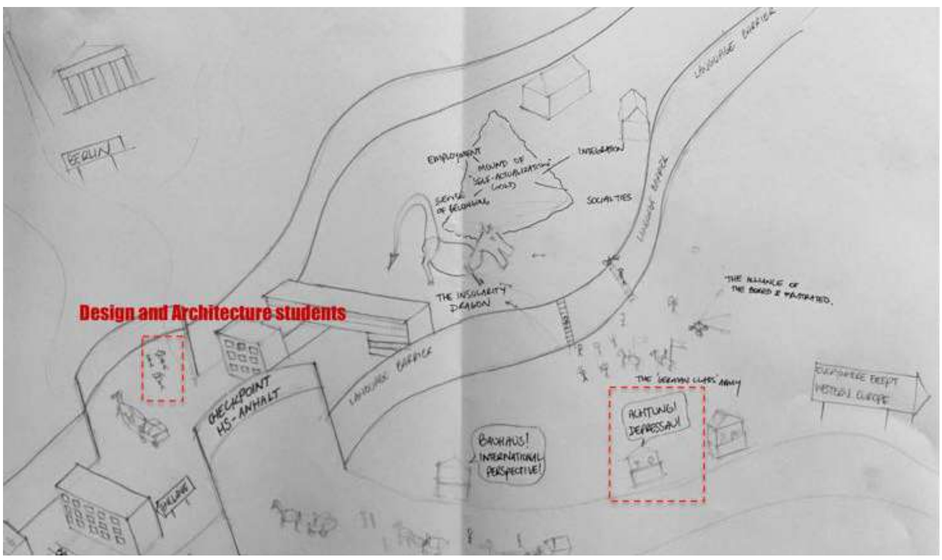

Figure 2. Dessau, Flows [sketch by Sam Koh, *Studio Fun Machines,* 2018]

2. Methods, Machines, Mess

The invocation of a design method as a machine in architecture can be traced back to Vitruvius with modernist re-appropriations in the work of Le Corbusier, Sigfried Giedion (Le Corbusier, 2014; Giedion, 2013). In all these appropriations the methods machine is one that is tuned precisely to perform a definable task. For systems theorists--proponents of the post-war design methods movement (DMS) who were instrumental in developing a specific discourse on methods within architecture--the machine relates to an actual devices (which is describes abstractly) and to systematic processes such as that of the design method. Therefore the design machine (design methods) propagated by the first generation of systems theory around the 1950s was something that embodies the idea that there is an optimizable right answer (Upitis, 2008). Designers utilized methods to systematize the design process and eliminate all the mess or contradictions that did not fit within the optimization framework.

However, the proponents of the 1970s movement on design methods (also known as second generation methods) pioneered by systems-design theorists such as Horst Rittel, were critical of these processes of optimization. Instead, Rittel attempted to explore how a design method could make sense of the multiple controversial dimensions of a design problem that he came to identify through the term "wicked problems"(Rittel & Webber, 1973). Rittel identified that the complexity of design problems arise from the fact that they relate not only to material systems but also social systems. The dynamic, networked, open systemic properties of these problems make it difficult to frame these problems with clarity (figure 03). According to Rittel traditional design methods attempted to tame wicked problems, thereby reducing the problems and treated them as closed systems.

As such, second-generation explorations in methodology question what method--and its politics--might be when not caught in an obsession with clarity, with specificity, and with professionalism. The two most significant themes that drive second-generation methodology are as follows: 1. The Design process is a process of argumentation and therefore framing design problems means framing conversations, 2. There is a Symmetry of ignorance and consequently, no single category of stakeholders of the problem know all there is to be known about the system. For a technologist and systems thinker such as Rittel, It was an opportunity to distance “instrumental knowledge” in design from the knowledge frameworks attempting to find truth, in the sciences (Sevaldson, 2010). This line of exploration suggests that other than working with nice clear research findings it is also important to take in to account the material that is othered such as confusing descriptions, imprecisions, and paradoxes. In "How to Know What is Known" Rittel suggests that most existing tools and information systems are limited because they merely confirm knowledge (Rittel, 2013). He argues that what is needed is in fact “mental crutches” that enhance “natural intelligence” that cast doubt, point out ignorance and thereby open up new ways of producing knowledge. One could state that Rittel’s work was an invitation for designers to find ways to move away from the crippling effects of the methods machine and instead explore it as a more playful device that opens up conversations. Considered in this manner Rittel’s take on the second-order methods machine makes a significant contribution to the broader field of “After methods” that argues that methods research needs to update itself in finding ways of knowing and living with confusion (Law, 2004).

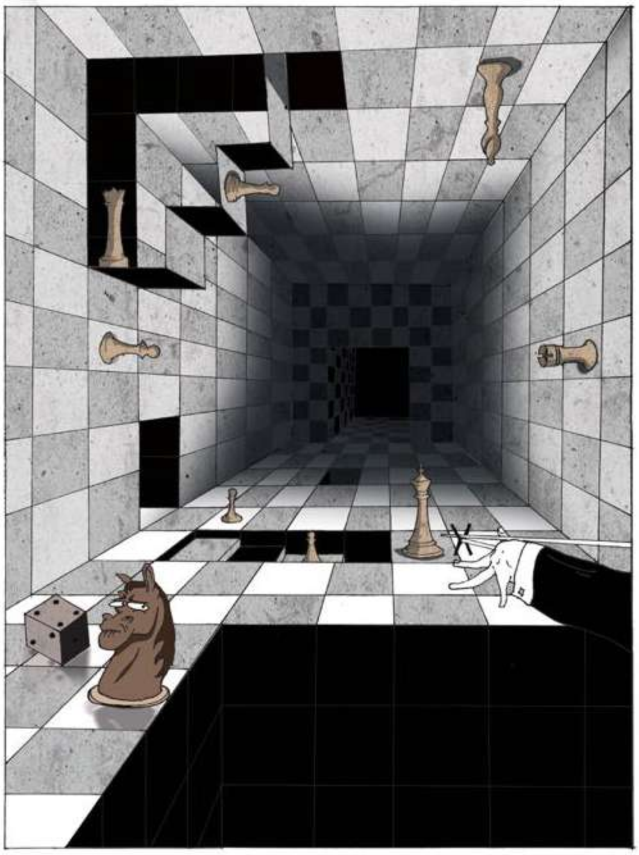

Figure 3. Wicked problems as wicked games [sketch by Aniruddha Phadke, 2018]

3. The Playful Second-Order Design Machine

Some of the most direct appropriations of the second-order machine's opening towards mess are found in the work of researchers that make explicit that design emerges through a process of controversies, arguments, and negotiations. Studies in this direction arising from within systemic design practices occupy a broad spectrum. It varies from the more direct applications of Rittel's notion of conversations in the idea of creating or evaluating participatory frameworks in both real and digital contexts (Conklin, 2006; Jones, 2018), to developing methods such as "Giga mapping" to co-map complexity visually (Sevaldson, 2011), all the way to prototypes developed through extended interactions with various human and non human stakeholders (Davidova & Zimova, 2017). Regardless of their differences, they remain as significant and productive ways that affirm the mess emerging through the negotiations between various agents within processes of innovation.

Another category of research particularly useful in rethinking the playfulness of the second generation machine in the context of crisis emerges in the work of Ranulph Glanville and Ben Sweeting and the particular ways in which they address the "undecidable" or "unknowable" within the design process (Glanville, 1988; Sweeting, 2014). Their constructivist take on wicked problems (via Second-order Cybernetician Heinz von Foerster's "non-trivial machine") extends the notion of "argument" and "symmetry of ignorance" from the external conversational framework to the way the "designing self" structurally emerges in relation to the context in which it acts. Ben Sweeting-- via his exploration on ethics --emphasizes that design is not about the implementation of right actions, but rather an exploration of how an action emerges as a right action in response to the situation. Their work collectively suggests that the construct of the designing agent (architect, designer) is something fuzzier than a clearly defined sensible stakeholder, and design as something that links to the everyday life, which can lead to, but not necessarily oriented towards innovation.

The work carried out with designers in the pilot crisis sites of Dessau (Shrinking cities) and Colombo (Garbage sites in Slums) suggest two essential areas that need further exploration. First is the need to question the distinction between methods for innovation and methods for survival. The inability to cope with the situation makes specific stakeholders exit the conversational process even before moving to a phase of hoping (innovation). Entangled within this idea are also the notions that in a coping stage the paradoxes and contradictions apparent in the site appear to the designer as "nonsensical" than “sensible.” Second is the need to question the very constructedness of the professional agency of the designer. More Often than not, the identification with the “professional persona” and what is expected of this persona was causing more frustration. What if the designers can construct/ choose the persona that enters the problem framing process?

4. Fun Machines

The fun machine--an extension of the playful second order machine discussed in the above sections--is an attempt to help designers cope with the problem at hand by dealing with the paradoxes/contradictions that appear as nonsensical. The fun machine uses fun-making (humor)--a specific form of conversational interaction--as a strategy to create a coping framework. Theorists such as Sigmund Freud, Arthur Koestler, and William Fry states that fun making becomes a technique of freedom through its attitude of not asking anything of the situation (Freud, 2013; Koestler, 2014; Fry, 2010). It aims at no satisfaction of serious needs but instead approaches the situation with only the interest of contemplating it further. Notably, Koestler and Fry whose work was devoted towards exploring how humor operates have clearly shown that contradictions, paradoxes that are usually the fundamental characteristics of the structure of a wicked problem—are also shared by the structure of humor (Koestler, 2014; Fry, 2010). One may not be able to work with the paradoxes/contradictions as it is, but when turned in to a fun machine, it can be handled, grasped, operated on, and handed over to others.

4.1. Play frame

William Fry argues that coping humor by its sheer energy can develop towards a basis for hoping (Fry, 2010). The ability of a Fun machine to translate from a coping method to a hoping method occurs by introducing a “play frame.” The moment one is asked to construct a fun machine it is an invitation to create a play frame with the materials of the situation. At the same time the play frame contains the real and the unreal, the sensible and the nonsensical. The play frame, paradoxically suggests that what is contained within it is to be played with and that it is nothing serious. The play frame in the context of pilot projects also takes on a particular form as it embellishes the basic pleasurable states of playfulness with various content tricks, the richness of joking, satire, caricature, etc. In effect, the fun machine frames the spatial (urban level, building level, object level) aspects of the wicked problem that requires a solution, in a way that reflects the ideological one: solving one should ideally aid in solving the other.

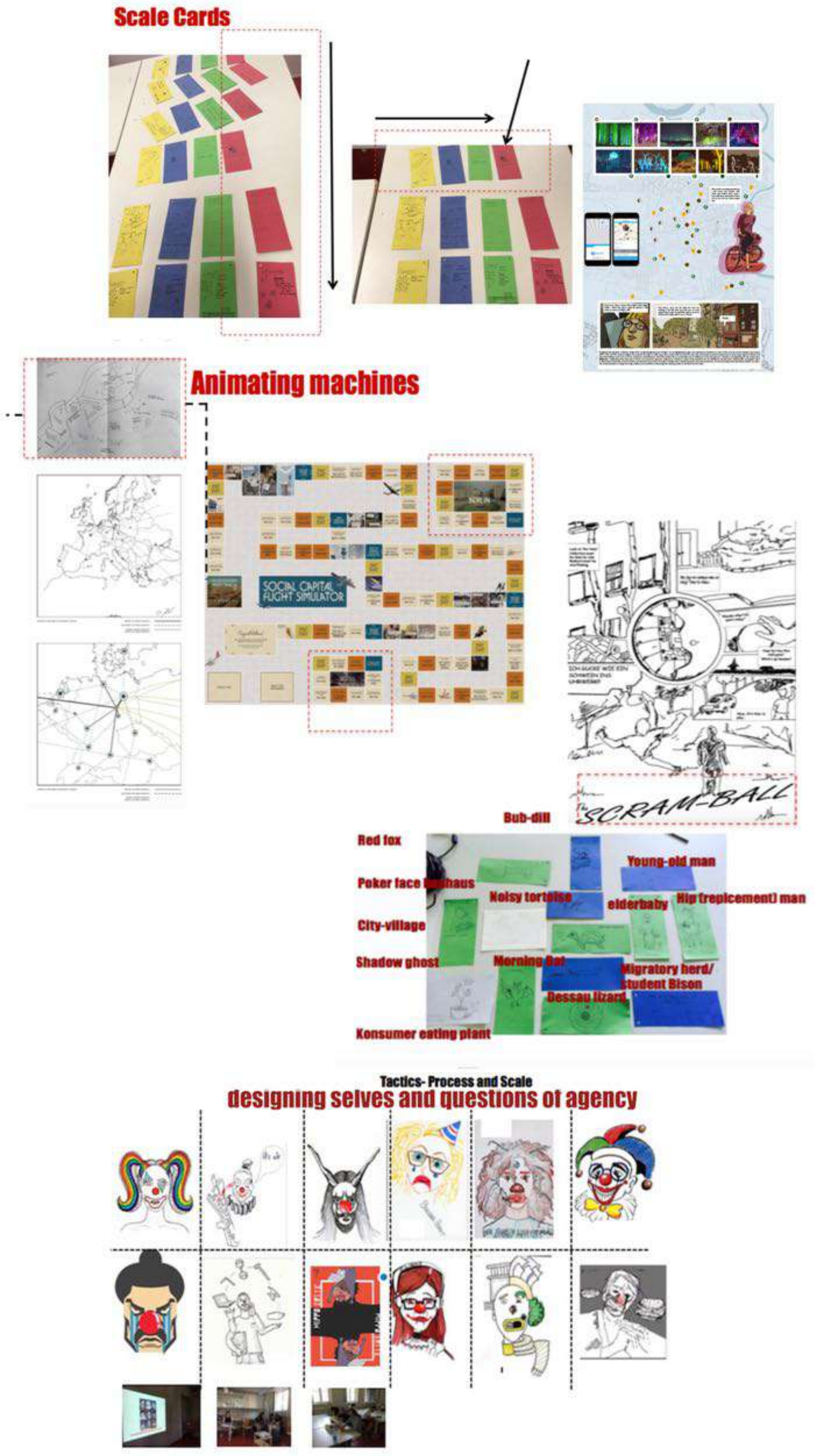

Figure 4. Process [sketches by *Studio Fun Machines,* 2018]

4.2. Wording, scrambling

A play frame that navigates between the real and unreal invites alternative imaginaries and enables the designer to work through the limitations of existing languages of framing the problem. Firstly, it is an invitation to reword the problem by not negating controversial aspects. Secondly, it can be an invitation to present the issue in a language that invites the participation of all agents and stakeholders. Puns, caricature, or composite words were used to break away from the generally accepted meanings of words and their basic structural configurations. Techniques such as animating the problem as a living entity or creating funny caricatured creatures that contain the controversies were promoted. The controversies in the problem were given a verbal form by the use of compositional words, the use of double meanings, etc. For example, questions of ageism, noise regulations, movement and flows, abandonment were reworded to reveal the contradictions (figure 04). The limitations of communicating with other stakeholders of the wicked problem were addressed by converting questions of space to cautionary games or cautionary tales with a twist of humor. Within these games or tales, the contradictions of the wicked problem were exaggerated and projected using an allegory to a different setting.

4.3. Scaling, mattering

A coping play frame suggests a different way to approach scale within a project. In general, a scale of a problem can range from more technocratic levels of categorizing the problem (according to the ease of operations) to levels that correspond with various forms of meaning generation for each of the project's stakeholders. The play frame when related to coping is not about figuring out the most operative level of the problem or what is the most meaningful in terms of public image etc. Instead, the scale at the coping level relates to mattering. What matters is sometimes finding an answer that works spontaneously in a given situation. Card games were played to portray each problem at 4 different scales to identify the scale that matters when the designer has to cope with the situation. For example, the mattering scale sparked the creation of *Mind-the-gap*, which was a critical reaction to the government's proposal to demolish abandoned buildings and create landscaped islands within Dessau (figure 04). While the government's idea was good from a meta-urban planning perspective, the paradox of people experiencing these vast stretches of open space was problematic for one of the primary users the young bikers. To maintain the paradoxical requirements expected of these gaps the fun machine (a blueprint for an app) connects temporary playful light installations that instantly create public environments in these dark gaps according to biker movements.

4.4. Framing flows, not taming flows

The play frame is used to depict wicked issues as open systemic issues. The frame itself can be a way of representing flows than a static situation. Most designers can *feel* the problem as a flow but are unable to transfer this flow into a design process diagram, as the flow appears nonsensical due to the multiple levels of abstraction and complexity. The designers are encouraged to play with the flows of the problem animating all its feedback loops and important nodes through caricature and satire. For example, The social flight simulator was a way of making fun of what it's designer terms as “the flight of creative capital” and the paradox of how Dessau can be home to such a diverse range of talented people, and at the same time, have cultivated a reputation as a cultural wasteland (figure 04). The factors that combine to create such a state of affairs vary in scale and complexity. Political and economic factors that affect the site operate at a global level, affecting things such as the housing market, employment prospects, etc. Through the animation of these flows in the form of a board game the inter-relatedness of these decisions is made apparent, and players are triggered to interrogate their roles in the perpetuation of the state of affairs that give Dessau its reputation. Players assume the role of an international student in Dessau and must navigate their way through the various decisions that face them in their journey till the end of their studies.

4.5. Laughing, clowning

All mastery, while enabling, can also be disabling. A crisis moment invites a question of what one's professional education allows one to do and *not do*. Unfortunately, it is often the case that those who are at the center of the problem, sometimes the most responsible, found it the hardest to escape the optimizable, functionalist quality of design methods. It seems more comfortable to negate the contradictions that one sees and ignore the multiple versions of one's self that responds in "other" ways to the problem. The fun machine makes an invitation to deal with these numerous selves explicitly by conjuring what is called an architectural clown.

The architectural clown—unlike professional architects—has no fear in dealing with confused thoughts and acts of failure. The clowns were invited to use their trickster persona to voice aspects of conflicting thoughts that they try to keep away (figure 04). The designers were encouraged to question the "morally righteous" lenses through which they frame crisis contexts. Reconsidering certain forms of extended altruism--such as narratives framed in the form of "helping the affected"--were a priority. The clown construct was used to reflect on the designer's feelings and questioning if the designers were voicing themselves the way they want regarding the issue at hand? According to Koestler, the jester uses a division of labor—the clash of incompatible codes within one's self—to frame the problem (Koestler, 2014). Making these controversies explicit means, one could actively work on resolving some of these issues and work towards self-development.

5. Unfinished Play

Fun machines use the notion of fun making-ironically-as serious ways of reframing wicked problems. To do so, fun machines utilize the curious parallels between the structure of humor (that affirmatively embraces the controversies and paradoxes) and the structure of wicked problems (characterized by of controversies and paradoxes) effectively juxtaposing them within a play frame. The play frame acts as both process and object, enabling the designers to cope with the situation at hand, and move on to a hoping phase. Though yet underdeveloped, the most significant contribution of the pilot project towards a broader position on after methods that deserve further exploration are in general twofold: (1) It makes a distinction between the coping and hoping in crises and calls for a much-needed emphasis on this crucial distinction, within the methods phase. While acknowledging that coping can lead to hoping, the project suggests that tactics are needed to enable the designers to not exit the process due to frustration in the coping phase. (2) The project questions the relation between sense and methods, more specifically the prevailing notion that one needs to negate what appears as "nonsense" to make sense of the problem. More concretely, it explores how the effort to make sense --particularly as professionals--can delimit, if not completely close off the designer's ability to identify himself as a stakeholder that can engage with the problem. To create a fun machine is also a way of playfully breaking away from one's image as a designer and embracing the chaos of the multiple versions of your designing self. Perhaps, a bit of clown-sense can go a long way in working with wicked problems?

Figure 5. On becoming an architectural clown [sketch by Aniruddha Phadke, 2018]

References

Beeck, S., & Bruckner, H. (2010) *Stadt umbau*. Saxony Anhalt: Grafisches centrum cuno GmBH. http://www.fad.cat/citytocity/2/cat/wp-content/uploads/guanyadora/booklet_dessau.pdf

Conklin, E. J. (2006). *Dialogue mapping: Building shared understanding of wicked problems.* Chichester, England: Wiley.

Davidova, M and Zimova, K(2017). COLridor: Co-Design and Co-Living for Sustainable Futures. Paper presented at *Relating Systems Thinking and Design 6: Environment, Economy, Democracy: Flourishing Together,* Oslo.

Freud, S. (2013). *Jokes and their relation to the unconscious.* London: Vintage.

Fry, W. (2010). *Sweet Madness: A study of humor*. New Brunswick, N.J.: Transaction Publishers.

Giedion, S. (2013). *Mechanization takes command: A contribution to anonymous history*. Minneapolis, Minn: University of Minnesota Press.

Glanville, R. (1988). Architecture and space for thought.(Unpublished doctoral dissertation). Brunel University, Uxbridge.

Jones, P. (2018). Contexts of co-creation: Designing with systems stakeholders. *Systemic Design: Theory, Methods, and Practice, Springer nature, 3-52.*

Koestler, A. (2014). *The act of creation*. Last century media.

Law, J. (2004). *After method: Mess in social science research*. London: Routledge.

Le C., & Etchells, F. (2014). *Towards a new architecture*. Connecticut: Martino Publishing.

Oswalt, P., Kulturstiftung des Bundes., Galerie für Zeitgenössische Kunst Leipzig., Stiftung Bauhaus Dessau., & ARCH+ Verlag GmbH. (2005). *Shrinking cities: International research*. Ostfildern-Ruit Germany: Hatje Cantz.

Oswalt, P., Rieniets, T., Schirmel, H., 1Kilo (Firm), & Kulturstiftung des Bundes. (2006). *Atlas of shrinking cities*. Ostfildern: Hatje Cantz.

Rittel, H. W. J. (2013). Woher weiß man, wer was weiß: Zur Entwicklung von Kommunikationskrücken. in H.W. J. Rittel & J. Wolfgang *Thinking Design: transdisziplinäre Konzepte für Planer und Entwerfer*. In H. W. J. Rittel., W.D. Reuter, & W. Jonas (Eds.), *Thinking design: Transdisziplinäre konzepte für planer und entwerfer*. Basel: Birkhäuser.

Rittel, H. W. J. & Webber. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences* 4.2, 155-169.

Sevaldson, B. (2011). GIGA-Mapping: Visualisation for complexity and systems thinking in design. *Nordes*, (4).

Sevaldson, B. (2010). Discussions and movements in design research : a systems approach to practice research in design. *FORMakademisk*, 3 (1): 8-35.

Sweeting, B. (2014). *Architecture and undecidability*. (Unpublished doctoral dissertation). University College London, London.

Thöner, W., Butter, A., Pfeifer, I., Savelsberg, W., Stiftung Bauhaus Dessau, Kulturstiftung DessauWörlitz. (2016). *Dessau/Wörlitz: Architectural guide*. DOM Publishers.

Upitis, A. (2008). *Nature normative: The Design Methods Movement, 1944-1967*. (Unpublished doctoral dissertation). Massachusetts Institute of Technology, Massachusetts.

Beyond user centric design

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Abstract: This working paper proposes a critical re-examination of the dominant and spreading logic of user centric design (UCD). The recognition and application of UCD has reached far beyond the design realm and is spreading into business and engineering environments, as a critique towards self-centred perspectives in those areas. As such, it is justified and successful but the question rises if we have reached the limits of this perspective when used as a dominant guiding star for the development of products, services and societal expressions at large. Is it time to critically question if not such a logic comes at the expense of other ways of seeing the world? These other world views could be affected non-users, future generations, people in the production pipelines and non-human beings and systems. Such questions seems justified in the increasing environmental crises and in the emerging perspective of non-anthropocentric design.

Keywords: Systemic Design, Systems Oriented Design, User Centred Design (UCD), Human Centred Design (HCD), Non-anthropocentric design, Sustainability

Introduction

This working paper will bring forward a criticism against the dominating attention to user centric design (UCD) and discuss it from a perspective of systemic design.

User centred design has gained an important position and attention in the design world and beyond. The spread of design thinking into management and engineering as well as the public sector has contributed to this. It has been useful and appropriate to bring these fields to a better understanding of user needs and their experiences.

This development has largely been beneficial for the consumers, the users of systems and operators of machines. The attention has also been directed towards the inner life of organisations and the internal users. In addition, universal design has expanded the agenda to include all humans. The development has been driven by its obvious congruent market orientation. Being user-oriented is also good for sales. It can be coupled to branding and experience design easily. The current focus in service design on user experiences has driven this further.

User oriented or user centric design has hence become a leading beacon for many. In design practice as well as in schools user orientation is a priori, taken for ethical beneficial and a goal for achievement. Also other professions like engineering and management have adopted user orientation within the concept of Design Thinking (Boland & Collopy, 2004) (Brown & Katz, 2009).

However, there are indeed some critical voices in the design dialogue. For example, the concept of user centric design has been discussed and questioned by Restrøm (Redström, 2008) clarifying the difficulties in the concept, proposing that the user is a fiction, designed during the design process. Baumer points to the blurred division of users and non-users (Baumer, 2015) and Wagenknecht defines the role of the unwantedly affected non-users, the *affected bystanding,* who comes with marginalization and passivity (Wagenknecht, 2017). Don Norman looks at Human-Centred Design (HCD) from a critical perspective, comparing it with, what he calls, activity based design (Norman, 2005). The arguments are that improving things for one individual or group could make things worse for others. In addition, users develop over time, so what seems appropriate now might be wrong in the future as the user gains or loses proficiency over time. Norman considers Human centric design to be harmful when it detracts attention from the activities and the complexity of the design. By criticising HCD, being rooted in interaction design, he exemplifies how human centric design can make things worse by pointing at the numerous examples of software, getting more cluttered with functions for each version, while usability deteriorates. This drift into cluttered interfaces is a result of direct responses to user needs. Don Norman argues that an orientation towards action would bring a different result and give the designer a more leading role. The critique also implies that HCD does not efficiently innovate. Don Normans focus on activity and how activity changes over time by gained proficiency indicates a more systemic view.

Vanessa Thomas et.al. go right to the core of the problem, criticising how HCD is insufficient in our times and how this is framed in the ISO standard, making it difficult to pursue a more holistically sustainable design approach. They state:

> These design approaches are perpetuating the trend of incremental improvements to the living standards of the already privileged and digitally connected whilst ignoring the broader environmental and socio-political effects of digital technologies. (Thomas, Remy, & Bates, 2017)

One might claim that UCD is catering for some of the weaknesses of HCD addressed by Norman and Thomas. However, in the age of the Anthropocene we need to lift the discussions to a higher level. This paper intends not to add to the discussion and refinement of UCD or HCD. Rather I want to take a step back, to a birds eye view, and raise the criticality towards the design methodologies and theories that put the idea of the human user at the centre on the costs of other concerns.
The critique against a user centric design approach might contain several points addressed below. For each of them one could point to practice cases that would demonstrate e.g. sustainability etc. and more advanced approaches. However, the dominating user oriented approach in design is structurally not including these issues. It puts one aspect in the centre and this has unavoidably come at the expense of others.

What is wrong with user centred design?

In the following, I will elaborate on some of the critical points and consequences of a user centred design approach. The criticism is presented in five points.

Anthropocentric

The first criticism is about worldview. User centric perspectives applied in design are by their nature anthropocentric. This means that it is centred on the needs, perspectives and worldviews of Homo sapiens, setting humans individually and humankind in general in the centre on the cost of the rest of the living world. In times when our planet is threatened by human activity, continuing to propagate a human centric worldview is no longer adequate. It is crucial to remove ourselves from the top of the pyramid and view the world from different perspectives. We need to take on a servant perspective towards the living world we are dependent on.

Not sustainable

The second criticism of user-centred design is that it does not cater for sustainability. From the anthropocentric worldview prioritising the solving of the needs of our fellow humans over solving other pressing issues, unavoidably follows unsustainable development and a further build down of our fundament to sustain life on earth. Action for sustainability is not a naturally integrated result from the user-centred worldview but is an addition to the human centric worldview, often implying actions that are against the user's spontaneous interest.

The same argument can be valid also when it comes to social sustainability. A user / consumer centric approach tends to be synergetic with immediate commercial perspectives. This comes at the cost of other perspectives, e.g. community dominated perspectives or other societal perspectives

Not based on the role of the agent

The third criticism against user centric design is that it does not cater for the role of the agent, meaning to act on behalf of others. A human centric approach is weak when it comes to agency, other than agency for the user. [1]
This type of common-sense agency in design becomes ever more important, to include secondary users, affected bystanders or non-users, or non-human beings that are affected by the design intervention often in unintended ways. Agency implies to act against one owns primary interests. The moral dilemmas of agency are described in the principal-agent model (Laffont & Martimort, 2009).

Does not care for the people in the production process

The fourth criticism against a user centred perspective is that it does not cater for the production chain. Amongst the secondary users, most often forgotten, are the people involved in the production process. Seen from a systems perspective, the purpose of a company is manifold even if it is not expressed so. One could claim, depending on the analyses, that from a systemic perspective the root purpose of companies is to create jobs.

Does not cater for unintended consequences

The fifth criticism of user centred design is that it disregards unintended consequences of the design intervention. A user centric perspective is inherently un-systemic and thereby is not able to cater for the unintended effects of our interventions. It is a well understood feature of systems that they act counter-intuitively and that solving one problem will create new ones (Forrester, 1971). Therefore, any centric perspective will run the risk of overlooking the counterintuitive kickbacks from solving singular problems according to particular perspectives.

The issue of perception

The problem with particular perspectives is that they heavily inform our perception. We see what we want to see. This comes at the cost of other aspects that might be of importance. We are globally in such a situation where we cannot ignore the unintended consequences of our action. This leads to an increased attention to how things are interlinked across fields and domains. This means a systemic

[1] The notion of agency in design is used with great confusion. We have uncritically adopted the use of the term from sociology and philosophy where it is used differently than in most other contexts, e.g. in business. Agency as used in sociology and philosophy is an individual's capacity or ability to act on one's will. This is very different from the more common-sensual notion of agency to act on behalf of others (as used in business and economic theory)

perspective. From this criticism, we can draw the conclusion that any singular perspective runs the risk of creating more problems than it can solve.

User centred design is such a strong perspective and strong filter to help us meet user's needs. Its strong position at the moment comes partly from the perspective issues of industrial development, that traditionally has been techno centred and hence has disregarded the user. Balancing the techno or economic perspectives with human perspectives seems reasonable. But replacing singular dominant perspectives with others runs the risk of creating a similar dysfunctional situation as before, only with different parameters.

Because user centred design is geared towards seeing the world through the glasses of the user, the designer is in a servant position form the outset. Such strong one-centric perspectives are guiding the perception and dominate or exclude other considerations. This indicates that any "centric" approach is self-fulfilling.

In contrast, in SOD we propose to do out-of-focus investigations in the start to try to avoid to arrive at conclusions that are coloured or even constructed around centric perspectives. Later in the process, recognising the benefit of clear perspectives we intend to apply a multi- perspectives design strategy, where the different perspectives would balance out and triangulate each other.

Beyond user centric design

Several writers in design have moved towards investigating non-anthropocentric perspectives. One of the early discussions was raised by Knappett and Malafouris when inviting writers to elaborate on the theme "material Agency" (but here the notion of agency is used as the capacity to act on one owns will)

> Material and nonhuman agency – surely this is a mistake? Is not agency a solely human property? How then can we devote a whole volume to a topic with such obviously shaky foundations? Certainly, the odds seem to be stacked against us when we think of agency as not only the capacity to act, but also the capacity to reflect on this capacity. A subject may feel his or her arm moving and recognise 'ownership' of that movement, but this is not necessarily the same as being able to reflectively understand that he or she is the cause or 'agent' of that movement (Gallagher 2007, p. 2). When agency is linked strictly to consciousness and intentionality, we have very little scope for extending its reach beyond the human. (Knappett & Malafouris, 2008)

Some architects have raised that discourse on a non-anthropocentric architecture, an architecture built for not only humans, but also allowing inhabitation by other species, to synergize and synthesize the co-living of species in urban habitats. Michael Hensel spearheaded this development by pointing to historical examples where architecture built for animals was more common. These architectures where partly built separate form human dwellings and partly combined. (Hensel, 2012).

This leads obviously to a systemic view on the coexistence of humans with other species. Marie Davidova demonstrated several experimental practice cases that involve a perspective of co-creation between the architect, the building material, (wood) and primitive organisms, in this case algae. (Davidová, 2017)
In design the issues and problems of an anthropocentric design have been problematized by e.g. Jönsson (Jönsson, 2015), who also proposes a design based on event rather than object. This might resonate with Normans action based design.
The idea of user and use reduces the potential complex relationship between object and actor (Latour, 2005) to a question of the object serving the user. The roles seem to be fixed: The providers of objects (and services) to the ones that receive them (the users). The user's role in such a scenario is relatively passive. Though this notion of division of roles is challenged by service design theory, where the user is allegedly co-designing the service in the moment of consumption, and the notion of participation and co-design inherent in user oriented design methodology. Still the user in service design is normally perceived as congruent with the consumer of particular services.
Hence, while co-design is inherently portrayed as an approach that reinforces a democratic design, by listening and involving the user it might not be what it seems. One could argue that user oriented or user centric design tends to reinforce the power divide in the liberalistic market economy and is politically not on the side of the disempowered but reinforces the means of the empowerment to increase their profit. The user is defined by her power as customer.

Susan Gasson implies a critical approach to user centric design and suggests "human centred design" as a …. *dialectic between organizational problem inquiry and the implementation of business process change and technical solutions.* (Gasson, 2003)

This indicates a design strategy that still keeps the human in the centre but that has multiple perspectives.
We have stated how user centric design, like any other particular perspective, is filtering our perception and reducing the amount of data. What is relevant is defined in the outset. This mechanism of our perception should be challenged so to include other seemingly irrelevant information in a design process, that might turn out significant seen from a different perspective. This leads to a design strategy based on a de-centric outset to reach beyond ones preconception and break schemata. From that, we might arrive at a multi centric approach to design.
Defying the relevance filter helps breaking schemata and preconceptions

Multi centric design process

A very de-centric approach, where, in the outset, everything is equal, is probably not possible to maintain and to operate within. Our mind and perception is geared towards application of particular perspectives to interpret the world. Our perception is an active process and is in-separately linked to our cognition (Arnheim, 1969). The good thing with particular perspectives is that it allows us to see things in clear filters, reinforcing some aspects on the costs of others. It helps us to see more clearly what affects certain actors in a system and what their needs are. It helps us lift out certain views from the grey cloud of information. Though we cannot defy the basic conditions of our perception, we can influence it through the rigging of our processes. Such a strategic move would be to implement multiple perspectives to critically interpolate between them.

A Multi-perspective approach to design has been proposed earlier by Bela Banathy (Banathy, 1997) and Churchman (Churchman, 1971). Also it is implicit in critical systems thinking (Midgley, 2000; Ulrich, 1983). A multi perspective approach is therefore an integrated part of modern systems thinking in how this deals with multiple actors. Banathy says:

> Design choices and decisions are authentic to the extent that they are made by all people who constitute the design community, namely by all those affected by the future system. (Banathy, 1997) p. 172

Yet there is a nuance in the multi centric design process, as conceptualized here. It is addressing the issue of perception and filters rather than the multi-perspectives represented by those who constitute the design community. This applies to both individuals and groups. A group of people like a design-community can also become streamed into singular perspectives, e.g. a user centric way of looking at and addressing the problems at hand.

This implies multi-centric design approaches where user centric design is one of several “lenses” through which we look at the world. In SOD we have introduced the Four Perspectives model. This model is universally applicable to any topic or situation.

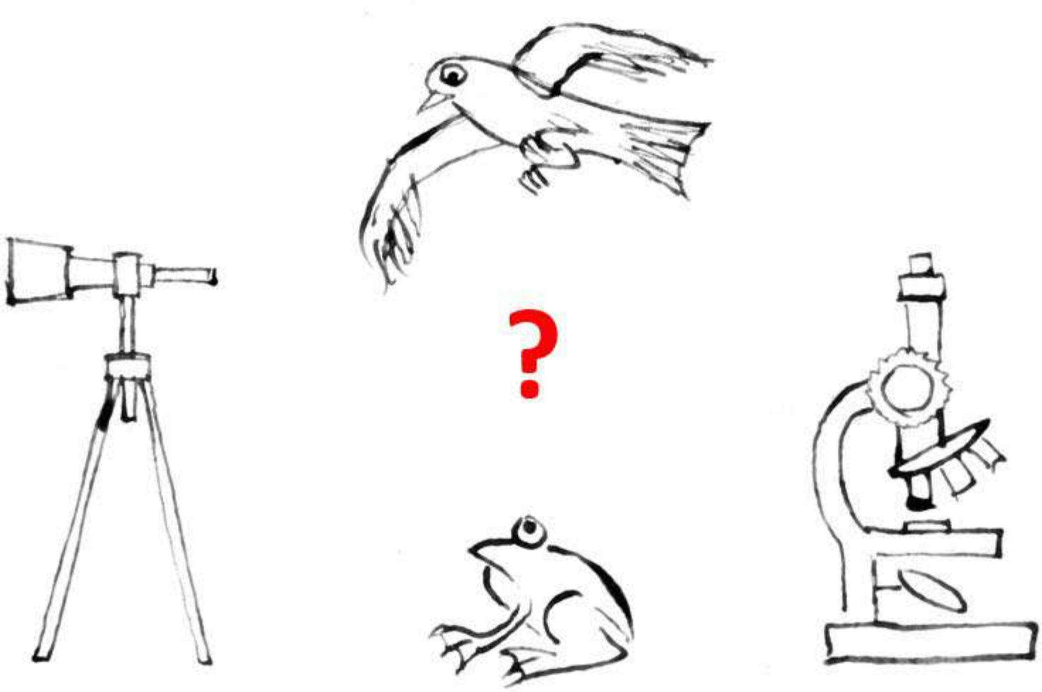

Figure 1 The Four Perspectives model: Bird, Frog, Microscope and Telescope (Birger Sevaldson 2018)

The four perspectives, the bird, the frog, the microscope and the telescope each change the mind-set of how one looks at the system or situation at hand. The Bird provides a total overview of the environment, the landscape and beyond, the frog provides a perspective from within the system or situation (could be the user), The microscope gives a vies on the amount of details and microsystems at play, the telescope reaches far out to the horizon to lift out particular issues and details.

While the four perspectives is a global and generic model, perspectives could be applicable according to the actors involved in the situation. Each actor or force in the system would provide a different lens to see the system through. Such lenses would for example be the one discussed in this paper, a human centric perspective. This could be challenged by a citizen centric view, social design perspective, design ethics, sustainability, technology, politics and organizational design, economic issues, production processes and more. Each particular design process would have its own set of lenses. By applying as many of those lenses as possible to the design process, we are getting closer to a systemic interpretation of the situations we work with.

Most important we need to investigate possible side effects and unwanted outputs from the systems we design. By applying multiple perspectives, we easily can overcome the one-sided view resulting from singular perspectives. This helps us to interpolate different needs, it helps us to uncover unintended and counterintuitive effects from our interventions and it helps finding creative solutions and synergies between diverting needs.

The multi-perspective design process could benefit from being paired with the hybrid design process, that suggest that the use of multiple media and the changing between media in phases will create deeper insights and leaps in the design process (Sevaldson, 2005).

In a multi-centric design approach, some issues need particular attention:

1) How the perspectives are related and how they might be strategized and orchestrated. For that, we need a systemic design approach. We provide such a framework in SOD (Sevaldson, 2009, 2011) and tools to cope with it in e.g. gigamapping
2) The notion of agency as representative acting on behalf of others comes in the forefront.

Conclusion and further work

This is a working paper. It brings forward some of the criticism against user centered design and expands it to a more generic critique of singular perspectives. It points forward to a systemic design multi-perspective design strategy. The criticism is far from exhausted and would benefit from further development.

A step forward would be to develop design methodology and praxeology towards the use of multi-perspective design processes. This is already inherent in gigamapping as practiced in SOD. However, there seems to be a good potential in developing particular processes for the application of multi-perspective design processes.

Read more about SOD here www.systemsorienteddesign.net

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References

Arnheim, R. (1969). *Visual Thinking*. Berkeley: University of California Press.

Banathy, B. H. (1997). *Designing Social Systems in a Changing World*. Springer.

Baumer, E. P. S. (2015). Usees. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (pp. 3295–3298). ACM.

Boland, R. J., & Collopy, F. (2004). Managing as Design. Stanford: Stanford university Press.

Brown, T., & Katz, B. (2009). *Change by design : how design thinking transforms organizations and inspires innovation*. New York: Harper & Collins Business.

Churchman, C. W. (1971). The design of inquiring systems basic concepts of systems and organization.

Davidová, M. (2017). Co-Habited, Co-Lived, Co-Designed and Co-Created Eco-Systemic Responsiveness in Systemic Approach to Architectural Performance: A Case Study on Interaction of Performative Solid Wood Envelope Ray and Algae. In M. João de Oliveira & F. Crespo Osório (Eds.), *KINE[SIS]TEM: From Nature to Architectural Matter* (pp. 36–45). Lisbon: DINÂMIA'CET-IUL ISCTE - Instituto Universitário de Lisboa.

Forrester, J. W. (1971). Counterintuitive behavior of social systems. *Technological Forecasting and Social Change*, *3*, 1–22. https://doi.org/10.1016/S0040-1625(71)80001-X

Gasson, S. (2003). Human-centered vs. user-centered approaches to information system design. *JITTA: Journal of Information Technology Theory and Application*, *5*(2), 29.

Hensel, M. U. (2012). Performance-oriented architecture: An integrated discourse and theoretical framework for architectural design and sustainability towards non-discrete and non-anthropocentric architectures. University of Reading.

Jönsson, L. (2015). *Design events: On explorations of a non-anthropocentric framework in design*. The Royal Danish Academy of Fine Arts, Schools of Architecture, Design and ….

Knappett, C., & Malafouris, L. (2008). *Material agency: towards a non-anthropocentric approach*. Springer.

Laffont, J.-J., & Martimort, D. (2009). *The theory of incentives: the principal-agent model*. Princeton university press.

Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-Network-Theory*. New York: Oxford University Press.

Midgley, G. (2000). *Systems Intervention: Philosophy, Methodology, and Practice*. New York: Kluver Academic / Plenum Publishers.

Norman, D. A. (2005). Human-centered design considered harmful. *Interactions*, *12*(4), 14–19. Retrieved from https://www.researchgate.net/profile/Donald_Norman/publication/200086092_Human-centered_design_considered_harmful/links/0c9605208fca197c2e000000.pdf

Redström, J. (2008). RE: Definitions of use. *Design Studies*, *29*(4), 410–423.

Sevaldson, B. (2005). *Developing Digital Design Techniques. Investigations on Creative Design Computing.* (1st ed.). Oslo School of Architecture and Design, Oslo.

Sevaldson, B. (2009). Systems Oriented Design. Retrieved January 1, 2009, from http://www.systemsorienteddesign.net

Sevaldson, B. (2011). GIGA-Mapping: Visualisation for complexity and systems thinking in design. In *Nordic Design Research Conferences, Making Design Matter*. Helsinki: NORDES. Retrieved from http://www.nordes.org/opj/index.php/n13/article/view/104/88

Thomas, V., Remy, C., & Bates, O. (2017). The limits of HCD: Reimagining the anthropocentricity of ISO 9241-210. In *Proceedings of the 2017 Workshop on Computing Within Limits* (pp. 85–92). ACM.

Ulrich, W. (1983). Critical Heuristics of Social Planning.

Wagenknecht, S. (2017). Beyond non-/use: The affected bystander and her escalation. *New Media & Society*, 1461444817708775.

Analogies and Distinctions: Mapping Social System Identity

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Abstract
The concept of "identity," with groundings in systems traditions from cybernetics and soft/critical systems to complexity/resilience and network theory, holds significant potential for the development of systemic design. These systemic groundings can inform understandings and interrogations of the constructed and interrelated nature of individual, organizational, and social identities, of divergent perspectives on social system stability and change, and of design activities that seek to engender transformative change. We use a visual approach to depict and describe an identity-based model of social-ecological interrelationships, a method for mapping analogies and distinctions in selected and bounded social systems and scenarios, a canvas for imagining and analyzing social system stability and change, and a set of diagrammatic variations on this design pathway. We conclude with a list of questions that might inform such mappings.

Keywords: bridge model, institutional logics, landscape model, regime shift, sensemaking and strangemaking

1. Introduction

Systemic design focuses on situations of greater “scale, social complexity and integration” than service or experience design (Systemic Design, accessed 2018). This is an exciting and much-needed area of exploration. Efforts to develop the theory and practice of systemic design face both challenges and opportunities. One is: how might the various systems traditions (cybernetics, soft/critical systems, complexity/resilience, networks, and so on) provide conceptual groundings for design practice in complex social situations? Another is: how might the conceptual tools (models, methods, metaphors, and so on) of design in the narrower sense – the design of artifacts and communications, products and services (i.e., design 1.0 and 2.0, in Jones 2014) – be repurposed for design in the broader sense – design for organizational and social change (i.e., design 3.0 and 4.0, in Jones 2014)?

We engage with these questions by describing a model, method, canvas, and variations for mapping social system identity. Throughout this paper we utilize and investigate the types of visual sensemaking techniques that have proven valuable to systemic design (Sevaldson 2012/2017, Jones and Bowes 2017).

The types of mappings we describe and depict will likely be familiar to practitioners of systemic design. Relevant examples are illustrated, for example, in Sevaldson (2012/2017), Jones (2013), and Jones and Bowes (2017). We aim to contribute not methodological novelty but rather to a discussion of systemic and designerly groundings.

2. Model

“When does a system retain its identity and continuity through change and when does it itself vanish or become something new? These questions are of great practical concern in the context of systems design.”
– Béla Bánáthy (1996:161)

In this section, we describe an identity-based model that might afford systemic groundings for one’s design practice.

Numerous systems theorists have used the concept of “identity” to characterize continuities and discontinuities in the experience and analysis of social and/or ecological life. These include: Allena Leonard (cybernetics), Geoffrey Vickers (soft/critical systems), Brian Walker and David Salt (complexity/resilience), and Harrison White (networks).

For example:

Leonard (1990/2004:33): "An identity is the mark of a whole, an indication of a distinction which may be consistently recognized or which persists over time."

Walker and Salt (2012:215): "Identity: The essential nature of a system (an individual, an ecosystem, a society) based on the way it functions and on its defining structural characteristics."

Based on a systemic approach, Silverman and Hill (2018) depicted a model to recursively link individual identity development with that of organizational, social, and ecological systems. We defined a model as a representation and abstraction that can be used in investigating and understanding how things work (Friedman 2003). In describing and depicting this model, we followed Friedland and Alford (1991:242), who specified three levels of relations (individual-organizational-social, micro-meso-macro) as "necessary to adequately understand society," and we added a fourth, ecological level to this specification. From complexity/resilience theory, we adopted the "landscape," "attractor," and "regime" concepts for representing stability and change in identity development, at each level of the scalar model (Byrne and Callaghan 2014).

This Silverman and Hill (2018) model is reproduced here:

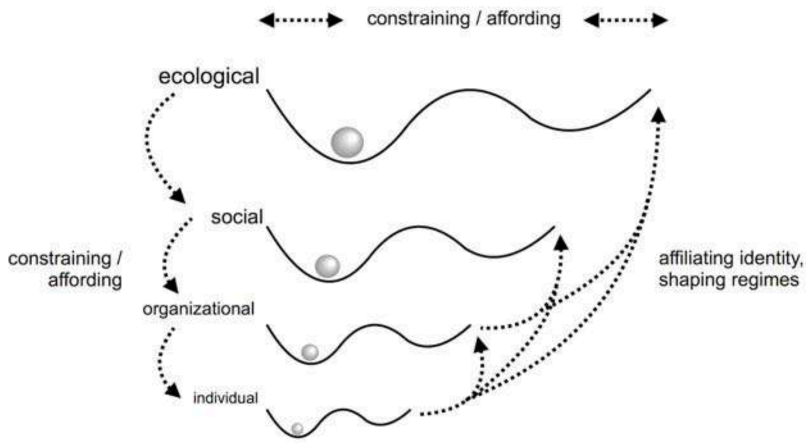

Figure 1: Landscape model of individual-to-ecological, identity-based stability and change.

This model may seem familiar or intuitive, as it is but a bricolage of existing ones. Theorists have used landscape and/or other attractor-based models to describe stability and change at each of these levels, i.e., in individual (Lewin 1947/1951), organizational (Morgan 1997), social (Westley et al. 2011), and ecological (Sheffer 2009) systems. What no one had done (that we are aware of) is to use the concept of identity to recursively link individual-to-ecological landscapes into a scalar model, and then to analyze the dynamics depicted therein.

What then is the value of this model? What "story" does it "tell"?

First, this model serves as a visual example of a specifically constructivist-realist ontology (MIngers 2014). This model reflects a constructivist ontology, e.g., in that it enables an examination of how systemic patterns of social relationships are “constructed” by people, individually and collectively. And this model reflects a realist ontology, e.g., in that it enables an examination of how such patterns of social relationships are constrained and afforded by ecological realities.

Second, by linking individual, organizational, and social systems, this model affords a micro-meso-macro examination of identity development. In these terms, to participate in an established regime is to affiliate one’s own identity with that of the regime, i.e., with the regime’s “logics” (i.e., social factors, structural characteristics, essential relationships). Likewise, to identify with an alternative (i.e., potential, nascent, or niche) regime is to imagine and/or seek alternatives for one’s affiliations of identity. In these terms, a social attractor is a constellation of logics, the “attraction” to which, among people, individually and collectively, serves to stabilize the regime. Particularly in contemporary life, each of us experiences many such systemic affiliations/entanglements, such that “[p]ersons consist of a bundle of these identities” (White 2008:17).

Systemic design requires a “[t]olerance for ambiguity and uncertainty,” wrote Banathy (1996:54). The embodied/entangled identity depicted in Figure 1 posits a particular type of ambiguity and uncertainty: the dissonance of participating in an existing regime, while at the same time potentially identifying with an alternative. In these terms, designers face the challenge of seeking to purposefully transform the very systems in which we/they are embedded.

Based on this analysis, we illustrate and rephrase the initial questions posed in the introduction:

- **How might one distinguish (draw analogies and distinctions) among systems tools?** For example, Silverman and Hill (2018) examined social systems in terms of “regimes,” while others have conceptualized them as, for example, “assemblages” (DeLanda 2016). Below, we investigate alternative approaches to what we have labelled social factors or logics.
- **How might a tool developed in one context be useful in another?** For example, Silverman and Hill (2018) investigated the stability landscape model, adapting it for use in linking individual-to ecological systems. Below, we investigate Hugh Dubberly and colleagues’ (2008) bridge model, adapting it for use in a specifically systemic design context.

3. Method

“We are always in situations, never outside them.”
-- Ray Ison (2010:37)

Situations, focal systems, regimes, and logics: this is a framework for an embodied ontology. Your situations and mine may overlap, but always imperfectly. Even when aligning our situational attentions, we might differently experience the affiliations of, differently draw the boundaries of, and/or differently characterize patterns of systemic relationships: the focal systems.

In this section, we illustrate and investigate interrelationships between people, focal systems, regimes, and logics through a case-based visual examination of three existing narratives. Then we look for patterns (draw analogies and distinctions) across these three cases.

First, a recent U.S. news headline: “Utilities have a problem: the public wants 100% renewable energy, and quick,” (Roberts 2018). In this headline (and article, by David Roberts), the focal system is described at the social level as U.S. electricity provision. The dominant regime for such provision is described as fossil fuel generation, and the alternative as renewable energy generation. The logics that effectively stabilize the identity of the dominant regime are the institutional structures, including utilities. These are named as the dominant factor in the regime’s inertia or “path dependence” (Page 2006:87). Meanwhile, the nascent emergence of an alternative regime is strengthened by the shifting logics of public values and/or goals. We use the landscape model to visualize this narrative (Fig. 2).

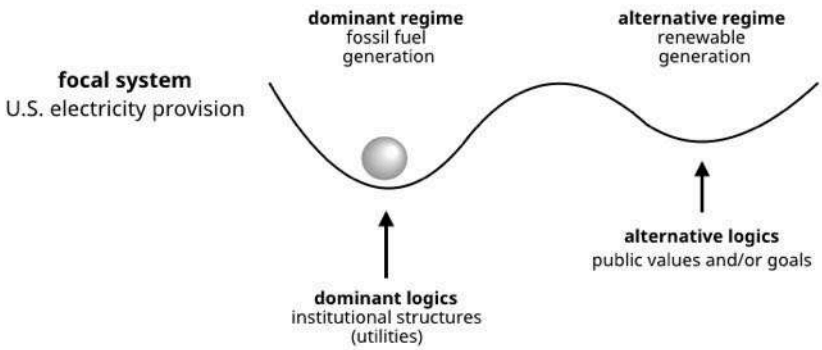

Figure 2: Visualizing stability and change with the landscape model, following Roberts (2018).

Second, Geoffrey Vickers on his home town, a brief passage under the heading “identity and continuity” (1981:20):

> My home town remains for me its old self though it has vastly grown and changed, and I have long since ceased to live there. But if some other old inhabitant said that for him it was no longer the same place, I should not assume that he or I must be wrong. I should only assume that some relationships now lacking were for him essential to the system called by that city’s name, whilst for me they were not.

VIckers and his compatriot agree on boundaries -- they are both focused on “the system called by that city’s name.” However, they do not agree on the “essential relationships” through which the identity of the city is experienced.

Vickers does not tell us which relationships he or his compatriot consider essential. If we could observe and interview them, what might we learn? For the purpose of this mapping, we hypothesize that, for Vickers, the town’s essential relationships are defined by friendships and particular places, and for his compatriot they are defined by traffic and safety. Here then are simple diagrams of the relationships experienced by each (Fig. 3).

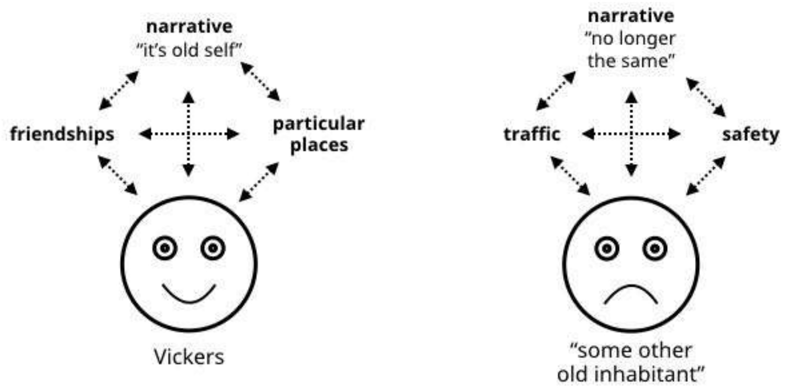

Figure 3: Identity and continuity in "my home town," following Vickers (1981) and hypothesizing essential relationships for both Vickers and his compatriot.

Based on and illustrated in this visualization, we propose:

- A web of essential social relationships connects a set of nameable nodes. These nodes are the social factors that we describe as logics.
- The narrative that one forms/adopts for the system is itself among the logics of the system.
- Experiences of social system identity and individual identity are interrelated. Vickers becomes invested in the narrative of "it's old self," while his compatriot becomes invested in the competing narrative: "no longer the same." While Vickers experiences a sense of belonging, his compatriot experiences the dissonance of living in a place where this sense of belonging has diminished or vanished.
- Vickers experiences/identifies logics for which there is continuity with the past. His compatriot experiences/identifies logics for which there is not continuity. For Vickers, the town has undergone an adaptive change. For his compatriot, the town has undergone a transformation to a different regime.

Third, the musical innovations of Harry Partch, based largely on the interpretation by sociologist Howard Becker (1995). Silverman (2017:138-9) summarized this narrative:

> Consider the story of 20th-century musical innovator Harry Partch, recounted in sociologist Howard Becker's "The Power of Inertia." Partch created a nontraditional 43- tone musical scale and achieved some recognition, including Guggenheim grants and a concert at Carnegie Hall. He also encountered systemic difficulties. To stage a performance of his music, Partch had to devise a notation for his compositions, had to build his own instruments, and had to teach people to both read the new notation and play the new instruments. The notation, the instruments, and their practiced performance are each components of a social system, sometimes called a package or assemblage or, in the terminology of resilience and transition theory, a regime. Notation, instruments, practiced performance: each reinforces the utility

> and value of the others, strengthening the stability of the regime as a whole. With his 43-tone alternative, Partch challenged the dominant regime of classical music composition, but the old regime proved more resilient.

In mapping this narrative, we use a simple table of analogies and distinctions, comparing continuities and discontinuities in the logics of the dominant classical regime and of Partch's alternative (Fig. 4). This tabular format of factor-by-factor analysis dates back at least to Mary Hesse's writings on "models and analogies in science," in which the columns are labelled "causal relations" and the rows, "relations of identity or difference" (Hesse 1963/1966:59).

Our mapping approach is analogous to those of analogy theorists (e.g., Hesse 1963/1966, Gentner and Markman 1997, Hofstadter and Sander 2013), and there are distinctions as well. In particular: the models we compare are of social systems (i.e., regimes); we include a column for naming the factors or logics by which the models are compared; and our "stance" is designerly rather than descriptive or scientific (Silverman 2015:717), that is, mappings are developed so as to inform prospective engagement with situations of concern or opportunity.

Naming the logics (e.g., the center column in Fig. 4) can be useful in several respects. First, for students of systemic design, naming these logics can serve as a metacognitive exercise: inducing (i.e., inductively naming) a category based on a pattern. Second, in practical terms, naming these logics can serve as a strategic step toward imagining by analogy the specifics of an alternative regime. Third, one might refer to systematic lists of such social factors or logics, to inform one's efforts, as we survey below.

classical regime	**logics**	**Partch's alternative regime**
equal temperament	narrative	just intonation
professionally constructed	musical instruments	constructed by Partch
standardized in 1700s	notation	developed by Partch
core repertoire	compositions	composed by Partch
core practices	performance techniques	taught by Partch
transactional, professionalized	economics	transactional, professionalized

Figure 4: Systems of music making, following Becker (1995) and using the concept "regime," where Becker used "package."

Next, we discuss analogies and distinctions across these three examples of mapping social system identity: U.S. electricity provision (landscape), Vickers's home town (pattern of essential relationships), and classical music versus Partch's innovations (table).

One insight is about the attractions of narrative. In mapping Vickers home-town narrative, we recursively emphasized the importance of narrative, for both Vickers and his compatriot. However, in Becker's narrative of inertia, he does not recursively emphasize Partch's own narrative. Partch based his alternative to the 12-tone, equal-temperament classical scale on a rationale with ancient traditions, both East and West: the just intonation of musical intervals. No doubt the strength of this rationale or narrative helped him to attract participants.

A second insight is about the investigative stance that each narrative author and actor adopts. Roberts adopts a designerly stance, that is, he prospectively seeks alternatives to the current regime of electricity provision. Vickers, in this brief passage about his home town, adopts a descriptive stance. Becker also adopts a descriptive stance, as he describes Partch's designerly stance, which was prospective for Partch but is retrospective for Becker's readers.

A third insight is that a range of logics may be required to nurture an alternative regime. Partch had to, as Becker emphasized, create logic-by-logic alternatives: instruments, notation, composition, techniques of performance. Each is essential; each contributed to the viability of an alternative music regime. What are the essential logics in the focal system of, for example, U.S. electricity provision? Much attention has naturally been devoted to alternative technologies for generation (solar, wind, etc.). Based on this one article (Roberts 2018), one might hypothesize that strategic effort is less needed with regard to public values and/or goals than it is with regard to the institutional structures of generation, transmission, and/or distribution.

Another insight lies in the diversity of logics across the three narratives in this case-based examination. Given this case-based diversity, we turn to systematic frameworks, i.e., theoretical characterizations of social factors or logics. Numerous theorists have described social systems at a first level of granularity, as comprised of structural, cultural, and/or material characteristics (e.g., Schön 1971, Archer 1995). Others have offered greater detail, listing a "design pallet of particulars" (Nelson and Stolterman 2012:86-91).

These three examples, from three fields of study, exhibit both similarity and diversity:

- Harold Nelson and Erik Stolterman (2012), design
- Patricia Thornton and colleagues (2012), organization and management studies
- Bruno Latour (2013) / An Inquiry into Modes of Existence (accessed 2018), anthropology, philosophy

perspectives
Nelson and Stolterman

- technical
- organizational
- personal
- political
- ethical
- economic
- spiritual

Harold Nelson and Erik Stolterman. 2012. The design way: intentional change in an unpredictable world (second edition). MIT Press, Cambridge, MA, USA.

institutional logics
Thornton et al.

- root metaphor
- sources of legitimacy
- sources of authority
- sources of identity
- basis of norms
- basis of attention
- basis of strategy
- informal control mechanisms
- economic system

Thornton, P., W. Ocasio, and M. Lounsbury. 2012. The institutional logics perspective: a new approach to culture, structure, and process. Oxford University Press, Oxford, UK.

modes of existence
Latour

- reproduction
- metamorphosis
- habit
- technology
- fiction
- reference
- politics
- law
- religion
- attachment
- organization
- mortality
- network
- preposition
- double click

Latour, B. 2013. An inquiry into modes of existence : an anthropology of the moderns. Harvard University Press, Cambridge, MA, USA. (This updated list of "modes" or "crossings" accessed 29SEP18 from: An inquiry into modes of existence, modesofexistence.org/.)

Figure 5: Examples of “design pallets” for characterizing social system identity

In order to further explore this method for mapping social system identity, we developed a canvas.

4. Canvas

“At all events, we shall not cure the Moderns of their attachment to their cherished theme, the modernization front, if we do not offer them an alternate narrative made of the same stuff as the Master Narratives whose era is over—or so some have claimed, perhaps a bit too hastily.”
-- Bruno Latour (2013:22)

In developing a Regime Shift Canvas, we adopted Dubberly et al.’s (2008) bridge model for its simple and effective, designerly depiction of a regime shift pathway. At the same time, our use of the bridge model meant that we would have to adapt it to a specifically systemic design context. In this section, we describe the bridge model and our adaptation. The current version of the canvas, a work-in progress, is attached as an appendix.

Drawing upon and comparing “several antecedents and variations,” Dubberly et al. (2008:58) described an “analysis-synthesis bridge model” that “makes explicit the role of modeling in the design process” (Dubberly et al. 2008:59). The bridge model depicts a four-node, three-arrow pathway whereby (1) the existing reality of what ‘is’ is distilled to (2) a model of what ‘is,’ which then suggests (3) a model of what ‘could be,’ which then aids in manifesting (4) what ‘could be’ (Dubberly et al. 2008:57).

In design 1.0, these models of “what is” and “what could be” are familiar as blueprints, wireframes, sketches, and diagrams of material and/or informational artifacts. However, in our adaptation of the bridge model, we use the terms “model of what is” and “model of what might be” specifically to indicate mappings of a regime, existing or potential.

In effect, we have developed a bricolage of systems and design concepts, which can be illustrated by mapping the landscape model to the bridge model (Fig. 6).

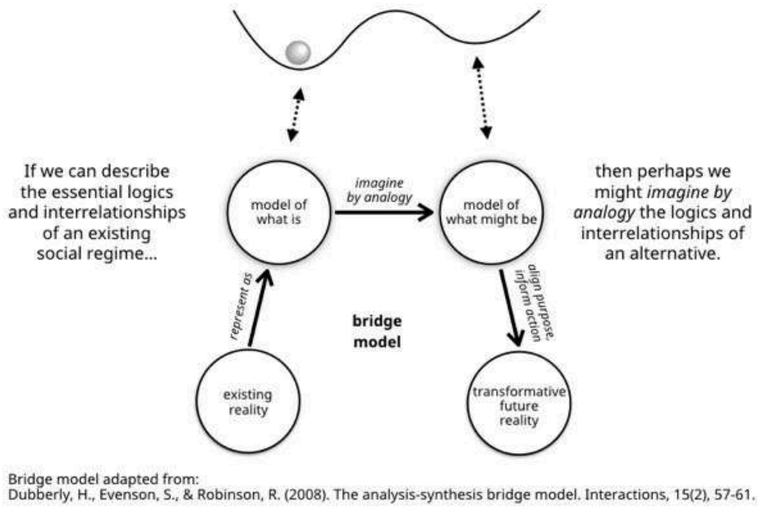

Figure 6: Landscape model mapped to the bridge model

In adapting the bridge model we have adjusted the original language in several places. One significant distinction is that we replaced Dubberly et al.’s (2008) “suggest” (the second, horizontal arrow on the bridge model pathway) with “imagine by analogy.” By definition, a regime shift is transformative. The process of moving from a “model of what is” to a “model of what might be” requires discontinuity. In design, this might be described as a process of “synectics” (Prince 1970) or “strangemaking” (VanPatter and Jones 2009). This use of analogical imaginaries is one way to formalize a strangemaking process.

Figure 7 is an example of a Regime Shift Canvas mapping, by Ophir El-Boher, a Master of Fine Arts (MFA) student at Pacific Northwest College of Art (PNCA) in Portland, Oregon, USA.

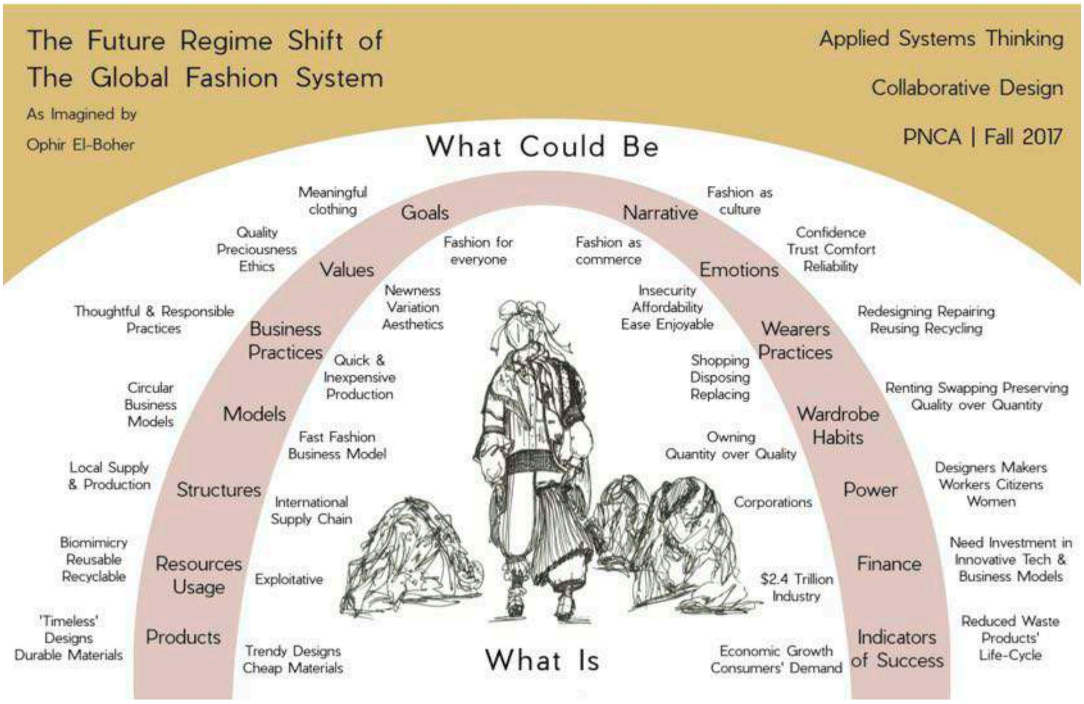

Figure 7: Mapping based on regime shift canvas (Ophir El-Boher)

5. Variations

"Without a sophisticated theory of analogy, there is only the negative dialectics of difference."
– Barbara Maria Stafford (1999:51)

In developing and describing the bridge model, Dubberly et al. (2008) drew analogies and distinctions among "several antecedents and variations." Given contemporary efforts to develop the theory and practice of systemic design, as distinct from design 1.0 and 2.0, we think it is useful to be explicit about diagrammatic variations on the bridge model pathway.

In this section, we diagram three such variations. Each features mappings (i.e., models) of social system identity, and each represents a variation on the linear bridge-model-as-regime-shift pathway.

The first variation is informed by the mappings of divergent perspectives on Vickers's home town (Fig. 3). A design strategy for reaching alignment among such divergent perspectives might be to elicit these perspectives and create mappings of each, as a basis for comparison and conversation. This strategy is illustrated in Figure 8, below. In effect, this divergent perspectives diagram illustrates efforts to reach alignment on the "model of what is," i.e., the second node on the bridge model pathway (Fig. 6).

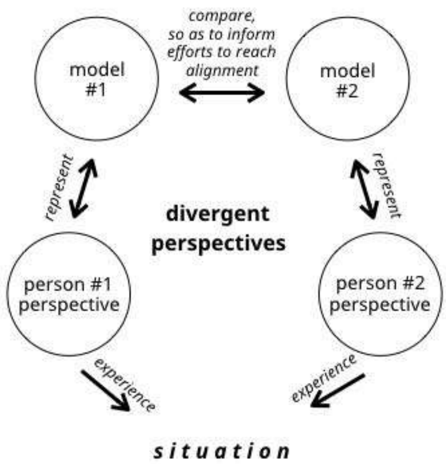

Figure 8: Divergent perspectives diagram

The second variation (Fig. 9) illustrates a reference <> target situation, in which one looks to a "reference" context to inform one's efforts in a "target" context, creating a mapping of each. This type of mapping and terminology draws upon the literatures on models and analogies in science (Hesse 1963/1966, Gentner and Markman 1997) and on case-based reasoning (Aamodt and Plaza 1994).

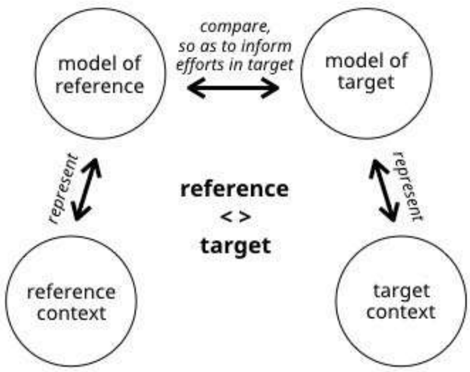

Figure 9: Reference <> target diagram

An example of reference <> target mapping in a systemic design context is illustrated below. Crystal Rome, as part of her PNCA MFA thesis work, mapped analogs on a project with the Association of Independent Colleges of Art and Design (AICAD). In examining the question of how AICAD might better function as a learning network for its member colleges, Rome performed interviews with AICAD leadership and membership, and then researched two examples of successful learning networks as references for this mapping: the Green Sports Alliance (GSA) and the interorganizational Biotech network described in Powell et al. (1996). Here, the social factors or logics, described as “parameters,” are listed on the left, and the target model is in the center column, in between the two reference models (Fig. 10).

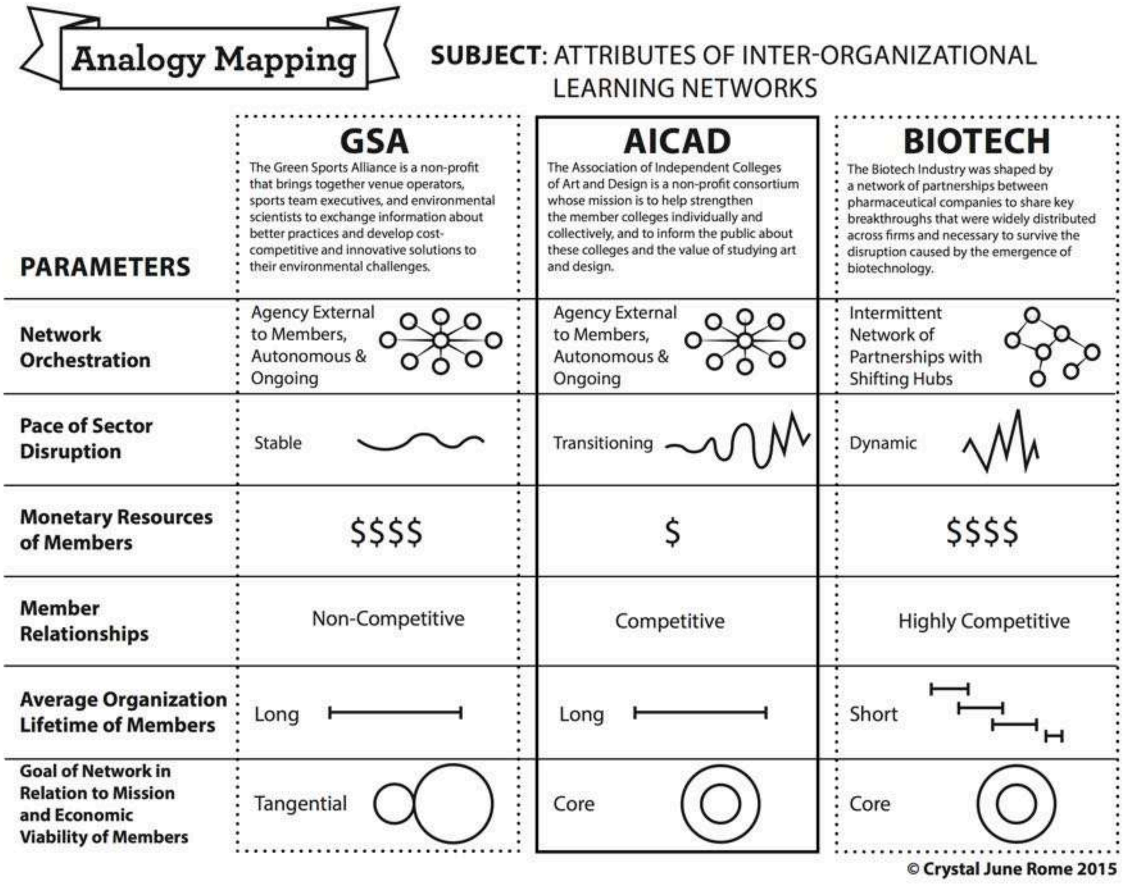

Figure 10: Example of reference <> target mapping (Crystal Rome)

A third variation is one that, like the bridge model, describes a regime shift from what is to what might be. But unlike the bridge model, it complicates the prescription of a linear, present-to-future pathway for design. Drawing upon foresight studies, this variation might be called: foresight <> backsight. Figure 11 is an interpretive, diagrammatic representation of the Three Horizons process (H3Uni, accessed 2018), in which models of “what is” and “what might be” are used as endpoints to inform the development of intermediate innovation strategies, i.e., tangible transition efforts that might lead to the desired future. An example of Three Horizons mapping can be found in Jones and Bowes (2017).

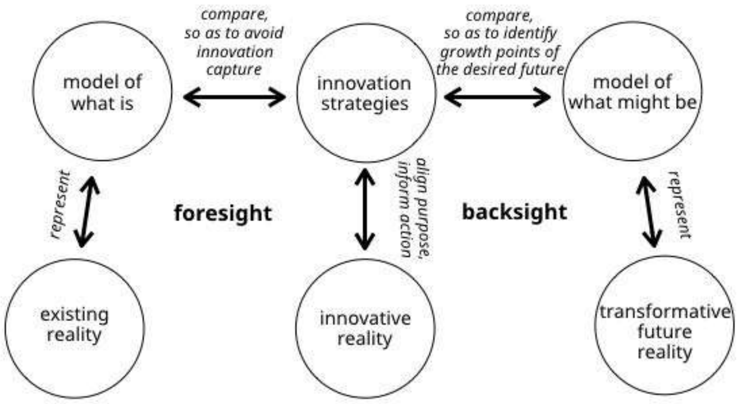

Figure 11: Foresight <> backsight diagram (based on Three Horizons process)

6. Conclusion

We posed two introductory questions, regarding: systemic groundings for designerly practice, and the use of design tools in a specifically systemic design context. We engaged with these questions through a step-by-step process of visual sensemaking (model, method, canvas, variations). Our emphasis throughout has been on analogies and distinctions, in particular a critical examination and repurposing of conceptual tools, with attention to these tools' reference and target contexts.

We used this approach to investigate ways of mapping stability and change in social system identity. In summary, here are some questions that might inform such mappings:

- Is there agreement on the situation of attention? On the boundaries of the focal system? How might differing focal system boundaries be experienced and/or imagined? By whom?
- Why is the dominant regime considered undesirable? By whom? In what ways do these undesirable aspects manifest as logics?
- How would one know which logics are most significant in stabilizing current and potential regimes? How and for whom are particular logics salient or essential? In what ways might "design palettes" of logics, like those depicted herein, inform one's investigations? (Additional questions to guide the formulation of logics are listed on the canvas, attached.)
- How might one visually depict the entangled identities of regime participants, individual and collective, so as to facilitate our/their acknowledgment, reflection, and investigation of such entanglements?
- Are there reference situations or systems, real or imagined, past or future, that might inform potential designs in the target regime?
- In addition: in what ways might systemic social change processes be diagrammed as variations on the bridge model pathway?

References

Aamodt, A. & Plaza, E. (1994). Case-based reasoning: Foundational issues, methodological variations, and system approaches. *AI communications*, 7(1), 39-59.

An inquiry into modes of existence. (Accessed 2018). Access the crossings. Retrieved from http://modesofexistence.org

Archer, M. S. (1995). *Realist social theory: The morphogenic approach*. Cambridge, UK: Cambridge University Press.

Banathy, B. H. (1996). *Designing social systems in a changing world*. New York, NY, USA: Plenum Press.

Becker, H. S. (1995). The power of inertia. *Qualitative Sociology*, 18(3), 301-309. https://doi.org/10.1007/bf02393344

Byrne, D. & Callaghan, G. (2014). *Complexity theory and the social sciences: The state of the art*. London, UK: Routledge.

DeLanda, M. (2016). *Assemblage theory*. Edinburgh, UK: Edinburgh University Press.

Dubberly, H., Evenson, S., & Robinson, R. (2008). The analysis-synthesis bridge model. *Interactions*, 15(2), 57-61. https://doi.org/10.1145/1340961.1340976

Friedland, R. & Alford, R. R. (1991). Bringing society back in: Symbols, practices, and institutional contradictions. In W. W. Powell & P. J. DiMaggio (Eds.), *The new institutionalism in organizational analysis* (pp. 232-266). Chicago, Illinois, USA: University of Chicago Press.

Friedman, K. (2003). Theory construction in design research: Criteria: approaches, and methods. *Design studies*, 24(6), 507-522. https://doi.org/10.1016/s0142-694x(03)00039-5

Gentner, D. & Markman, A. B. (1997). Structure mapping in analogy and similarity. *American Psychologist*, 52(1), 45-56. https://doi.org/10.1037//0003-066x.52.1.45

H3Uni. (Accessed 2018). *Facilitation guide: Three horizons*. Retrieved from http://www.h3uni.org/project/facilitate-3h-mapping/

Hesse, M. (1963/1966). *Models and analogies in science*. Notre Dame, IN, USA: University of Notre Dame Press.

Hofstadter, D. & Sander, E. (2013). *Surfaces and essences: Analogy as the fuel and fire of thinking*. New York, NY, USA: Basic Books.

Ison, R. (2010). *Systems practice: How to act in a climate change world*. London, UK: Springer.

Jones, P. H. (2013). *Design for care: Innovating healthcare experience*. Brooklyn, NY, USA: Rosenfeld Media.

Jones, P. H. (2014). Systemic design principles for complex social systems. In G. Metcalf (Ed.), *Social systems and design* (pp. 91-128). Tokyo, Japan: Springer.

Jones, P. & Bowes, J. (2017). Rendering systems visible for design: Synthesis maps as constructivist design narratives. *She Ji: The Journal of Design, Economics, and Innovation*, 3(3), 229-248. https://doi.org/10.1016/j.sheji.2017.12.001

Latour, B. (2013). *An inquiry into modes of existence: An anthropology of the moderns*. Cambridge, MA, USA: Harvard University Press.

Lewin, K. (1947/1951). Frontiers in group dynamics. In D. Cartwright (Ed.), *Field theory in social science: Selected theoretical papers* (pp.188-237). New York, NY, USA: Harper & Brothers Publishers.

Leonard, A. (1990/2004). *Coming concepts: The cybernetic glossary for new management*. Retrieved from http://i2s.anu.edu.au/sites/default/files/unified-systems/cybernetic_glossary.pdf

Mingers, J. (2014). *Systems thinking, critical realism and philosophy: A confluence of ideas*. Abingdon, UK: Routledge.

Morgan, G. (1997). *Images of organization*. Thousand Oaks, CA, USA: Sage Publications.

Nelson, H. G. & Stolterman, E. (2012). *The design way: Intentional change in an unpredictable world* (2nd ed.). Cambridge, MA, USA: The MIT Press.

Page, S. E. 2006. Path dependence. *Quarterly Journal of Political Science*, 1, 87-115. https://doi.org/10.1561/100.00000006

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1), 116-145. https://doi.org/10.1007/978-3-658-21742-6_109

Prince, G. M. (1970). *The practice of creativity: A manual for dynamic group problem solving*. New York, NY, USA: Collier Books.

Roberts, D. (2018). *Utilities have a problem: the public wants 100% renewable energy, and quick*. Retrieved from https://www.vox.com/energy-and-environment/2018/9/14/17853884/utilities-renewable-energy-100-percent-public-opinion

Scheffer, M. (2009). *Critical transitions in nature and society*. Princeton, NJ, USA: Princeton University Press.

Schön, D. A. (1971). *Beyond the stable state*. New York, NY, USA: The Norton Library.

Sevaldson, B. (2012/2017). *GIGA-maps samples*. Retrieved from http://www.systemsorienteddesign.net/index.php/giga-mapping/giga-mapping-samples

Silverman, H. (2015). Designerly ways for action research. In H. Bradbury (Ed.), *The Sage handbook of action research* (3rd ed.) (pp. 716-723). London, UK: Sage Publications.

Silverman, H. (2017). Systems literacy: A toolkit for purposeful change. In D. Lerch (Ed.), *The community resilience reader: Essential resources for an era of upheaval*. Washington DC, USA: Island Press.

Silverman, H. & Hill, G. M. (2018). The dynamics of purposeful change: A model. *Ecology and Society,* 23(3):4. https://doi.org/10.5751/ES-10243-230304

Stafford, B. M. (1999). *Visual analogy: Consciousness as the art of connecting*. Cambridge, MA, USA: MIT Press.

Systemic Design. (Accessed 2018). *Systemic Design Association*. Retrieved from https://systemic-design.net/sdrn/

Thornton, P. H., Ocasio, W., & Lounsbury, M. (2012). *The institutional logics perspective: A new approach to culture, structure, and process*. Oxford, UK: Oxford University Press.

VanPatter, G. K. & Jones, P. (2009). *Design 1.0, 2.0, 3.0, 4.0: The rise of visual sensemaking*. New York, NY, USA: NextDesign Leadership Institute (article). Retrieved from http://www.humantific.com/the-rise-of-visual-sensemaking/

Vickers, G. (1981). Some implications of systems thinking. In Open Systems Group (Ed.), *Systems behavior* (3rd ed.) (pp. 19-25). London, UK: Harper & Row Publishers.

Walker, B. & Salt, D. (2012). *Resilience practice: Building capacity to absorb disturbance and maintain function*. Washington, D.C., USA: Island Press.

Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., Thompson, J., Nilsson, M., Lambin, E., Sendzimir, J., Banerjee, B., Galaz, V., & van der Leeuw, S. (2011). Tipping toward sustainability: emerging pathways of transformation. *Ambio*, 40(7), 762- 780. https://doi.org/10.1007/s13280-011-0186-9

White, H. C. (2008). *Identity and control: How social formations emerge* (2nd ed.). Princeton, New Jersey, USA: Princeton University Press.

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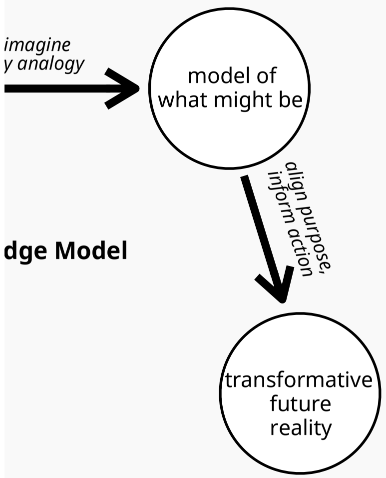
escribe what is. Then imagine by analogy



dge Model

em(s)

logics (escribe what is, gine by analogy hat might be)	model of what might be (an alternative regime)
narrative	food security & sovereignty
goal	access to healthy & culturally appropriate food
core values	ecological health, social equity, resilience, sufficiency
overnance & practices	small- and medium-scale agroecology
physical inputs	labor intensive

How to Fill Out the Canvas

Start by asking
What is a situation that you see as problematic? Identify a set of systemic social relationships in this situation. This is your focal system.

Regimes are functioning instances of the focal system — ways that the system is manifested, experienced, and described.

Name the logics stabilizing the dominant regime — and then imagine how such logics might stabilize an alternative
How does the dominant regime maintain its legitimacy? How and why do individuals and organizations participate in the regime's ongoing development? Take these relational characteristics of the regime as its *logics*.

Fill out the canvas by considering how these logics are expressed in the dominant regime — and then how they might be differently expressed in your preferred alternative.

For example:

- **narratives**: How is the meaning or function of the regime described or understood? Through what story do participants identify with the regime or see it as legitimate?
- **goals**: What spoken or unspoken goals are assumed for or attributed to the regime?
- **values**: What values are affirmed through participation in and/or identification with the regime?
- **norms, practices, habits**: How do the activities of participants shape the regime? — and how are these activities shaped in turn?
- **governing institutions**: How does institutional design shape participation? How are legal, administrative, or regulatory lock-ins established or enforced? Are some excluded from participation?
- **materials**: How do physical materials or material artifacts shape and stabilize participation?
- **finance**: How do investments shape and stabilize participation?
- **indicators**: How do indicators of success affirm the legitimacy of the regime?
- **power**: Who benefits from the regime's persistence?
- **emotions**: How does the regime's persistence afford a sense of security or otherwise satisfy the emotional needs of participants?

For discussion
After filling out the canvas, consider how the logics of the dominant regime reinforce each other. Does each coherently support the regime's narrative? By analogy, how might such reinforcements and coherence be engendered in your preferred alternative regime?

Fill Out Your Own Ca

Focal system:

model of what is
(the dominant regime)

logics
(describe what is, imagine by analogy what might be)

narrative

Regenerative Value Systems – Models illustrating flows and transformations of value within production systems

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Abstract:
This paper studies various foundational economic concepts, with the purpose to support the development of new systemic frameworks for *regenerative value systems*: those systems that we design, build, and work in, that help us provide for our physical needs of food, water, materials, products, structures, and energy et cetera – which also clearly influence and are influenced by our sense of being, culture, worth and abilities and so forth.
The term *regenerative*, underlines that these systems need not only to be sustainable – and to be resilient, but also be actively (and dynamically) engaged in their own *(re)production* and persistence. With a systemic view (verses a reductionist one) to be engaged in one's own reproduction, also implies that the surrounding system in which one persists (and thrives), also needs to reproduce itself (regenerate) – and one affects and is affected by the other.

Keywords: Value Chains, Circular Economy, Institutional Economics, Production, Value, Values, Natural Systems, Ecology, Modelling, Systemic Design.

1. Introduction

This is about systems, that not only produce goods and services, but also create jobs, and generate wealth and incomes, and so, this is foremost an economic study. With a look at some different aspects and contrasting economic views (or schools of economic thought). Within the frame of economics, the topic of 'value' will be looked at, as well as the use of metaphor, some of the various different forms of 'problem framing,' and the circularity or linearity of concepts for instance.

As this is about regeneration and production, this is also in part, an ecological study. Ecological systems (life, nature…) are, by the very 'nature' *regenerative*, (reproductive and self-replicating). The ecological part of this study is illustrated within two images within the conclusion, which also includes a tentative regenerative value systems framework, which compliments the ecological frameworks.

This is seen as a foundational work for further development.

2. Some Differences in Economic Thought

2.1. Physics or Biology (& Experience)

According to Reinert (2008), in very broad terms, two main types of economic theory can be characterised: those based on *metaphors* from physics, and those based on a combination of experience and metaphors from biology. Both have developed concurrently (and influenced each other) over time, however, according to Reinert, it is the economic schools of thought built on the metaphors of (Newtonian) physics that have dominated - and continue to be.

Metaphors from physics are generally inspired by Newton's work (circa. 1880's) – such as 'the invisible hand' – inspired by the invisible theory of gravity that keeps the Earth orbiting around the Sun, and 'equilibrium' for instance. Physics-based economics often attempts to distil concepts down to the most simplified uniform form, often using maths, is *quantitative*, and is often linear.

Experience-based economics, according to Reinert, is based on practical policies, which are put in place and tried-and-tested, prior to being 'distilled' into theory. His example is the understanding by medieval sailors, that eating oranges or lemons at sea prevented scurvy, prior to science finding and isolating the active agent, Vitamin C in 1929. And he continues:

> "It is perfectly possible to cure illnesses, economic or other, simply by lesson-drawing without having a complete understanding of the mechanisms at work." (p 27 Reinert 2008).

For this, 'less abstract' 'other cannon,' Reinert states that metaphors of biology are often used, helping to provide an often holistic and *qualitative* understanding of synergies, change, interdependence, trade-offs, stocks and flows, creativity, and spirituality for instance - often inspired by the human body. Here Reinert (2008) uses the example of Thomas Hobbes's '*Leviathan*,' [1] where he shows the state as literally formed from its citizens.

Neither can be said to be 'better' than the other (Reinert, 2008) - particularly as more recent theories such as electromagnetism, relativity theory, and quantum theory have 'shattered' much of the Newtonian (and Cartesian) world view (Capra et al., 2014), perhaps modern physics will continue to help develop different forms of economic metaphor models in the future.

[1] Hobbes, Thomas (1981 [1651]) '*Leviathan*.' (or '*The Matter, Forme and Power of a Common-Wealth Ecclesiasticall and Civil*.' UK: Penguin Classics.

2.2. Cyclical or Linear

The '*economic problem*' – sometimes called the basic or central economic problem, has various definitions and has changed over time. Economics, as a field, made a substantial change in what was defined as the 'economic problem,' during the so-called 'marginalist revolution' (commonly cited 1871-1874) (Roncaglia, 2005; Mazzucato, 2018). Classical economics (the predominant school of economics prior to the marginalist schools) defined (political) economy as the study of the:

> "[…] functioning of an economic system based on the division of labour, and hence analysis of production, distribution, accumulation and circulation of the product" (p279 Roncaglia, 2005).

Classical economics considered an objective (fact-based, measurable, observable…) view of economic value based on the difficulties and costs of production (principally labour), and prices attained the role of indicator for the relative difficulties in production. These concepts of circulation were developed with an objective to understand how the economy 'reproduces' itself – continues to make itself anew (p45Mazucato).

The economic problem from the marginalist approach, can be said to be:

> "…the optimal utilisation of scarce available resources to satisfy the needs and desires of economic agents." (p279, Roncaglia 2005)

In marginalist economics, the '*marginal*' utility and scarcity defines the price and the magnitude of the market (p65 Mazzucato, 2018). The supply and demand of scarce resources adjusts value, which is conveyed in monetary terms. In the market, this becomes 'prices,' which become the indicators for relative scarcity and consumer preferences. Prices are kept in check through competition, and simultaneously indicate the level of demand, and the required quantities for supply - greater demand raises prices, which raises (willingness to generate more) supply; and a fall in demand visa-versa (p56 Heilbroner, 1999).

> "Sraffa […] sums up the contrast with two images: the classical approach consists in the 'picture of the system of production and consumption as a circular process,' while the marginalist approach aligns the perspective along 'a one-way avenue that leads from "Factors of production" to "Consumption goods"'." (p279 Roncaglia 2005)

As Piero Sraffa (1898-1983) alludes, economics shifted from a view of the economy as being 'circular' - by looking at relations between entities, and attempting to calculate how the 'system' reproduced and maintained itself for future production (including concepts of (re)distribution) (p45 Mazzucato); to one which is more 'linear' (one-way), that begins with (industrial) inputs and ends with consumers – with markets in-between.

2.3. Values or Value

The word 'value' is derived from the Latin *valere*, which means 'to be strong or worthy.' Since this origin, 'value' has developed different connotations; the most popular are listed below - the order in the Oxford dictionary indicates the given importance/or level of common usage:

• [Value] "The regard that something is held to deserve; the importance, worth, or usefulness of something.

- The material or monetary worth of something.
- The worth of something compared to the price paid or asked for it.

• (Values) Principles of standards of behaviour; one's judgement of what is important in life." [2]

Roncaglia (2005), proposes that the discipline of political economy (therefore, economics) grew around these two different meanings of value: the *moral* issues – the rules of conduct (thus related to values), and the *economic scientific* issues – how to organise a society, based on the division-of-labour, to keep the process going (thus related to value).

The emphasis, in economics, on moral values (hence forth, 'values') and economic scientific value (hence forth, 'value'), has evolved from an initial focus mainly on values in early societies, as social interactions dominated, to a greater focus on value in modern societies, as economic interactions have come to dominate (p19 Heilbroner et al., 2012). According to Heilbroner (1985 p107-118), the ancient canons of virtue and justice, which were founded on a scrutiny of *motives* and an 'external' assessment of '*social outcomes*,' were slowly replaced, in the early nineteenth century with the rise of utilitarian philosophy, which made these canons null and void. Utilitarianism, asserted that:

> "…whatever served the individual served society. By logical analogy, whatever created a profit (and thereby served the individual capitalist) also served society, so that a blanket moral exemption was, so to speak, extended over the entire range of activity that passed the profit-and-loss test of the marketplace." (Heilbroner, 1985)

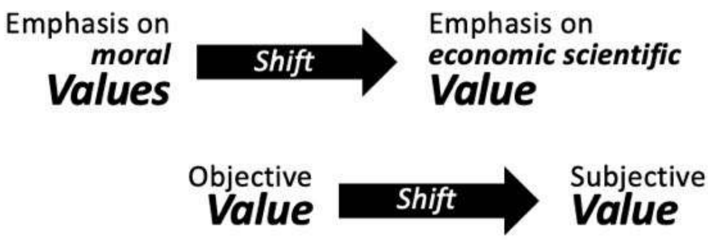

Figure 1. Shifting Emphasis of Values and Value (Author)

[2] Oxford Dictionary

What value actually *is*, and where it can be 'found,' or measured, or produced, particularly within production and distribution [3] systems, has been of great deliberation during the development in the field of economics (p7 Mazzucato, 2018).

As briefly mentioned in the previous section - up until the mid-nineteenth century, economists believed that a clear **objective theory of value** (also known as intrinsic theory of value) was a prerequisite to having a clear appreciation of the prices of services and goods in the economy. Objective value means that an object's value can be estimated using *objective measures*, such as the conditions of production, the amount and quality of the labour required to produce goods or services, the technological and organisational form, or the relationships between capital and labour for instance (p7 Mazzucato, 2018).

However, after the mid-nineteenth century, the understanding of what economic value was shifted towards one of '***subjectivity***;' where the price which is paid by the consumer (who is said to have subjective 'preferences') in the 'market,' determines the value of the goods or service, which are now regularly conceptualised as being 'scarce' [4] (p7 Mazzucato, 2018).

Modern economics has, according to Mazzucato (p8, 2018), all but left the study of value behind (in all its forms). What resides, are theories of '*share-holder value*,' '*adding value*,' and '*value chains*' (Porter, 1998), which are often found in greater presence in modern business schools, than in the study of economics.

[3] The term '*distribution*' in economics, should not be confused with the retail and logistics of goods; in economics, distribution theory "…is concerned with the basic question of *for whom* economic goods are to be produced. In examining how the different factors of production—land, labor, and capital—get priced in the market, distribution theory considers how supplies and demands for these factors are linked and how they determine all kinds of wages, rents, interest rates, and profits." (p244 Samuelson et al., 2010)

[4] Formal (orthodox) economics "…is the study of how societies use scarce resources to produce valuable goods and services and distribute them among different individuals." (p4 Samuelson et al.,, 2010)

2.4. Chrematistiké or Œconomia

One of the most famous visual models of how the 'macroeconomy' is supposed to work was developed by Paul Samuelson in 1948 (p 63 Raworth, 2017). Entitled the 'Circular Flow Diagram,' it illustrates how households supply their labour and capital to firms, in exchange for profits and wages. It also shows an interdependence between production by businesses and consumption and the flow of income to households. The model also illustrates that this is allowed to continue thanks to (the right amount of) '*leakages*' and '*injections*' from trade, governments and banks (Raworth, 2017).

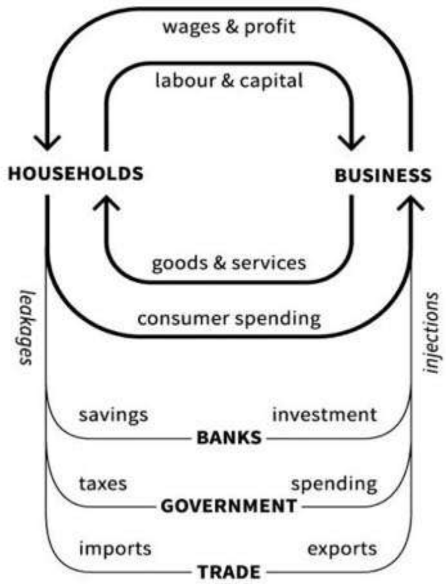

Figure 2. 'The Circular Flow.' Diagram by Marcia Mihotich. Copyright © 2017 Kate Raworth. Based on the 'Circular Flow Diagram' by Samuelson (1948)

According to Harvey (2017) illustrated a circular model of what he believes Karl Marx was describing (in his collections of finished and unfinished – and 'finished' by Engels - work). As a comment, in Harvey's book '*Marx, Capital and the Madness of Economic Reason*,' Harvey uses the physical metaphor of the water cycle to introduce the concepts further described in his book.

In essential terms, according to Harvey, there are four rudimentary processes within the overall circulation process of capital. The 'first' stage is called '*valorisation*,' whereby capital is produced in a firm in a form called '*surplus value*.' This stage is then followed by '*realisation*,' where the commodities produced during production (which are either luxuries, 'wage goods' or means of production - the machines that are used to make the machines) and are exchanged for (or 'transformed' into) money. The next stage, '*distribution*,' is where the value and surplus value is distributed to certain economic entities. The 'final' stage shows how a portion of the profit is cycled back into the appropriation of the commodities (Labour Power and the Means of Production) required to continue the valorisation process.

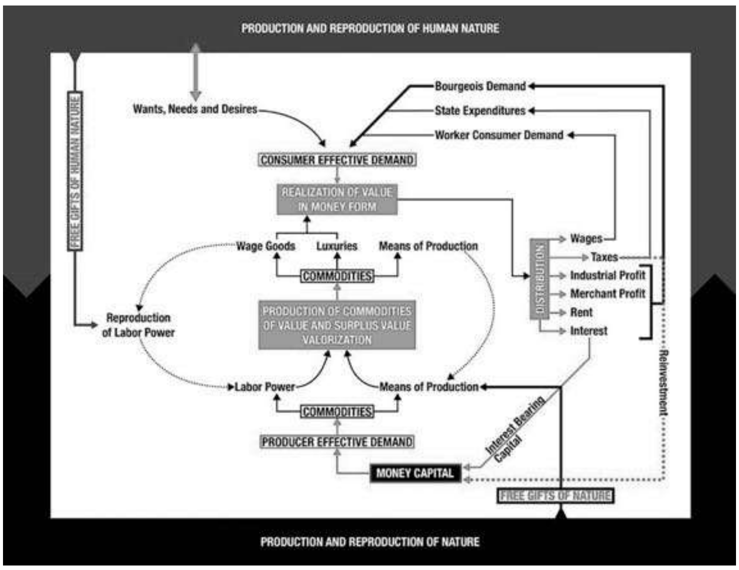

Figure 3. 'The paths of value in motion as derived from the study of Marx's writings on political economy.' Copyright © 2017 David Harvey

There is however, another potential starting point – another view on what is *within* the '*economic problem.*'

According to Gerber (2016), it was Aristotle that first distinguished between two forms of economics. Initially, Aristotle defines two forms of value: the value in use, and the value in exchange. With this distinction, he proposed a moral peculiarity between them both, by stating that it was 'proper' – or 'natural' - to use goods (*consumption*), but it is was 'improper'- 'unnatural' - to exchange them (*commerce*) (Heilbroner et al., 2012).

Aristotle also used his moral concept of 'natural' or 'unnatural,' not only to the goods, but also to the way in which wealth was created. For example, pasturage, agriculture, hunting, and fishing were said to be 'natural', whilst usury (the lending of money for a rent profit – interest), and all forms of commerce (profits from the selling of goods in exchange for money) were considered 'unnatural.'

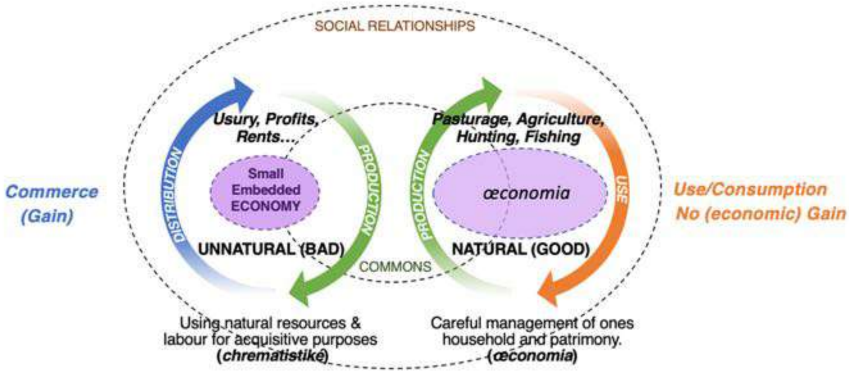

Figure 4. The View of the Economy According to Aristotle (Author)

Instead of redefining economy into production and distribution terms, Aristotle looked at economics through the lens of *use* (œconomia) and *gain* (chrematistiké) (p20 Heilbroner et al., 2012). This famous distinction is arguably the first distinction of a 'substantive view' of the economy (*œconomia*), alongside a formal view of the market economy (closer to chrematistiké) (p187 Gerber, et al., 2018).

Therefore, substantive (in *substance* and in the *concrete*:) economics:

> "…centers on how human beings organize and allocate the pursuit of the things needed to sustain human life." (p 29 Block et al., 2014)

In this view, Karl W. Kapp (1910-1976), asserted that economics should begin with actual human needs, and then going outward to his dependence upon, and his interaction, with his social and natural environment (Kapp, 1975). As well as Kapp, Karl Polanyi (1886-1964) with whom Kapp exchanged ideas and corresponded with (Gerber, 2016), also developed a substantive approach to economics. One of his many contributions with this approach was in developing the idea of '*embeddedness'* – a term he used to describe politics, social relations, and institutions (p10 Block et al., 2014) – which he said framed and organised (different types of) markets.

3. Value Models

3.1. *Competitive* Linear Value-Chains

Arguably, one of the most famous studies and visual models of a 'business view' of value, was developed by Michael E. Porter, which he presents in his book '*Competitive Advantage*.'

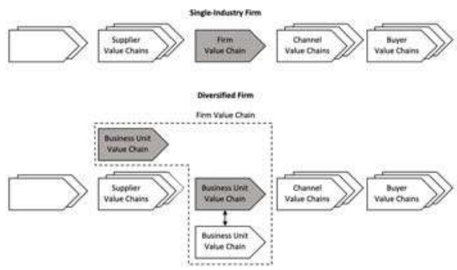

Figure 5. The Value System by Michael E. Porter (1998)

Porter (1998) describes a model, that has two main levels of abstraction – the largest, 'macro view,' is called '*The Value System*' (Figure 5). This value system includes upstream '*Supplier(s)*' – *upstream*, implying their preceding position in the models' linear sequence – followed by the industrial '*Firm*' (which is the central 'protagonist' of the concept), followed by the downstream '*Channel(s)*' – the often, but not always present, intermediate distribution firm(s), which is finally followed by the '*Buyer(s)*.' The Value System represents the organisation of these entities from the point-of-view of a '*Single-Industry Firm*' or a '*Diversified Firm*.'

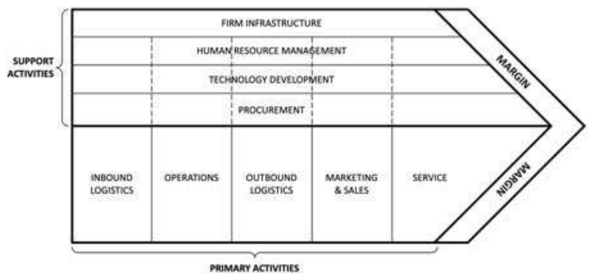

Figure 6. The Generic Value Chain by Michael E. Porter (1998)

'*The Value System*' is then reduced to a second level of abstraction, either as the '*Firm Value Chain*,' for a single-industry firm, or as a '*Business Unit Value Chain*' for a diversified business firm. These two variants are analysed using one model (and treated in a similar way), which Porter (1998) calls '*The Generic Value Chain'* (Figure 6) – which models a generic sequence of 'individual value activities,' that he asserts take place within all industrial firms (and hence, not in the market directly). Porter (1998) states that, it is here, at the level of the 'Generic Value Chain,' that the most effective form of analysis can be made:

> "The relevant level for constructing a value chain is a firm's activities in a particular industry (the business unit). An industry- or sector- wide value chain is too broad, because it may obscure important sources of competitive advantage." (Porter, 1998 p36)

'The Generic Value Chain,' therefore, becomes a form of minimal unit or cell, where internal production processes can be disaggregated into a sequence of discrete tasks, where they can then be analysed for improvements. Porter also describes his concept of value and margin:

> "The value chain displays total value, and consists of value activities and margin. Value activities are the physically and technologically distinct activities a firm performs. These are the building blocks by which a firm creates a product valuable to its buyers. Margin is the difference between total value and the collective cost of performing the value activities." (p38 Porter, 1998)

3.2. Circular Models

"Looking beyond the current take-make-dispose extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system."
(Ellen MacArthur Foundation, 2018a)

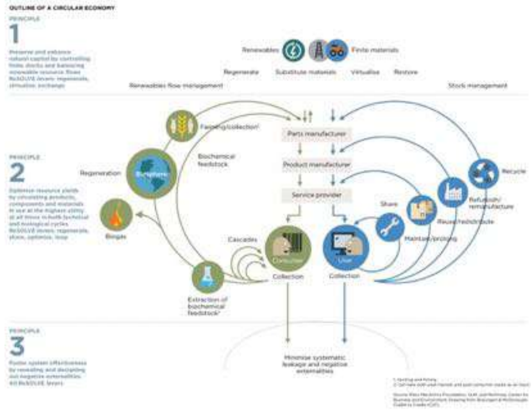

Figure 7. The Circular Economy (CE) System Diagram by the Ellen MacArthur Foundation

Due to planetary wide issues such as climate change, and the destruction and pollution of eco-systems [5] [6], there has been an amplified demand for industrial firms to evolve how they do business. As stated by the Ellen MacArthur Foundation (EMF) above, it is proposed that firms need to transition towards 'circular systems' – which include a larger (macro view) of the firm and it's interaction with it's environment.

Possibly the most internationally recognised 'circular model' in the field, is the '*circular economy system diagram*' (Figure 7), developed by the EMF. [7] In many ways, the central column maintains much of the '*The Generic Value Chain*' concept developed by Porter (1989) - although turned 90° clockwise. Nevertheless, the model goes much further, by integrating it within a more expansive system of '*biological*' and '*technical*' - two 'metabolisms' (Braungart et al., 2002).

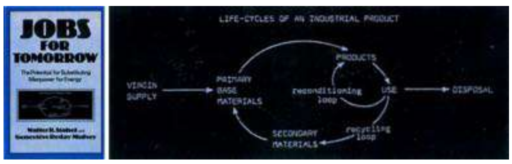

Figure 8. Cradle-to-Cradle Model by Walter Stahel

The circular economy system diagram was built upon and inspired by the previous work of many people and schools of thought. [8]
Prior to the CE diagram, there has been other 'circular' models, such as the '***Cradle to Cradle***' model by Walter Stahel (Figure 8) [9], or the more sophisticated '***Comet Circle ™***,' developed by Ricoh., Ltd (Figure 9).[10]

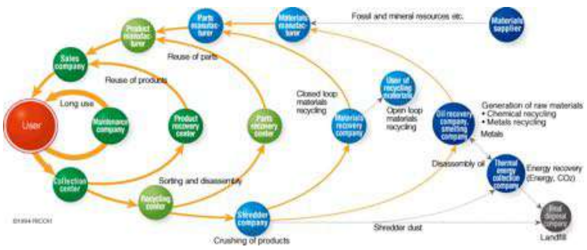

Figure 9. Concept of a Sustainable Society: The Comet circle TNM Copyright © 1999-2011 Ricoh Co., Ltd All Rights Reserved

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5 United Nations (2015) 'The 17 UN Sustainability Development Goals (SDGs).' Retrieved October 18, 2018, from https://www.un.org/sustainabledevelopment/sustainable-development-goals
6 IPCC (2018) 'Special Report: Global Warming of 1.5°C.' Retrieved October 18, 2018, from https://www.ipcc.ch/sr15/
7 Ellen MacArthur Foundation, 'Circular Economy System Diagram.' Retrieved October 18, 2018, from www.ellenmacarthurfoundation.org/circular-economy/infographic
8 See this link for more information: https://www.ellenmacarthurfoundation.org/circular-economy/concept
9 Stahel, Walter (1981) 'Jobs for Tomorrow, the Potential for Substituting Manpower for Energy.' Vantage Press; 1st edition 1981, U.S. Image: '*Cradle to Cradle*' model. Retrieved October 18, 2018, from www.product-life.org/en/cradle-to-cradle.
10 RICOH Company Ltd*,* '*The Comet Circle* ™' model. Retrieved October 18, 2018, from www.ricoh.com/environment/management/concept.html

3.3. Embedded Models

The models shown thus far, focus on material flows and transformations, however, there are also models within this theme that are based around ‘*embedded systems’* (see section 2.4). This includes work by the Forum for the Future, such as ‘*The Five Capitals*’ framework (Figure 10)[11], and the work by Ricoh Ltd with their ‘*Vision - Pursuing the Ideal Society (Three Ps Balance* ™*)*’ – Image 5 of 5, shown in Figure 11 [12] – which also integrates resource flows.

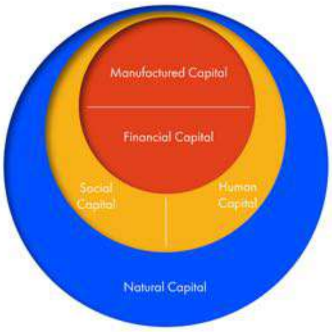

Figure 10: The Five Capitals by Forum for the Future

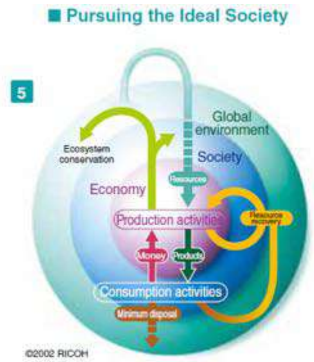

Figure 11. Vision - Pursuing the Ideal Society (Three Ps Balance ™) Image 5 of 5 © 2002 Ricoh

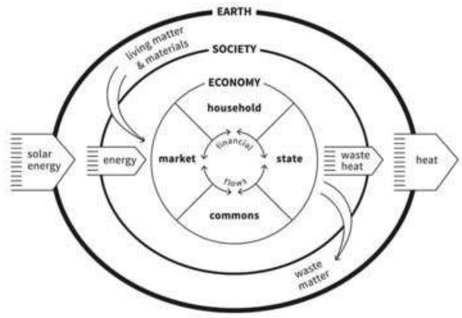

Figure 12. Embedded Economy. Diagram by Marcia Mihotich © Kate Raworth (2017)

The more recent work by Kate Raworth, and her ‘*Embedded Economy*’ diagram (Figure 12), also includes different ways communities organise themselves to provide for their needs - the so called ‘*provisioning systems*’ (household, state, commons, and market) (Raworth, 2017), which is *embedded* within the larger social and planetary system.

3.4. Input-Output Webs

These are less circular, but more ‘networked’ or ‘webbed’ (like food-webs) - ***input-output** diagrams*. Developed and promoted by the Zero Emissions Research & Initiatives [13] (and others, including the Systemic Approach Foundation, who also worked with ZERI [14]). ‘Input-output’ models are both models describing a concept, and are also dynamic tools that can be used to design new material flows through integrated production systems. Also, as in nature, there is no distinction between ‘agriculture’ or ‘industry’ – just transformative ‘nodes’ linked together with material flows.

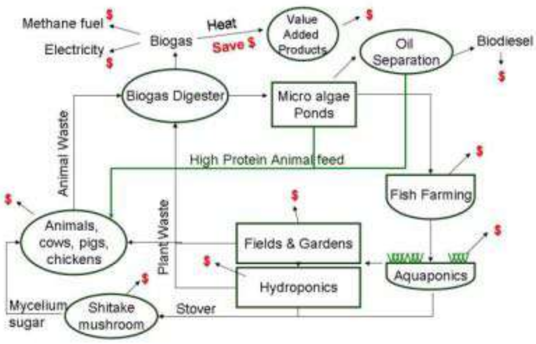

Figure 13. Simple Zero-Waste Agriculture System promoted by ZERI [13]

[11] Forum for the Future, ‘The Five Capitals,’ Retrieved October 18, 2018, from www.forumforthefuture.org/the-five-capitals.
[12] RICOH Company Ltd, ‘Three Ps Balance™.’ Image retrieved October 18, 2018, from www.ricoh.com/environment/management/earth.html
[13] Zeri Emissions Research & Initiatives, ‘Simple Zero-Waste Agriculture System.’ Retrieved October 18, 2018, from https://en.wikipedia.org/wiki/Zero_waste_agriculture;
[14] The Systemic Approach Foundation http://www.systemicfoundation.org

3.5. Values Models

As well as Aristotle's concepts of œconomia and chrematistiké, he also developed concepts around how to develop values. One of his concepts was 'Virtue,' which includes a breadth of philosophical thought around:

> "cultivating the attitudes and dispositions, qualities of character, on which a good society depends" and by "[…] giving people what they morally deserve – allocating goods to reward and promote virtue." (Sandel, 2010).

Unlike other moral (economic linked) concepts, such as, welfare and freedom, virtue is perceived to be more *judgemental* – as it ascertains to hold a preconceived position on what virtues are worthy of honour and reward and what are not. In economics, virtue can focus on the concept that goods differ in qualitatively in higher and lower ways (Sandel, 2010).

Another of Aristotle's concepts of value was based around the concept of '*Telos,*' which attempts to:

> "…identify the norms appropriate to social practices by trying to grasp the characteristic end, or purpose, of those practices." (p98 Sandel, 2010)

And so *Telos* (from the Greek τέλος for "end", "purpose", or "goal") is the concept that things should and do have purpose. In this way, one can ask, what is the purpose of economics – or a business?

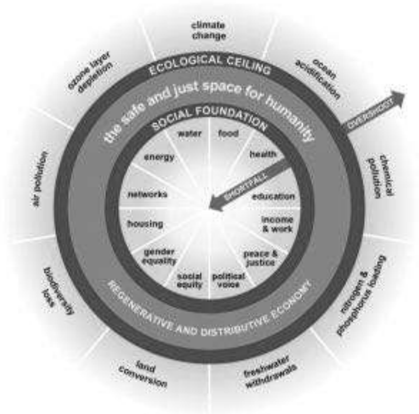

Figure 14. The essence of the Doughnut. Diagram by Christian Guthier ©2017 Kate Raworth

The models in Section 3.3, Figure's 10, 11 and 12, illustrate human and social systems as related to economic activities therefore, this implicitly shifts the potential debate towards values. However, Raworth (2019) has taken this further, with a model that both explicitly states '*social foundations*' (forms of virtues?), whilst also developing a *Telos* (a form of purpose) of where *not* to go – not into 'overshoot' or 'shortfall – and stay within the safe space for humanity.

Finally, there has also been a model developed by Alexandre Lemille, within his '***Circular Humans phere***' [15] (*Figure 14*), that also integrates some concepts of 'telos' *within* the circular economy system diagram by the Ellen MacArthur Foundation.

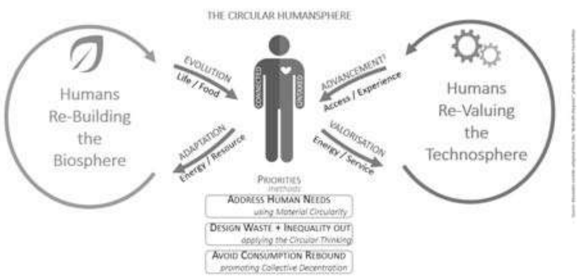

Figure 15. The Circular Humansphere by Alexander Lemille

[15] Lemille, Alexandre. 'The Circular Humansphere,' Image retrieved October 18, 2018, from www.alexandrelemille.com/optimising-circular-value

3.6. Some Further Concepts of the 'Economical Problem'

In their book *The Making of Economic Society*, Heilbroner and Milberg outline *two* key tasks of economic society which is to:

"…organise a system to assure the *production* of enough goods and services for its own survival,.." and to "…arrange the *distribution* of the fruits of its production so that more production can take place."

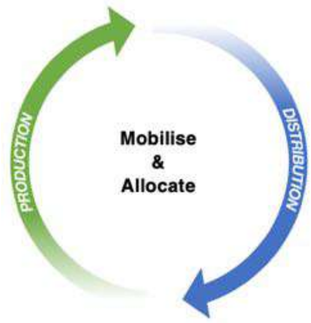

Figure 16. The Production & Distribution Cycle

Following this, they emphasise that society is also required to both *mobilise* (or motivate) and appropriately *allocate* human effort, in the making of *useful* things for the society.

In her book *The Value of Everything*, Mariana Mazzucato, defines the tasks of economic society through her description of value:

"Value can be defined in different ways, but at its heart it is production of new goods and services. How these outputs are produced (production), how they are shared across the economy (distribution) and what is done with the earnings that are created from their production (reinvestment) are key questions in defining economic value." (Mariana Mazzucato 2018 p6)

Mazzucato, defines the term value as "…the 'process' by which wealth is created – it is a flow. This flow of course results in actual things, whether tangible (a loaf of bread) or intangible (new knowledge)." She adds that, that which is being created needs to be '*useful*;' and that value can be discussed in terms of both '*value creation*' (the ways in which different resources are established and organised to produce new services and goods) and '*value extraction*' (the way in which different *existing* resources and outputs are moved around – with potentially disproportionate gains).

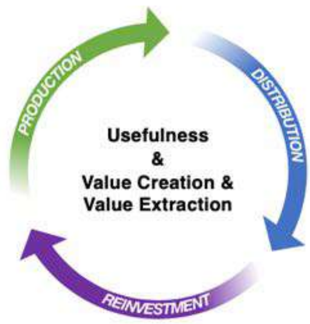

Figure 17. The Production, Distribution, and Reinvestment

Both these definitions (and the works behind them) integrate many of the elements in substantive economics, with the additional element of 'reinvestment,' from Mazzucato, which brings in her important concepts of value creation and extraction – and a potential integration with the capital flow concepts of Marx (described by Harvey).

4. Some Conclusions

4.1. Some Concepts that Should be in the Model(s)

> "If you look at that definition closely for a minute, you can see that a system must consist of three kinds of things: elements, interconnections, and a function or purpose." (Meadows, 2008)

After this first review of some of the different economic perspectives, and models, here is a brief list of what could be included within a model for regenerative value systems:

1) A representation of at least three levels of abstraction: the *micro* – being the key stakeholders; the *meso* – the production activities; and the *macro* – the community, the infrastructure and institutions, and natural ecosystem of the region.
2) A representation of the micro *drivers* - framing, developing, and selecting goals, purpose, and motivations of the stakeholders – which can then be implicitly linked to KPI's.
3) A representation of the general *flows* – the energy, material, components, goods, and residuals, within the meso and macro system.
4) A representation of the general *nodes* – the types of organizational and technical systems, and how they function, that are able to transform, move around, regenerate, or maintain the elements in flow. Again, at the meso and macro levels.
5) An explicit representation of the *embeddedness* of different *provisioning systems* (Commons, Households, States and Markets) – within the surrounding society and environment. This also implicitly brings in the important functions of the reproductive system.
6) A representation of how the different flows and nodes *interact* – the systemic dynamics such as potential symbiosis, competition, power dynamics. This needs to be represented at the meso level of the level of production, and at the macro level.
7) An explicit representation of the different forms of production (agricultural, material extraction and transformation, upcycling/cascading, and industrialization) all within a non-hierarchical scheme. [16]
8) A representation of the *flows of capital and money* - how and where it goes (how it is distributed) and how and where it is reinvested for instance.
9) An explicit visual, metaphor and objective relationship between the representation of regenerative production systems with an ecological system it works with and within.

[16] This point was not discussed in the paper; however, this is framed within the dynamics between the different factors of production (land, capital, labour, and entrepreneurship), in terms of how much power they yield towards the other within the economy. For example, land (and rent from it) prior to the 19th Century in Europe, was where the power resided, as most of the GDP came from agriculture; as GDP in many countries transitioned to industrial activities, with this heightened focus and need for capital, capital became more important (and powerful) (Galbraith, 1985). This legacy has left agriculture (as well other collective factors, such as the different dynamics in terms of returns, and increasing divisions-of-labour e.g. added-value shifting off the farm) has continued to keep agriculture as the underdog to capital in the economy.

4.2. Some Initial Visual Models/Frameworks

Shown below are some first models that have been developed that attempt to answer some of those topics highlighted in previous section 5.1.

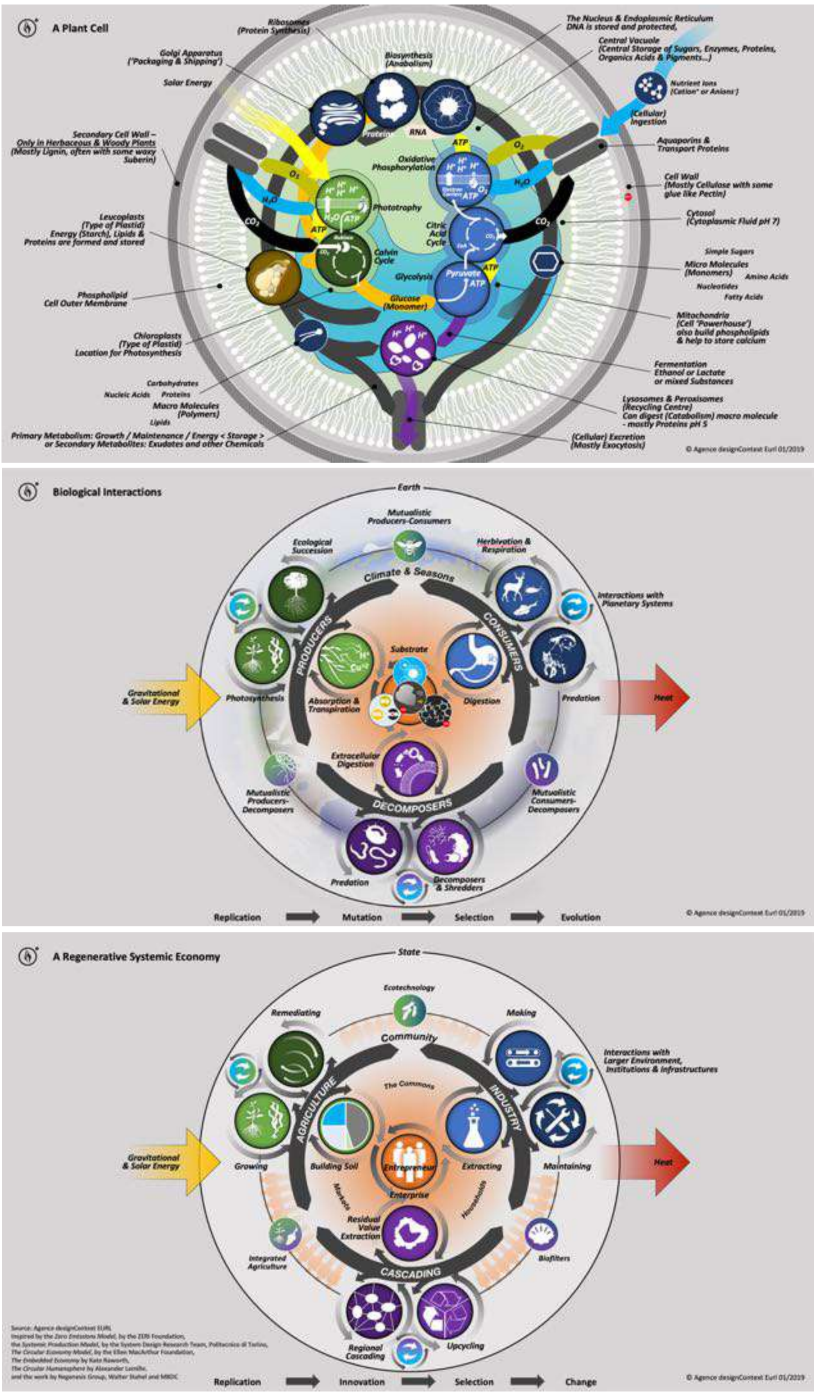

Figure 18. Three different Models: Top, 'A Plant Cell'. Middle, 'Biological Interactions,' Bottom, ‘A Regenerative Systemic Economy.’ Source: Tom Snow

Acknowledgements

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Since the first draft project proposal was written, followed by the first long abstract, followed by the presentation, followed by this final long abstract (with all the inputs listed above), the 'seed' of what actually wanted to be looked at, and wanted to be expressed has finally emerged. Thank you.

References

Bistagnino, Luigi (2011) '*Systemic Design: Designing the Productive and Environmental Sustainability*.' Italy: Slow Food® Editore srl.

Block, Fred & Somers, Margaret R. (2016 [2014]) 'The Power of Market Fundamentalism: Karl Polanyi's Critique.' Cambridge,USA: Harvard University Press

Braungart, Michael & McDonough, William (2012) '*Cradle to Cradle: Remaking The Way We Make Things*.' New York USA: North Point Press

Capra, Fritjof & Luisi, Pier Luigi. (2014) '*The Systems View of Life: A Unifying Vision*.' Cambridge, UK: Cambridge University Press

Ellen MacArthur Foundation (2018a) '*www.ellenmacarthurfoundation.org*.' Retrieved (October 18, 2018) from https://www.ellenmacarthurfoundation.org/circular-economy/concept

Galbraith, John, Kenneth. (1985 Edition) '*The New Industrial State*.' 41 William Street, Princeton, New Jersey 08540 USA: Princeton University Press

Gerber, Julien-François (2016, June 07) 'The Legacy of K. William Kapp.' *Development and Change*, 47(4), pages 902–917. https://doi.org/10.1111/dech.12238 The Hague: © 2016 International Institute of Social Studies.

Gerber, Julien-François & Scheidel, Arnim. (2017, August 12) 'In Search of Substantive Economics: Comparing Today's Two Major Socio-metabolic Approaches to the Economy – MEFA and MuSIASEM.' *Ecological Economics*, Volume 144 (February 2018), pages 186-194. http://dx.doi.org/10.1016/j.ecolecon.2017.08.012

Haggard, Ben. & Mang, Pamela (2016) '*Regenerative Development and Design: A Framework for Evolving Sustainability*.' Hoboken, New Jersey, USA: Wiley

Harris, Sam (2010) "*The Moral Landscape: How Science Can Determine Human Values*." 1230 Avenue of the Americas, NY 10020, USA: Free Press, A Division of Simon & Schuster, Inc.

Harvey, David (2011 [2010]) 'The Enigma of Capital and the Crisis of Capitalism.' London, UK. Profile Books.

Heilbroner, Robert L. (1979) '*Beyond Boom and Crash*.' New York, USA: W. W. Norton & Company.

Heilbroner, Robert L. (1985) '*The Nature and Logic of Capitalism*.' New York, USA: W.W. Norton & Company.

Heilbroner, Robert L. (1997) '*Teachings from the Worldly Philosophy*.' New York, USA: W.W. Norton & Company.

Heilbroner, Robert L. (7th Edition 2000) '*The Worldly Philosophers: The Lives, Times and Ideas of the Great Economic Thinkers*.' UK: Penguin Books.

Heilbroner, Robert L (2nd Edition 2000) '*A Biographical Dictionary of Dissenting Economists*.' Edited by Arestis, Philip and Sawyer, Malcolm. Cheltenham UK, Northampton, MA, USA: Edward Elgar Publishing. p287

Heilbroner, Robert L. & Milberg, William (13th edition, 2012) '*The Making of Economic Society*.' Upper Saddle River, New Jersey, 07458. USA: Pearson Education, Inc.

Hodgson, M. Geoffrey (2001) '*How Economics Forgot History: The problem of Historical Specificity in Social Science*.' London, UK: Routledge.

Kapp, K. William (1975 [1950]) 'The Social Costs of Private Enterprise.' New York, USA: Shocken Books

Korzybski, Alfred (5th Edition 1994 [1933]), '*Science and Sanity: An Introduction to Non-Aristotelian Systems and General Semantics*.' New York, USA: The International Non-Aristotelian Library Pub. Co.

Kuhn, Thomas (50th Anniversary Edition 2012 [1962]) '*The Structure of Scientific Revolutions*.' USA: University of Chicago Press.

Lovelock, James (2nd Edition 1995) '*The Ages of Gaia: A Biography of Our Living Earth*.' UK: Oxford University Press.

Mazzucato, Mariana (2018) '*The Value of Everything: Making and Taking in the Global Economy*.' UK: Allen Lane, an imprint of Penguin Random House Books.

Meadows, Donella, H. (2008) '*Thinking in Systems: A Primer*.' Edited by Diana Wright. USA: Chelsea Green Publishing.

Milberg, William & Winkler, Deborah (2013) '*Outsourcing Economics: Global Value Chains in Capitalist Development*.' UK: Cambridge University Press.

Pauli, Gunter (1998) '*Upsizing: The Road to Zero Emissions. More Jobs, More Income and No Pollution*.' UK: Greenleaf Publishing.

Porter, Michel E. (New Edition 1998 [1985]) '*Competitive Advantage: Creating and Sustaining Superior Performance*.' New York, USA: The Free Press.

Raworth, Kate (2017) '*Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist*.' UK: Random House Business.

Roncaglia, Alessandro (2006) '*The Wealth of Ideas: A History of Economic Thought*.' Cambridge, UK: Cambridge University Press.

Samuelson, Paul Anthony & Nordhaus, William D. (19th edition, 2010) '*Economics*.' New York, USA: McGraw-Hill/Irwin, International Edition.

Sandel, Michael (2010) '*Justice: What's the Right Thing to do?*' UK: Penguin Books

Sterman, Jon D. (2002) 'All Models are Wrong: Reflections on Becoming a Systems Scientist.' *Systems Dynamics Review* (18: 4) p513

Reinert, Erik S. (2008 [2007]) '*How Rich Countries Got Rich …and Why Poor Countries Stay Poor*.' London, UK: Constable & Robinson Ltd.

Walras, Léon (2014 [1883]) '*Elements of Theoretical Economics*.' Translated & Edition by D.A. Walker and J. van Daal. Cambridge, UK: Cambridge University Press.

Radically constructing 'place'

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Abstract: Place—what it means to be somewhere, or to be from somewhere—is a common thread running through the many systemic crises of our time. Place is a value under threat from globalisation, gentrification, networked technologies, human conflict and environmental disasters. At the same time, it is an underlying cause of some of the political and social tensions that are intertwined with these issues. Within architectural theory, place is strongly associated with phenomenology, the foundations of which are entangled with the sort of nativist politics that is currently resurgent around the world. In this working paper, I outline an alternative approach to place as a way to address its double-edged quality, building on Ernst von Glasersfeld's radically constructivist interpretation of Jean Piaget. In doing so, I establish points of connection between architectural discourse on place and the cybernetic foundations of systemic design.

Keywords: Place, Architecture, Radical Constructivism, Phenomenology, Systemic Design

1. Systems and places

Place—what it means to be somewhere, or to be from somewhere, and how we then construct this as an idea and in built form—is a common thread running through the many systemic crises of our time. Place is a value under threat from globalisation, gentrification, migration and the development of networked technologies. Many places are also very *literally* at risk from human conflict, climate change and ecosystem collapse. As well as being under threat from these systemic crises, place is, *at the same time*, a contributing factor to some of the political and social tensions that are intertwined with these issues. This double-edged quality is becoming ever more visible around the world in the reinforcement of borders and in current tendencies towards ever more specific units of political identity and nationhood.

While this may seem somewhat intractable, we can see some of this interaction between systems and places within our everyday experience. During this conference, several speakers have spoken about the importance of *getting the whole system into the room* where decisions are made (e.g. Jones, 2018). We might also ask, what systems are already implicit in the rooms that we enter? During the presentation of this paper at the conference, I located this question in the tiered lecture theatre in which I was speaking. As Gregory Bateson (1972/2000, pp. 493-494) has pointed out, spaces such as this encourage a unilateral relation between speaker and audience, with the former standing to deliver a monologue to a mostly passive audience who sit and listen. This reinforces the epistemological error that we are separate from each other, in turn perpetuating the idea that we are separate from our environment, which Bateson goes on to identify as being at the root of the ecological crisis. That is, the way we place ourselves—and each other—in the world through the design and use of space has much wider systemic ramifications.

It is clear that place should be an important consideration within systemic design, and indeed it has been an emerging theme in RSD conferences and related publications (Ellefsen, 2017; Ruttonsha, 2016, 2018; Sweeting, 2018). Integrating a consideration of place within systemic approaches is, however, far from straightforward. The strengths of systems theory and cybernetics come at the cost of abstraction. Ross Ashby, for instance, stressed that "systems theory must become based on methods of simplification" and that "*the systems theorist of the future…must be an expert in how to simplify*" (Ashby, 1964/2001, p. 594, italics original). Similarly, Ashby's influential introduction to cybernetics characterised it as the study of "all possible machines", focusing on general principles and downplaying material embodiment (Ashby, 1956, pp. 1-2). This abstraction is part of what gives systemic approaches their tremendous reach and transdisciplinary potential, but in so doing it distances them from specific situations and material conditions. One way in which to counter this is by integrating more situated methods, as has been prominent within this conference series and the development of systemic design (e.g. Aguirre & Paulsen, 2014; Perera, 2018; Sevaldson, 2017). An alternative approach, and the one I pursue here, is to look to how place is understood in architectural theory and to develop connections between this architectural discourse and the foundations of systemic design.

2. Place in architectural phenomenology

In architectural theory, place is strongly associated with phenomenology, and especially Martin Heidegger's later philosophy, through figures such as Christian Norberg-Schulz (1971, 1980, 1986), Karsten Harries (1997), and Kenneth Frampton (1974, 1983) amongst others. Although it is possible to draw aspects of phenomenology into systemic and cybernetic approaches to architecture and design in various ways (e.g. Jelić, 2015; Ruttonsha, 2018), there is little common ground between architectural phenomenology's concern for place and the areas of architecture where systemic approaches have been most influential. Indeed, the prominent examples of Melvin Webber (co-author with Horst Rittel of the seminal paper on 'wicked problems' (Rittel & Webber, 1973)) and Cedric Price (who collaborated extensively with cybernetician Gordon Pask (Sweeting, 2016b)) are amongst those cited by architectural historian Christian Norberg-Schulz (1986, p. 27, including footnote 7) as disregarding the importance of place.

While phenomenological approaches remain influential, they have been in retreat within architectural theory in recent decades. This has followed significant criticisms (e.g. Leach, 1998, 2005):

- Firstly, architectural phenomenology is entangled with the nativism that Leach (1998) has characterised as the “dark side” of Heidegger’s thinking. This is manifest in the idea that some ways of dwelling are less authentic than others because they are less rooted in place. See for instance Leach’s (2005) critique of the all too sharp contrast that Harries (1997) constructs between mobile homes and traditional farmsteads.
- Secondly, the regionalist approach that phenomenology helped to motivate has itself been recognised as a product of the homogenising global capitalism it sought to counter (Jameson, 1997).
- Thirdly, phenomenological accounts of place have tended to downplay the spatial significance of social, political and economic factors, which are some of the most important aspects of what is at stake when we discuss place today.

Thus, while architectural phenomenology may have much to contribute, it is bound up with some of the issues that, from a systemic perspective, are in need of being addressed. We might therefore look elsewhere to inform our approach to place (see e.g. Cumberlidge & Musgrave, 2007; Gehl, 2010; Jacobs, 1961; Ruttonsha, 2018). Yet, the aspects of architectural phenomenology that make it problematic also offer an opportunity for critical reflection, and this is my purpose in continuing to focus on it here.

The work of Norberg-Schulz, in particular, offers a point of departure from which to integrate issues of place within systemic design. The phenomenological framing that Norberg-Schulz gives to his work is not what it first appears. Although he is perhaps best known for introducing Heidegger into architectural theory, Norberg-Schulz’s use of Heidegger tends to be illustrative, with his arguments supported by quotations from Heidegger but not dependent on them. As Jorge Otero-Pailos (2010, p. 176) has put it, “Norberg-Schulz used Heidegger as a theoretical mask to add philosophical credibility” to his primarily visual argument. Norberg-Schulz draws on an eclectic range of other references, including systems theorist Talcott Parsons and psychologist and epistemologist Jean Piaget. This is usually presented as a weakness of Norberg-Schulz’s work compared to more philosophically sophisticated writers such as Harries, in that the ad hoc character of Norberg-Schulz’s theoretical sources presents an unstable basis for his position. Yet, this instability also presents an opportunity to rethink place in different terms, avoiding some of the difficulties with which phenomenological approaches are entangled, while also bringing architectural and systemic considerations into dialogue.

3. Reformulating place in radically constructivist terms

Piaget is one of Norberg-Schulz’s most important points of reference. This is especially so in Norberg-Schulz’s earlier work, but continues to be the case alongside and after his turn towards phenomenology. In *Existence, Space and Architecture*, Norberg-Schulz (1971, pp. 9-14) uses Piaget’s concepts of accommodation and assimilation to set out an understanding of space in terms of an interactive relationship between people and their surroundings. He contrasts this with the tendency of other treatments of space to reduce it to either abstract geometrical description or sense impressions and feelings. This forms a foundation to Norberg-Schulz's argument, independent of the concepts he draws from Heidegger.

Norberg-Schulz's use of Piaget offers a point of departure from which to understand place in constructivist terms and to bring it into dialogue with contemporary concerns in systemic design. This theoretical reframing is perhaps an odd thing to suggest. Yet, in the particular case of Norberg-Schulz, it is in keeping with how he himself developed his work, re-theorising his ideas in combination with new sources as he developed his position. My purpose is not to offer a reinterpretation of Norberg-Schulz's intentions, but to use his work to explore what is at stake in how we understanding place.

At the same time as Norberg-Schulz's turn towards phenomenology during the 1970s, Piaget's work was the principal reference for the development of radical constructivism by Ernst von Glasersfeld (1974, 1982). Radical constructivism critiques the way conventional approaches to epistemology focus on the possibility of a correspondence between one's experience and the world beyond it. As Glasersfeld points out, the question of such a correspondence is unresolvable in principle. One cannot experience the world beyond one's experience, and so cannot evaluate such a claim. Glasersfeld draws on Piaget's studies of how knowledge is actively built up in order to reformulate the domain of epistemology to be concerned with how we make sense of the world of our experience. Glasersfeld's approach is primarily a critique of realism but he also differentiates it from what he refers to as "trivial" forms of constructivism, where while the knower's role is acknowledged, knowledge is still understood in terms of correspondence:

> From my perspective, those who merely speak of the construction of knowledge, but do not explicitly give up the notion that our conceptual constructions can or should in some way represent an independent, 'objective' reality, are still caught up in the traditional theory of knowledge that is defenseless against the sceptics' arguments. From an epistemological point of view, therefore, their constructivism is trivial. Trivial constructivism manifests itself in professionals who treat the knowledge of others as subjective construction and never doubt the 'objectivity' of their own. (Glasersfeld, 1991, p. 17)

There is some similarity between the ways that, in their respective contexts, Glasersfeld and Norberg-Schulz each attempt to move beyond the dichotomy between realism and idealism. However, radical constructivism is in sharp tension with Norberg-Schulz's view of place as an enduring quality, linked to landscape and persistent through social and economic change. While Norberg-Schulz does emphasise the active role of experience, he sees the meaning of place as something to be selected from possibilities already "inherent in the world" (Norberg-Schulz, 1980, p. 170). This interpretation can be characterised as trivial constructivism in Glasersfeld's terms. To understand place in radically constructivist terms is to see it as something that we are continually creating within our experience, rather than an already given that is to be discovered. This has significant consequences for the status of claims about the character of a place, such as the tendency of the phenomenological approach to see some places as more authentic than others. From a radically constructivist perspective, place is as much a matter of our participation as anything else:

just because someone experiences somewhere as placeless, does not mean that it will not be a coherent place for someone else or at another time. In this light, the way that Harries (1997) and Norberg-Schulz (1980) characterise mobile homes or suburban developments as lacking in place tells us at least as much about the authors as about the places they are trying to describe.

To adopt a radically constructivist approach is not, however, to say that place is arbitrary or to deny that the character of particular places can persist over time or between people. Stable and shared conceptions of a place can be understood as developing through recursive social processes. Factors such as history, landscape, and the built environment can be understood to act as *constraints* on what conceptions of place can be viably maintained rather than *sources* of meaning. Places that have particularly strongly defined and consistent characters, such as many of the examples that Norberg-Schulz (1980) focuses on, can be understood in terms of the recursive reinforcement of these constraints through the ongoing design of the built environment, such as where a building echoes or reinterprets its context. Norberg-Schulz advocates this process as a way of making our environments intelligible. To take a radically constructivist approach is not to dismiss the importance of this, but rather to raise critical questions about it. Who do particular attempts at placemaking serve? Where architecture contributes to a sense of place, whose interpretation is being reinforced? By strengthening one reading of place, which alternatives are excluded because they become harder to construct? In this way, a radically constructivist approach allows for place to be differentiated from the nativism with which phenomenology is entangled.

4. Connecting place with systemic design

One of the weaknesses of architectural phenomenology is that it has tended to see place as solely a matter for spatial disciplines such as architecture and planning, understanding it in isolation from political, social and economic factors. By contrast, understanding place in terms of radical constructivism suggests connections with cybernetics and, through this, with the framework of systemic design, allowing a broader treatment.

Radical constructivism overlaps significantly with cybernetics, with which Piaget’s work has a number of sympathies and connections (Boden, 1979, pp. 126-148; Glanville, 2013; Glasersfeld, 1992; Pask, 1976, p. 19). The work of Ranulph Glanville has understood radical constructivism, cybernetics and design as closely interwoven with each other (Glanville, 2006, 2013, 2006/2014, 2014; Herr, 2015). Glanville is perhaps best known for his influential argument about the relation of design and research: that rather than design being one particular form of research, it makes more sense to understand research as a specific form of design activity (Glanville, 1999, 1981/2014; Sweeting, 2016a). He later generalised this argument, drawing on Piaget’s account of how we establish the constancy of objects across our different experiences of them (Glanville, 2006, 2006/2014). Glanville argues that the Piagetian mechanisms of assimilation and accommodation form what is, in effect, a design process, creating the constant objects of our experience. Design can therefore be understood as an “essential part of thinking” (2006/2014, p. 231), leading to the conclusion that “to be human is to be a designer, and there is no more important human act than to design” (p. 237).

Combining the ways in which Piaget's ideas are taken up by Glanville and Norberg-Schulz, spatial experience can be understood as a design activity on the part of the experiencer. This supports the idea that place is something we create rather than something we find, as discussed above, while also forefronting the role of constraints within this. Consider, for instance, how place might be thought of in terms of Schön's (1992, p. 133) well-known characterisation of design as a "reflective conversation with the materials of the situation".

Understanding place in this way has the advantage of bringing it into a closer relation to fields that are not overtly concerned with physical spaces. It is easy to think of the design and experience of digital technologies, systems and services as intangible. Nevertheless, they become manifest in and shape our spatial environments, and are bound up with the economic, social and political issues that are characteristic of contemporary conflicts over place. The approach that I have outlined in this paper allows place to be understood in similar terms to these less tangible factors, providing a framework in which the role of place within the systemic may be addressed.

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References

Aguirre, M., & Paulsen, A. (2014, October). *Using material properties to understand and shape relationships in public and social services*. Paper presented at Relating Systems Thinking and Design (RSD3) 2014 Symposium, Oslo, Norway. Paper retrieved from https://systemic-design.net/rsd3-proceedings/

Ashby, W. R. (1956). *An introduction to cybernetics*. London: Chapman & Hall.

Ashby, W. R. (2001). Introductory remarks at a panel discussion. In G. J. Klir (Ed.), *Facets of systems science* (2nd ed., pp. 591-594). New york, NY: Kluwer Academic/ Plenum Publishers. (Reprinted from: M. Mesarovic (Ed.), Views in general systems theory. Chichester: John Wiley and Sons, 1964).

Bateson, G. (2000). *Steps to an ecology of mind*. Chicago, IL: University of Chicago Press. (Original work published: 1972).

Boden, M. A. (1979). *Piaget*. London: Fontana.

Cumberlidge, C., & Musgrave, L. (2007). *Design and landscape for people: New approaches to renewal*. London: Thames & Hudson.

Ellefsen, K. O. (2017, October). *The imprints of the fisheries on land – the dynamics and adaptions of a Norwegian fishing village.* Keynote presentation at Relating Systems Thinking and Design (RSD6) 2017 Symposium, Oslo, Norway. Presentation retrieved from https://systemic-design.net/rsd6/keynotes/

Frampton, K. (1974). On reading Heidegger. [Editorial statement]. *Oppositions, 4*, no pagination.

Frampton, K. (1983). Towards a critical regionalism: Six points for an architecture of resistance. In H. Foster (Ed.), *The anti-aesthetic: Essays on postmodern culture* (pp. 16-30). Port Townsend, WA: Bay Press.
Gehl, J. (2010). *Cities for people*. Washington, DC: Island Press.
Glanville, R. (1999). Researching design and designing research. *Design Issues, 15*(2), 80-91. doi: 10.2307/1511844
Glanville, R. (2006). Construction and design. *Constructivist Foundations, 1*(3), 103-110. Retrieved from http://www.univie.ac.at/constructivism/journal/1/3/103.glanville
Glanville, R. (2013). Radical constructivism = second order cybernetics. *Cybernetics and Human Knowing, 19*(4), 27-42.
Glanville, R. (2014). Design and mentation: Piaget's constant objects. In *The black b∞x: Living in Cybernetic Circles* (Vol. 2, pp. 231-237). Vienna: Edition echoraum. (Reprinted from: The Radical Designist, 0, 2006).
Glanville, R. (2014, October). *How design and cybernetics reflect each other*. Keynote presentation at Relating Systems Thinking and Design (RSD3) 2014 Symposium, Oslo, Norway. Paper and presentation retrieved from http://systemic-design.net/rsd3-proceedings/rsd3-keynote-abstracts/
Glanville, R. (2014). Why design research? In *The Black B∞x: Living in Cybernetic Circles* (Vol. 2, pp. 111-120). Vienna: Edition Echoraum. (Reprinted from: Jacues, R. and Powell, J. (Eds.), Design, science, method: Proceedings of the 1980 Design Research Society conference, Westbury House, Guildford, 86-94, 1981).
Glasersfeld, E. von (1974). Piaget and the radical constructivist epistemology. In C. D. Smock & E. von Glasersfeld (Eds.), *Epistemology and education* (pp. 1-24). Athens, GA: Follow Through Publications.
Glasersfeld, E. von (1982). An Interpretation of Piaget's constructivism. *Revue Internationale de Philosophie, 36*(4), 612-635. Retrieved from http://www.vonglasersfeld.com/077
Glasersfeld, E. von (1991). Knowing without metaphysics: Aspects of the radical constructivist position. In F. Steier (Ed.), *Research and reflexivity* (pp. 12-29). London: Sage.
Glasersfeld, E. von (1992). Why I consider myself a cybernetician. *Cybernetics and Human Knowing, 1*(1), 21-25.
Harries, K. (1997). *The ethical function of architecture*. Cambridge, MA: MIT Press.
Herr, C. M. (2015). The big picture: Relating design, second order cybernetics and radical constructivism. *Cybernetics & Human Knowing, 22*(2/3), 107-114.
Jacobs, J. (1961). *The death and life of great american cities*. London: Jonathan Cape.
Jameson, F. (1997). The constraints of postmodernism. In N. Leach (Ed.), *Rethinking architecture: A reader in cultural theory* (pp. 247-255). London: Routledge. (Reprinted from: *The seeds of time*. New York: Columbia University Press, 1991, pp. 189-205).
Jelić, A. (2015). Designing "pre-reflective" architecture: Implications of neurophenomenology for architectural design and thinking. *Ambiances, 1*. doi: 10.4000/ambiances.628
Jones, P. H. (2018, October). *Evolutionary stakeholder discovery: Requisite system sampling for co-creation*. Paper presented at Relating Systems Thinking and Design (RSD7) 2018 Symposium, Torino, Italy.
Leach, N. (1998). The dark side of the domus. *The Journal of Architecture, 3*(1), 31-42. doi: 10.1080/136023698374297
Leach, N. (2005). Less aesthetics, more ethics. In N. Ray (Ed.), *Architecture and its ethical dilemmas* (pp. 135-142). London: Taylor and Francis.
Norberg-Schulz, C. (1971). *Existence, space and architecture*. London: Studio Vista.

Norberg-Schulz, C. (1980). *Genius loci: Towards a phenomenology of architecture*. London: Academy Editions.

Norberg-Schulz, C. (1986). *Architecture: Meaning and place: Selected essays*. New York, NY: Rizzoli.

Otero-Pailos, J. (2010). *Architecture's historical turn: Phenomenology and the rise of the postmodern*. Minneapolis, MN: University of Minnesota Press.

Pask, G. (1976). *Conversation theory: Applications in education and epistemology*. Amsterdam: Elsevier.

Perera, D. (2018, October). *Wicked problems, wicked humor: Fun machines as a method to frame wicked problems in architecture*. Paper presented at Relating Systems Thinking and Design (RSD7) 2018 Symposium, Torino, Italy.

Rittel, H., & Webber, M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*, 155-169.

Ruttonsha, P. (2016, October). *Toward a (social) science of settlement*. Workshop session at Relating Systems Thinking and Design (RSD5) 2016 Symposium, Toronto, ON, Canada. Abstract retrieved from https://systemic-design.net/rsd-symposia/rsd5-2016/rsd5-workshops/

Ruttonsha, P. (2018). Towards a (socio-ecological) science of settlement: Relational dynamics as a basis for place. In P. Jones & K. Kijima (Eds.), *Systemic design: Theory, methods, and practice*. Tokyo: Springer.

Schön, D. A. (1992). Designing as reflective conversation with the materials of a design situation. *Research in Engineering Design, 3*(3), 131-147. doi: 10.1007/BF01580516

Sevaldson, B. (2017). Redesigning systems thinking. *FORMakademisk, 10*(1). doi: 10.7577/formakademisk.1755

Sweeting, B. (2016a). Design research as a variety of second-order cybernetic practice. *Constructivist Foundations, 11*(3), 572-579. Retrieved from http://www.univie.ac.at/constructivism/journal/11/3/572.sweeting

Sweeting, B. (2016b, October). *The role of Gordon Pask in the Fun Palace project*. Paper presentation at An Afternoon with Cedric Price #1: A CCA c/o Lisboa event, Lisbon, Portugal. Organised by the Canadian Centre for Architecture. Presentation retrieved from https://www.cca.qc.ca/en/events/40500/an-afternoon-with-cedric-price-no-1

Sweeting, B. (2018, October). *Systems and places*. Workshop session at Relating Systems Thinking and Design (RSD7) 2018 Symposium, Torino, Italy.

Systemic Design and Its Discontents: Designing for Emergence & Accountability

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Abstract

Systemic design holds promise to address grand challenges such as the United Nations Sustainable Development Goals. Toward these ends, we argue that the systemic design mindset needs better awareness and norms for accountability. We recommend greater use of knowledge from psychology to bring insight about motivations and cognitive biases. We call on systemic designers to integrate principles of ethical practice, as new technological affordances, which amplify risk, increasingly impact social and economic life. To highlight wanted and unwanted emergent effects in complex techno-social systems, we introducing a schema with three layers of activity: regulating, building, and using. To illustrate the risks and benefits of designing in a data-intensive world, we unpack exemplary cases from history and contemporary society. We highlight emerging initiatives where systemic design thinkers introduce ethical accountability to a system by cross-pollinating and collaborating between the three layers of activity with respect to these complex systems.

Keywords: design, ethics, psychology, responsibility, systems

1. Introduction

The aim of this paper is to better prepare systemic design to realize its potential to address complex problems. We seek to advance the role of systemic design in enabling communities to flourish, as represented in the United Nations' Sustainable Development Goals (UN SDGs). Given this high potential for impact, what are the ethical implications of moving up through the orders of design? As systemic design needs to balance its ambition with humility and ethical commitment, we ask: How might we lead systemic design toward more self-awareness, care, and responsibility?

We observe that systemic design is not the output from a group of self-identifying practitioners but may be understood as a mindset. A code of conduct for a single profession will not encompass all the people making impactful design decisions everyday, who may or may not identify as systemic designers. Our paper explores alternative pathways to bringing awareness and ethics to systemic design activities.

We introduce a simple model that looks at system activities across three layers: regulating; building; and using. We argue that psychological dimensions of actors in the system are important to consider across all three layers. We identify new conditions including systemic effects arising from the interactions given the unprecedented scale of contemporary systems. To promote hindsight and insight, we reference cases from history as well as from contemporary society, highlighting technological amplification as a factor for increased risks and benefits.

How might we unlock the promise of systemic design while mitigating its inherent risks?

- Recommit to holism
- Acknowledge emergence while promoting accountability
- Take up explicit knowledge from the field of psychology
- Embrace ethics and move from "Can we...?" to "Should we...?"

Toward these ends we examine recent developments at the intersection of democracy, social media, and artificial intelligence. This work seeks to shed light on potentially manipulative techniques at the intersection of choice, persuasion, influence, politics, and other nonlinear societal forces.

2. When Complexity is Exponential

What are the ethical implications of moving up the Four Orders of Design (Buchanan, 2001)? Over the last two decades, 'design thinking' has gained increasing recognition. We are seeing the rise of a new kind of design, ready to take a lead role in addressing complex problems at the level of UN SDGs, such as boosting gender equality, wellbeing, social justice, and social innovation. Design's expanded reach and dematerialization is noted by Bruno Latour, who states: "…the typically modernist divide between materiality on the one hand and design on the other is slowly being dissolved away. The more objects are turned into things – that is, the more matters of facts are turned into matters of concern – the more they are rendered into objects of design through and through" (Latour, 2008). At the fourth order of design, systemic design is concerned with the design material of relationships and interactions among diverse systems components. At this level, there is high potential for risks as well as benefits, which can translate to unintended consequences as well as impact.

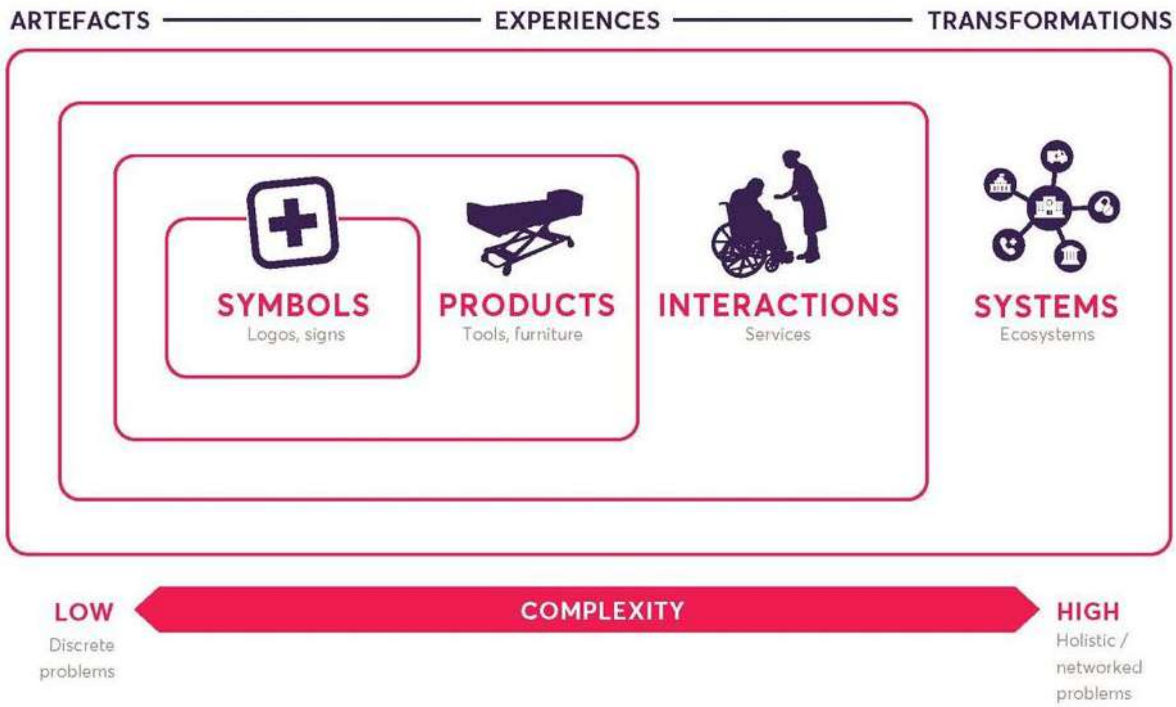

Figure 1. Four Orders of Design, based on Buchanan, 2001, in Leurs & Roberts, 2018.

Astute observers have pointed out that impactful decisions are being made every day by designers. For Latayna Sweeney, Director of the Data Privacy Lab at Harvard, “Technology designers are the new policymakers and AI is the new policy. No one elected these designers, and most people do not know their names, but the decisions they make … dictate the code by which we conduct our daily lives and govern our country” (Sweeney, 2018).

We introduce this simple illustrative model that delineates system activities across three layers:

- Regulating
- Building
- Using

3. Systemic Design is a Mindset.

Systemic design may be understood as an interdisciplinary synthesis of systems theory and human-centered design (HCD). Alex Ryan describes systemic design as a “new space for harnessing dynamic complexity as a generator of innovation and value creation” (Ryan 2016). Systemic design does not espouse the total design of entire systems; it marks a decisive pivot away from modernism toward 'designing for emergence' (Van Alstyne & Logan, 2007). In systemic design *we do not design systems, we design pathways through systems* (RSD6 audience, 2017).

Hallmarks of the systemic design approach we wish to avocate include working from a normative values basis, using co-design and inclusive participation, while anticipating and mitigating risks and unintended consequences, guided by stringent criteria such as Ashby's Law of Requisite Variety (Ashby 1958).

Ryan argues that systemic design is a *mindset* — a set of values and habits:

> The systemic design mindset describes a set of values and habits.... Both values and habits share the characteristics of being resistant to change and slow to change. The systemic design mindset cannot be taught directly. It is only through repeated systemic design experiences that individuals can, through reflection and behaviour modification, choose to enact new values and form new habits.

To fulfill the ambitions of systemic design, we want to pose the question of whether norms of participatory, human-centered design are effective and sufficient, practically and ethically. Given the potential scale of impact, we propose the embedding of normative values from ethics into actionable principles that mitigate risks. We also recommend creating robustness on the behavioural front by gaining greater understanding of various actors' motivations and cognitive biases from the field of psychology.

What is needed are beneficial results that are measurably more effective (better services from the same designers); more ethical (inclusive of representative data and perspectives from domains impacted by the design); and less risky (subject to due diligence through broader end-user participation and direct observation).

4. Risk and the Wisdom of Hindsight

To better understand systemic design's inherent risks, and establish historical and critical context, we ground this inquiry with reference to influential twentieth century conceptions of management and public relations.

Frederick Winslow Taylor's Principles of Scientific Management prescribes systemization, codification, and subdivision of all work tasks, to the extent of having individual tasks (Taylor 1911, 36–37). Even laying a single brick is deconstructed and re-designed scientifically by engineers, rather than bricklayers practicing trades of long tradition (Taylor, 1911, 77–85). This marks the emergence of industrial engineering as a field of 'applied science'.

> The change from rule-of-thumb management to scientific management involves … a complete change in the mental attitude of all the men in the shop toward their work and toward their employers. The physical improvements ... can be made comparatively quickly. But the change in the mental attitude and in the habits of the three hundred or more workmen can be brought about only through a long series of object-lessons, which finally demonstrates to each man the great advantage he will gain by heartily cooperating in his every-day work with the men in the management. (ibid., 100–1)

The 'great advantage' Taylor refers to includes shorter hours, higher pay, and reliable relationships between productivity, quality, and reward. Workers did not have to be *consulted* but they did have to be *convinced*, as conscious and rational agents. His "four great underlying principles of scientific management":

> *First.* The development of a true science. *Second.* The scientific selection of the workman. *Third.* His scientific education and development. *Fourth.* Intimate friendly cooperation between the management and the men. (ibid., 132)

The apparently odd fit between the top-down behaviourism implied by the first three principles and the congenial collaboration of the fourth implies a variant of what eventually became the sub-discipline of industrial psychology, and presages the contradictions of 'participatory action research'. Are Taylor's workers peers, experimental subjects, objects of passive study, or efficiently mobilized masses?

In another twentieth-century development, Freud's American nephew, Edward L. Bernays, honed the craft we know today as propaganda by rebranding it as public relations (PR). Bernays anticipated spaces and practices of persuasion including marketing and consumer psychology. His name has never been well known to the public, which is surprising considering his long shadow. In the early twentieth century Bernays pioneered forms of advertising without advertising: product placement. Bernays used this to 'solve problems' like selling cigarettes to women, calling them 'Torches of Freedom' to associate them with liberation. He provided a blueprint for industrial, design-fueled techniques of persuasion. In hindsight these works present an unsettling roadmap for risks and benefits of mass culture and communications.

Reviewing this work is critical to understanding the use and misuse of persuasion for social purposes. As a researcher and practitioner, Bernays developed experimental group psychology techniques. He found that emotions such as fear brings rapid results whereas rationality and facts drive persuasion much less. Bernays ideas are unsettling in their contemporary relevance as is his frank assertion that democracy requires guidance and constraint by a shadowy elite (Bernays 1928). Bernays describes 'engineering consent' as "Use of an engineering approach—that is, action based only on thorough knowledge of the situation and on the application of scientific principles and tried practices to the task of getting people to support ideas and programs" (Bernays, 1955).

Today we are experiencing disclosures that bear chilling resemblance to those of Bernays's time. UK firm Cambridge Analytica acquired data for some 50 million Facebook users and built psychographic profiles for micro-targeting manipulative election ads based on users' dispositions and vulnerabilities (Grassegger & Krogerus, 2017; Cadwalladr & Graham-Harrison, 2018). In rapid succession, similarly election gaming also took place in the Philippines (Curato, 2017). Serious concerns are being raised about potential effects of China's social credit system with its centralized citizen reputation score (Chorzempa, Triolo & Sacks, 2018).

These events demonstrate negative risks for the democratic process from large-scale data-driven systems; such systems form the incentive infrastructure of the attention economy. Amazon founder Jeff Bezos recently described social media as "a confirmation bias machine" (Tiku, 2018). His metaphor points to the intersection of a social media company's desire to generate profits through ad sale revenue, a human's tendency to search for new evidence that confirms existing beliefs through the consumption of ads, and an algorithm's ability to show ads that a user is likely to engage with. This business model incentivizes algorithms to show 'relevant' content to a user that he or she is likely to agree with.

5. Designing with Emergence in Mind

This paper extends the theoretical framework, "Designing for Emergence" (Van Alstyne & Logan, 2007; Van Alstyne & Logan, 2016). Fostering social innovation and knowing how we might give rise to desirable state change within systems requires us to understand emergence -- bottom-up forces of 'morphogenesis' -- the creation of new forms. The first step is recognizing the design-emergence distinction which, unspoken in most modernist traditions, is becoming an explicit understanding in the systemic design mindset. This basic distinction may be stated as follows:

> [D]esign is characteristically a top-down process.... In contrast, emergence is a bottom-up process in which the components of the system self-organize through their interactions with each other without a singular, overarching intention. The designer is typically in control of the design process, whereas in emergence the components of the system do not control the outcome – they merely influence it through their mutual interactions with each other. (Van Alstyne & Logan, 2007)

In the case of systems change, a new state arises through a myriad of interactions among elements or components. Consider the following emergent forms: a state of mind arising from neurons firing in the brain; leadership of a jurisdiction following votes cast by the electorate; or market share dominance of a brand due to purchases made by consumers. Such a form is not the product of a design process because it is the net result of innumerable individual actions by agents, acting within a system with degrees of freedom as well as rules and constraints (Capra, 2002).

Through systemic design we can reach an understanding of why, how and when it is possible and necessary to design for emergence. This knowledge is already present in the systemic design community and expressing itself in different ways. One emergent quality that cannot be directly designed, but be *designed with* and *designed for*, is human experience. Liz Sanders states this succinctly: "There is no such thing as experience design. Experiencing is in people and you can't design it for someone else. You can, however, *design for experiencing* (Sanders, 2001, author's emphasis).

6. Unlocking the Promise of Systemic Design

Precaution in the Era of Emergence

Risk and uncertainty in science- and technology-rich arenas, particularly in European jurisprudence, have given rise to the *precautionary principle*. UNESCO defines the precautionary principle as follows:

> When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm. Morally unacceptable harm refers to harm to humans or the environment that is
>
> - threatening to human life or health, or
> - serious and effectively irreversible, or
> - inequitable to present or future generations, or
> - imposed without adequate consideration of the human rights of those affected. (COMEST, 2015)

This approach holds up desirable aims yet bears many of the hallmarks of top-down thinking. While assessment of prospects or good practice for the precautionary principle are outside the scope of this paper, we note that it is intended to play a role in the space of dynamic balance between benefits and harms that accompany powerful technologies. Wherever this principle is in effect it will have bearing on the issues we address here: questions of how and why to design with emergence in mind.

A Professional Oath of Practice May Not Be Sufficient

Well known to systemic designers is Herbert Simon's contention that "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones" (Simon 1988). Simon argues that "Design, so construed, is the core of all professional training: it is the principal mark that distinguishes the professions from the sciences. Schools of engineering, as well as schools architecture, business, education, law, and medicine, are centrally concerned with the process of design" (Simon, 1988). In such a condition, what we can we say about the "duty of care" that systemic design might need to adopt, for broader physical, social, and environmental impacts of design outcomes either in place or possible for designers? And where do we go from here? In this work we call on systemic design to:

- Reaffirm holism: willingness to engage in accounting for emergent qualities
- Take up explicit knowledge from the field of psychology: the science of feeling, thinking, deciding and behaving, working with bias as designers and as system actors
- Embrace ethics: explicit principles of right and wrong, and inclusive participation

Taking Up the Wisdom of Psychology

We note that psychology has successfully lent its wisdom to other disciplines. *Behavioural economics* is one pathway that has found significant value and traction. This subfield has been illuminated through captivating work that reveals biases (Kahneman & Tversky, 1974; Ariely, 2008). The approach has seen enthusiastic take up, especially by the public sector, through terms that include 'nudging' and 'choice architecture' (Thaler & Sunstein, 2008). Behavioural economics reintroduces highly recognizable human motivations and biases that had been omitted from the rationalist models of classical economics. In so doing this work has begat a more resilient and mature hybrid. We take encouragement from experiment and exploration in arenas that hold strong interest for systemic design: policy, governance, community development, economic cooperation, innovation.

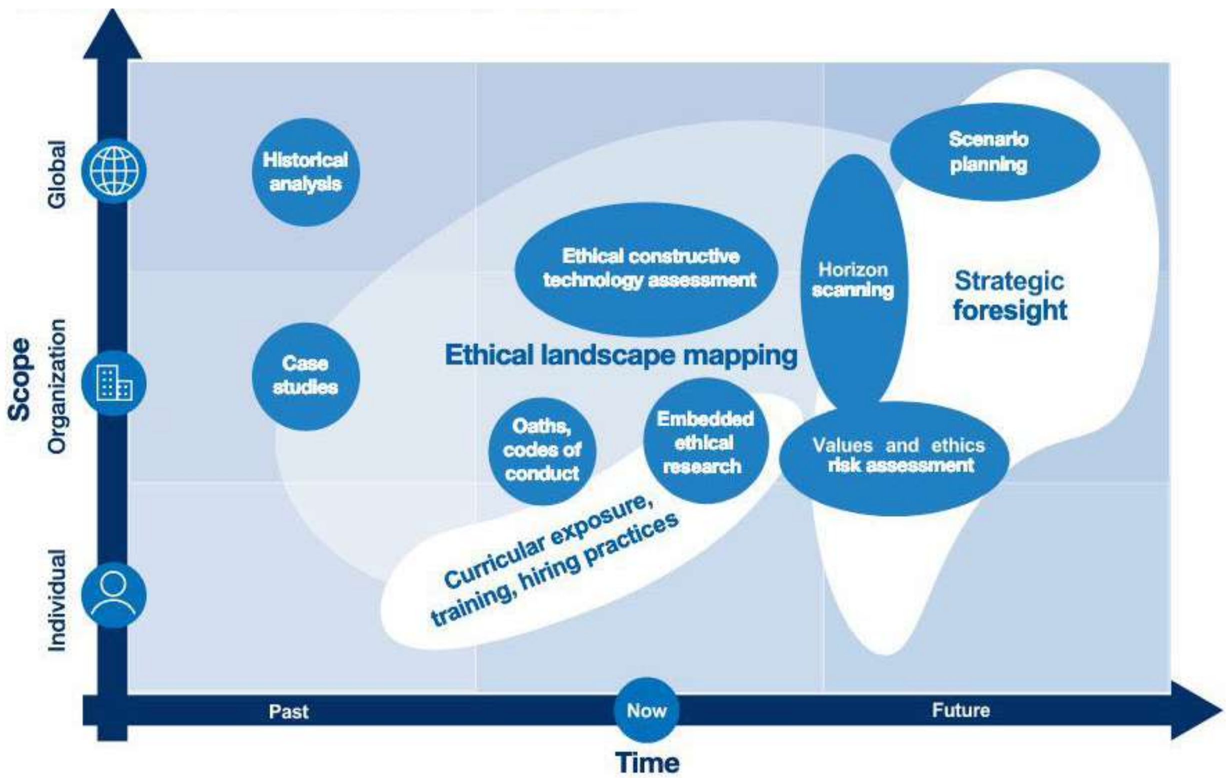

Figure 2. Mapping Values and Ethics Tools and Frameworks. Philbeck, T., Davis, N. & Engtoft Larsen, A. M. (2018)

Moving from "Can We?" to "Should We?"

> *Any machine constructed for the purpose of making decisions, if it does not possess the power of learning, will be completely literal-minded. Woe to us if we let it decide our conduct, unless we have previously examined the laws of its action, and know fully that its conduct will be carried out on principles acceptable to us!* (Wiener, 1950)

In a more urgent sense we see a need to stem and mitigate unwanted consequences arising from inadequate development and deployment of automated and augmented systems in which emergent dynamics play an inherent functional role as well as leading to potentially unsettling social and political effects. Working from first principles, Ryan articulates the “formulating” role of systemic design as a normative move that directly engages our shared values:

> Formulating shifts the focus of designing from understanding what is, to prescribing what ought to be…. Questions of what ought to be engage our values. As a normative activity, formulating should declare a reference system of values that the team seeks to enhance by acting within the situation. This should not be limited to the values of the team, but explicitly includes the values and interests of stakeholders (Ryan, 2014).

In an early contribution Liz Sanders (2001) asks a similar question: “Attention is shifting to the fuzzy front end of the design development process where the discussion is centered around questions such as “what should we make?” instead of “what should it look like?”

Emerging Initiatives

Opening Up Artificial Intelligence

OpenAI is a counterintuitive initiative that tries to bridge the gap between ‘regulating’ and ‘using’ and mitigate risk by building Artificial General Intelligence (AGI) through open collaborative research that “is free from financial obligations.” OpenAI is a non-profit artificial intelligence research organization founded by Silicon Valley veterans Elon Musk of Tesla and Sam Altman of Y-Combinator. Its stated mission is long-term research to build safe AGI, and to ensure AGI’s benefits are as widely and event distributed as possible (OpenAI, 2015).

On February 14, 2019, the organization gained extensive media attention for its groundbreaking unsupervised language model GPT-2. This is significant because the model was able to achieve “state-of-the-art performance on many language modeling benchmarks, and perform rudimentary reading comprehension, machine translation, question answering, and summarization -- all without task-specific training.” (Better Language Models, 2019). OpenAI grappled with the societal implications of this discovery and decided to embrace responsible disclosure principles by not releasing the dataset, training code, or model weight, citing the clear potential for misuse through generation of “deceptive, biased, or abusive language at scale” (Better Language Models, 2019).

The Guardian experimented with the released smaller model, and to their astonishment, GPT-2 wrote a coherent article; performed tasks such as mimicking the author’s tone; “wrote its own made-up quotes; structured its own paragraphs; added its own ‘facts’” (Parkinson, 2019). Following OpenAI’s cue, *The Guardian* decided to limit its release to *print only* for the similar fear of the digital amplification of mis-information.

Building Trust in Civic Data

Civic Data Trusts represent a novel approach to balancing stakeholder interests in data-intensive systems. The general problem is how best to provide for the management of data collected in and about patterns of human behaviour in the public realm, whether for commercial exploitation or to inform public sector service delivery and planning.

Civic data trust is also newsworthy as an initiative under consideration for Toronto's Waterfront, proposed in October 2018 by Sidewalk Labs, a Google affiliate with a contract to co-develop public spaces and services in Quayside development. The proposal describes an "independent entity to control, manage, and make publicly accessible all data that could reasonably be considered a public asset, and a set of rules that would apply to all entities operating in Quayside, including Sidewalk Labs. With the Data Trust, we move away from entities, including Sidewalk Labs, solely owning and controlling these assets" (Sidewalk Labs, 2018).

To be clear, a civic data trust is not necessarily an organ of a municipal government, or publicly held at any other level of the formal public sector. According to Open Data Institute's working definition, "A data trust is a legal structure that provides independent stewardship of data" (Hardinges & Wells, 2018). A civic data trust set up to handle the Quayside data would have to be designed not only to be technically competent to manage data and data licensing, but also to manage aspects of long term viability as an entity, including potential legal defenses, while remaining fiscally independent of its primary stakeholder, Sidewalk Labs. The design process is presently a matter of contract negotiations between representatives of Sidewalk Labs and the staff and trustees of Waterfront Toronto, disciplined by vocal contributions by local activists and media.

New Generations of Users Learning to Spend Time Well

From the perspective of empowering users, the first decade of the twenty-first century saw the rise of social media and rapid realization of benefits, including new awareness of how to design with emergence (O'Reilly, 2007; Van Alstyne and Logan, 2007). The second decade has demanded that we better understand risks and unintended consequences. Looking at the work of Tristan Harris is illustrative here. After working in B. J. Fogg's Persuasive Technology Lab where he studied the psychology of behavior change, Harris founded a company that was acquired by Google in 2011. Harris became increasingly concerned with the distracting and addicting qualities of smartphones and related systems, and through his efforts there became known as Google's 'Design Ethicist'.

Harris has since left to found the not-for-profit Center for Humane Technology to promote mindful reform under the banner "Time Well Spent" (Harris, 2016). Harris is working in partnership with Common Sense Media, a 15-year-old non-profit organization that has built trust through advice and advocacy to families promoting safe technology and media for children. A related effort in Europe asks, How might we teach people critical and ethical competencies such as how to spot fake news? Italy's speaker of the House Laura Boldrini is also working on this question. Italy is now teaching media literacy in eight thousand Italian high schools (Livesay, 2017). These optimistic developments are about building awareness and educating young people.

7. Conclusion

Learning to design with emergence in mind calls for new design principles. We present the following as work in progress for further consideration and discussion:

Principles for Designing with Emergence	
● Relinquish total control	● Understand people
● Balance creativity & stability	● Understand latent & blatant bias
● Acknowledge parasitism & hacking	● Nothing about us without us
● Give up 'strong derivability'	● Ethical by design

The purpose and process we are advocating for the systemic design community is to advance our maturity and thereby our positive impact for the many, not the few. In other words, we want to learn to act more responsively and responsibly, to do *both* risk-taking and risk-management. In explicitly seeking integration of values and habits, in other words, by maturing and integrating itself as a field of practice we see opportunity and responsibility for the project of systemic design to become more deeply intertwined with ethics and psychology.

References

Ariely, D. (2008). *Predictably Irrational*. HarperCollins.

Ashby W. R. (1958). Requisite variety and its implications for the control of complex systems. *Cybernetica* 1:2, 83–99.

Bernays, E. L. (1928). *Propaganda [the public mind in the making].* New York, NY: Horace Liveright.

Bernays, E. L. (1952). *Public relations.* Norman: University of Oklahoma Press.

Bernays, E. L., & Cutler, H. W. (1955). *The engineering of consent.* Norman: University of Oklahoma Press.

Better Language Models and Their Implications. (2019, February 14). Retrieved February 21, 2019, from https://blog.openai.com/better-language-models/

Buchanan, R. (1992). Wicked problems in design thinking. *Design issues*, 8(2), 5–21.

Buchanan, R. (2001). Design research and the new learning. *Design issues*, 17(4), 3–23.

Cadwalladr, C., & Graham-Harrison, E. (2018). Revealed: 50 million Facebook profiles harvested for Cambridge Analytica in major data breach. *The Guardian*, 17.

Capra, F. (2002). *The hidden connections: A science for sustainable living*. New York: Anchor Books.

Cavoukian, A. (2011). Privacy by design in law, policy and practice. A white paper for regulators, decision-makers and policy-makers.

Chorzempa, M., Triolo, P., & Sacks, S. (2018). China's Social Credit System: A Mark of Progress or a Threat to Privacy? (No. PB18-14).

Christensen, C. M. (1997). The innovator's dilemma. New York, NY, USA: HarperCollins.

COMEST. (2005). *The precautionary principle*. World Commission on the Ethics of Scientific Knowledge and Technology (COMEST), United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris.

Curato, N. (2017). Flirting with authoritarian fantasies? Rodrigo Duterte and the new terms of Philippine populism. *Journal of Contemporary Asia*, 47(1), 142–153.

Geist, M. (2018, October 10). How Canada Surrendered Policy Flexibility for Data Localization Rules in the USMCA. Retrieved February 21, 2019, from http://www.michaelgeist.ca/2018/10/how-canada-surrendered-policy-flexibility-for-data-localization-rules-in-the-usmca/

Grassegger, H., & Krogerus, M. (2017). The data that turned the world upside down. *Vice Motherboard*, 28.

Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Öhman, M. C., Shyamsundar, P., ... & Noble, I. (2013). Policy: Sustainable development goals for people and planet. *Nature*, 495(7441), 305.

Hardinges, J., & Wells, P. (2018, October 19). Defining a 'data trust.' Retrieved February 21, 2019, from https://theodi.org/article/defining-a-data-trust/

Harris, T. (2016). How technology hijacks people's minds—From a magician and Google's design ethicist. *Medium Magazine*.

Kahneman, D. (2011). *Thinking, fast and slow.* New York: Farrar, Straus and Giroux.

Latour, B. (2008). A Cautious Prometheus? A few steps toward a philosophy of design (with special attention to Peter Sloterdijk). In *Proceedings of the 2008 annual international conference of the design history society* (2–10).

Leurs, B. & Roberts, I. (2018). Playbook for innovation learning : 35 diagrams to support talking and thinking about learning for innovation. NESTA, UK.

Livesay, C. (2017). Italy Takes Aim At Fake News With New Curriculum For High School Students. National Public Radio (US).

OpenAI. (2015, December 12). About OpenAI. Retrieved February 22, 2019, from https://openai.com/about/

OpenAI Blog. (2015, December 12). Introducing OpenAI. Retrieved February 22, 2019, from https://blog.openai.com/introducing-openai/

O'Reilly, T. (2007). What is Web 2.0: Design patterns and business models for the next generation of software. *Communications & strategies*, (1), 17.

Parkinson, H. J. (2019, February 15). AI can write just like me. Brace for the robot apocalypse | Hannah Jane Parkinson. *The Guardian*. Retrieved from https://www.theguardian.com/commentisfree/2019/feb/15/ai-write-robot-openai-gpt2-elon-musk

Philbeck, T., Davis, N. & Engtoft Larsen, A. M. (2018). Values, Ethics and Innovation: Rethinking Technological Development in the Fourth Industrial Revolution. Retrieved February 22, 2019, from https://www.weforum.org/whitepapers/values-ethics-and-innovation-rethinking-technological-development-in-the-fourth-industrial-revolution/

RSD6 Audience. (2017, October). RSD6 Symposium. Conference, Oslo School of Architecture and Design.

Ryan, A. (2014). A Framework for Systemic Design. *FormAkademisk - Forskningstidsskrift for Design Og Designdidaktikk*, 7(4).

Sanders, E. B. N. (2001). A new design space. *Proceedings of ICSID 2001 Seoul: exploring emerging design paradigm,* 317–324.

Simon, H. A. (1988). The science of design: creating the artificial. *Design Issues*, 67–82.

Sweeney, L. (2018). Saving Humanity. Presented at the ACM Conference on Fairness, Accountability, and Transparency (ACM FAT*). Retrieved from https://fatconference.org/2018/program.html

Taplin, J. (2017). *Move fast and break things: How Facebook, Google, and Amazon cornered culture and undermined democracy*. New York: Little, Brown and Company.

Taylor, F. W. (1911). *The Principles of Scientific Management*. Plimpton Press, Norwood MA https://archive.org/stream/principlesofscie00taylrich#page/28/mode/2up

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth, and happiness*. S.l.: Yale University Press.

Tiku, N. (2018, October 15). Jeff Bezos Says Tech Companies Should Work With the Pentagon. *Wired*. Retrieved from https://www.wired.com/story/amazons-jeff-bezos-says-tech-companies-should-work-with-the-pentagon/

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, 185(4157), 1124–1131.

Van Alstyne, G. and Logan, R. K. (2016) Designing for emergence: Integrating systems & design. In: *Relating Systems Thinking and Design Symposium (RSD)*, 13–15 Oct 2016, Toronto, Canada.

Van Alstyne, G., & Logan, R. K. (2007). Designing for emergence and innovation: redesigning design. *Artifact*, 1(2):120–129.

Wiener, N. (1950). *The human use of human beings: Cybernetics and society*. Boston: Houghton Mifflin.

Wylie, B. (2018). Report from Executive Committee on Sidewalk Toronto. Plus a Word About Consent, Consultation, and Innovation. *Medium*, January, 30.

Sustainable Product Service System Design applied to Distributed Economies: a New Sustainable System Design Approach

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Abstract (150 words) One major issue attached to the transition towards a sustainable society is improving social equity and cohesion in low and middle-income contexts, while empowering locally-based enterprises and initiatives for sustainability, characterised by a democratisation of access to resources, goods and services.

Two promising and interwoven offer models coupling environmental with economic and social sustainability are the Sustainable Product-Service System (S.PSS) and the Distributed Economies (DE). The coupling of these two models is a new promising Research Hypothesis of the LeNSin (the international Learning Network of networks on Sustainability) for contributing to the transition towards a sustainable society for all, aiming at the diffusion of design for sustainability worldwide with a learning-by–sharing, open and copy-left ethos.

Within this framework, a new system design approach with method and tools have been developed, tested, and articulated. They are now part of the first open learning e-package on S.PSS applied to DE design.

Keywords: Sustainable Product-Service System (S.PSS), Distributed Economies (DE), Design for Sustainability (DfS), open and copyleft

1. Sustainable Product-Service Systems (S.PSS): A Win-Win Offer Model for Sustainability

A key contemporary query is the following: within the environmental and economic crisis which are the opportunities? Do we know any offer/business model capable of creating (new) value decoupling it from the materials and energy consumption? In other words, significantly reducing the environmental impact of traditional production/consumption systems?

In fact, Sustainable Product-Service System (S.PSS) has been studied since the end of the 90th as (one of) the most promising offer/business models in this perspective (Gpedkoop, van Halen, Riele et al.,1999; Mont, 2002; Tischner, Rayan, Vezzoli et al., 2009; UNEP, 2002; Vezzoli, Kohtala, Srinivasan, 2014). S.PSS has been recently defined as: "*an offer model providing an integrated mix of products and services that are together able to fulfil a particular customer demand (to deliver a "unit of satisfaction"), based on innovative interactions between the stakeholders of the value production system (satisfaction system), where the ownership of the product/s and/or its life cycle responsibilities remain by the provider/s, so that the economic interest of the providers continuously seeks environmentally and/or socioethically beneficial new solutions.*" (Vezzoli, 2018).

1.1. S.PSS types

Three majors S.PSS approaches to system innovation have been studied and listed as favorable for eco-efficiency (Vezzoli, Kohtala, Srinivasan, 2014; Tukker & van Halen, 2003):

1. Product-oriented S.PSS: services providing added value to the product life cycle
2. Use-oriented S.PSS: services providing 'enabling platforms for customers'.
3. Result-oriented S.PSS: services providing 'final results' for customers.

Product-oriented S.PSS: adding value to the product life cycle (type I)

Product-oriented S.PSS innovation adding value to the product life cycle is defined as:
a company (alliance of companies) that provides additional services to guarantee an extended life cycle performance of the product/semi-finished product (sold to the customer).

A typical service contract would include maintenance, repair, upgrading, substitution and product take-back services over a specified period.
This reduces the user's responsibility in the use and/or disposal of the product/semi-finished product (owned by her/him), and the innovative interaction between the company and the customer drives the company's economic and competitive interest in continuously seeking environmentally beneficial new solutions, i.e. the economic interest becomes something other than only selling a larger number of products.

Use-oriented S.PSS: offering enabling platforms for customers (type II)

A use-oriented S.PSS innovation offering an enabling platform to customers is defined as:
a company (alliance of companies) offering access to products, tools, opportunities or capabilities that enable customers to meet the particular satisfaction they want (in other words efficiently

satisfying a particular need and/or desire). The customer obtains the desired utility but does not own the product that provides it and pays only for the time the product is actually used.

Depending on the contract agreement, the user could have the right to hold the product/s for a given period (several continuous uses) or only for one use. Commercial structures for providing such services include leasing, pooling or sharing of certain goods for a specific use.

The client thus does not own the products and does not operate them to obtain the final satisfaction (the client pays the company to provide the agreed results). Again, in this case the innovative interaction between the company and the client drives the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. to design highly efficient, long-lasting, re-usable and recyclable products.

Result-oriented S.PSS: offering final results to customers (type III)

A result-oriented S.PSS innovation offering final results to customers can be defined as:
a company (alliance of companies) that provides a customized mix of services (as a substitute for the purchase and use of products), in order to provide an integrated solution to meet a particular customer's satisfaction (in other words a specific final result). The mix of services does not require the client to assume (full) responsibility for the acquisition of the product involved. Thus, the producer maintains the ownership of the products and is paid by the client only for providing the agreed results.

The customer does not own the products and does not operate them to achieve the final satisfaction; the client pays the company to provide the agreed results. The customer benefits by being freed from the problems and costs involved in the acquisition, use, and maintenance of equipment and products. The innovative interaction between the company and the client drives the company's economic and competitive interest to continuously seek environmentally beneficial new solutions, e.g. long-lasting, re-usable and recyclable products.

2. Distributed Economies (DE)

Distributed Economies (DE) is another model studied since 2005 (Johansson, Kisch, Mirata, 2005; Van Del Dool, Marchington, Ripken et al., 2009) as an alternative economic structure to the dominant Centralised one promising for locally-based sustainability (Johansson, Kisch, Mirata, 2005); DE has been recently defined as *"Small-scale production units, located by or nearby the end-users, whether individuals, entrepreneurs and/or organisations/institutions, i.e. the producers are the same end-users or nearby them. If the small-scale production units are connected with each other to share various forms of resources and/or goods (physical and knowledge-based ones), they become a Locally Distributed Economy Network, which may in turn be connected with nearby similar networks. If properly designed they are promising to promote locally-based sustainability, i.e. Sustainable Distributed Economies (S.DE)"* (LeNSin Polimi Team, 2018).

2.1. Types of Distributed Economies

There are different types of Distributed Economies (DE). Here below is a classification so far proposed within the LeNSin project classified in two groups: *hardware/natural resources-based DE* and *knowledge/information-based DE* (LeNSin Polimi Team, 2018)*:*

HARDWARE/NATURAL RESOURSES-BASED DISTRIBUTED ECONOMIES (DE) TYPES

Distributed energy Generation (DG)
An example of Distributed energy Generation (DG) system is (the shift from *centralized coal power plant* to) a *home-based solar energy plants connected in mini-grid.*

Distributed Manufacturing (DM)
An example of Distributed Manufacturing (DM) system is (*the shift from centralized furniture production to) a 3D printed furniture production.*

Distributed production of Food (DF)
An example of a Distributed production system of Food (DF) is (the shift from *intensive farming/ supermarket* to) *a urban gardening.*

Distributed Water management (DW)
An example of Distributed Water management (DW) system is (the shift from *centralized urban water supply* to) *a decentralized access to clean water from underground.*

KNOWLEDGE/INFORMATION-BASED DISTRIBUTED ECONOMIES (DE) TYPES

Distributed production of Software (DS)
A well-known example of a Distributed production of Software (DS) is (the shift from *proprietary software* to) *an open source software "Linux".*

Distributed production of Information/knowledge (DI)
A well-known example of a Distributed production of Information/knowledge (DI) is (the shift from *traditional encyclopaedia* to) *open encyclopaedia "Wikipedia". In fact, the same LeNS network of HEIs network could be classified into this category.*

Distributed Design (DD)
An example of a Distributed production of Information/knowledge (DI) is (the shift from *Design department of multinational car manufacturer* to) *an open source car design platform e.g. the OSVehicle a Modular Open Source Electric Car Platform that enable businesses and startups to design, prototype, and build electric vehicles and transportation services. https://www.osvehicle.com. Other examples of a Distributed Design (DD) are: the Open IDEO platform https://openideo.com/; the Innonative platform developed with the support of the Life+ programme of the European Union www.innonative.com.*

2.2. Distributed Economies configuration

Distributed Economies (DE) are in fact **small**-scale **locally-based** offer models, eventually **network-structured**, defining a paradigm shift from dominant centralized production systems (see Figure 1).

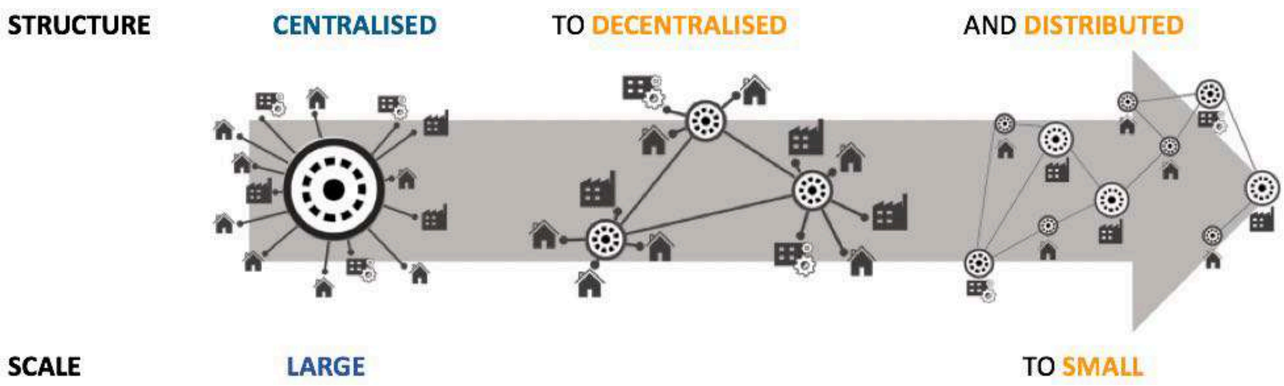

Figure 1. The paradigm shift from centralized to distributed locally-based systems

Centralized Economies could be defined as large-scale production units that controls essential activities and deliver their goods (physical and/or knowledge-based) via great distribution networks, to very many (often) far away customers, whether individuals, entrepreneurs or other organizations/institutions.

Figure 2. The structure of the production unit of Centralized Economies

Decentralised Economies could be defined as small-scale production units that deliver their goods (physical and/or knowledge-based ones) directly to nearby customers, whether individuals, entrepreneurs or other organizations/institutions. These production units could be standalone or connected to each other to share various forms of resources and/or goods (physical and/or knowledge-based ones); e.g. to share the energy surplus). In the latter case, they become Decentralized Economy Local Network, which may in turn be connected with nearby similar networks.

Figure 3. The structure of the production unit of Decentralized Economies

Distributed Economies (DE) could be defined as (very) small-scale production units of goods (physical and/or knowledge-based ones) located by the end-users (that become the producers, i.e. prosumer) that have the control on essential activities, whether individuals, entrepreneurs or organizations/institutions. These production units could be standalone or connected to each other to share various forms of resources and/or goods (physical and/or knowledge-based ones). In the latter case, they become Distributed Economy Local Network, which may in turn be connected with nearby similar networks.

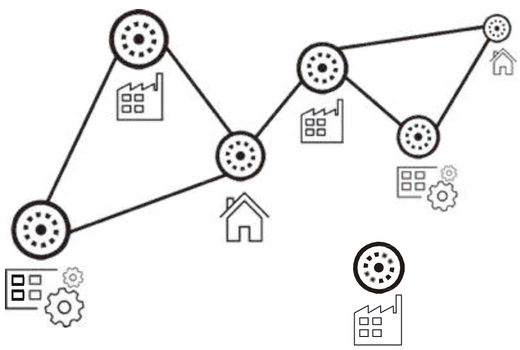

Figure 4. The structure of the production unit of Distributed Economies

Distributed Economies in comparison to Centralised Economies (as shifting from Centralised Economies to Distributed Economies) could be distinguished in term size, proximity, structure, resilience, responsiveness, diversity of solutions, locally-based sustainability potential.

In fact, the DE configuration could be characterised by one of the following sub-structures:

- Stand-Alone DE systems
- A DE network
- A DE network of networks
- A DE connected to a Centralized Network.
-

Stand-Alone DE systems

They are, either distributed or decentralised production unit without any local delivery system (network) with nearby customers and/or production units.

A *Stand Alone Distributed* system is an isolated production unit by the user; either an individual or an enterprise (see the examples in Table 2).

A *Stand Alone Decentralised* system is an isolated production unit where customer go to benefit from the outcomes of the production unit (see examples in Table 2).

A DE network

They are either distributed, decentralised or centralised production unit or hybrid of more than one such type of production units with a delivery system (network) with customers and/or production units.

A *Centralised network system* is a network of production unit far from the user with a large delivery system for various forms of resources (physical and/or knowledge-based ones) towards either individuals or enterprises distributed in a large scale of area such as a state/s, country/ies, continent/s or worldwide.

A *Decentralised network* system is a production with a local delivery system (network) for various forms of resources (physical and/or knowledge-based ones) towards either nearby individuals or nearby enterprises (see the figure in Table 1).

A *Distributed network* system is a network of production unit by the user; either an individual or an enterprise(see the figure in Table 1) to share locally various forms of resources (physical and/or knowledge-based ones; e.g. to share the energy surplus) with nearby individuals.

A *Hybrid network system* is a network of production unit that consists of two or more type of centralised, decentralised, or distributed network systems.

A DE network of networks

They are either centralised, distributed or decentralised production units or local networks *connected to a other Networks* to share various forms of resources (physical and/or knowledge-based ones; e.g. to share the energy) (see the figure in Table 1).

A DE connected to a Centralized Network

They are either distributed or decentralised production units or local networks *connected to a Centralized Network* to share various forms of resources (physical and/or knowledge-based ones; e.g. to share the energy) (see the figure in Table 1).

The tab below summarizes the main possible configurations of DE systems.

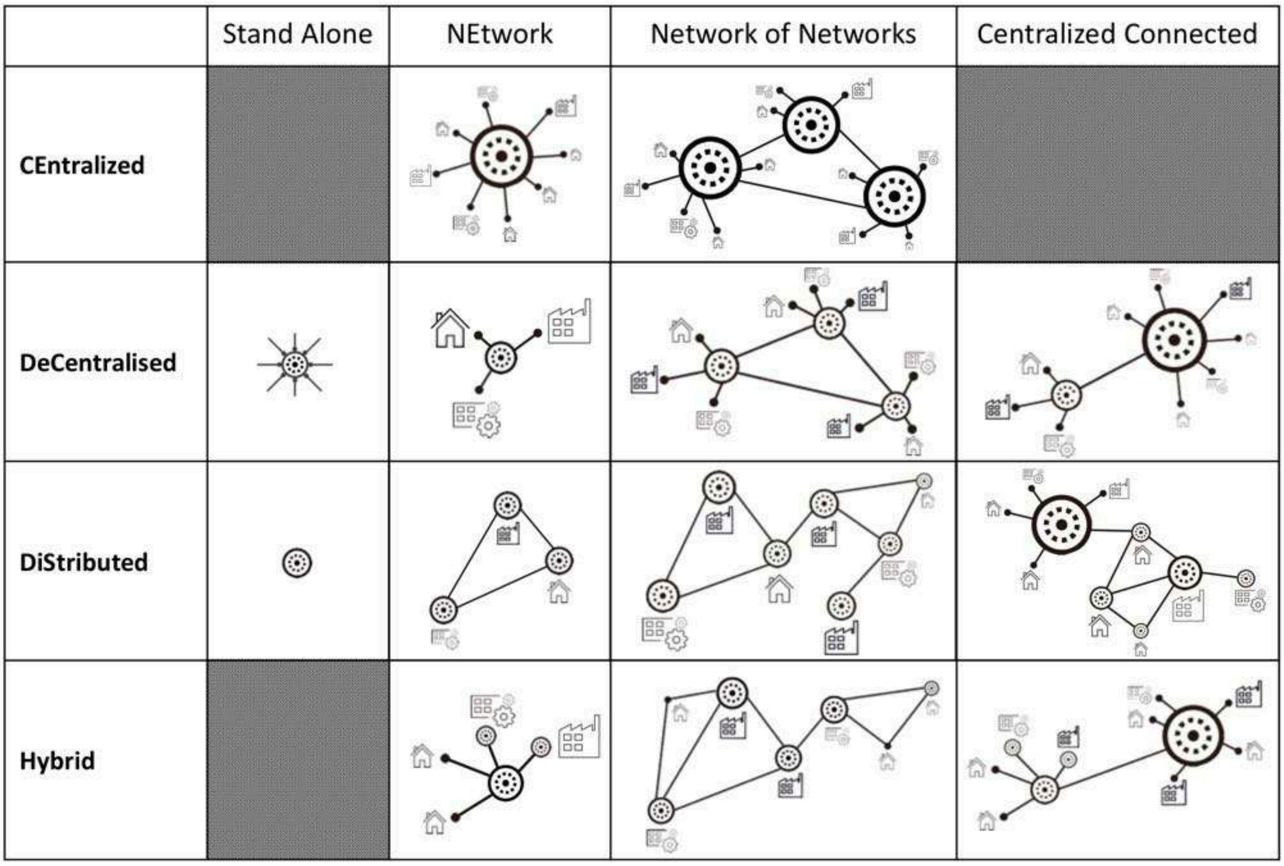

Table 1. Possible DE systems configurations

In the following table, various key network-DE structure configurations are exemplified with different DE classifications:

	Stand-alone - distributed	Stand-alone - decentralised	Network - distributed	Network - decentralised
DG	a small wind farm which provides energy to a village with a local mini-grid	solar powered energy charging station, where people go to charge their phone, etc.	set of solar panels for home use, connected via a local-mini grid to share the energy surplus	solar panel for a single household energy production
DF	local baker which delivers bread to the houses in the neighbourhood every morning	local producer of organic vegetables and fruits selling directly to consumer in a shop by the fields	neighbourhood club for home gardening for private use, enabling the sharing of production surplus	home gardening for private use
DW	water gathered from a local spring water source distributed to the households in the village through a local piping infrastructure	medium size water collector where local people access with their tanks to get the water	roof rain water harvesting for private use, with neighbourhood piping infrastructure for surplus sharing	harvesting rain water from the home roof for private use
DM	an entrepreneur locally delivering 3D printed items made on request	maker selling 3D printed artefacts directly to final user in a shop by the workshop	a local 3D printer owner produces items for home use while producing for the local community on request during the unused time of the printer	making clothes at home using sewing machines for own use
DS	a software developer providing service installing the home security system she developed going to the homes	a software developer selling the home security system she developed from her office to the local community	developing open source software collaborating with a local community of developers at home to create a home security system	developing software at home to create a home security system
DI	providing a local consultancy service about gardening, by going to the customers' gardens in the town	a farming expert providing a consultancy service in her office about farming for the region	small weather station for forecast located at home for your own use + sharing the information with your local community	(very) small weather station for home forecast
DD	an architect providing a service for the local community to improve the houses going to the location of the houses	providing a service in your studio for the local customers to design custom furniture	Designing your own clothes at home and sharing your design with your local community	designing your own clothes at home

Table 2. Different DE Classification Examples for network-DE structure configurations

3. S.PSS Applied to DE: a Promising Approach to Diffuse Sustainability in Low/Middle-Income (All) Contexts

The paper discusses an innovative system approach to sustainability, i.e. the win-win potential of coupling S.PSS and DE for a sustainable society for all, which is the Research Hypothesis of the LeNSin (the international Learning Network of networks on Sustainability) project, funded by the EU Erasmus+ programme involving 36 universities from Italy, Finland, Netherlands, United Kingdom, China, India, Brazil, Mexico and South Africa. The Research Hypothesis runs as follow: (LeNSin Polimi Team, 2015).

A S.PSS applied to DE is a promising approach to diffuse sustainability in low/middle-income (all) contexts, because it reduces/cuts both the initial (capital) cost of DE hardware purchasing (that may be unaffordable) and the running cost for maintenance, repair, upgrade, etc. of such a DE hardware (that may cause the interruption of use), while increasing local employment and related skills, as well as fostering for economic interest of the producer/provider to design low environmentally impacting DE products, i.e. resulting in a key leverage for a sustainable development process aiming at democratizing the access to resources, goods and services.

Below in Figure 5 it is given an example of a win-win S.PSS model applied to DRE (one of the type of DE) in a low income context.

Figure 5. An example of S.PSS. applied to DE (DRE)

Let us specify a bit further the above Research Hypothesis, i.e. let us see in a more schematic way the main reasons why a Sustainable Product Service System model offer applied to Distributed Economies should open new opportunities for a sustainable development (even) in low and middle-income contexts:

- selling to **final users** the **access** rather than **DE product** ownership, reduces/**avoids** the **purchasing costs** of those DE hardware (frequently too high for low and middle-income people), making goods and services more easily accessible
- selling to **final user** all-inclusive **life cycle serv**ices with **DE product** offer, reduces/**avoids running cost** for maintenance, repair, upgrade, etc. (frequently too high for low and middle-income people) avoiding the interruption of DE product use
- selling to to **entrepreneur** the **access** rather than **DE equipment** ownership, reduces/**avoids** initial (capital) **investment costs** (frequently too high for low and middle-income entrepreneurs), facilitating new business start-up
- selling to **entrepreneur** all-inclusive **life cycle serv**ices with **DE equipment** offer, **r**educes/**avoids running cost** for maintenance, repair, upgrade, etc. (frequently too high for low and middle-income entrepreneurs), avoiding the interruption of DE equipment use, i.e. interruption of working activities
- offering goods and services without DE product/equipment purchasing costs, open **new market opportunities** as new potential customers form low and middle income contexts (BoP), i.e**. potentially empowering locally-based economies.**

For what concern the environmental benefits we could highlights that applying an S.PSS model foster an environmentally sustainable DE diffusion, because a DE producer/provider selling it to a final user/entrepreneur as an S.PSS offer model to is economically interested in designing it for DE product/equipment:

- lifespan extension and use intensification;
- material life extension (recycling, energy recovery, composting);
- materials minimizations;
- energy minimizations;
- resources (materials and energy) renewability/biocompatibility;
- resources (materials and energy) toxicity/harmfulness minimizations.

It is useful to highlight that the Research Hypothesis is, in fact, the coupling of two paradigm shifts (see the Figure 6):

- the shift from traditional product sale model to S.PSS, i.e. the shift of customer perceived value from individual ownership to access to a mix of products and services (systems) fulfilling a given unit of satisfaction;
- the shift from centralized to decentralized/distributed systems in which a small scale unit of production is locally-based, i.e. nearby or at the point of use, and where the user can become a producer.

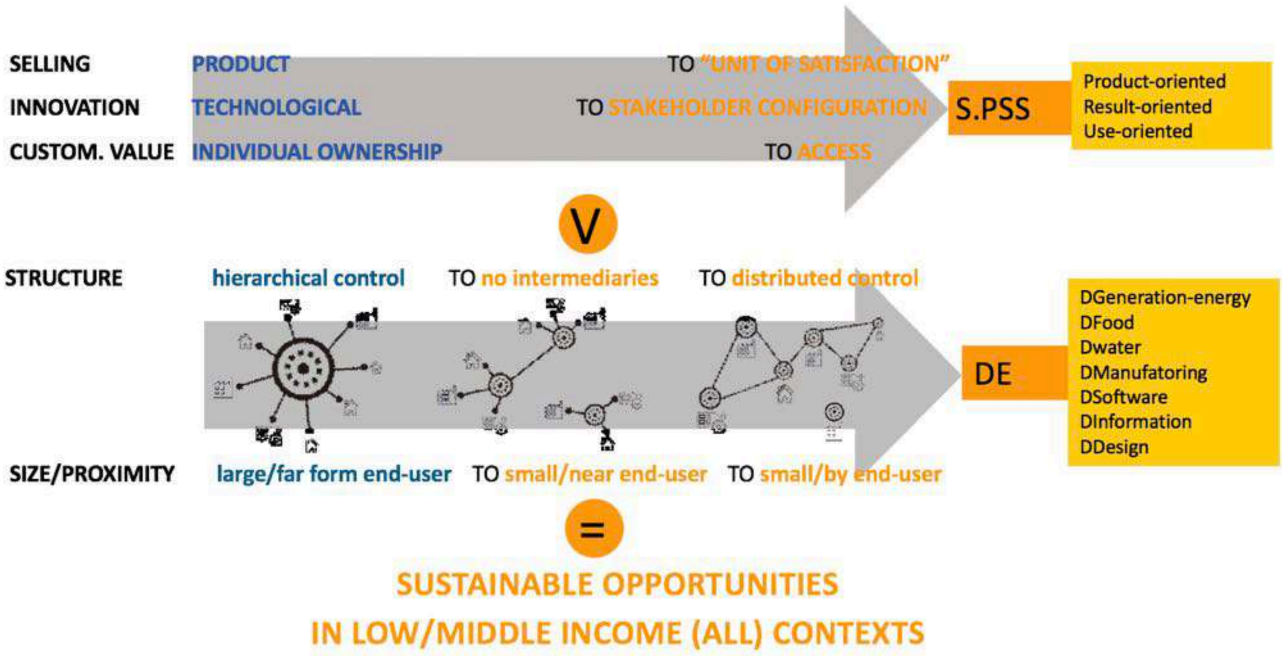

Figure 6. The coupling the 2 paradigm shifts represented by S.PSS and DE

Shifting the concern of the design role, the following Research Hypothesis (LeNSin Polimi Team, 2015) has been studied by envisioning a new system design role to design for S.PSS applied to DE.

4. Methodology

S.PSS applied to DE Design Approach, method and tools have been explored and characterised mainly within the LeNSin project with the following process:

State of the Art: each of the 36 partner institutions carried out literature review on the Design for Sustainability (DfS) topic, current practices and approaches in DfS, followed by a coordinated case study analysis. The results of those activities were shared between all partners in a meeting and trough the project web platform.

Design of the new method and tools: A new method and design tools for S.PSS applied to DE has been designed and developed within the LeNS Lab Polimi as well as by the other project partners in relation to their own sustainability agenda. These activities were followed by 5 seminars held in Brazil, South Africa, Mexico, China and India, where the partners gathered academics, companies, NGOs, governmental institutions, etc. All developed until that point has been shared in these seminars, in which the input from the attendees have been collected. All the activities of the project were video-recorded and uploaded on the project website to be made accessible to all the researchers in the project, which made possible to gather feedback from a large group of researchers. All these activities led to a refinement and characterisation of the Research Hypothesises (that includes the approach), and the developed methods and tools.

Testing and further development: All produced that far were the bases for the design and implementation of the first round of 5 pilot courses held in the non-European partner countries, where local and European teachers were involved in the teaching and evaluating boards. All of the learning resources (syllabus, videos of the lectures, slides, case studies, tools, etc.) have been shared with other partners right after the end of each course. A second round of pilot courses was then carried out with the same logic in different universities and with different guest EU teachers and observers. At the end, a total of 10 pilot courses were carried out, each of them evaluated by a questionnaire given to both students and professors. All the pilot courses were also video-recorded and shared on the project platform.

Development of the final version: In parallel to the activities in the LeNSin Projects, the method and design tools for System Design for Sustainability for All have also been used and tested in the System Design for Sustainability course at Politecnico di Milano by Polimi LeNS Lab, where the final working versions of the method and tools have been developed. Nevertheless, their update and development are continuing by Polimi LeNS Lab through testing-by-using in the System Design for Sustainability course at Polimi as well as through synergies among the course materials developed by the other LeNS partners since all the course materials developed on the topic by the partners of the project are uploaded on the LeNS Platform as open source.

5. Sustainability Design-Orienting Scenario for S.PSS Applied to DE

A Sustainability Design-Orienting Scenario for S.PSS applied to DE has been developed within the project, which is composed by a polarity diagram with 4 visions (see Figure 7), each representing a Sustainable win-win configuration; combining socio-cultural, organizational and technological factors, fostering solutions with a low environmental impact, a high socioethical quality and a high economic and competitive value. It is polarised on the vertical axis by the type of DE structure, **distributed** or **decentralised**, and on the horizontal axis on the type of customer, **B2C** (final user or small communities) or **B2B** (small entrepreneur or small business). The crossing of those polarities produced the 4 vision that are shown in the diagram below:

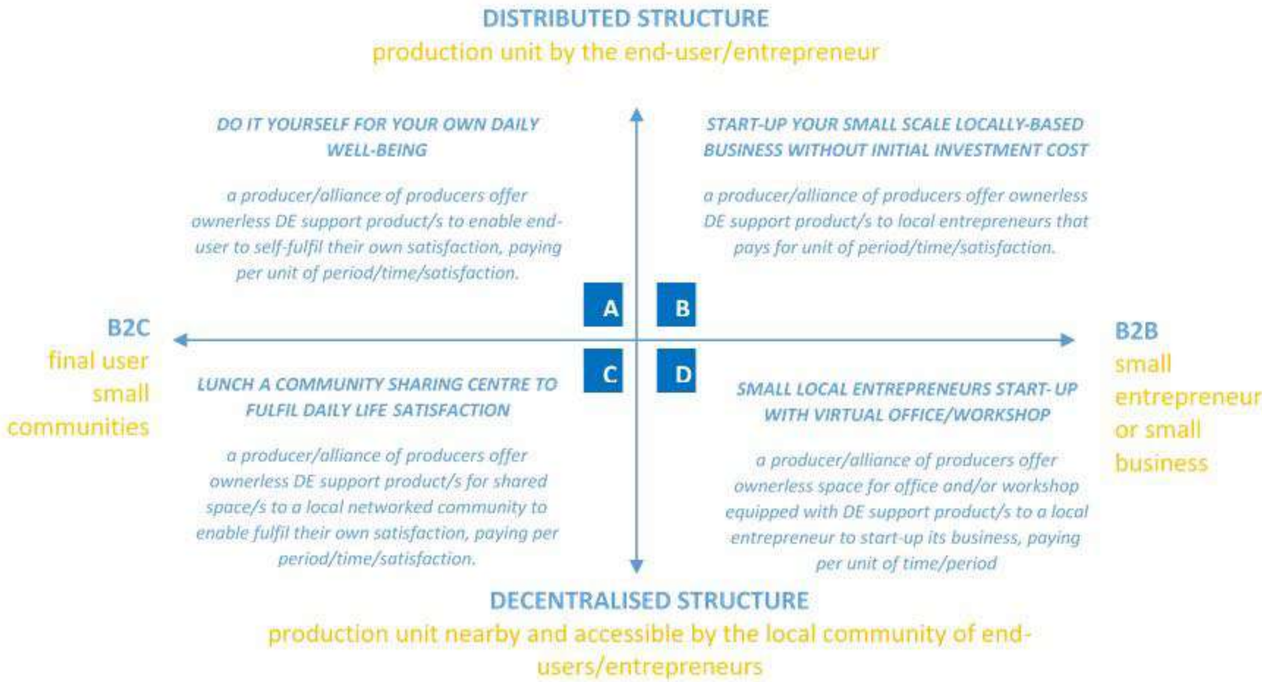

Figure 7. The design-orienting scenario for S.PSS applied to DE

6. System Design for Sustainability for All: a New Role Designing S.PSS Applied to DE

Finally, for ***Designing Sustainable Product-Service System applied to Distributed Economies,*** the following new role of designer is envisioned as defied below: (LeNSin Polimi Team, 2015)

SD4SA:
"design of S.PSS applied to DE, i.e. the design of the Systems of Products and Services that are together able to fulfil a particular customer demand (deliver a "unit of satisfaction"), within the DE paradigm; based on the design of innovative interactions among locally-based stakeholders, where

the ownership of the product/s and/or its life cycle responsibilities remain by the provider/s, so that economic interests of the provider/s continuously seek both environmentally and socio-ethically beneficial new solutions, i.e. solutions accessible to all".

Within this framework there is the need to develop the new knowledge-base and know-how for the new competences in Designing and implementing Sustainable Product-Service System applied to Distributed Economies.

Based on the key approaches/skills of S.PSS design (Vezzoli, Kohtala, Srinivasan et al., 2017) the following could be derived as a first tentative description for System Design for Sustainability for All:

A. "satisfaction-system" approach: *design the satisfaction of a particular demand ("satisfaction unit") and all its related DE products and services;*
B. "stakeholder configuration" approach: *design the interactions of the stakeholder of a particular DE satisfaction-system;*
C. "system sustainability4all" approach: *design sustainable for all DE (offer model) where the economic and competitive interests of the providers continuously seek for environmental and socioethical beneficial new solutions.*

In fact, this new role in (System) Design for Sustainability for All, moves from mere "appropriate technologies" design to "appropriate stakeholder configuration" design, to address S.PSS applied to DE.

In this framework, the two key disciplinary grounds to be merged, redefined and up-dated are those of Product-Service System design for Sustainability and that of Distributed Economies (DE) design and development.

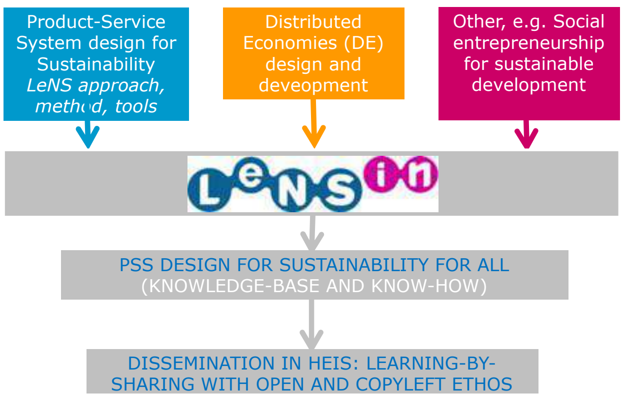

Figure 8. Knowledge area sources for the building of the new discipline of System Design for Sustainability for All

7. Tools Developed for System Design for Sustainability for All Approach

A set of design tools for System Design for Sustainability for all (SD4SA) are developed to support design processes for the development of S.PSS, applicable to DE at the LeNS Lab at Politecnico di Milano. These tools are adaptable to specific design requirements and usable in existing design processes. In the figure below, the main phases and tools are listed.

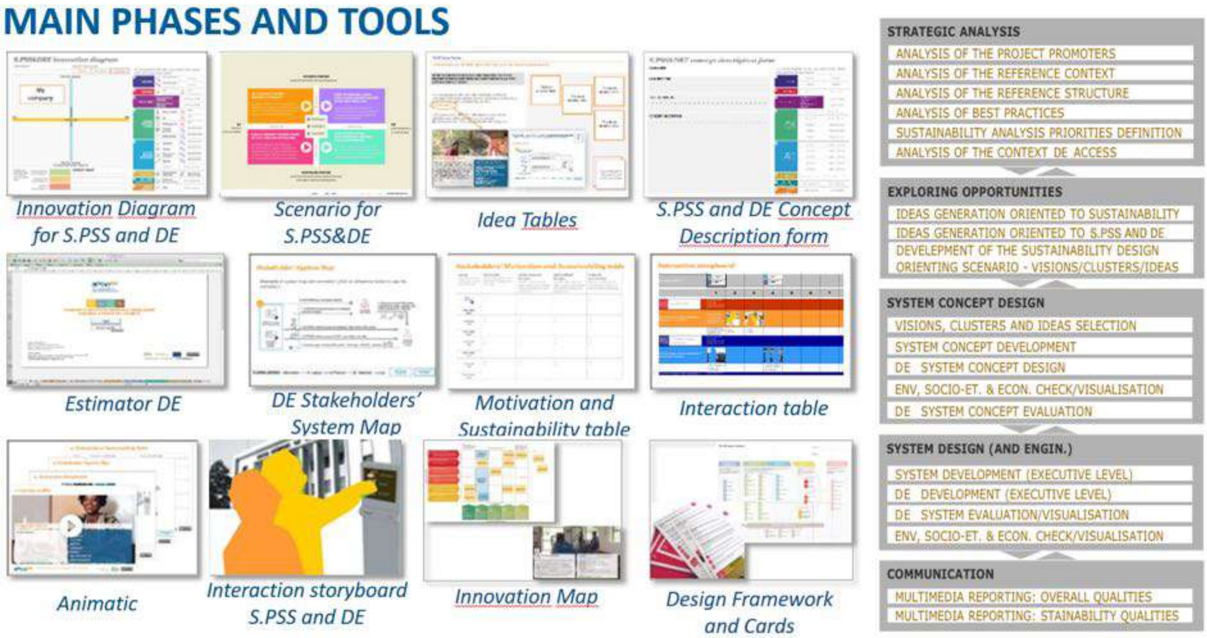

Figure 9. SD4SA main design phases and tools

In particular, the following tools are developed for S.PSS applied to DE:

- **Sustainability Design-Orienting Scenario _S.PSS&DE** for inspiring Sustainability For All ideas generation (S.PSS applied to DE)
- **Sustainability Design-Orienting (SDO) Toolkit** for orientating system design process towards sustainable solutions (environmental, socio-ethical, economic)
- **SDO Idea Table** for orientating DE idea generation process towards S.PSS offer model
- **Innovation Diagram** for positioning and characterizing existing offer and competitors; selecting promising ideas and starting characterizing S.PSS&DE concept profile
- **System Map** for visualizing (design and co-design) the configuration of the system, describing actors involved and their interactions

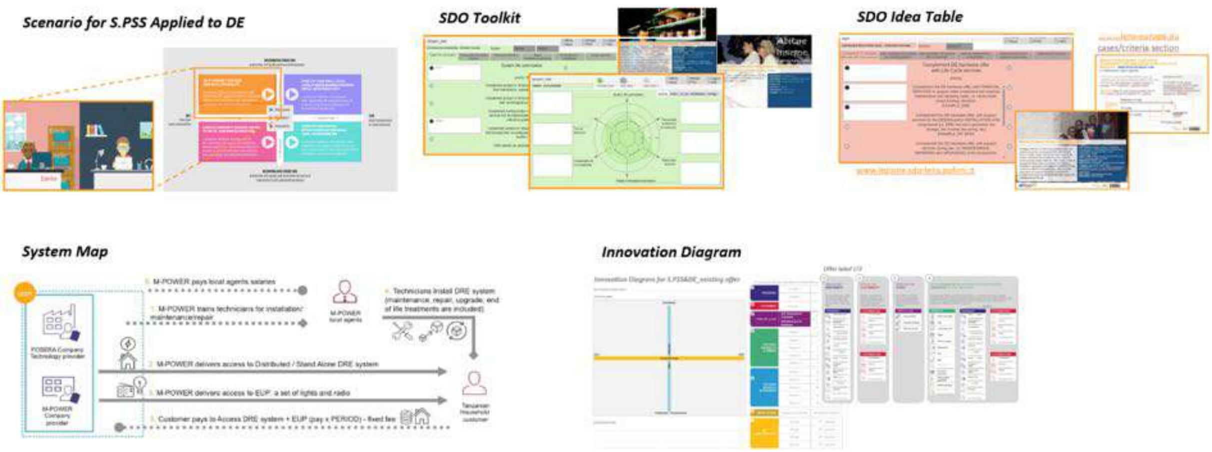

Figure 10. Tools developed for S.PSS applied to DE

8. Conclusion

The paper contents are innovative as both the understanding (and the description) of the win-win potentials of S.PSS applied to DE; and the related system design approaches, skills and tools are new. Those outcomes resulted from a process where their validity and characterisation have been carried out by a well-integrated groups of multidisciplinary and multicultural worldwide researchers. Finally, all the learning resources on the knowledge-base and know-how developed in the project are uploaded on the LeNS web platform, where they could be downloaded free of charge, with an open and copy-left ethos. The outcomes achieved are already innovative and relevant, but at the same time, it is clear that new research activities are needed to better identify the win-win characteristics of S.PSS applied to DE as well as the approaches and the skills for a new generation of designer adopting a system approach to effectively address the sustainability challenge.

References

Goedkoop, M. (1999). Product service systems. *Ecological and economic basis*.

Johansson, A., Kisch, P., & Mirata, M. (2005). Distributed economies–a new engine for innovation. *Journal of Cleaner Production*, *13*(10-11), 971-979.

LeNSin Polimi team. (2015). The LeNSin research hypothesis: system design for sustainability for all. The design of S.PSS applied to DE a win-win offer model for a sustainable development for all, submitted Project Proposal (EU funded, 2015-2018). Milan. Retrieved from http://lens-international.org/

LeNSin Polimi team. (2018). The LeNSin research hypothesis: system design for sustainability for all. The design of S.PSS applied to DE a win-win offer model for a sustainable development for all, Polimi Internal Document of LeNSin project (EU funded, 2015-2018). Milan. Retrieved from http://lens-international.org/

Mont, O. (2002). *Functional thinking: the role of functional sales and product service systems for a function-based society,* research report for the Swedish EPA. Lund, Sweden: IIIEE Lund University.

Tischner, U., Ryan, C., & Vezzoli, C. (2009). Chapter 7: Product-service systems. In M. R. M. Crul, J. C. Diehl, & C. Ryan (Eds.*), Design for Sustainability: A Step by Step Approach*. UNEP, TUDELFT

Tukker, A., & Van Halen, C. (2003). *Innovation scan product service combinations, manual.* Delft: TNO-STB.

UNEP. (2002). Product-Service Systems and Sustainability. Opportunities for Sustainable Solutions. Paris, France: UNEP, Division of Technology Industry and Economics, Production and Consumption Branch.

Van Den Dool, A., Marchington, E., Ripken, R., Hsieh, A. S., Petrasova, M., Bilic, D., ... & Yao, C. (2009). The future is distributed: a vision of sustainable economics. *IIIEE SED reports*.

Vezzoli C., Kohtala C., Srinivasan A., with Xin L., Fusakul M., Sateesh D., Diehl J.C. (2014). *Product-Service System Design for Sustainability.* London: Greenleaf Publishing Inc.

Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D., & Diehl, J. C. (2017). *Product-service system design for sustainability*. Routledge.

Vezzoli, C. (2018). Design for Environmental Sustainability: Life Cycle Design of Products. London: Springer.

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