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Systemic Design Principles in Social Innovation: A Study of Expert Practices and Design Rationales

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Abstract
In recent decades, design has expanded from a practice aimed at designing things to one that helps to address complex societal challenges. In this context, a field of practice called *systemic design* has emerged, which combines elements of systems thinking with elements of design. We use a case study approach to investigate how expert practitioners carry out systemic design work in the context of public and social innovation, and explore what we can learn from their practices and design rationales when we compare them to systems thinking theories and approaches. Based on findings from five case studies, we present five systemic design principles: 1) opening up and acknowledging the interrelatedness of problems; 2) developing empathy with the system; 3) strengthening human relationships to enable creativity and learning; 4) influencing mental models to enable change; and 5) adopting an evolutionary design approach to desired systemic change. One way that scholars can contribute to this field is by continuing to monitor and describe emerging systemic design principles developed and performed at the forefront of the field, strengthening these learnings by building on the body of knowledge about systems thinking and design.

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Introduction

In recent decades, design has moved from a practice aimed at designing things to one that plays a part in addressing today's complex societal challenges[1] through social innovation. Social innovation is the generation and implementation of novel solutions to a social problem situation such that the value created accrues primarily to society as a whole rather than private individuals.[2] Some well-established practices and principles have contributed to the success of design in this new context, including problem framing,[3] human-centered design,[4] iterative design,[5] and collaborative design practice.[6]

The social innovation context has an expanded focus compared to traditional product design: from users and customers to society more broadly; from designing products and services to designing complex service systems, organizations, policies, and strategies; and from the private sector to include the private, public, and social sectors together. The move of traditional design to the domain of social innovation means that traditional design practice needs to be adapted to this field. Kees Dorst has argued that we cannot simply *adopt* a practice that we have found to be successful in a particular domain and apply it in another domain: useful practices borrowed from one field must be *adapted* to the needs in the target field.[7] This applies to both the process of designing and the design rationale, or reasoning, underlying the outcome.

One such adaptation is visible in design practices that have become increasingly *systemic*. This includes designers gaining a deep understanding of the complexity and wickedness of problems and societal systems, and developing new practices to design for these systems. This new form of design was described by Richard Buchanan in the 90s as fourth order design.[8] It has become increasingly popular amongst design scholars and practitioners over the past decade, who have referred to it as transformation design,[9] DesignX,[10] and Design 4.0.[11] Many of these scholars have argued how design practices can be enriched through *systems thinking* theories and practices.

Systems thinking is based on a method of reasoning called *synthesis*: considering things in relation to a larger system — or indivisible whole — of which they are part. It was developed in response to the observed inadequacy of deterministic and reductionist approaches to complex problem solving. Systems thinking has developed a rich body of knowledge over the past century, including several schools of thought.[12] However, it has also been criticized for focusing only on analyzing and modelling systems, while lacking practical approaches to innovate on problems within those systems.[13]

While there is a strong history of conceptual connection between the fields of systems thinking and design, each one has evolved to specialize in separate methods and applications.[14] However, in recent years, growing complexity and increasing strain on societal systems has reignited an interest in integrating systems thinking and design practices to build on the analytical strengths of systems thinking and the action-oriented strengths of design.[15] This unified field of *systemic design* is emerging as a new area of practice and academic study.[16] It is fostered by the systemic design community[17] and the transition design community,[18] with each network organizing

1 Kees Dorst has defined these types of problems as open, complex, dynamic, and networked. Kees Dorst, *Frame Innovation: Create New Thinking by Design* (Cambridge, MA: The MIT Press, 2015), 9. The Club of Rome refers to them using the term "problematique." Hasan Özbekhan, *The Club of Rome–The Predicament of Mankind: Quest for Structured Responses to Growing World-Wide Complexities and Uncertainties* (Philadelphia: University of Pennsylvania Management and Behavioral Science Center, 1970), 12, available at https://demosophia.com/wp-content/uploads/Predicament-Club-of-Rome-1970-1.pdf.

2 Adapted from a definition in James A. Phills, Kriss Deiglmeier, and Dale T. Miller, "Rediscovering Social Innovation," *Stanford Social Innovation Review* 6, no. 4 (2008): 34–43, available at https://ssir.org/articles/entry/rediscovering_social_innovation.

3 Kees Dorst, "The Core of 'Design Thinking' and Its Application," *Design Studies* 32, no. 6 (2011): 521–32, DOI: https://doi.org/10.1016/j.destud.2011.07.006.

4 Mieke van der Bijl-Brouwer and Kees Dorst, "Advancing the Strategic Impact of Human-Centered Design," *Design Studies* 53 (November 2017): 1–23, DOI: https://doi.org/10.1016/j.destud.2017.06.003.

5 The underlying pattern of iterative design is a co-evolution of the problem and solution. Kees Dorst and Nigel Cross, "Creativity in the Design Process: Co-evolution of Problem–Solution," *Design Studies* 22, no. 5 (2001): 425–37, DOI: https://doi.org/10.1016/S0142-694X(01)00009-6.

6 Design Council, Danish Design Centre, Aalto University, and Design Wales, "Design for Public Good" (Report from Design Council, London, 2013), 1–50, https://www.designcouncil.org.uk/resources/report/design-public-good.

7 Kees Dorst, "Frame Creation and Design in the Expanded Field," *She Ji: The Journal of Design, Economics, and Innovation* 1, no. 1 (2015): 22–33, DOI: https://doi.org/10.1016/j.sheji.2015.07.003.

8 Richard Buchanan, "Wicked Problems in Design Thinking," *Design Issues* 8, no. 2 (1992): 5–21, DOI: https://doi.org/10.2307/1511637.

9 Colin Burns et al., "Red Paper 02: Transformation Design" (Report from Design Council, London, 2006), available at https://www.designcouncil.org.uk/resources/report/red-paper-02-transformation-design.

10 Donald A. Norman and Pieter Jan Stappers, "DesignX: Complex Sociotechnical Systems," *She Ji: The Journal of Design, Economics, and Innovation* 1, no. 2 (2015): 83–106, DOI: https://doi.org/10.1016/j.sheji.2016.01.002.

events and establishing publications to accumulate and share a body of knowledge.

The academic literature exploring systemic design has expanded significantly through these recent networked efforts. Contributions are largely driven by theoretical propositions for integrated principles and postures for the field, methods drawn from either systems thinking or design which are adapted and trialed in practice, and numerous self-reflective case studies applying these methods in various domains. We make several unique contributions in this article. We identify the practices used by expert practitioners at the forefront of social innovation across five global case studies and discern the systemic design principles inherent in their practices. Rather than being an explicit application of theory, we provide ground-up principles based on emerging practitioner experience of what works when it comes to influencing complex problem situations. By comparing and critiquing their practices and design rationales to the systems thinking and design literature, we contribute to the understanding of how real-world practice aligns with or differs from current theory, provide a rich and contextualized illustration of the application of systemic design approaches, and identify opportunities for further development of the field. Our practice-led approach also provides more accessible guidance to those seeking to advance their practice and design outcomes in the face of increased complexity.

In a previous issue of this journal we presented the results of a study focused on investigating the design practices of public and social innovation agencies, and in particular the design practice of problem framing.[19] One of our key insights was that the practitioners approached the complex challenges they were addressing in a systemic way—the practices they used appeared to be consistent with systems thinking theories and approaches, beyond the design practices we were initially interested in. This led us to conduct a second analysis of the data using a systems thinking lens alongside the design lens. In this article we present the findings on systemic design principles from this second study.

The next section contains a brief overview of systems thinking, and its relation to design, to frame our study. We then present the methodology and results of our study and, after that, conclude by setting a research agenda for the study of systemic design principles.

Systems Thinking—An Introduction

A system is an integrated whole whose essential properties arise from the relationships between its parts.[20] These essential properties are called *emergent properties*,[21] and none of the parts has these properties individually. For example, the whole human body arises from the relationships between body parts, and the emergent property of the body is life.[22] Similarly, the whole of an airplane arises from the relationships between its parts, and its emergent property is flying.

Systems thinking is the understanding of a phenomenon within the context of the larger whole. This process is referred to as *synthesis*, which is opposed to, and complements, the reductionist process of *analysis*. Russell

11 Peter Jones and G. K. VanPatter, "Understanding Design 1, 2, 3, 4: The Rise of Visual Sensemaking," in *Meanings of Designed Spaces*, ed. Tiiu Poldma (New York: Fairchild Books, 2013), 311–42.

12 Examples of well-known schools of thought include social systems: see for example Bela H. Banathy, *Designing Social Systems in a Changing World* (New York: Plenum Press, 1996); complexity: see for example Helen Hasan, "Complexity Theory," in *Being Practical with Theory: A Window into Business Research*, ed. Helen Hasan (Wollongong: THEORI, 2014), 49–54; system dynamics: see for example Jay W. Forrester, "System Dynamics: A Personal View of the First Fifty Years," *System Dynamics Review* 23, no. 2/3 (2007): 345–58, DOI: https://doi.org/10.1002/sdr.382; soft systems: see for example Peter Checkland, *Systems Thinking, Systems Practice* (Chichester: John Wiley, 1999); and cybernetics: see for example Norbert Wiener, *Cybernetics, or Control and Communication in the Animal and the Machine* (New York: Wiley and Sons, 1944).

13 For example, Russell Ackoff argued that systems thinkers "have had little or no effect on the global mess … we can contribute by making public policy and decision makers aware of ideas and concepts that would enable them to think more creatively and effectively about the mess the world is in." Russell L. Ackoff, "Transforming the Systems Movement," *The Systems Thinker* 15, no. 8 (2004): 3, available at https://thesystemsthinker.com/wp-content/uploads/pdfs/150801pk.pdf.

14 Systems thinking was incorporated into design science from the 1960s, notably by Peter H. Jones in "Systemic Design Principles for Complex Social Systems," in *Social Systems and Design*, ed. Gary S. Metcalf (Tokyo: Springer, 2014), 91–128; while Ackoff and others included idealized design steps within systems thinking, described by Richard Buchanan in "Systems Thinking and Design Thinking: The Search for Principles in the World We Are Making," *She Ji: The Journal of Design, Economics, and Innovation* 5, no. 2 (2019): 85–104, DOI: https://doi.org/10.1016/j.sheji.2019.04.001.

15 Buchanan, "Systems Thinking and Design Thinking."

16 Sevaldson and Jones call systemic design "an open-ended, dynamic, living, emerging, organically developing field." Birger Sevaldson and Peter Jones, "An Interdiscipline Emerges: Pathways to Systemic Design," *She Ji: The Journal of Design, Economics and Innovation* 5, no. 2 (2019): 77, DOI: https://doi.org/10.1016/j.sheji.2019.05.002.

Ackoff explains that "in analytical thinking, the thing to be explained is treated as a whole to be taken apart. In synthetic thinking, the thing to be explained is treated as part of a containing whole."[23]

Systems thinking emerged in response to the limitations of analytical and reductionist thinking as presented within the scientific viewpoint that has prevailed since the age initiated by the Renaissance.[24] This viewpoint is based on the belief that the behavior of the whole can be understood entirely from the properties of its parts. This reductionist thinking and approach is core to many disciplines and professions—for example in Western medicine, which is organized into specializations based on parts of human bodies.

Although science and analysis have had an immense and positive impact on society, a limitation of reductionist thinking is (as explained by Ackoff)[25] that "improvement in the performance of parts of a system taken separately may not, and usually does not, improve performance of the system as a whole."[26] This limitation manifests itself in many disciplines, for example in psychiatry, where mental health is reduced to chemical processes in the brain and, as a result, solutions for mental illness are limited to medication.[27]

The acknowledgement of the limitations of reductionism and subsequent development of the main characteristics of systems thinking emerged simultaneously in several disciplines during the 1920s.[28] The Austrian biologist Ludwig von Bertalanffy is commonly credited[29] with the first formulation of a theoretical framework describing the principles of organization of living systems in the General Systems Theory he introduced in the 1930s. Since then, a wide variety of systems theories and schools of thought have been developed across disciplines. This includes organismic biology, whose proponents emphasized the view of living organisms as integrated wholes. In physics, systems thinking emerged in quantum physics, which forced physicists to accept that subatomic particles are not things, but rather interconnections between things.[30] And in psychology, gestalt psychologists argued that our human perception is more than the sum of its parts.[31]

Systems thinking can be understood through a large number of key theories that aim to explain the nature and behavior of different types of systems. For example, system dynamics describes the behavior of systems such as economies or technical systems through *stocks and flows*,[32] while living systems theories explain the behavior of living organisms and ecologies through the concept of *autopoiesis* (self-making),[33] and complexity theory explains the behavior of ecological and socio-technical systems through concepts such as *self-organization*[34] and *emergence*.[35] These theories often overlap and complement one another, while in other cases they contradict or challenge each other.

The contexts that social innovation practitioners work in can be considered sociotechnical systems,[36] which comprise interacting (groups of) people, institutions, and (material) artifacts and knowledge held by organizations, communities, teams, families, or sectors (for example the health care system or the child protection system). These social innovation contexts can be perceived through various theoretical systems lenses, including those above. Birger Sevaldson and Peter Jones[37] argue that since systemic design is a newly emerging field, we should not settle into a fixed paradigm

17 This community was recently formalized into the Systemic Design Association. For more information, please visit https://systemic-design.net/sdrn/.

18 Terry Irwin, "Transition Design: A Proposal for a New Area of Design Practice, Study, and Research," *Design and Culture* 7, no. 2 (2015): 229–46, DOI: https://doi.org/10.1080/17547075.2015.1051829.

19 Mieke van der Bijl-Brouwer, "Problem Framing Expertise in Public and Social Innovation," *She Ji: The Journal of Design, Economics, and Innovation* 5, no. 1 (2019): 29–43, DOI: https://doi.org/10.1016/j.sheji.2019.01.003.

20 Fritjof Capra, *The Web of Life: A New Synthesis of Mind and Matter* (London: Flamingo, 1997), 27.

21 The term "emergent properties" was coined by philosopher Charlie Dunbar Broad to indicate properties that emerge at a certain level of complexity but do not exist at lower levels. Capra, *Web of Life*, 28.

22 For example, Ackoff explains how "people can run, play piano, read, write, and do many other things that none of their parts can do by themselves." Russell Lincoln Ackoff, *Ackoff's Best: His Classic Writings on Management* (New York: John Wiley & Sons, 1999), 16.

23 Ibid., 16.

24 Ibid., 9.

25 Ackoff, "Transforming the Systems Movement," 1–4.

26 Ibid., 4.

27 A holistic approach to mental health acknowledges its connection to physical health and social determinants, and as a result, finds (complementing) solutions in physical exercise, and 'social' interventions, as for example promoted in positive psychology. Martin E.P. Seligman and Mihaly Csikszentmihalyi, "Positive Psychology: An Introduction," *American Psychologist* 55, no. 1 (2000): 5–14, DOI: https://doi.org/10.1007%2F978-94-017-9088-8_18.

28 Capra provides a comprehensive overview of the history and development of systems thinking. Capra, *Web of Life*, 17–150.

29 Capra argues that Alexander Bogdanov developed an equally sophisticated systems theory about 30 years before Bertalanffy. Capra, *Web of Life*, 43.

30 Capra, *Web of Life*, 30.

31 Ibid., 31.

32 Donella H. Meadows, *Leverage Points: Places to Intervene in a System* (Hartland: The Sustainability Institute, 1999), 1–19, available at http://donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/.

or methodology. In line with this argument we adopt a pluralistic perspective on relevant systems theories and will use and introduce theories in this paper that help to explain and critique the practices we identified in our study.

Design and Intervening in Systems

Systems approaches include processes to investigate and analyze systems, as well as strategies to design or intervene in systems. We distinguish the approaches that aim to *design* a system, from those that merely aim to *intervene* in an existing system. The former are commonly referred to as *hard systems approaches*, which originate in systems engineering, a goal-directed approach based on predicting and controlling the behavior of the system to be designed.[38] They are appropriate for the design of technical systems such as computer systems and other types of machines. However, the domain of sociotechnical systems targeted by social innovation practitioners is characterized by high levels of complexity and unpredictability and cannot be sufficiently described or controlled through a pre-determined design solution.[39] While we can design and engineer technical systems within a sociotechnical domain, we can only aim to influence or intervene in the broader complex systems they are part of.

There are various approaches that acknowledge the limitations of predicting and engineering complex societal systems, and instead refer to their aims as cultivating systems change,[40] transformation,[41] or transitions[42] towards more sustainable and equitable societies. An example of such a systems change approach is the identification of leverage points (described by Donella Meadows[43]): strategic places to intervene within a complex system where a small shift in one area can produce significant changes across the whole system. Other systems-influencing approaches provide us with strategies to manage systems change. For example, within transition studies, Jan Rotmans and Derk Loorbach have proposed a set of systemic management[44] instruments to influence societal change, for instance by forming coalitions and networks to drive activities in a shared and desired direction.

Whilst it is essential that we understand where we can and should intervene in sociotechnical systems, and how such processes of intervening can be effectively managed, there is a gap in dominant systems theory with regard to practice: how *to design* those interventions. Design enables us to develop interventions at multiple levels of a system. Design is inherently systemic, as reflected in the way that designers synthesize their designs. For example, Donald Schön describes how designers oscillate between the total and the unit in their design process.[45] Harold Nelson and Erik Stolterman also argue that "designers must be able to create essential relationships and critical connections in their designs and between their designs and the larger systems in which they are embedded — in other words, designers must be systemic in everything they do and make."[46]

However, as argued in the introduction, traditional design needs to adapt to the new social innovation context. While many interesting systemic design approaches and principles have been proposed and developed in

33 Capra, *Web of Life*, 97.
34 Hasan, "Complexity Theory."
35 Ibid.
36 For an overview, see Jochen Markard, Rob Raven, and Bernhard Truffer, "Sustainability Transitions: An Emerging Field of Research and Its Prospects," *Research Policy* 41, no. 6 (2012): 956, DOI: https://doi.org/10.1016/j.respol.2012.02.013.
37 Sevaldson and Jones, "An Interdiscipline Emerges," 75–84.
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38 Checkland, *Systems Thinking, Systems Practice*, 129.
39 Checkland argues that real-world human activity systems contrast with hard technological systems because they can "never be described or modelled in a single account which will be either generally acceptable or sufficient" (Ibid., 191). The soft systems methodology that Checkland developed is therefore "a means of organizing discussion, debate, and argument, rather than a means of engineering efficient 'solutions'" (Ibid., 191).
40 Anna Birney, *Cultivating System Change: A Practitioner's Companion* (Oxford: Dō Sustainability, 2014).
41 According to Ackoff, transformation is required to handle the "global mess" we are in, not reformation. "Peter Drucker put this distinction dramatically when he said there is a difference between *doing things right* (the intent of reformations) and *doing the right thing* (the intent of transformations). Ackoff, "Transforming," 2, emphasis original.
42 For example, Jan Rotmans and Derk Loorbach hypothesize that "it is possible to use the understanding of transition dynamics to influence the direction and pace of a transition of a societal system into a more sustainable direction." See Jan Rotmans and Derk Loorbach, "Complexity and Transition Management," *Journal of Industrial Ecology* 13, no. 2 (2009): 185, DOI: https://doi.org/10.1111/j.1530-9290.2009.00116.x.
43 Meadows, *Leverage Points*, 1–19.
44 "Management — in the context of complexity theory — means influencing the process of change of a complex, adaptive system from one state to another." Rotmans and Loorbach, "Complexity and Transition Management," 188.
45 Donald Schön, *The Reflective Practitioner: How Professionals Think in Action* (New York: Basic Books, 1983), 102.
46 Harold G. Nelson and Erik Stolterman, *The Design Way: Intentional Change in an Unpredictable World*, 2nd ed. (Cambridge, MA: The MIT Press, 2012), 57.

academic contexts, the field is also rapidly evolving in practice. We therefore chose to investigate this adapted practice by studying expert practitioners who are working at the forefront of the field of social innovation.

The Role of Principles in Social Innovation Practice

Rather than a deep exploration of practice, as is typical in the field of organizational studies, we focus on deducing the principles underlying those practices. In the context of design, we consider a principle as a rule or heuristic established through experience that guides a practitioner towards a successful solution.[47] Principles are context-dependent, but can be applied across similar design contexts.[48] Examples of design principles for the emerging systemic design field include those proposed by Peter Jones,[49] such as boundary framing, requisite variety, generative emergence, and continuous adaptation. Design principles can provide the foundation for new methods, tools, and techniques to be developed.

Throughout the study, we found repeating systemic design principles within the processes of designing as well as the outcomes being designed. Principles related to the process of designing provide guidance on how practitioners perform their work, their practice. For example, the established principle of requisite variety[50] informs the practice of selecting participants in an effective multi-stakeholder design process. Principles inherent in the outcomes of design processes reveal the rationales[51] of how practitioners are seeking to influence complex problem situations through their work. For example, a designer applying circular design principles will design products or services intended to have a reduced negative impact on the planet through designing out waste and renewing resources.

Research Objective and Method

This study is aimed at investigating the reoccurring, systemic principles that underlie the design practices and design rationales of public and social innovation agencies. Practices are patterns of activity that are situated, social, and relational.[52] Rather than fixed methods, practices are unique to each design and problem situation. A principle can be derived from deducing common patterns across practices in different design situations. A design rationale is the representation of reasoning behind the design of an artifact.[53] Dorst explains how a fundamental reasoning pattern in design constitutes how a solution and working principle lead to an aspired value.[54] In the context of systemic design, it therefore becomes relevant to investigate which working principles practitioners apply in their solutions to achieve *systemic value*. For example, we identified the working principle of "strengthening human relationships" for systemic interventions that practitioners used to foster learning and creativity, both of which are systemic values.

This study was executed as part of broader research project investigating the designerly practices of public and social innovation agencies. These agencies, sometimes called labs, work within or alongside public or social sector organizations. We conducted the study using a retrospective case study approach, because design and social innovation practices are situated

47 Katherine Fu, Maria Yang, and Kristin Wood propose a formal definition for a design principle, based on an extensive literature review, as a "fundamental rule or law, derived inductively from extensive experience and/or empirical evidence, which provides design process guidance to increase the chance of reaching a successful solution." Katherine K. Fu, Maria C. Yang, and Kristin L. Wood, "Design Principles: Literature Review, Analysis, and Future Directions," *Journal of Mechanical Design* 138, no. 10 (2016): 3, DOI: https://doi.org/10.1115/1.4034105. Design principles are also referred to as guiding principles in Bryan Lawson, *How Designers Think: The Design Process Demystified*, 4th ed. (Oxford: Architectural Press/Elsevier, 2006), 159. The term "heuristic" is sometimes preferred in place of "principle" in the design literature. Fu, Yang and Wood describe heuristics as the "conceptual kin" of principles, reaching the conclusion that heuristics differ in that they are context-dependent and based on intuition, whereas principles have been established as a fundamental rule through extensive experience. Fu et al., "Design Principles," 2.

48 Fu et al., "Design Principles," 1–13.

49 Jones, "Systemic Design Principles"; Fu et al., "Design Principles," 1–13.

50 Jones, "Systemic Design Principles."

51 A design rationale is defined as "a representation of the reasoning behind the design of an artifact." Simon Buckingham Shum and Nick Hammond, "Argumentation-Based Design Rationale: What Use at What Cost?," *International Journal of Human-Computer Studies* 40, no. 4 (1994): 603, DOI: https://doi.org/10.1006/ijhc.1994.1029.

52 Kathleen Mahon and her colleagues provide an overview of practice theories and their basic tenets. Kathleen Mahon et al., "Introduction: Practice Theory and the Theory of Practice Architectures," in *Exploring Education and Professional Practice: Through the Lens of Practice Architectures*, ed. Kathleen Mahon, Susanne Francisco, and Stephen Kemmis (Singapore: Springer, 2016).

53 Shum and Hammond, "Argumentation-Based Design Rationale," 603–52.

54 Dorst, "The Core of 'Design Thinking' and Its Application."

Table 1 **Case study overview.**

Agency	Initial brief	Key partnering organization(s)
MindLab	Address the dilemma of time versus quality for Danish elementary school teachers, following a reform of educational policy in terms of increased teaching and administration hours, resulting in reduced preparation time and poorer staff satisfaction.	Municipality, Denmark
KennisLand	Support the municipality, relevant stakeholders, and partnering organizations wanting to know "How might we design better policy?" and "What is it like to be living well as a young person in [this municipality]?"	Municipality, the Netherlands
InWithForward	Address the question of how to reduce social isolation among adults living with cognitive disabilities.	Three nonprofits and providers of services for adults living with disabilities, Canada
The Australian Centre for Social Innovation (TACSI)	Increase the number of children restored from foster care to their birth families by asking, "How do we enable more children to safely return home to their families, remain at home, and thrive?"	Philanthropic organization, academic institute, and state government department, Australia
CoLab	Work with a provincial government that asked, "How can we effect changes to our data systems architecture and information dissemination procedures, and leverage or modify governance processes to ensure we make significantly more of the most valuable data open and available?"	Provincial government, Canada

and cannot be separated from the case study context itself. We selected a project from each of the five participating agencies based on the following criteria: the project aimed to address a complex, ill-defined problem situation; it included collaboration with a public and/or social sector organization; it was recent enough for team members to be able to reflect on their practices. Table 1 contains a brief description of the five cases we selected.

Data Gathering

We gathered data via semi-structured interviews with at least two team members from each innovation agency or department and at least one staff member from the partnering public or social sector organization(s). All the agencies gave us access to project documentation, including reports and other design materials. We interviewed staff members from the participating organizations individually or in their teams of two or three people. Individual interviews took 30–60 minutes, while group interviews took 60–90 minutes. In total, we conducted 16 interviews with 14 innovation agency staff members and eight partner organization staff members. Seven interviews took place in person and the other interviews we conducted over the phone or by video call.

To gain an understanding of both the activities in the design process and the reasoning used to arrive at the proposed designs, we broke the interviews with the innovation agency staff members down into three parts. In the first part, we asked participants to explain the different activities undertaken from initial project proposal to final (or current) result. In the

second part, we asked participants to reason from the initial problem brief to final (or current) design proposal to get a basic understanding of how their design rationale had evolved in relation to the activities. In the third part of the interview, we sought a deeper understanding of the reasoning of the proposed design by asking participants what they thought the design meant to specific stakeholders and which needs or aspirations were met. The data gathering process ensured a data set of multiple interviews and documents per case.

Data Analysis

We had the interviews transcribed in full, and took an inductive thematic approach to analyze the practices and design rationales. The triangulated data was used to summarize each project in a case study report that clearly outlined the different steps in each design process, the methods used, and the way the design rationale developed. Our first analysis focused on the designerly practice of problem framing and showed the various strategies that the practitioners used to arrive at fruitful problem frames. These results were presented in an earlier article published in this journal.[55]

Once we identified that certain practices and design rationales had a systemic nature, we conducted a second analysis of the data as presented in this study. This analysis was executed using an iteratively developed systems thinking lens. We started by conducting a broader literature review of systems thinking and consulted four design and systems thinking experts to critique our preliminary principles in an iterative process. The experts' critique included additional literature suggestions to develop our systems thinking lens. We subsequently defined systemic design principles as ones based on prominent design principles that, at the same time, share characteristics with systems thinking theories or approaches. Finally, by investigating the resulting tensions between systems thinking and design practice, we defined opportunities and questions for further development of systemic design methods and practices.

For our data analysis we used systems thinking literature as a way to both identify and critique the practices and design rationales. A limitation of this approach is the inherent subjective bias in the development of this lens. It is likely that other researchers would observe different patterns in our data set. Therefore, rather than claiming a complete overview of systemic design principles, we show how systems literature can shed light on current social innovation practices, and identify further opportunities to evolve this practice.

Findings

We identified the following systemic design principles in the case studies:

- opening up and acknowledging the interrelatedness of problems,
- developing empathy with the system,
- strengthening human relationships to enable learning and creativity,
- influencing mental models to enable change, and
- adopting an evolutionary design approach.

55 Van der Bijl-Brouwer, "Problem Framing Expertise."

The third and fourth principles relate to the *design rationales* of the social innovation practitioners: the working principle of their designed interventions, which they envisioned would lead to desired systemic change. The other three principles relate to the social innovation *practice*. In this section, we will explain and illustrate each of these principles; compare them to the relevant systems thinking and design literature; and discuss resulting tensions, opportunities, and questions.

Opening Up the Problem Space and Acknowledging Problem Interrelatedness

Every agency adopted a systemic perspective on the nature of the problem situation, acknowledging that these problems are interrelated and cannot be solved independently. For example, a team member from TACSI explained the complexity of challenges within the child protection system as "complex, interrelated, chronic risk factors that span social, health, and education sectors." A Kennisland team member explained that the challenges of youth are "often interrelated. Housing, school, finance are actually related to each other, so it is a bit of a fake solution if it is only presented from one side."

Taking a systemic perspective was not just a recognition of the complex nature of the problem situations the innovation agencies were addressing, it was also an explicit component of their problem framing practices, meaning that the practitioners actively considered the perspective they were choosing to take on the problem.[56] This included *opening up* the problem space. For example, a TACSI interviewee indicated how this happened early on in the briefing process: "What we learnt very, very, very quickly were some fundamental things that opened up the brief to a whole new level," referring to the challenges of child protection being intergenerational.

In systems thinking this is referred to as expansionism,[57] and various tools are available to generate this expanded systems view. For example, the rich picture tool was developed by Peter Checkland[58] as part of the soft systems methodology. Three of the teams used visualization tools to generate an expanded systems view, including rich pictures, concept mapping, and the iceberg model.[59]

The designerly practice of problem framing contributes to developing a systemic perspective on problem situations. This is not just about mapping out the problem space using traditional systems thinking tools. By developing different perspectives on the problem, new pathways for solutions can be opened up.[60]

The way that practitioners developed a perspective on the problem thus combines practices and tools from systems thinking—investigating the interrelatedness of problems and adopting an expanded systems view—with the practice of problem framing from design. This integrated approach is also reflected in the systemic design principle of appreciating complexity proposed by Jones.[61] At the same time, some tensions in the terminology used in these fields emerge here, in particular in relation to the use of the words "problem" and "solution," which are often used in design. This was explained by one of the interviewees as follows:

56 See our earlier article for a detailed description of their problem framing practice and expertise. Van der Bijl-Brouwer, "Problem Framing Expertise."

57 Ackoff explains how "in systems thinking, increases in understanding are believed to be obtainable by expanding the systems to be understood, not by reducing them to their elements." Ackoff, *Ackoff's Best*, 19.

58 Checkland explains how to build up the richest possible picture of the situation in which there is perceived to be a problem. Checkland, *Systems Thinking, Systems Practice*, 163.

59 The popular "iceberg model" places mental models as the deepest level of a system on which patterns of behavior and events are founded. Michael Goodman, "Systems Thinking: What, Why, When, Where, and How?," *The Systems Thinker* 8, no. 2 (1997): 5–7, available at https://thesystemsthinker.com/systems-thinking-what-why-when-where-and-how/.

60 Dorst, "The Core of 'Design Thinking' and Its Application."

61 Jones, "Systemic Design Principles," 106.

> "I have strong ideas about social relations, and that someone's problem is often also the problem of someone else, which might confuse things. If my problem is solved, it has often become a problem of someone else…. So we avoid the terms problem and solution in [our] approach."

Social innovation practitioners in many of the cases had adopted alternative terms to address the tension around the use of problem and solution, including "problem situation" or "challenge," and "systemic intervention" or "prototype."[62]

While opening up and looking at interrelations in problem spaces are inherent to the framing practices used by designers, the systems thinking lens offers opportunities to further strengthen these framing practices—for example, by using analytical system visualization tools mentioned earlier. Some practitioners in the systemic design field have already adopted and adapted these methods to a more designerly practice: Birger Sevaldson, for example, has developed a gigamapping approach, based on rich pictures, which combines the visualization of many types information about a complex problem situation with generative design visualizations.[63] A question to explore further is how such mapping practices can be integrated with the dynamic practice of problem framing in which perspectives change over time during the design process and evolve with generated systemic interventions.

Developing Empathy with the System

The agencies engaged in various practices to explore the problem space systemically. This included acknowledging and investigating the diversity of perspectives across system stakeholders, and working with the tensions that such diversity can create. A team member from TACSI referred to this as developing empathy for the system: "You really have to build and develop empathy for the system…. So often … we'd have fallen into this trap of such a hyper, hyper focus on end users and you become very tunnel-visioned around end users and that is not an enabler for systems change at all."

This principle of systemically exploring the problem situation through stakeholder perspectives combines elements of systems thinking—a focus on relationships and tensions—with the human-centeredness of design. While human-centeredness is a prominent attribute of design, practitioners in four of the five case studies explicitly moved beyond exploring the perspectives, needs, and aspirations of an end-user to exploring the diversity of perspectives across stakeholders. For example, an InWithForward team member explained how they identify "different groups that have different particular sets of needs or resources…. And what is interesting is [that] this grouping was not only describing people with disabilities, but also staff."

The diversity of perspectives meant that tensions would emerge between stakeholders. Rather than viewing these tensions as obstacles, multiple interviewees mentioned how surfacing these tensions is key to finding a way forward:

> "What I like most about our approach is that this is a structured way of engaging in conflict…. We don't just collect stories of [citizens] and hang them on the wall, but we engage with them politically. So we take these stories and go to the police, or to school, or to whoever is mentioned in these stories, and

62 The Dutch respondents used the term "vraagstuk" instead of "problem," which can be explained as "point of inquiry" or "question."

63 Birger Sevaldson, "Giga-Mapping: Visualization for Complexity and Systems Thinking in Design," *Nordes* 4 (2011): 1–20, available at https://archive.nordes.org/index.php/n13/article/view/104.

> we collect the counter-stories, because also the system is trying its best when tackling societal challenges, and has its own stories about what does and does not work well."

A focus on relationships is at the core of all systems thinking theories. Since the agencies were exploring relationships between human beings, it is relevant to look at social systems theories. Social systems consist of groups of purposeful organisms such as human beings.[64] These systems differ from non-social systems in that their relations mostly reside in a symbolic domain, an "inner world of concepts, ideas, and symbols that arises with human thought, consciousness and language."[65] So it makes sense to explore tensions between these invisible layers and forces as part of a social innovation process.

While human-centered design focuses on in-depth exploration of people's experiences in social systems as input for an innovation process,[66] the systemic perspective moves the focus from the individual to consider human relations. This highlights opportunities for design practitioners to work with systemic relational tools such as dialogue. For example, Jones developed the dialogic design[67] method, which includes a dialogic process that "enables the connection of diverse stakeholders to the joint processes of inquiry and design."[68] While such methods bear similarities with participatory design methods, they focus more on relationships between stakeholders rather than needs and aspirations of individual participants.

Strengthening Human Relationships to Enable Learning and Creativity

The focus on human relationships mentioned in the previous principle comes to the fore in this systemic design principle which focuses on systems change through targeting and strengthening relations between people in the system, particularly by enabling learning and creativity. In each case study we found examples of design rationales that represented this working principle.

Two examples of this are the co-parenting model proposed by TACSI and the speed sharing event proposed by MindLab. TACSI aimed to "better enable children and families engaging with the child protection system to live safely and thrive."[69] When children cannot live with their parents, one of the alternatives is foster care. The proposed co-parenting model focuses on the relationship between birth parents and foster parents. It "simultaneously helps the process of restoration [children returning to their birth families], helps to maintain positive birth parent relationships during separation, and supports birth parents in improving their parenting capability."[70]

MindLab was asked by a municipality to help design interventions for primary school teachers who needed to align their teaching practices with a reform recently introduced by the education ministry. The reform required teachers to deliver the same quality of education with less preparation time. An elaborate design process led to the design of a speed sharing event (based on the practice of speed dating). Speed sharing would enable teachers to share ideas about lessons around a specific theme, for example physical education, during an event facilitated by the municipality or by schools themselves.

64 Russell Ackoff and Fred Emery describe purposeful individuals as "one that can change its goals in constant environmental conditions. It selects goals as well as the means to pursue them. It thus displays will." Russell L. Ackoff and Fred E. Emery, *On Purposeful Systems* (London: Tavistock Publications Limited, 1972), 31.

65 Capra, *Web of Life*, 206

66 Van der Bijl-Brouwer and Dorst, "Advancing the Strategic Impact."

67 For example, Jones describes dialogic process as one of five systemic design methods, in Jones, "Systemic Design Principles." Dialogic design is based on the Structured Dialogic Design methodology developed by Alexander N. Christakis and Kenneth C. Bausch in *How People Harness Their Collective Wisdom and Power to Construct the Future in Co-Laboratories of Democracy* (Charlotte: Information Age Publishing Inc., 2006).

68 Jones, "Systemic Design Principles," 125.

69 Internal TACSI document.

70 Ibid.

An interesting characteristic of the focus on human relationships is that the proposed interventions do not provide one-size fits all solutions or prescriptions to change patterns of behavior top down. Instead these interventions let ideas for new behaviors, experiences, and learnings emerge from fostering and supporting these relationships. For example, the co-parenting model allows foster parents and birth parents to collectively develop parenting behavior that is best for the child, and the speed sharing program allows teachers to learn from one another's teaching ideas.

Complexity theory and living systems theory provide an understanding of how working with human relations impacts the emergent behavior of the social system (community or organization) as a whole. In complexity theory, the principle of self-organization states that individual, interconnected actors in a complex system have the capacity to evolve into organized forms without outside influence.[71] For example, management approaches that adopt a complex systems view of organizations focus on emergent organizational behaviors resulting from (healthy) human relationships,[72] rather than on top-down control of the organization. Such emergent behavioral properties include creativity and learning. Anna Birney uses a living systems[73] lens to explain: "Humans create novelty through processes of innovation and learning. We are constantly trying out new ideas and actions … so that we learn, adapt, and evolve."[74] By strengthening human relationships in ways that contribute to learning and creativity, the relational interventions[75] described in the case studies enable the emergence of new behavior, learning, and creativity, and the adaptation and resilience[76] of the system as a whole.

The human-centeredness of design contributes to designing for relationships. These types of design have been referred to as relational design, which is also a trend in service design.[77] Service design in particular is well positioned to design for human relationships, by using its practice of designing for the intangible aspect of relationships and for human experience. Service design was traditionally focused on designing scripts or blueprints that prescribe interactions between a service staff member and a consumer. By contrast, a complex systemic perspective lets go of controlling these interactions and instead focuses on designing conditions, infrastructures, or enabling platforms[78] that promote the emergence of new behavior and learning within human relationships, as well as the behavior and learning of the social system as a whole.[79]

Influencing Mental Models to Enable Change

In addition to strengthening human relationships, another systemic design principle that focuses on the intangible aspect of systems is the influence of human mental models on enabling change. Mental models can foster or inhibit change by facilitating or limiting the way we see the world.[80] All of the practitioners in our case studies identified dominant mental models either held by the client organization, or by users or other stakeholders that held the system back from enabling more positive outcomes. This included the belief that restoration of a child to their birth family is the best outcome in child protection in the TACSI case study, and that it is more important for adults with a disability to be safe than to learn in the InWithForward case study.

71 Hasan, "Complexity Theory," 52.

72 Ralph Stacey states that organizations are "ongoing iterated patterns of relationships between people." Margaret Wheatley takes a living systems view of organizations and explains how those that have the capacity for healthy relationships have the capacity to adapt and grow. Ralph Stacey, "Ways of Thinking About Public Sector Governance," in *Complexity and the Experience of Managing in Public Sector Organizations*, ed. Ralph Stacey and Douglas Griffin (London: Routledge, 2006), 39; Margaret J. Wheatley, *Leadership and the New Science: Discovering Order in a Chaotic World* (Oakland: Berrett-Koehler Publishers, Inc., 2006), 40, 15.

73 Living systems theory states that creativity is a key property of all living and social systems. Capra, *Web of Life*, 216.

74 Birney, *Cultivating System Change*, 22.

75 In an earlier article, we explain how these "social infrastructures" contribute to better service outcomes in service systems. Mieke van der Bijl-Brouwer, "Designing for Social Infrastructures in Complex Service Systems: A Human-Centered and Social Systems Perspective on Service Design," *She Ji: The Journal of Design, Economics, and Innovation* 3, no. 3 (2017): 183–97, DOI: https://doi.org/10.1016/j.sheji.2017.11.002.

76 How resilient a system is, depends on the multiplicity, diversity and variability of the relationships. Birney, *Cultivating System Change*, 22.

77 Manuela Aguirre-Ulloa and Adrian Paulsen, "Co-designing with Relationships in Mind: Introducing Relational Material Mapping," *Formakademisk - Forskningstidsskrift for Design og Designdidaktikk* 10, no. 1 (2017): 1–14, DOI: https://doi.org/10.7577/formakademisk.1608; Carla Cipolla and Ezio Manzini, "Relational Services," *Knowledge, Technology & Policy* 22, no. 1 (2009): 45–50, DOI: https://doi.org/10.1007/s12130-009-9066-z.

78 Daniela Sangiorgi, "Transformative Services and Transformation Design," *International Journal of Design* 5, no. 1 (2010): 29–40, available at http://ijdesign.org/index.php/IJDesign/article/view/940.

79 Van der Bijl-Brouwer, "Designing for Social Infrastructures," 183–97.

80 Patricia H. Werhane, "Mental Models, Moral Imagination and Systems Thinking in the Age of Globalization," *Journal of Business Ethics* 78, no. 3 (2008): 463–74, DOI: https://doi.org/10.1007/s10551-006-9338-4.

Because mental models are socially learned ways of perceiving and organizing information, they can be changed. Interestingly, the practitioners in all of the case studies sought ways to challenge and influence people to see new possibilities. TACSI worked to change public narratives by introducing new language about the child protection system in meetings with political leaders, which was then used in press releases. InWithForward worked to shape public perceptions around the goals of their disability service Kudoz with messaging that expressed the value of skills and employment, versus merely keeping adults with cognitive disabilities safe.

Several of the practitioners noted that mental models or beliefs can be difficult to change, and drew on different strategies to move forward. This included TACSI focusing their work on stakeholders who already held an enabling mental model: "We've observed a pattern in the instances where both families and professionals have the propensity to change, parents tend to experience successful restoration outcomes."[81] Kennisland decided to let go of an ambition to shift youth from their focus on material culture toward a happiness mindset, and instead opted to focus on other design prototypes due to the difficulty of influencing this deeper change.

Mental models are described as being key to system transformation in systems thinking discourse, notably because they form the deepest level of a system[82] and the strongest leverage point for change.[83] Peter Senge highlights how difficult mental models are to change, as they generally exist beyond our conscious awareness;[84] and although Jay Forrester explains that making mental models explicit can facilitate discussion and change,[85] systems thinking literature has little information about how to do this.

This case study demonstrates that understanding mental models can provide practitioners with another opportunity to influence human beings within a system — alongside working with human relationships, cognition, emotion, experience, and values.[86] However, it is not a commonly used approach in traditional design practice.[87] Recently, research has identified how service design processes can influence mental models through tangible interventions.[88] Such studies are essential to further improve the impact of design on systems change.

Adopting an Evolutionary Design Approach to Desired Systemic Change

We identified an *evolutionary design approach* in each of these case studies: practitioners were taking multiple small steps to shift the problem situations in a desired direction. We saw this as a systemic approach, because it resembles the evolutionary process of "vary, select, and amplify" described in living systems theory.[89] The identified practice included taking small steps, while also aiming big, developing a portfolio of various prototypes and problem frames, and looking for traction in the system.

Interviewees from every case study acknowledged the importance of taking small steps. For example, one said, "I often think in terms of these complex wicked problems; you need to start really small." At the same time, some agencies also explicitly adopted a greater vision or directionality for desired systems change. TACSI called this "two track thinking." As one of

81 Internal TACSI document.
82 Goodman, "Systems Thinking."
83 Meadows, *Leverage Points*.
84 Peter M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization* (New York: Doubleday, 1990).
85 Jay W. Forrester, "Counterintuitive Behavior of Social Systems," *MIT Technology Review*, January 1971, last modified March 1995, available at https://ocw.mit.edu/courses/sloan-school-of-management/15-988-system-dynamics-self-study-fall-1998-spring-1999/readings/behavior.pdf.
86 Van der Bijl-Brouwer and Dorst, "Advancing the Strategic Impact."
87 There has been some limited consideration of mental models by design scholars in the past focusing on the usability of products. Don Norman described how users have mental models of how physical products work. Don Norman, *The Design of Everyday Things* (New York: Basic Books, 2013).
88 Josina Vink and her colleagues identified accounts of actors reshaping their mental models in response to three categories of service design practices: experiencing bodily sensations, perceiving alternative mental models and enacting different mental models. Josina Vink et al., "Reshaping Mental Models — Enabling Innovation through Service Design," *Journal of Service Management* 30, no. 1 (2019):75–104, DOI: https://doi.org/10.1108/JOSM-08-2017-0186.
89 See Capra, *Web of Life*, 217 for a history of evolutionary thought.

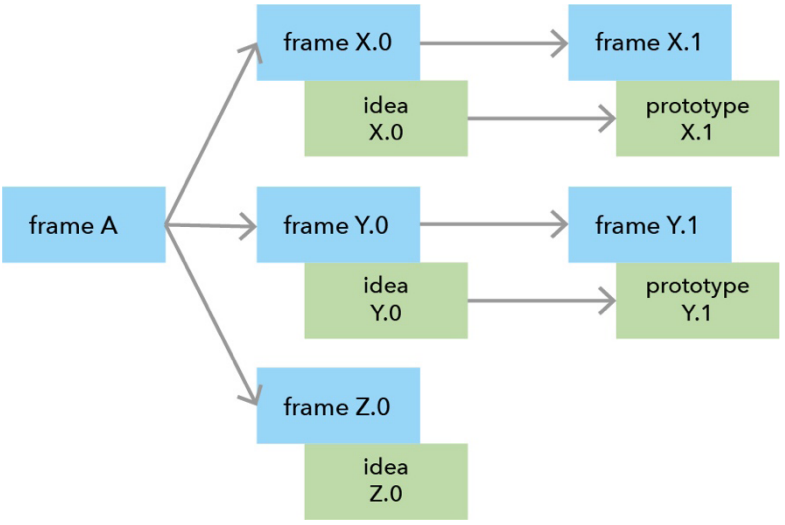

Figure 1
A representation of how a portfolio of problem frames and accompanying designed interventions evolves over time in three of the cases we studied. © 2019 by Mieke van der Bijl-Brouwer.

its team members explained, "We're going to test some things involved in evidence base and we're going to think about which larger changes need to happen in the system as a whole." Those larger changes can be seen as the desired directionality of system evolution.

As noted in our earlier article, the detailed analysis of idea and prototype evolution alongside their accompanying problem frames revealed that the practitioners worked with a *portfolio* of problem frames and prototypes. While divergence in ideation and framing was observed in every case study—as is common in traditional design practice—the variations we identified in three of the case studies went a step further. Divergence did not just happen during the idea generation stage—it continued during the prototyping and testing stage, and also included ongoing variation in problem framing (Figure 1).[90]

In traditional design, alternatives are selected by the design team and by the design team's client or parent organization, who then "amplify" the design through implementation and scaling. In the case studies, this selection and amplification process had a different character, because the interventions proposed needed to be adopted by a system and it was not always clear who was going to implement and scale the prototypes and who would have or take ownership. For example, in two case studies there were "demo days," during which a varied range of prototypes were presented to a wide group of system stakeholders, who were asked to select from among these prototypes based on observed ownership and buy-in. One interviewee indicated how, during problem framing, they looked for "traction" when selecting challenges to focus on. "We keep looking for traction in these steps." Her colleague added, "It is very much about the energy it generates; in the first instance, to start working with it." In some of the case studies the teams explored strategies that would increase the chances that promising prototypes would be amplified, for example by seeking out the right partners or

90 **See our preceding article for a further explanation of how this approach differs from the Double Diamond model and the traditional design approach. Van der Bijl-Brouwer, "Problem Framing Expertise."**

stakeholders, or by generating buy in and legitimacy with incumbents such as government.

The practices identified resemble evolutionary approaches towards desired systems change as described in various systems theories. This includes a focus on experimentation. David Snowden argues that in complex contexts, we can only understand why things happen in retrospect.[91] Action must therefore be aimed at conducting experiments that are safe to fail and at learning about what works to create change. If the impact of the experiment is positive, we can safely amplify it. If not, we will need to forgo or adjust the experiment. An evolutionary approach would require multiple experiments of small interventions. This idea is based on living systems, which adapt to their environments in a process of co-evolution based on a process of differentiation, selection, and amplification.[92] Eric Beinhocker explains how this underlying evolutionary algorithm can also be actively applied to innovation in a business context to create organizations that adapt to changing economic conditions. This approach includes continuously running a variety of innovation experiments,[93] monitoring the success of these experiments, and amplifying where possible. Likewise, in the context of social innovation, transition management promotes guided variation and selection of transition experiments to influence sociotechnical transitions.[94] These transition management experiments are based on a multi-level analysis of patterns in the system,[95] and the principle of generating long term visions that can be used as frameworks to formulate short term objectives.[96]

Adapting Design to an Evolutionary Context

The notion of taking small steps while aiming big is similar to the principle of using long-term visioning to frame short-term objectives; working with a portfolio of prototypes and frames resembles the experimental approach. The prominent design practice of prototyping is a way to run such evolutionary experiments. However, rather than only enabling evolution through *execution*, design practices also use the evolutionary process in the *design* of the prototype experiments themselves. Design practice reflects a co-evolutionary problem and solution process, which means that

> "Creative design is not a matter of first fixing the problem, and then searching for a satisfactory solution concept. Creative design seems more to be a matter of developing and refining together both the formulation of a problem and ideas for a solution."[97]

Prototyping in design is therefore not just about testing ideas for interventions—it also helps reframe the problem. This integration of prototyping and framing practices in design offers opportunities for design to contribute to evolutionary practices.

At the same time, the systems theories and practices identified in our study show that design practices need to adapt to this evolutionary context in multiple ways. Firstly, the evolutionary approach asks for continuous innovation, beyond individual projects, to align current activities continuously with a future vision; it requires working with a portfolio of problem frames and systemic interventions, rather than converging on a single problem

91 David J. Snowden and Mary E. Boone, "A Leader's Framework for Decision Making," *Harvard Business Review* 85, no. 11 (2007): 68–76, available at https://hbr.org/2007/11/a-leaders-framework-for-decision-making.

92 A new theory of living systems states that evolution cannot be limited to the adaptation of organisms to their environment, but that the evolution of living organisms is coupled to the evolution of their environment in a process of co-evolution. Capra, *The Web of Life*, 222.

93 Eric Beinhocker views economies as complex adaptive systems in which business models, physical technology, and social technology co-evolve. He argues that human rationality and intentionality can play a role in shifting economies by feeding them with a sufficient variety of experiments that can then be selected from for future action. Eric D. Beinhocker, *The Origin of Wealth: Evolution, Complexity, and the Radical Remaking of Economics* (Boston: Harvard Business School Press, 2006).

94 Rotmans and Loorbach, "Complexity and Transition Management," 191.

95 The multi-level framework distinguishes different aggregation levels for transitions: a sociotechnical landscape at the macro level; a regime level related to dominant practices, rules, and shared assumptions; and a niche level related to individual actors, technologies, and local practices, and at which variations to and deviations from the status quo can occur. There must be interaction between developments at the micro, meso, and macro level if the transition process is to be expedited. Jan Rotmans, René Kemp, and Marjolein van Asselt, "More Evolution Than Revolution: Transition Management in Public Policy," *Foresight* 3, no. 1 (2001): 20, DOI: https://doi.org/10.1108/14636680110803003.

96 Ibid., 22.

97 Dorst and Cross, "Creativity in the Design Process," 434.

frame and intervention; it requires two-track thinking, including short and long term initiatives; and it requires new selection mechanisms for design proposals that are able to gain traction in the system.

Discussion and Conclusion

All five principles presented in this article combine elements of systems thinking with elements of design. For each, we have presented opportunities for designers and social innovation practitioners to adopt systemic thinking in their practice, while at the same time highlighting tensions between systems thinking and design. In this section we further discuss how designerly practices contribute to systems change, and how the resulting systemic design practices differ from traditional design.

How Designerly Practices Contribute and Adapt to Systems Change

Each case study included interventions or prototypes designed to address complex societal problem situations. The practitioners acknowledged that these problem situations could not be "solved." Instead, they required ongoing interventions targeting social innovation and systems change. While there are many existing models and principles for systems change, each context requires a customized, synthesized intervention. We argue that to design such interventions requires *designerly* practices, in particular through the use of the prominent design practices of problem framing, co-evolution and iterative design, and human-centered design.

- The designerly practice of problem framing contributes to developing a systemic perspective on problem situations, and to expanding the problem space. By developing different perspectives on the problem, new pathways for contextualized 'solutions' can be opened up.[98]
- The designerly practice of co-evolution of problem and solution[99] underlies the practice of iterative design, and contributes to the required experimental and evolutionary approach to addressing complex problem situations. Prototypes are used as safe to fail experiments that concurrently understand the problem situation and test the success and traction of interventions.
- The designerly practice of human-centered design contributes to the design of interventions that address the human aspects of systems based on a deep understanding of human beings.[100] Where traditional design is focused on individual needs and the aspirations of end users, systemic design focuses on human *relationships*. Human-centeredness contributes to the systemic exploration of existing relationships and tensions in the problem situation, as well as to the design of new interventions.

These practices are interrelated, as human-centeredness and iterative design are both key drivers of framing.[101] They are also supported by many other practices, methods, and tools. Designers tend to possess a rich repertoire of methods and tools to draw from, such as qualitative design research methods, collaborative and participatory design methods, scenario creation

98 Dorst, "The Core of 'Design Thinking' and Its Application."

99 Dorst and Cross showed empirically how expert designers adopt a process of co-evolution of problem and solution. In our preceding paper we showed how this expert practice is also adopted in public and social innovation. Dorst and Cross, "Creativity in the Design Process"; Van der Bijl-Brouwer, "Problem Framing Expertise."

100 We show how a deep understanding of human needs and aspirations contributes to designing for complex service systems in van der Bijl-Brouwer and Dorst, "Advancing the Strategic Impact."

101 We explain how human-centered design contributes to framing in van der Bijl-Brouwer and Dorst, "Advancing the Strategic Impact," and also explain the relationship between framing and iterative design in van der Bijl-Brouwer, "Problem Framing Expertise."

and roleplaying, visualization, and various prototyping methods. In the preceding article, we showed how design practices such as framing require a high level of expertise. Experts do not necessarily need to be trained professionals such as product designers or architects. In fact, we see that many social innovation practitioners who are not trained designers have achieved a high level of expertise in these designerly practices in their work as well. Identifying and naming these practices explicitly as *designerly* will help in capability building and identifying the competencies required for social innovation.[102]

While we argue in this paper that designerly practices contribute to addressing complex problem situations, the findings from this study highlight that practitioners at the forefront of social innovation are developing more diverse forms of systemic design to effect change. The key differences we identified between prominent design practices and the systemic design practices within the case studies were

- *An expansion of designers' natural tendency to open up the problem space and perceive the interrelatedness of challenges within a problem situation.* Systems maps and other systems thinking tools might be used to develop this expanded perspective.
- *The shift from a focus on end users to a focus on broader system perspectives means that designers need to work with tensions between stakeholders with conflicting values and needs.* This brings multi-stakeholder practices such as co-design more to the forefront of design, and requires advanced skills in facilitation and dialogue.
- *Intervention designs have a systemic nature, including a focus on enhancing human relationships and enabling the transformation of mental models.* Designers must develop repertoires of precedents to design these types of interventions.[103]
- *The ongoing, evolutionary approach to social innovation demands long-term commitment and responsibility from designers.* It also requires soft skills to build long-term relations with key stakeholders such as funders and service providers.

Some of these systemic design principles have been identified in existing literature.[104] This study contributes to existing knowledge by providing a contextualization of systemic design within professional practice settings and by articulating an evolved set of systemic design principles based on expert practice and design rationales.

The Emergence and Development of Systemic Design Practices and Principles

In addition to the five principles we have presented here, we identified a number of additional systemic design principles that were less prominent across the case studies. One example is the principle of *designing as systems change*, meaning that practitioners experimented with embedding design capability within the system to improve its functionality. This principle views (prospective) social innovation practitioners as being an important part of the system that can help it continuously adapt to complex and dynamic

102 These competencies complement existing competency frameworks for social innovation, including Nesta, "Competency Framework for Experimental Problem Solving," in *Skills, Attitudes and Behaviours that Fuel Public Innovation* (London: Nesta, 2019), 2, available at https://states-of-change.org/assets/downloads/Nesta_CompetencyFramework_Guide_July2019.pdf; and the "Competencies for Systems Change Education," in Anna Birney et al., eds., *Systems Change Education in an Innovation Context* (New Haven: Forum for the Future/School of System Change/Systems-led Leadership/Evolutions Lab, 2018), available at http://systemschangeeducation.com/report/.

103 Donald A. Schön argued that practitioners such as designers build up a repertoire of examples, images, understandings, and actions. This allows them to use what they already know in a situation which they take to be unique. A practitioner's repertoire includes the whole of his experience insofar as it is accessible to him for understanding and action. Schön, *The Reflective Practitioner*, 138.

104 For example, Jones's principle of appreciating complexity is similar to the first principle we mention in this study, and Vink et al. recently introduced a study that was similar to the fourth principle (influencing mental models). Jones, "Systemic Design Principles"; Vink et al., "Reshaping Mental Models."

contexts.[105] While the principles presented in this paper are limited to what was observed across the five case studies, there is evidence that a sophisticated practice is emerging to address complex societal challenges that borrows from both the design and systems thinking fields.

The practices we observed are not homogenous—each has its own characteristics. Some were more designerly, others more systemic; for example, the MindLab team used many iterations of framing and prototypes, while the CoLab team leant more heavily on systems thinking tools. At the same time, common to all the case studies were elements of a systemic perspective on the problem situation, a systemic exploration of the problem space, and a focus on human relationships. We did, however, observe limits to the extent of potential systems change in the case studies. Although in all cases the teams were aware of the importance of mental models, effective proposals for changing them were rare. In addition, certain practices could be construed as altogether non-systemic. For example, some cases were one-off projects instead of ongoing social innovation programs, and some initiatives did not target multiple levels of the system, such as the speed sharing event, which had to fit into the parameters of an existing government initiative.

Interestingly, the systemic practices were mostly *implicit*. Only CoLab mentioned explicitly that they had used "systemic design" and "systems thinking." This may imply that many of the practitioners were naturally embracing more systemic ways of working in response to the complexity of the problem situations. The study presented in this article makes these systemic design practices explicit by linking them to systems thinking and design literature. In the future, we aim to translate these results into educational programs and practitioner guidelines which we hope will contribute to advancing the field of systemic design.

The study also raised a number of questions that require further development of systemic design methods and practices. How can we integrate the principle of problem framing with the expanded perspectives captured in system visualizations? How can we facilitate dialogue and work with tension during systemic problem exploration? How can we develop systemic interventions to strengthen human relationships and influence mental models? And how can we manage collaborations that foster continuous social innovation, rather than one-off projects? Such questions rely on continued action research being undertaken in practice and academia. Close collaboration between practitioners and scholars will continue to be essential to further develop this field.

A Final Note

In this paper we have shown how the interdiscipline of systemic design contributes to tackling complex societal challenges. Even though we have homed in on one area of knowledge and practice that social innovation practitioners draw on, systemic design is part of a larger body of transdisciplinary approaches.[106] For example, in addition to systems thinking and design, social innovators may use academic knowledge from social sciences and humanities, or other types of knowledge such as indigenous ways of knowing or community involvement. Transdisciplinary innovation is about

105 In the preceding paper we elaborated on the practice of designing as systems change. Van der Bijl-Brouwer, "Problem Framing Expertise."

106 Transdisciplinarity was introduced as a term in the early 1970s when it was discussed as a seminar on interdisciplinarity in universities in Nice, organized by the OECD. Léo Apostel et al., eds., *Interdisciplinarity, Problems of Teaching and Research in Universities* (Paris: OECD Publications, 1972).

placing interactions between disciplines and other types of knowledge in an integrated system with a social purpose, resulting in a continuously evolving and adapting practice.[107] Key to such transdisciplinary approaches is learning.[108] As each complex problem situation is different, there is not one way of doing things and we must rely on adaptive practice, where practices are adapted to the problem context at hand. Such adaptations require every actor concerned to engage in a continual and mutual learning process. We therefore stress the need for ongoing education *together*, through learning communities that include academics and practitioners across multiple disciplines. Learning engagements may include studies integrating multiple disciplines, such as the one presented in this paper, action research, and academic-practitioner collaborations. We hope this will help the field of systemic design mature, and increase positive impact towards addressing today's complex societal challenges.

107 Erich Jantsch, "Towards Interdisciplinarity and Transdisciplinarity in Education and Innovation," in *Interdisciplinarity, Problems of Teaching and Research in Universities*, ed. Léo Apostel et al. (Paris: OECD Publications, 1972), 97–121.

108 For example, transition management theory promotes a focus on learning and a special learning philosophy. In addition, Merrit Polk argues that transdisciplinary research emphasizes mutual learning between a range of participants through deliberate processes of reflexivity. Rotmans et al., "More Evolution Than Revolution," 22; Merritt Polk, "Transdisciplinary Co-production: Designing and Testing a Transdisciplinary Research Framework for Societal Problem Solving," *Futures* 65 (January 2015): 110–22, DOI: https://doi.org/10.1016/j.futures.2014.11.001.

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Declaration of Interests

There are no conflicts of interest involved in this article.

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