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Navigating Designerly Systemic Approaches for Sustainability Transitions

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Navigating Designerly Systemic Approaches for Sustainability Transitions

An evaluative investigation for change agents

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Contemporary systemic challenges, such as social and environmental issues, force practitioners to rethink their approaches to problem-solving. Systems themselves are, by nature, resilient to change. Their structural and relational dynamics must be deeply understood to enable substantial, lasting change when addressing sustainability issues. Both private and public sectors are now acknowledging the complex, interconnected nature of their operations, which is increasingly reflected in the framing of innovation processes. Accordingly, an emerging field of sustainability research includes scholars investigating the opportunities within designerly approaches (i.e., design thinking, systemic design, and systemic innovation) as promising contributions to the planning and facilitation of sustainability transitions.

Thus, design practitioners increasingly find themselves recruited to central, orchestrating roles in complex sustainability transition processes. In the wake of current academic work on the intersection of sustainability and design, we observe a proliferation of designerly systemic approaches in the form of

[1] https://www.sustainabilitylab.uio.no

frameworks, methods and tools made available to practitioners. So far, investigations into these nascent practical approaches are limited, arguably contrasting their promise to support facilitators and practitioners in application to contemporary challenges.

This paper evaluates three prominent designerly systemic approaches through a lens of key theoretical strands from sustainability-, systems theory- and design research. The author argues that such a structured, evaluative exercise offers an outline to inform the practice of future systemic changemakers and sustainability researchers.

KEYWORDS: systemic design framework, sustainability, transitioning, systemic innovation

RSD TOPIC(S): Methods & Methodology

Introduction

The substantial exogenous pressure on current societal systems from factors such as climate change (IPCC, 2022), resources depletion, ecological degradation (Rockström et al., 2009) as well as social and welfare issues (Raworth, 2012), force private and public actors to reshape their operations as well as offerings. The sense of urgency has paved the way for innovation-centric approaches that include systemic perspectives. The efficacy of such "whole systems perspectives" is well documented in the literature as it is deemed essential to identify systemic interventions (Kania et al., 2018; Meadows, 2008) that would be sufficient in changing the conditions that hold the current problems in place.

Furthermore, the role of innovation in sustainability efforts is recognised in business research (Bocken et al., 2019; Boons et al., 2013), where it is argued to enable actors to take the lead in market and industry transformation. Comparably, innovation in the public sector and social application is considered vital in enabling the radical changes and improvements called for by society (Brown & Wyatt, 2010; Vink et al., 2019). Finally,

contemporary scholars have made connections between sustainable innovation and systems perspectives in approaches such as design thinking and systemic design (Buhl et al., 2019; Jones, 2020; Geissdoerfer et al., 2015).

While researchers are increasingly involved with rethinking designerly contributions for sustainability transitions (ST), conversely, design practitioners find themselves in central, orchestrating roles or as key actors in innovation projects that aspire to systemic change. These emergent practices include leading roles in planning, facilitation, and advising stakeholders in inter-organisational, cross-sectoral innovation processes that explicitly state sustainability ambitions. The role becomes then more that of a transition manager "...analysing change of the socio-technical and societal situation." by "...targeting socio-technical or societal problems, operating from policy and political objectives" with a "Descriptive and analytical process, aimed at understanding socio-technical or societal questions" (Joore & Brezet, 2014, p. 3).

In this context, we find a knowledge gap, as little research exists on the application of the aforementioned academic perspectives in current professional design practice, be it intra-organisational or in consultancy. On the other hand, the surge of designerly systemic frameworks and tools emerging in recent years suggests that some integration is taking place. However, It can be argued that they have commonly been adopted in a professional context through the anecdotal promotion of design and design thinking as an organisational resource for innovation or a general approach to problem-solving (Kimbell, 2011).

A few notable studies investigating the emergent role of design in ST can be found: Joore and Brezet propose the multilevel design model that seeks to address increasingly complex design challenges in the context of socio-technical transitions (Joore & Brezet, 2014). Not unlike the Multi-Level Perspective (MLP) (Geels, 2002; Kemp et al., 1998), the multilevel design model suggests that transitions must be addressed as interlinked interventions at multiple levels of engagement, and as such, the authors connect design with strategies for socio-technical system innovation. However, this prominent study is arguably focused on the designers' role as creative problem-solvers and artefact makers.

This paper suggests the application of key strands of research from the fields of sustainability-, systems theory-, and design as analytical lenses to explore their navigational potential. Three prominent designerly systemic approaches (DSA) in practice today are evaluated through these lenses to identify their theoretical and conceptual lineage as well as their potential for addressing the challenges of sustainable transitions as identified by the literature. The following discussion will argue for their transferability to ST processes, reflect on their practical applications, and provide a way of summarising those considerations as a theoretical contribution to systemic practitioners reflecting on their methodological choices.

Sustainability transitions and systemic design

The transitioning of societal-scale systems through historical perspectives has been thoroughly examined. Notable contributions are the theories of MLP (Rip & Kemp, 1998), socio-technical transitions (Geels, 2002) and sustainability transitions (Grin et al., 2010). The latter arguably adds a normative, interventionist dimension, and it is through this perspective that this paper includes the designerly approach; As an interdiscipline that integrates systems theory with advanced design methods to " ... effect anticipatory change in complex, social socio-technical and social systems." (Jones, 2020. p.1).

Adjacent academic perspectives can be found within sustainable systemic innovation. While not an established concept, it seeks to encompass common concepts in the literature, such as sustainability-oriented innovation (Adams et al., 2016) and design for sustainability (Ceschin & Gaziulusoy, 2016), while explicitly including the system's dimension as a complex, multi-level and multi-stakeholder context that implies that sustainability challenges are systemic in their nature, and should be addressed as such (Clayton & Radcliffe, 2018; Holling, 2001).

Numerous attempts to define a system exist, spanning scientific fields and time. From general systems theory, one can find a definition by von Bertalanffy stating that a system is "a complex of interacting elements." In his seminal book *Systems Thinking, Systems Practice*, Checkland describes the concept of a system as "the idea of a whole entity which, under a range of conditions maintains its identity, provides a way of viewing and interpreting the universe as a hierarchy of such interconnected and

interrelated wholes" (Checkland, 1999). More recently, and closer to the field of design, Buchanan suggests a definition in that "a system is a relationship of parts that work together in an organized manner to accomplish a common purpose" (Buchanan, 2019, p. 86).

Systems theory and systems thinking relating to this article first and foremost propose a holistic approach with a focus on synthesis in contrast to reductionist thinking through analysis (Harwood, 2019). Systems thinking in practice encourages exploration of inter-relationships (i.e. context and connections), exploration of boundaries (i.e. scope, scale) and engagement with new, unique perspectives, including that of actors and stakeholders. As such, it could be suggested that certain designerly approaches, i.e. design thinking, are closely related to systems thinking.

As design professionals are engaging with increasingly systemic societal issues, we observe the emergence of new approaches, practices, methods and tools incorporating academic frameworks and theory in an attempt to match the complexity and criticality of said challenges.

The following section briefly presents three prominent DSAs investigated in this paper, selected by the following criteria:

- Prominence in the field through academic standing or industry presence
- Systemic intervention is at its core raison d'être
- Adoption in actual design-practice

The author acknowledges that the DSAs included in this study (Table 1) are not a comprehensive selection. Other researchers might argue them differently or as non-comparable units of analysis as they are a mix of frameworks, process descriptions and toolkits. However, they all represent distinctly designerly approaches to systemic interventions and describe methodological considerations for their application. Thus, they make a useful unit of analysis to address real-life methodological considerations for practitioners in their framing, planning and facilitation of ST processes.

Table 1. Overview of designerly systemic approaches included in the article.

	The Systemic Design Framework	The Systemic Design Toolkit	The Transition Design Framework
Authors, background	・Developed by the british Design Council ・Launched in spring 2021 ・Synthesis of input from prominent, international academics and practicioners in design.	・Co-developed by Namahn, shiftN, MaRS and Systemic Design Association ・First presented at RSD5, 2016 ・Launched and hosted by the SDA community in 2018	・Conceptualised by Terry Irwin & collegues at Carnegie Mellon University ・Presented at the 2015 Transition Design symposium (Irwin, 2015) ・Adopted as a study course and a distinct institute at CMU (2022)
Rationale	Propose a systemic design framework for industry and practitioners to guide efforts towards net zero and sustainable living, across sectors and disciplines.	Pragmatic, practice development of systemic design as a response to the need for tackling increasingly complex projects.	Need for societal transition to long term desirable futures, supported by new design-led approach to address contemporary challenges that are complex and wicked.
Theoretical foundations	・Divergent-convergent thinking, CPS (Guilford, 1967) ・The Double Diamond design process (Design Council, 2004) ・Circular- (Ellen Macarthur F. 2012) ~ and Regenerative design (Reed 2006) ・System Thinking ・Radical / disruptive innovation	・Systems Theory (Meadows, 1999; Ackoff 1993, 2004) ・Systems Thinking (Alexander, 2004; Checkland 1993) ・Systemic Design (Buchanan 1992; Jones, 2014) ・Socio-technical MLP theory (Geels, 2006)	・Wicked Problems (Rittel & Webber, 1973) ・Transition theory, Theories of change ・Theory of needs (Max-Neef) ・Systems Theory (Meadows, 1999) ・Socio-technical MLP theory (Geels, 2006) ・Futuring and visioning (Lindley & Coulton, 2016; Dunne & Raby, 2013; Candy & Kornet, 2017)
Designerly approaches	・Design-led facilitation ・Participatory, inter-disciplinary ・Human and Planet Centered ・Multi Level, multi stakeholder ・Iterative, protyping process	・Democratised, participatory, co-creative ・"Thinking & Doing" driven ・Multi level, multi stakeholder ・Visual mapping and synthesis (sensemaking)	・Place based (spatio-contemporal) ・Multi level, multi stakeholder processes ・Participatory, inter-disciplinary ・Visual mapping and synthesis (sensemaking)

The systemic design framework

Beyond Net Zero: A Systemic Design Approach introduced the systemic design framework (British Design Council, 2021) as an approach to help designers work on significant complex challenges across different disciplines and sectors. Rooted in human-centred design, “It places our people and our planet at the heart of design.” it is considered an evolution of the Double Diamond, one of the most universally adopted design approaches.

Key elements of the systemic design framework include

- Six systemic design principles to help people develop or adapt new design methods and tools from their practice: people and planet-centred, zooming in and out, testing and growing ideas, inclusive and welcoming difference, collaborating and connecting, circular and regenerative.
- Four key roles for designers to play when tackling systemic issues: system thinker, leader and storyteller, designer and maker, connector and convenor.
- Types of design activities: exploring, reframing, creating and catalysing.
- Enabling activity surrounding the design process: orientation and vision setting, connections and relationships, leadership and storytelling, and continuing the journey.

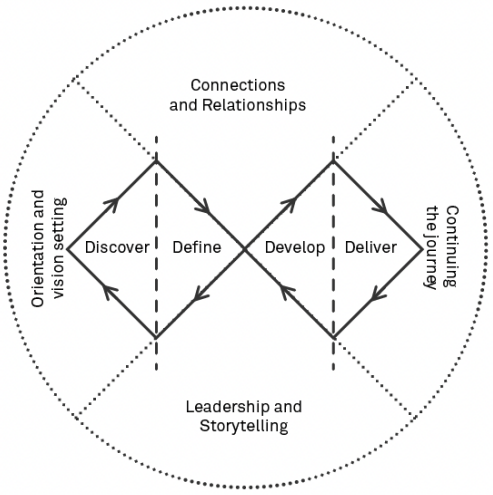


Figure 1. The systemic design framework (Design Council, 2021).

Systemic design toolkit

Systemic Design Toolkit (Ael et al., 2018) was first presented at the RSD5[2] symposium in 2016. A collaborative effort by prominent profiles in the SDA community, with its theoretical foundation including the work of Peter Jones, Kristel Van Ael, Alex Ryan and Philippe Vandenbroeck. The toolkit was conceived by designers and change-makers to trigger a process of systemic transformation. The tools are meant to be used during collaborative co-creation sessions. The methodology includes seven key steps:

1. Framing the system: Setting boundaries of systems in space and time, identifying hypothetical parts and relationships.
2. Listening to the system: Experiences of people, discovering interactions, system's behaviour and verifying the initial hypotheses.
3. Understanding the system: Variables and interactions that influence dynamics and emergent behaviour. Identifying leverage points.
4. Defining the desired future: Helping stakeholders articulate commonly desired futures and intended value creation.
5. Exploring the possibility space: Ideas for intervening on leverage points. Empowered by working with the paradoxes in the system.
6. Designing the intervention model: Defining the engine for change. Iterating on its implementation in different contexts.
7. Fostering the transition: Defining how interventions will mature, grow and be adopted in the system.

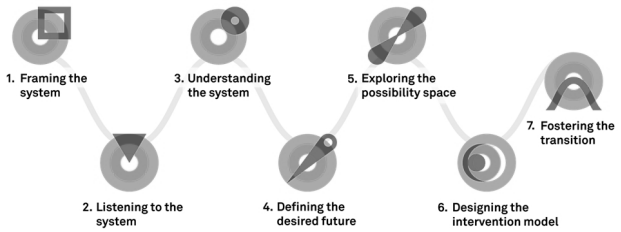


Figure 2. The toolkit in the design process (Jones et al., 2018, slide 6).

[2] https://rsdsymposium.org/rsd5-symposium/; https://rsdsymposium.org/are-we-ready-for-systemic-design-toolkits/

The transition design framework

Transition Design: An Educational Framework for Advancing the Study and Design of Sustainable Transitions (Tonkinwise, Irwin & Kosoff, 2015) is an interdisciplinary approach that acknowledges the need for entire societies to transition to more sustainable futures and that it would need to be enabled by intentional system-level change (Irwin, 2015). It suggests four evolving areas of practice, knowledge and supporting skills (Irwin, 2018):

- Vision for Transition: Clear, long-term visions of what we want to transition toward
- Theories of Change: That address the dynamics of change within complex systems
- Mindset & Posture: Open, collaborative, self-reflecting posture enabling this work
- New Ways of Designing: Which will arise out of the previous three areas

Furthermore, it is considered a phased approach rather than a process description, cycling through re-framing of present and future, designing interventions and waiting and observing. The framework has been taught as a master's level course for the last few years, with the launch of a dedicated institute[3] for Transition Design set for 2022.

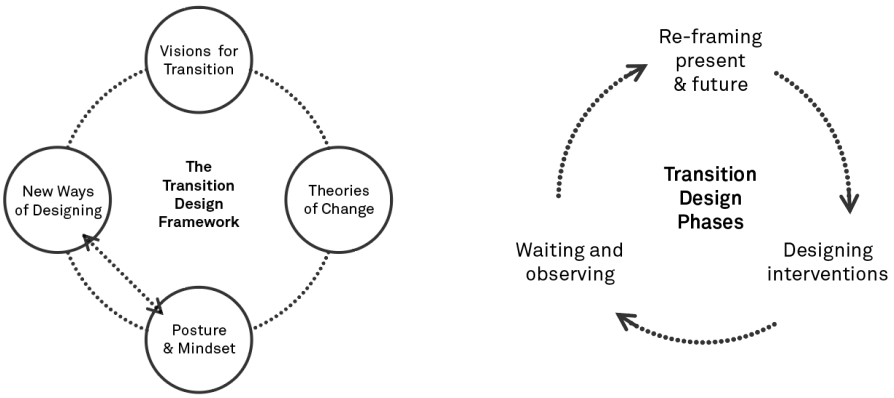


Figure 3. The transition design framework and transition design phases (Irwin, 2015).

[3] At the Carnegie Mellon School of Design. https://transitiondesigninstitute.net/

Theoretical and methodological approach

It is argued that the complex, systemic societal issues addressed by this paper are wicked in nature (Rittel & Webber, 1973) and should be addressed accordingly by designers through their ability to think and explore systematically (Buchanan, 1992) in a reflexive manner, or "reflection in action" (Schön, 1983). Sevaldson argues that designers are generally well-equipped to deal with fuzzy, complex issues through their synthesising ability, mainly derived from tacit skills taught through experience and project-based education (Sevaldson, 2013).

However, Sevaldson and Jones pose that systemic design has yet to " … to achieve a satisfying philosophical platform, including an agreement on methodology …" and argue that there is no single right way to respond, and of paramount that the field continues to evolve in a dynamic and pluralistic manner (Sevaldson & Jones, 2020, p. 75). Indeed, Sevaldson states that approaches adopted from adjacent fields of expertise are not easily adapted to the designerly process and that integration of such foreign methods is lacking (Sevaldson, 2013). This practice-theory-gap is addressed in this paper by positioning the study closely to research on design practice (Fallman, 2008) and situating the investigation in a real-world application, further adopting a pragmatic approach to accommodate the framing of design practitioners as transition managers and change agents.

Pragmatism

The above-mentioned scholars trace a clear lineage to design practice from the ideas of pragmatism as explored by Dewey; Dalsgaard has made this link explicit when drawing on pragmatism to prompt an appropriate understanding of a systemic design situation (Dalsgaard, 2014). This perspective is reflected in the recent development of systemic design, which gravitates toward pragmatism and pluralism (Sevaldson, 2017). Sevaldson suggests the field itself observes an emergence of generative, adaptive and dynamic design- one in which the so-called real-life context of the challenges drives a primacy of practice; " … if the models do not fit, or they are too cumbersome to operate, they need to be changed." (Sevaldson, 2017, p. 1)

This development is perhaps in response to the failed systemic approaches to design (Collopy, 2009) attributed to an over-focus on prescriptive and reductionist theories of design practice (VanPatter, 2020). Reductionist approaches have long been criticised both by systems and sustainability research, and the latter through the dominant ecological assertions that "knowledge gained from observation of the parts [alone] is necessarily distorted" (Santos, 2007, p. 28).

Pragmatism remains important in the more orchestrating role in systemic design processes, such as ST, in which it is argued that prescriptive process should be resisted in " ... favour of a framework or 'palette of practices' that can be configured in situation- and place-specific ways." (Irwin, 2019, p. 22).

Methodology

Qualitative analysis of documents presenting the SDAs is used to interpret their academic lineage, methods, practices they infer and outcomes that can be achieved. "Qualitative research methods are designed to help researchers understand people and the social and cultural contexts within which they live." (Myers, 1997)

For this article, documents are the primary data source. Presenting the SDAs retrieved from what could be understood as publicly available resources in the form of documents, websites and digital content, shaped with the intention of a broad, unfacilitated distribution/dissemination. Therefore, it could be argued that the documents can be evaluated as contained, stand-alone "social 'facts', which are produced, shared and used in socially organised ways" (Atkinson & Coffey, 1997, p. 47). The documents yield a rich combination of text, such as digital documents or web pages, illustrations and photos that constitute the data used for the study. A complete list of the documents in question can be seen in Table 2.

The author acknowledges the inherent limitations of such an approach as it can be argued that design research, in its nature, requires closer proximity to actual practice. However, the desk-oriented research aims to attain an objective distance, considering the author's 20+ years of design practice. It should also be noted that the book, *Design Journeys through Complex Systems* (Jones & Ael, 2022), could be considered an

accompanying theoretical expansion of the systemic design toolkit. Published in July 2022, its perspectives have not been investigated in time for inclusion in this article.

Table 2. Documents retrieved and used for evaluation in this study.

	ID	Document type	Title / Author	Description	Publication / retrieval date
The Systemic Design Framework	#01	Print publication, 60 pages PDF-format	"Beyond Net Zero : A Systemic Design Approach" - Design Council	Main document including background, methodology and toolkit with instructions	2021-04-22 / 2021-09-13
	#02	Web page	"Beyond Net Zero: A Systemic Design Approach", Design Council	Dedicated webpage on the authors website (designcouncil.org.uk)	2021-04-22 / 2021-09-13
	#03	Recorded talk (33m10s)	"Cat Drew: Beyond Net Zero Framework", Design and Architecture Norway	Recording of video-streamed lecture	2021-09-13 /
	#04	Online article	"Developing our new Systemic Design Framework", Cat Drew	Opinion piece on medium.com	2021-04-27 / 2021-09-13
The Systemic Design Toolkit	#05	Print publication, 40 pages PDF-format	"Systemic Design Toolkit Guide"	Main document including methodology and toolkit instructions	2018-11-26 / 2021-10
	#06	Print publication, 7 worksheets PDF-format	"Systemic Design Toolkit Templates"	Toolkit templates, 7 worksheets	2018-11-26 / 2021-10
	#07	Web site	"Systemic Design Toolkit"	Dedicated webpages on the authors website (systemicdesigntoolkit.org)	2018-10-28 / 2021-10
	#08	Online article	"State of the Art Practice: Are we ready for systemic design toolkits?"	Opinion piece on RSD	2018-10-26 / 2021-10
	#09	Academic paper	"Codifying Systemic Design: A Toolkit"	Proceedings of RSD5 Symposium	2016-09- / 2021-12-10
The Transition Design Framework	#10	Web site	"Transition Design Seminar 2021"	Dedicated webpages on the authors website	2018-10-28 / 2021-10
	#11	Academic paper	"The Emerging Transition Design Approach"	Journal Article, Design Research Society	2018-06-25 / 2021-10
	#12	Academic paper	"Transition Design Provocation"	Journal Article, Design Philosophy Papers	2016-1-14 / 2021-10
	#13	Academic paper	"Transition Design: A Proposal for a New Area of Design Practice, Study, and Research"	Journal Article, Design and Culture	2015-09-28 / 2021-10
	#14	Print publication, 36 pages PDF-format	"Transition Design: An Educational Framework for Advancing the Study and Design of Sustainable Transitions"	Study course description, with theoretical overview	2015-09- / 2021-10

Method: document analysis

According to Bowen, document analysis in qualitative research "… involves skimming (superficial examination), reading (thorough examination), and interpretation. This iterative process combines elements of content analysis and thematic analysis. Content analysis is the process of organising information into categories related to the central questions of the research." (2009, p. 27). The approach has been chosen for its stability, unobtrusiveness, exactness and availability while acknowledging the challenge of biased selectivity and insufficiency for a complete understanding of the cases in question (Bowen, 2009).

The study includes only primary documents (Merriam, 1992); That is, content that has been created and made available by the creators/authors of the cases and has not undergone manipulation by the author. The data has, in turn, constituted the basis for an analytical process that includes "… finding, selecting, appraising (making sense of), and synthesising data contained in documents. Document analysis yields data– excerpts, quotations, or entire passages– that are then organised into major themes, categories, and case examples specifically through content analysis" (Bowen, 2009, p. 28). This interpretive process is adopted "in order to elicit meaning, gain understanding, and develop empirical knowledge" (Corbin & Strauss, 2008).

Towards an evaluative matrix

Prominent strands of research from the fields of sustainability-, systems-theory-, and design were applied as lenses for interpreting the documents of this study. These strands of knowledge were chosen to reflect the study's main interest pertaining to the designers' role in orchestrating systemic innovation for ST.

- Safe operating space for humanity: Conceived through the Planetary Boundaries (Rockström et al., 2009) and Donut-Economy (Raworth, 2012).
- Systemic change: Includes structural and phenomenological perspectives (Kania et al., 2018) to systems interventions (Meadows, 2008).
- Orders of design: Encompass linked perspectives on "Evolution of design for sustainability" (Ceschin & Gaziulusoy, 2016) and systemic design (Jones, 2020).
- Scope of design engagement: A practice orientation that contextualises design along a scale of expertise/level of engagement for scoping purposes (Winterhouse Institute, 2013).

Safe operating space for humanity

The sustainability discourse has primarily adopted a systems understanding of sustainability as it suggests that both the living and man-made world can be described as entangled environmental, social and economic systems. Furthermore, it is also argued that these systems, in turn, have numerous nested sub-systems that form their interconnected nature. This multidimensional dynamic emphasises the need for a non-reductionist, holistic approach to aid in the understanding and organising of any sustainability intervention (Boehnert, 2019; Clayton & Radcliffe, 2018).

For the purpose of this article, two widely recognised strands of research are included: planetary boundaries, which describes nine essential and interlinked earth-system processes (Rockström et al., 2009), and the doughnut economy (Raworth, 2012), a framework for sustainable (societal) development that builds upon the planetary boundaries concept while adding complementary, internationally acknowledged social themes. Combined, these concepts give rise to the idea of a safe operating space for humanity that honours the absolute carrying capacity of the ecosystems and planet. Therefore, sustainability could be understood as " … the integration of the environmental, social and economic systems to improve the quality of life within earth's carrying, regenerating and assimilating capacity." (Adetunji et al., 2003, p. 161). One of the most prominent examples of real-life application can be found in the city of Amsterdam's decision to use the "Doughnut" (Figure 4) as a tool to develop a transformational plan towards a more sustainable, thriving city.[4] The project, in turn, has inspired several city-scale initiatives, such as in Melbourne, Aarhus, and Tampere.

[4] "Amsterdam City Doughnut": https://doughnuteconomics.org/stories/1

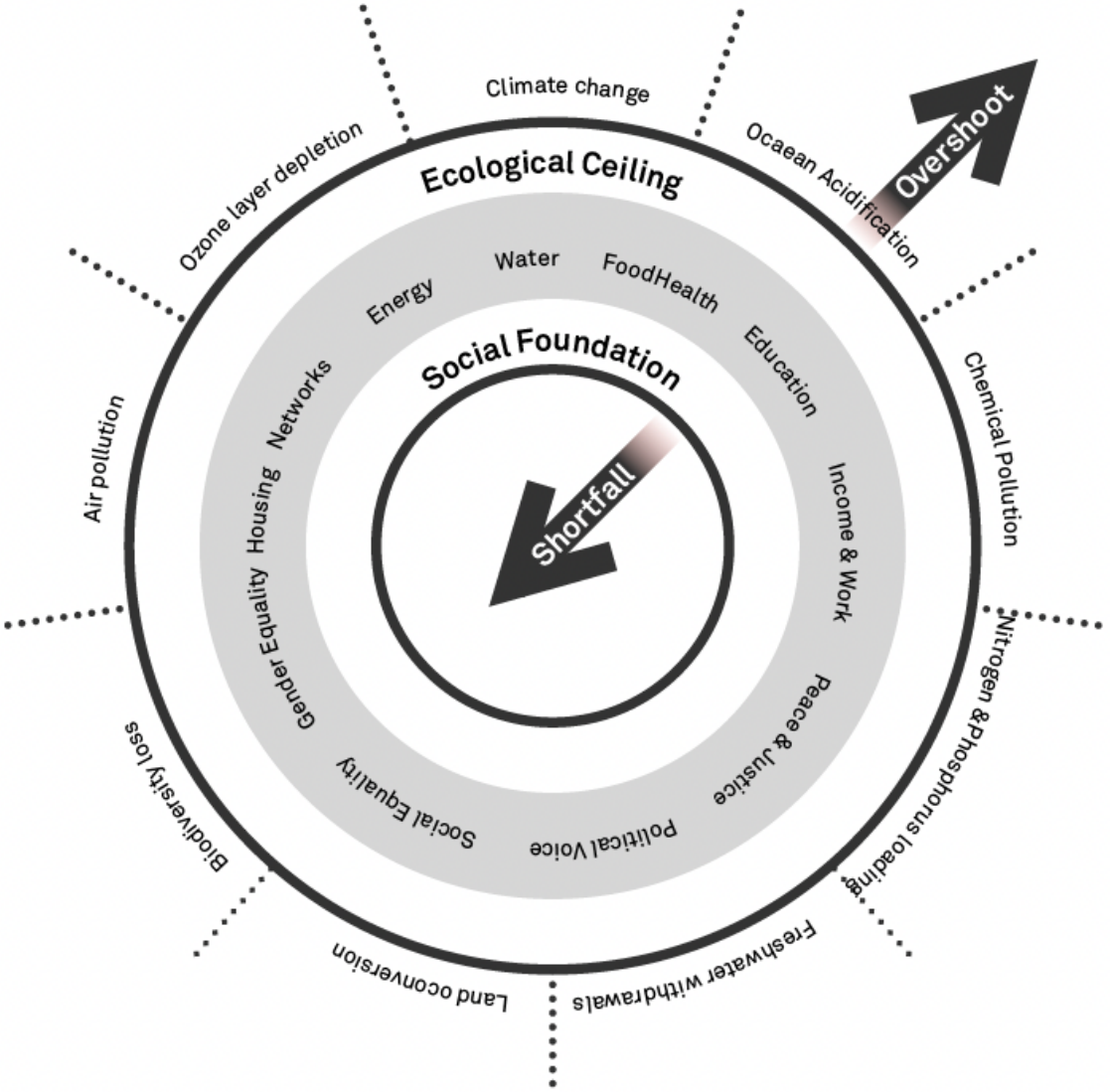


Figure 4. The Doughnut (based on Rockström et al., 2009; Raworth, 2012).

Systemic change

Kania et al. pose that system change could be defined as the “shifting of conditions that are holding the problem in place” (Kania et al., 2018). Six interdependent systemic conditions (Figure 5) are identified at varying levels of visibility and should be addressed as intertwined elements that can both mutually reinforce or counteract systemic change:

- 3 are structural (Explicit): Policies, practices, and resource flows.
- 2 are relational (Semi-Explicit): Relationships & connections; power dynamics.
- And finally, the transformational (Implicit): Mental models.

Similar mechanics relevant to systems interventions are found in systems theory with varying terminology and specific definitions; They commonly describe similar elements that are entangled and interact with varying degrees of tangibility to stakeholders and actors. These perspectives are arguably related to the influential works of Donella Meadows and her concept of leverage points for change in systems (Meadows, 2008). She identifies 12 points of intervention within a system with increasing potential to create efficient, lasting change to a system, with the most potent ones addressing ways of an organisation (designed intent of the system) and its paradigms (mental models).

Both frameworks point towards a key element of structural change that lies within the social fabric of our systems: “Complex systems are shaped by all the people who use them, and in this new era of collaborative innovation, designers are having to evolve from being the individual authors of objects, or buildings, to being the facilitators of change among large groups of people.” (Thackara, 2006, p. 7) It is apparent then that in such systems perspectives, the human component is of utmost importance both as structural and phenomenological elements and that change agents must engage with the social dynamic of systems to enact fundamental change.

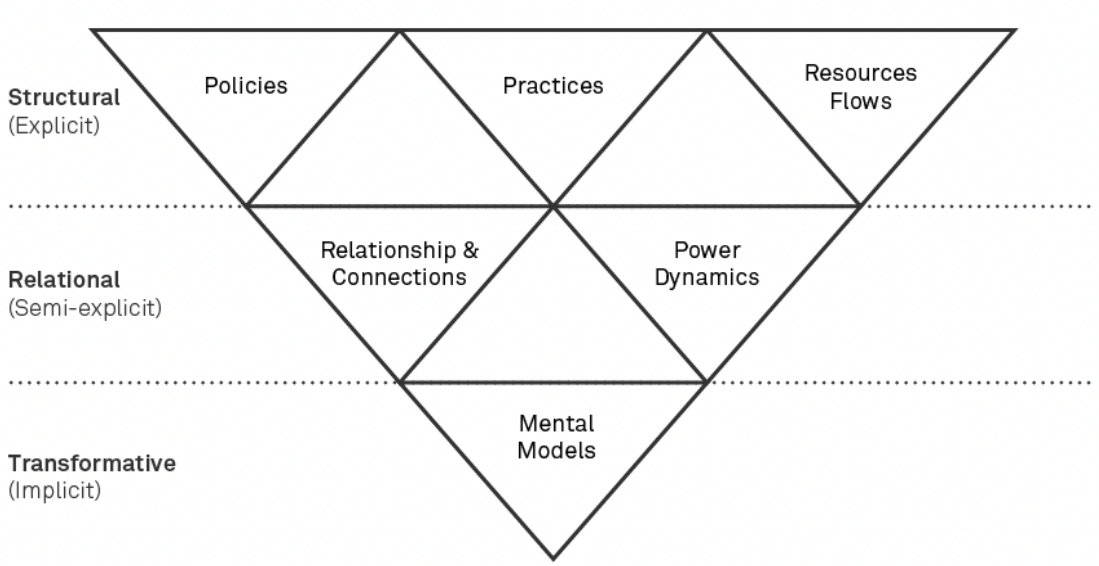


Figure 5. The six conditions of systems change (based on Kania et al., 2018).

Orders of design

The design-related practices have been a key factor in realising innovation and economic growth over the last century, engaging deeply with industrialisation supported by scientific and technological advances. However, early proponents of responsible design like Victor Papanek and Richard B. Fuller also called for Design to actively engage in environmental and social issues, using their tools and methods for positive change. Furthermore, scholars have recently argued for a designerly engagement in systems-level change and transition. In this sense, the scope of the design practice has seen a vast expansion in its relatively brief history, commonly organised as the "*Four Orders of Design*" (Duman & Timur Ogut, 2021).

The systems perspective has long been present in design practice and theory. Jones argues that design integrates systems theory and thinking with advanced methods from design to form the interdisciplinary field of systemic design that can "effectively inform human-centered design for complex sociotechnical and multi-stakeholder social systems." (Jones, 2020). The overall aim is to propose high-leverage interventions through adaptation of systems theory and thinking, engaging stakeholders in designerly processes for co-creating better solutions, policies and organisations. He expands this notion by linking systemic design to the concept of wicked problems (Rittel & Webber, 1973) through the " ... concern for longer-term contemporary challenges irresolvable by conventional problem-solving approaches".

Closely related to the abovementioned orders of design and relevant to this investigation is the "Evolution of design for sustainability," as suggested by Ceschin and Gaziulusoy (Figure 6) The framework maps design extensively from its roots in product development, expanding into new arenas and contexts of systemic complexity (Ceschin & Gaziulusoy, 2016).

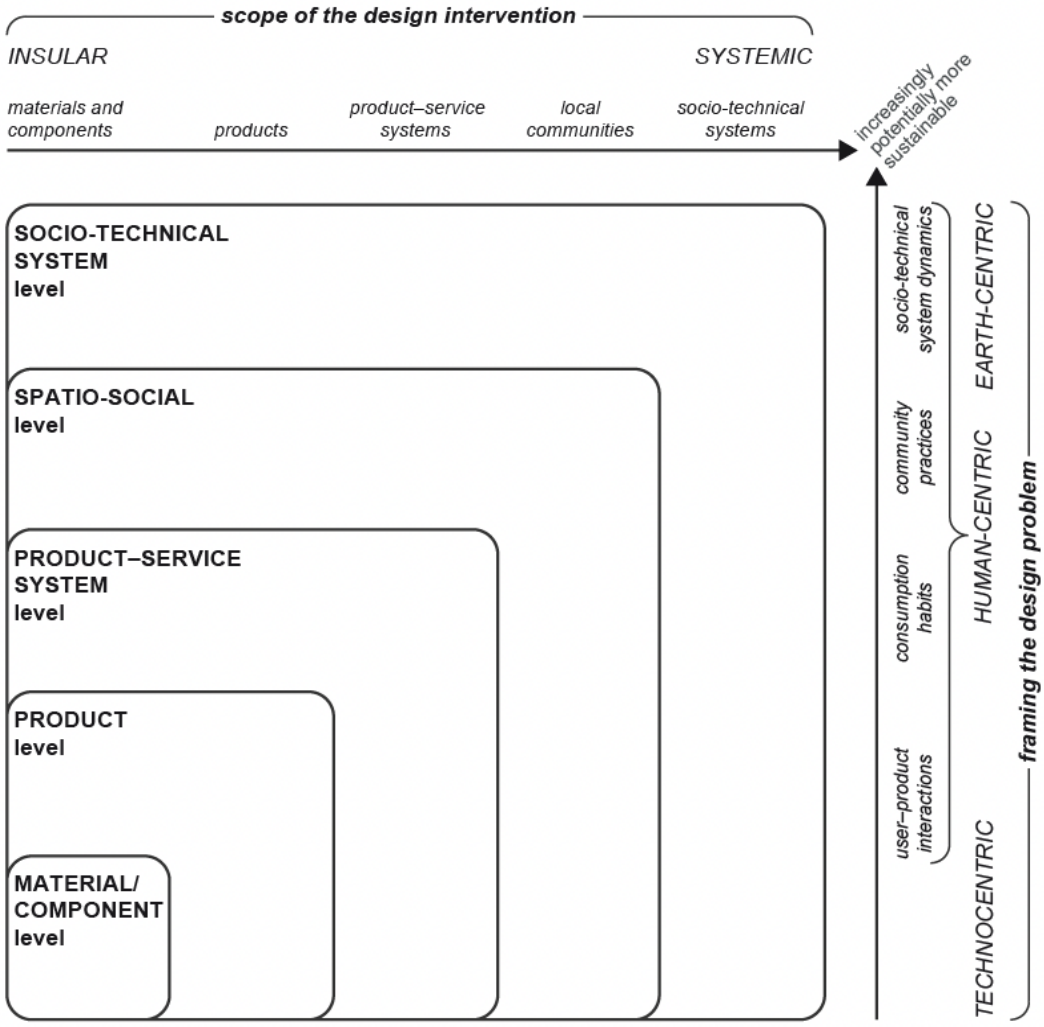


Figure 6. Evolution of design for sustainability (based on Ceschin & Gaziulusoy, 2016).

Scope of design engagement

According to the socio-technical innovation strategies, as conceived by Geels et al., a key element is the formation of transformative coalitions in which actors from all sectors are involved to ensure the identification of key roles in the establishment of learning processes, multi-stakeholder networks and for establishing shared and articulated visions of STs. Accordingly, the *Social Design Pathways* matrix (Figure 7) seeks to help change agents frame the design challenge as it can "...reveal the skill required for action, the kinds of participants and partners required ..., the scales of engagement and the possible outcomes for a given social impact challenge" (Winterhouse Institute, 2013). Its use, suggested by Tonkinwise et al., is to; 1) envision, map and link projects, interventions and experiments at multiple levels of scale for greater impact; 2) to guide research, design and development; 3) establish an index for specific skills, resources and partners necessary for a successful project/solution; 4) to assess project outcomes and impacts (Tonkinwise et al., 2015, p. 9)

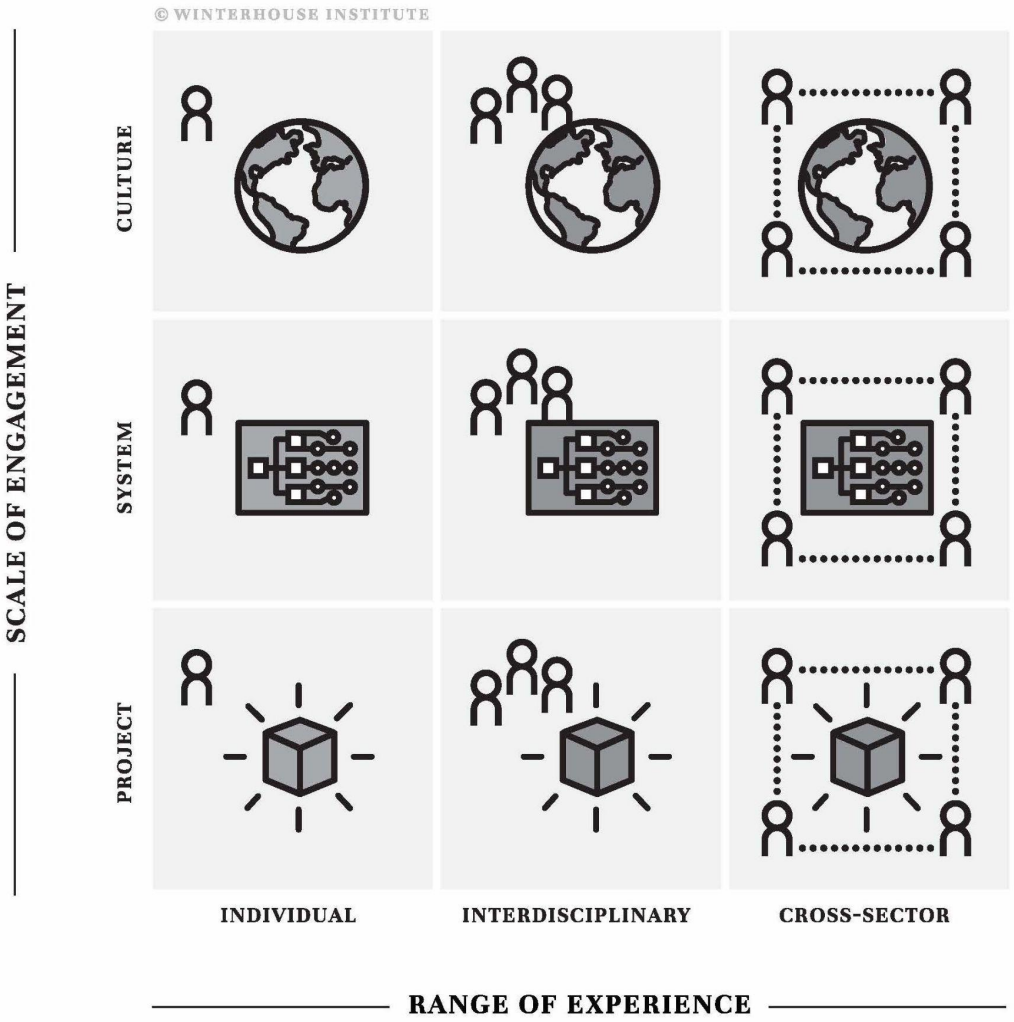


Figure 7. Social Design Pathways (Winterhouse Institute, 2013. CC BY 3.0)

Evaluative lens matrix

The matrix of the lenses (Table 3) based on the four perspectives of ST is suggested to aid the evaluative process of the designerly approaches investigated.

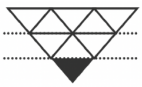
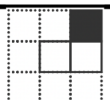
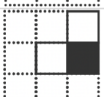
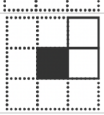
Two facets of safe operating space for humanity were chosen to evaluate the systemic perspective of sustainability; the *planetary boundaries* are, in its essence, an overview of earth-/ecosystems (Rockström et al., 2009, p. 472), while Raworth's Doughnut acknowledges the social and societal systems in our built world. Together they represent a deep understanding of sustainability (cf. strong sustainability) that could be considered pertinent as guiding principles for any human activity (Raworth, 2017; Steffen et al., 2015), including sustainability transitions (Leach et al., 2012).

The six conditions for systemic change framework by Kania et al. (2018) is chosen to evaluate the extent of the systemic change considerations addressed by the approaches. Drawing upon the seminal works of Meadows and Checkland, the framework acknowledges "levels of potential for changing systems" in ways of structuring, organising and addressing paradigms (Birney, 2021). In this sense, it is also analogous to the idea of shallow vs deep interventions when identifying leverage points for sustainability transitions (Abson et al., 2017). For the purpose of this investigation, this paper stays with the three levels of systems conditions described by Kania; structural, relational and transformational.

Ceschin and Gaziulusoy's "Evolution of design for sustainability" (2016) is included to identify the levels of systemic design in the context covered by the DSA in question. The levels constitute product, product-service system, socio-spatial and socio-technical. The lower product level is omitted for the purpose of this analysis (including a sub-level of material) as it has traditionally been the domain of green design and ecodesign, which has historically been concerned with resource efficiency, and hazard/toxicity avoidance. Behavioural considerations in product development could be argued as a more systemic approach; however- it is clear from the authors that the product-service system level is the threshold for all intents and purposes of this paper.

Winterhouse Social Design Pathways is included to help in the scoping of design engagement. Recent additions have been made to the framework, including notions of best practices and axial scale of problem-solving and facilitation of situational innovation. Accordingly, only three quadrants of the framework are deemed relevant for this study: societal socio-technical level, cross-sectoral system level and the interdisciplinary system level.

Table 3. Evaluative Lens matrix.

Lens	Framework	Author(s)	Element	Topic / Issues
Safe Operating Space for Humanity	The Doughnut / Planetary Boundaries	Rockström et al. 2009, Raworth 2012		Planet systems: *Climate change, biosphere integrity, land-system change, freshwater use, biogeochemical flows , ocean acidification, atmospheric aerosol pollution, stratospheric ozone depletion*
				Societal systems: *Food security, Health Education, Income and work, Peace and justice, Political voice, Social equity, Gender equality, Housing, Networks, Energy, Water*
Systemic Change	Six Conditions for systems change	Kania et al. 2018		Structural: *Policies, Practices, Resources Flows* *-Explicit and tangible elements, visible to the players in the system.*
				Relational: *Relationships & Connections, Power Dynamics* *-Semi-explicit and social / organisational*
				Transformational: *Mental Models* *-Implicit and untangable, but powerful conditions for change*
Orders of Design	Evolution of Design for Sustainability	Ceschin & Gaziulusoy 2017		Socio-Technical System level: *Transformation of socio- technical systems through (strategic) design.*
				Spatio-Social level: *Assisting conception, development and scaling-up of social innovation; Designing locally-based productive systems with circularity of resources.*
				Product-Service System level; *Product-service propositions where economic / competitive interest seek environmentally beneficial new solutions; Integrating also the socio-ethical dimension of sustainability.*
Scope of Design Engagement	Social Design Pathways	Winterhouse Institute (2012)		Societal Socio-Technical level: *Strategic Cultural Transformation through Cross Sector collaboration, Visioning Futures, Public Policy innovation*
				Cross-Sectoral System level: *Strategic Cultural Transformation through interdisciplinary teams,*
				Interdisciplinary System Level: *Systems innovation through interdisciplinary teams, Facilitate organisational innovation,*

Applying the matrix and discussion

The following sections will discuss the DSAs in light of the prominent theoretical frameworks as suggested in the evaluative lens matrix (Table 3). The matrix is used to support a structured investigation into the key concerns in navigating the approaches in the context of facilitating ST initiatives (Table 4), namely, Do the DSAs in question …

- address guiding principles according to safe operating space for humanity?
- address structural/phenomenological aspects of systemic change?
- orientate the design challenge in the orders of design?
- orientate the challenge by complexity/level in a scope of design engagement?

Sustainability, planetary- and societal boundaries

The climate crisis is clearly the focal point for the systemic design framework, with its explicit reference to net zero and decarbonisation. However, it is mentioned by all the cases to illustrate the gravity and nature of the wicked problems systemic approaches are suggested to address: “Fundamental change at every level of our society, and new approaches to problem-solving are needed to address twenty-first-century “wicked problems” such as climate change, loss of biodiversity, depletion of natural resources and the widening gap between rich and poor.” (Irwin, 2015, p. 229)

General environmental issues such as pollution and natural resource depletion are also described as systemic challenges in all cases, indicating an understanding of our natural environment as ecological, interconnected systems that are intrinsically bound to human activities. The concept of sustainable development, in which the design agenda operates as a means to change the conditions for industry and economy to become more sustainable, is arguably present in the systemic design framework through referencing the SDGs.[5] This understanding is in accordance with the definition set by the Brundtland commission's report,[6] implicitly referenced in a paraphrase:

[5] https://sdgs.un.org/goals

[6] https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

"SUSTAINABILITY: meeting the needs of current generations without compromising the needs of future generations…" (Design Council, 2021, p. 5).

However, the systemic design framework also includes *regenerativity* as a concept suggesting a more advanced understanding, moving towards paradigms set forth by scholars such as Bill Reed and Pamela Mang (Reed, 2007; Mang & Reed, 2020). The transition design framework is arguably building on similar ideas of moving "beyond sustainability", arguing for a more progressive paradigm with a renewed "humility, reverence for nature" – ultimately suggesting a commitment to a more "radically alternative socio-economic-political structures and paradigms" (Irwin, 2015, p. 236) The systemic design toolkit is the exception in that sustainability issues are to a lesser degree the explicit concern. Rather it conceptualises the nature of challenges addressed by the toolkit as systemic and complex. In this sense, systemic design is a sustainability challenge by proxy.

Societal and social issues are strongly linked to the inclusive and participatory element in all cases. Transition design suggests that social issues are at the foundation of many wicked problems, asking traditional design practices to move beyond dominant user perspectives. Rather, humans affected by systemic interventions are considered stakeholders empowered through a high degree of participation and co-creation. Expanding on these notions, the systemic design framework conceptualises a "people and planet centred" principle aiming for the shared benefit for all living things: "…there is a tendency to differentiate between environmental and social approaches. The two are intrinsically linked, and the false dichotomy hinders our capacity to think systemically." (Design Council, 2021, p. 15)

Only the systemic design toolkit explicitly references the concept of doughnut economics (Raworth, 2012); however, it is not outright represented as a guiding principle or knowledge component in the framework itself.

Table 4. Theoretical concepts and applications addressed by the DSAs.

Lens	Concept element	Topic / Issues	The Systemic Design Framework	The Systemic Design Toolkit	The Transition Design Framework
Safe Operating Space for Humanity		Planetary boundaries, earth-systems	·Focus: Climate crisis, decarbonisation ·Acknowledges: natural resource depletion, environmental pollution	·Focus: Identify exogenious environmental factors for context; climate change, resource depletion	·Focus: Acknowledgement of natural systems in crisis (climate, biodiversity) ·Acknowledges: natural resource depletion, environmental pollution
		Societal boundaries, Global social issues	·Sustainable Development (UN SDGs) ·Social issues of marginalisation and inequality ·Doughnut economics (Raworth, 2017)	·Focus: Identify exogenious societal factors for context;; population growth, ageing, inequality	·Focus: Symbiotic relationship with environment through Improvement of quality of life ·Acknowledges: Cosmopolitan localism
Systemic Change		Structural: Policies, Practices, Resources Flows	·Organisational design ·People and resource mapping ·Information sharing/flow	·Identify practices, rules, infrastructure, existing networks ·Mapping leverage points of systems (Meadows) ·Information sharing/flow, feedback loops	·Practices and behaviors (Niedderer et al 2014, Ajzen1991) ·Transdisciplinary cooperation ·Leverage points of systems (Meadows)
		Relational: Relationships & Connections, Power Dynamics	·Partnership and network building ·Create inclusive spaces ·Power relations	·Identify Cultural and social norms, ·Power relations ·Multi stakeholder processes	·Conflict resolution (Mason & Rychard, 2005) ·Power dynamics (Baur et. al, 2010) ·Multi stakeholder processes (Hemmati, 2002) ·Network and alliance building
		Transformational: Mental Models	·Assumptions and beliefs ·Mindset and posture (of participants/facilitators)	·Paradigm and worldviews change ·Paradoxical thinking, challenge established truths	·Mindset and posture (of participants/facilitators) ·Beliefs and worldviews (Woodhouse, 1996; Kearney, 1984) ·Co-creating visions of alternative futures (Rawolle et al. 2016) ·Dealing with ambiguity and
Orders of Design		Socio-Technical System level	·Design for Socio-technical systems (Ceschin & Gaziulusoy, 2019) ·Regenerative systems	·Transitional roadmaps for systems change implementation ·Scaling of niche initatives	·Systems-transitions ·Multi Level Perspective (Geels 2006) ·Socio-technical regimes
		Spatio-Social level	·Community inclusion ·Place and nature based solutions	·Self organisation	·Placed based, context based design ·Amplification of grass roots efforts ·Socio-economic-political change
		Product-Service System level	·Supply- and value chain analysis ·Circular flows ·Sustainable business modeling	·Physical and digital structures	·Design for behavioural change
Scope of Design Engagement		Societal Socio-Technical level	·Societal level orientation and vision setting ·Societal culture change	·Societal level value proposals ·Transitional pathways planning	·Sustainability Transitions ·Transformations of attitudes, behaviour of society
		Cross-Sectoral System level	·Cross-sectoral alignment and interventions ·Community inclusion	·Mapping systems level regimes and practices ·Orientation of system level interventions on complexity scale	·Placed based, context based design with local stakeholders
		Interdisciplinary System Level	·Transdisciplinary approaches and methods/tools	·Engaging stakeholders and actors through intervention modelling	·link projects, interventions and experiments at multiple levels of scale for greater impact

Systemic change and systemic interventions

It is suggested that current practices have largely adopted the notion of systems leveraging (Meadows, 2008) when designing for systems change (Tonkinwise et al., 2015, p. 13). Accordingly, all three cases studied make explicit reference to Donella Meadows' concept of leverage points for catalysing change in systems.

Most prominent is arguably the transition designs' application of the concept, with an extensive discourse on the non-material leverage points analogous to the relational and transformational conditions described by Kania et al. (2018). Furthermore, all the cases acknowledge the transformational potential of mental models and beliefs, with the systemic design framework - and transition design incorporating posture and mindset as key factors in enabling the practitioners' and participants' capacity for these new ways of working:

> Transition Design argues that living in and through transitional times calls for self-reflection and a new way of "being" in the world. This change must be based upon a new mindset or worldview and posture (internal) that lead to different ways of interacting with others (external) that informs problem-solving and design. (Irwin, 2015, p. 235)

> Only through first questioning and then redesigning fundamental processes and values will we be able to create sustained change. This means becoming aware of and questioning the assumptions that underlie contemporary practice. (Design Council, 2021, p. 18)

The importance of relational phenomena, including social and cultural norms, power dynamics and conflict, is particularly reflected in the systemic design framework and transition design; The former attribute the importance of the four roles in systemic design framework processes to several key relational factors (ref. section 4.1) suggesting that these dynamics are facilitatory responsibilities as well as general systems considerations:

> Design processes need to prioritise creating inclusive spaces which build shared language and relationships between different professions and value different ways of knowing. (Design Council, 2021, p. 15)

Concerning the structural level of systemic conditions, the systemic design toolkit includes a variety of tools to identify and propose interventions for a broad range of systems elements such as infrastructure, information flows, rules and regulations as well as practice (Ael et al., 2018, p. 8,24)

Order of design and scope of engagement

The application of design in increasingly complex contexts (Ceschin & Gaziulusoy, 2019; VanPatter, 2020) has renewed interest from design academics and practitioners. Accordingly, transition design was proposed as a response to "… designs expansion into systems-level change, " and the framework consequently draws upon a number of current academic discourses related to systems change, including socio-technical transitions. It is in this context that the evolution of design for sustainability into the socio-technical system level is made explicit in that: "Design for sustainability transitions (DfST) (or transition design, as popularised by Irwin, 2015b), focuses on the transformation of socio-technical systems through technological, social, organisational and institutional innovations" (Ceschin & Gaziulusoy, 2019, p. 127). This operational expansion is also acknowledged by the systemic design framework and the systemic design toolkit through the notion of systems transitioning and scaling towards lasting, system-wide changes. Vandenbroeck, a key contributor to the systemic design toolkit, reflects on the evolution of the design practice leading up to the formation of the toolkit: "This has been characterised by an increasing scale of design-led interventions: from graphic to product to service to environment/systems design" (2016, p. 2).

The systemic design framework shows less emphasis on visioning, planning, and organising of transition pathways —a strategic perspective identified by Cheschin and Gaziulusoy to be vital as "Design for System Innovations and Transitions focuses on transforming systems by actively encouraging development of long-term visions for completely new systems and linking these visions to activities and strategic decisions of design and innovation teams" (2016, p. 148).

> The spatio-social level of engagement is most thoroughly covered by the transition design framework insofar as the framework emphasises the need for a place-based approach, a so-called cosmopolitan localism. Comparably in the social design pathways matrix, it is also considered to be the scale where social innovation is best situated: Social Innovation occupies a position further along the continuum where projects are usually situated within social and community contexts, engagements are ideally longer, and solutions begin to challenge existing socioeconomic and political paradigms. (Irwin, 2015, p. 231)

All approaches give focus on the identification of stakeholders and their participatory inclusion. However, little is described in the ways of organising knowledge and competencies of ST processes. The systemic design framework conceives the concept of four core roles, and their characteristics reflect both the emerging codification of skillsets for designers working in systemic contexts and the inherent need for interdisciplinary approaches and roles in systemic change. Interestingly, the four roles (system thinker, leader & storyteller, designer & maker and connector & convener) closely align with the key competencies in sustainability as suggested by Wiek et al. in the research relating to sustainability knowledge in higher education (Wiek et al., 2011).

Summary and conclusion

In our study, we have attempted to trace the fundamental theoretical foundations of these designerly approaches and their relevance to systemic sustainability challenges. Furthermore, we have analysed key documents to identify the extent of application or referencing of select, prominent frameworks from sustainability-, systems- and design research to help methodological considerations in the facilitation of ST processes.

The evaluative lens matrix used for the analysis adopts the safe operating space for humanity as a principle for sustainability as a long-term systemic effort that acknowledges the boundaries of the natural and built systems and societal and social structures. Furthermore, the lens of systemic change provides a reference for evaluating an intervention that acknowledges both structural and phenomenological aspects of systems. Finally, the order of design and scope of engagement helps situate

the type of design for which the approaches are considered suitable and to scope the challenge appropriately in terms of its systemic complexity.

The three designerly approaches investigated exhibit little if any clear reference to the key sustainability concepts selected for this exploration. None of the cases includes the prominent use of any sustainability definition or reference as a means to guide the approach or process described. However, universal appraisal and adoption were found in the theories for systems change by Donella Meadows, which in turn form the basis of Kanias' six conditions for systems change as included in the analytical matrix by the author. The rich academic foundation of transition design distinguishes itself by being clearly reflected in the work of Cheschin and Gaziulusoy in describing the evolutionary frontiers of design for sustainability, suggesting that systemic design will ultimately be challenged to address the sustainability of socio-technical transitions.

The fact that these designerly approaches include few explicit references could be attributed to the fact that little empirical knowledge on the effect of such systemic design exists at the current stage. However, it is important to note that the adoption of these approaches can be observed in an increasing number of case-application, generating knowledge that might not reach academic publications. The approaches also reveal continued friction between design and system thinking, with the former's wish for practical implementation. The tension might also be one of simplification to enable participation vs the need for embracing complexity (Vandenbroeck, 2016)

This paper argues the application of the proposed evaluatory lenses has helped navigate the three systemic design approaches in a structured manner and aided in evaluating their potential for addressing the inherent challenges of ST processes. In turn, the paper can hopefully inform practitioners and scholars in building their competence in framing their future practice and research.

Finally, the author suggests that further research should be done, investigating the actual uptake of these approaches by practitioners and consequent implications for methodological and processual choices for ST projects.

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