Framing System Dynamics for Designers Innovating in Transitions

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In recent years, designers have increasingly engaged with sustainability transitions, using design and innovation activity to drive systemic change. However, we still have a limited understanding of how designers can best frame complex system dynamics to understand which innovations will foster desired changes. This study aims to better understand how design decisions are made when innovating for transitions and how to support this process. We take a research-through-design approach to explore the dimensions of scale and time and propose a conceptual framework to specify how to include these dimensions in framing transition challenges for design. In our view, exploring and specifying 1) systems principles that drive the future system, 2) organizational roles that stakeholders can play in the transition, and 3) changes in people's behavior and capabilities that drive the transition, is key to identifying what future practice(s) to design for to foster desired transitions. We discuss the design activities and process artifacts developed and used to support our investigation into framing for transitions in a way that aligns short-term innovation efforts with long-term systemic change. Our contributions advance our understanding of framing in transition design, and we hint toward some of the design activities and process artifacts to support this.

Keywords – Design Expertise, Framing, Systemic Design, Transition Design.

Relevance to Design Practice – How to frame system dynamics for innovation by navigating across scales and time is relevant to transition designers working in transition contexts who want to contribute to long-term systemic change.

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Introduction

Designers are increasingly engaging with challenges related to transitioning systems and driving systemic changes (Norman & Stappers, 2015). This has sparked meaningful discussions about how designers cope with complexity and has led to new design practices like systemic design (Ryan, 2014), system-shifting design (Drew et al., 2021), and transition design (Irwin, 2015). While these new design practices support designers in relating to system dynamics and complexity, the emphasis has been on analyzing these dynamics rather than integrating them to drive innovation. To support designers in their pursuit of fostering transitions, we need to develop a deeper understanding of how to frame system dynamics in a way that identifies opportunities for innovation that drive meaningful and desired system changes.

Transitions are conceptualized as long-term and large-scale changes in complex societal systems with a directionality toward desirable alternatives (e.g., Loorbach, 2007; Markard et al., 2012)—for instance, transitions within the energy system, transportation system, and agro-food system to become more just and sustainable. Such systems are considered complex because they are composed of numerous interconnected and interdependent components (e.g., actors, institutions, and material artifacts) that exhibit emergent behaviors, where the overall properties and behaviors of the system cannot be easily predicted from those of the individual components (e.g., Geels, 2002; Markard et al., 2012; Meadows, 2009). Despite this complexity, the main aim of transition research is to understand these processes and identify ways to advance and accelerate desired systemic changes (Loorbach et al., 2017). As transitions unfold, new products, services, business models, and organizations emerge, which (may) challenge and alter or complement the dominant system structures, cultures, and practices (Loorbach et al., 2017).

The ability of design to relate to people's everyday lives is key in helping societies shift to more just and sustainable alternatives (Gaziulusoy & Ryan, 2017a; Irwin, 2015). Not only can designers identify and address the problematic and persistent (consumption) patterns that contribute to complex societal challenges (Spurling et al., 2013), the human-centered approaches used in design can help to understand in what way desired changes are or can become meaningful for people and organizations (Tromp & Hekkert, 2018; Van der Bijl-Brouwer & Dorst, 2017). According to Dorst (2011), designers engage in a reasoning process called design abduction. This reasoning process involves designers hypothesizing about how their design proposals will deliver specific value to users and/or stakeholders. This process, depicted in Figure 1, comprises a *what* (design) and a *how* (mechanism) that together achieve a desired *value* (desired outcome) (Dorst, 2011). In design projects, designers often begin with an understanding of the value they seek to achieve and use frame(s) to explore and articulate how their design proposal and

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its working principle will lead to the intended value. Essentially, frames connect certain issues with solution directions. The process of proposing if/then statements (i.e., different frames) to predict how a mechanism will achieve desired values is called 'framing' (Dorst & Cross, 2001).

Framing is an essential design practice, occurring in the process of co-evolution between a frame and a solution (Dorst & Cross, 2001). To illustrate with an example: if a designer aims to create something to make people feel special (*value*) for a commercial internet provider, a birthday can be a frame to hypothesize what working principle might lead to this value. This frame can help to identify the mechanism of receiving personal attention (*how*), supporting the ideation of interventions, such as addressing people with their names in automated mailings (*what*). Throughout the framing activity, designers can evaluate if the proposed frame supports them in making design decisions and developing a clear argumentation and reasoning for a design proposal. In less complex design challenges, like in the example just used, this reasoning is relatively simple, while in the more complex transition design challenges there are more considerations to take into account while framing.

WHAT + **HOW** *leads to* **VALUE**

FRAME

Figure 1. Design reasoning framework developed by Dorst, 2011 (image adapted by the author)**.**

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Nynke Tromp holds a PhD and is currently the program director at the Dutch Design Foundation, where she develops the public design practice in the Netherlands, commissioned by the Ministry of Education, Culture and Science. She is co-founder of the Systemic Design Lab, co-founder of Redesigning Psychiatry, and author of Designing for Society (2019). This work was conducted when Tromp worked as an associate professor of Social Design & Behaviour Change at the department of Human-Centered Design, Delft University of Technology. She was also director of the MSc program Design for Interaction and part of the management team of the Delft Design for Values Institute. Her research focused on the role of design in addressing complex societal issues—both through the capacity of designed artifacts to shape behaviour and the methodological value of design thinking and reframing. Her work spanned a variety of domains including democracy, mental health, food consumption, safety, and wildlife trade.

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Reasoning toward a frame in transition design challenges is complex due to multi-stakeholder involvement, diverse knowledge fields, multiple problem owners, interconnected and dynamic problems, and the need to navigate multiple system scales (micro, meso, macro) and timeframes (now, near future, far future) simultaneously (Dorst, 2015; Loorbach et al., 2017). While transitions ultimately aim for sustainable and just societies, the tremendous scope of such challenges allows a large variety of interventions to move through such processes and (temporarily) establish the more desirable alternatives. Therefore, the framing that supports design reasoning to interventions should ensure design interventions are applicable in people's daily lives tomorrow and align with aims for nature and society over the next 30-50 years. As such, effective design reasoning for transitions requires a nuanced understanding of current system dynamics in light of desired future system dynamics to hypothesize what change mechanism(s) can foster desired values through design interventions.

Despite the recognized importance of framing in complex systems change (Dorst, 2019), the framing needed to design interventions that foster transitions is underexplored and not methodologically well supported yet. Therefore, this paper focuses on understanding how designers can frame system dynamics in a way that supports them in making design decisions and developing a strong design reasoning for what innovations to propose to foster desired transitions. We apply a research-through-design approach (Stappers & Giaccardi, 2017) to understand how long-term implications and short-term mechanisms are combined in the framing activity. To investigate the phenomenon of framing, we develop a process supported by various design activities and artifacts that are tested and refined over time. The findings in this paper expand knowledge about how designers apply their framing expertise for innovating in transition contexts, informing future research into framing and methodological development to support this key design activity. In the following section, we describe the state-of-the-art of how designers currently frame system dynamics for innovating for systems change and what challenges they face.

State-of-the-Art

Over time, design has evolved from a practice focused on designing things to tackling complex societal challenges, thereby shifting emphasis from the utility to the meaning innovations offer (Dorst, 2015; Verganti, 2008). The future has long been embedded in design practice due to its commitment to innovation and change. By engaging in complex challenges, designers stimulate their futures awareness and incorporate broader timeframes within their design process (Candy & Dunagan, 2017). Adopting longer-term perspectives allows designers to go beyond the constraints of current socio-technical systems to envision alternative lifestyles that offer radical new meaning to people and society (Geels & Schot, 2007; Verganti & Öberg, 2013). This new meaning challenges and changes the current system structure into a preferred alternative, a shift supported by the human-centered approach of design practice. Human-centered design is a group of methods that places people's interests at the center of the design process

(Van der Bijl-Brouwer & Dorst, 2017). They describe strategies for acquiring and integrating insights about human beings into products, services, and systems that fulfill people's needs and aspirations. In the context of complex societal challenges and transitions, human-centered knowledge is viewed as a positive design attribute as it supports designers in making change meaningful to people (Goss et al., 2024; Tromp & Hekkert, 2018).

Systemic design is a relatively new design practice that combines elements from design research and practice with systems thinking and complexity in methods for systems change (Ryan, 2014). In light of this study, we critically analyzed and compared a selection of methods recently published in a systemic design methodology handbook aimed at supporting designers in analyzing systems, i.e., Actors Map, Actants Map, Rich Context, Multi-capitals Model, and Story loop diagramming (Jones & Van Ael, 2022). The reviewed methods differ in what they deem most important to focus on in the analysis of system dynamics. Some methods build an understanding of system dynamics by analyzing actor relationships and considering factors like relative power, influence, and shared or conflicting values. This perspective is illustrated by the Actors and Actants maps, which adopt an actor-centric view to understand how actors with significant influence can steer system changes and direct design efforts to focus on these actors. Other methods help to build an understanding of system dynamics by analyzing the transfer of resources and considering factors like knowledge, goods, and money. This is illustrated by the Rich Context, Multi-capitals Model, and the Story loop diagram, which seek to understand how shifts in these resources may trigger cascading effects throughout the system and direct design efforts toward resources that yield the most positive effect—also known as leverage points (Meadows, 2009).

While the reviewed methods help identify and define what should change, they do not reveal how to realize the desired values through innovation or what values it should offer people who will use it. In other words, they do not integrate the human-centered knowledge of design. For instance, understanding actor relationships can indicate who has the most power to change the system or which critical actor values are at stake relative to a transition. However, it does not indicate how design might address these to foster intended and desired values for people in day-to-day life and/or for stakeholders. This results in the systems perspective remaining disconnected from people's everyday lives. Although the Story Loop Diagram attempts to bridge this gap by adding narrative elements to contextualize the system's interactions, the resulting maps often remain overwhelming and impractical for innovation (Murphy & Jones, 2021). Additionally, while these methods support designers in understanding current systems, they do not explicitly relate this understanding to future dynamics. As a result, they fail to provide a nuanced understanding of current system dynamics in light of desired future system dynamics. Consequently, they do not sufficiently support designers in addressing the temporal dimensions of transitions to hypothesize what change in the present can lead to desired changes considering the envisioned future system. With our focus on design intervening in people's daily lives to onboard them on a desired transition and recognizing the gap in methods linking system analysis to the context of people over time, we reviewed the few transition design cases reported in the literature to learn how the designers made this step.

Reviewing transition design cases showed that designers explicitly take steps to bring in human-centered design and connect systemic values to the values offered to individuals in their daily lives. For instance, Hyysalo et al. (2019) use personas to help stakeholders relate to the people who need to change their behaviors in the near future to enact the desired transition. However, the personas failed to generate empathy and support stakeholders in exploring systemic changes beyond their own repertoire, resulting in outcomes focused on system-wide changes without clearly articulating their impacts on people's daily lives. In other research, Gaziulusoy and Ryan (2017b) work with descriptions of system dynamics to communicate the system level while at the same time communicating the qualities of day-to-day life. For instance, to communicate how decisions are made in a city in the far future, they explain a top-down, centralized economy as 'others doing it for the citizens' versus a bottom-up, decentralized economy as 'citizens doing it themselves.' They also use terms like density to describe how living in the city might feel. For example, a denser city might make life feel more hectic, while a less dense city might feel calmer. These envisioned future dynamics serve as starting points to backcast to the present to consider what innovations to propose that might lead to the desired changes. Similarly, in Goss et al.'s (2024) study, the interaction between people and the food system is described as outsource-oriented or 'I want everything done for me' versus action-oriented or 'I want to do everything myself.' While these studies report on explicit descriptions of the (envisioned) relationship between citizens and organizations/authorities to understand the impact of different systemic realities on people's daily experiences, the economic and financial mechanisms necessary to implement these innovations are not as articulated in these descriptions, leading to some stakeholders questioning the feasibility of the proposals.

Other studies report on the use of social practices to explore and connect systemic values to the values offered to individuals. Social practices, as described by Reckwitz (2002), are routinized everyday actions that are habitually performed in (a large part of) a society. Bailey and Gamman (2022) use social practices to understand the drivers and features of violence among young people to bring a more just and safer urban environment. Viewing violence as a social practice uncovered key conditions in the broader system (i.e., in the social structures, cultural beliefs, and values of societal groups) that shape the enactment of violence in young people's lives. Another study by Wallace (2021) maps social practices related to overconsumption across different system scales and timeframes. For example, in the present, global trade and a culture of disposability normalize practices like early technological upgrades and shopping as a hobby. At the same time, a small but growing number of people engage in re-use, repair, and sharing communities. Wallace (2021) identifies interventions outside mainstream practices, such as repair cafés, that can challenge and alter the problematic system outcomes. However, both studies

encountered challenges in bridging conceptual system mapping and practical application within stakeholder organizations. The difficulty lies in relating the insights associated with people's everyday lives to the stakeholders' innovation agendas. This highlights the need for the framing of system dynamics not only to facilitate a shift from system analysis to innovation synthesis from the perspective of the designer but also to align with the organizational stakeholders' goals and perspectives, enhancing their engagement with and uptake of innovation opportunities needed to drive systems change.

In summary, the literature shows that designers are increasingly working on complex systems change and transition challenges, applying their framing expertise and design skills to engage in and accelerate desired changes. However, understanding how to unite reasoning about system dynamics and value for people to support the conceptualization of design interventions that foster desired transitions is lacking. Methods either seem to focus on mapping the system perspective but lacking a lifeworld perspective, or they focus on understanding current dynamics but fail to connect to a desired future. Examining cases reported in the literature, we found that designers use different strategies to shift from system analysis to people's everyday lives. Namely, by connecting system characteristics and individual behaviors through the concept of social practices or by describing system characteristics with terminology that describes their meaning to the everyday lives of people. While these instances showed ways to connect system dynamics (macro level) to user value in the design of interventions (micro level), connections with the broader business context and organizational leverage points (meso level) for such interventions were lacking. Therefore, in the present study, we hope to gain a better understanding of the specifics of navigating system complexity, system scale, and time in a way that supports innovation for transitions and how this framing can be supported.

Method

We took a research-through-design approach to explore how designers can apply their framing expertise to frame system dynamics for innovating in transition design challenges. Research-through-design is an approach that explicitly uses design activities as a means of knowledge generation (Stappers, 2007; Stappers & Giaccardi, 2017). We adopted the research-through-design tactic of sequencing (Redström, 2017), iteratively shifting between literature and experimentation, to gain a more sophisticated understanding of the phenomenon of interest, in our case, framing for innovating in transitions. To this end, we reviewed literature related to complex systems change, including literature pertaining to system thinking and dynamics, organizational change, social innovation, transition studies, and systemic and transition design. While this body of literature offers theoretical accounts and examples of framing complex systems, research-through-design offers a structured way to integrate and apply this diverse knowledge in transition design processes.

In our experiments, we investigated what framing activities can result in a useful and convincing frame for innovating in transition design challenges and how to support this. This involved developing design activities and process artifacts to investigate various aspects of the framing and design activities. These artifacts were designed with a specific focus on systems complexity, scale, and time. Consequently, the specific outcomes of the experiments (i.e., proposals for design interventions) are secondary to the study's main objective. They serve primarily to investigate, evaluate, and validate the proposed framing and the integration of relevant concepts within the transition design process. Through these experiments, we gained a deeper understanding of the framing activity and how the design activities and process artifacts support designers in making design decisions and generating design proposals. Each experiment generated insights or raised questions, leading to new activities and process artifacts in subsequent experiments (Krogh & Koskinen, 2020).

We conducted five experiments over 2.5 years, ranging from single workshops (2 to 6 hours) to multi-day sessions. Participants included bachelor design students, design researchers and practitioners, and industry actors. Each experiment focused on different parts of the framing and design process, and we adapted each experiment to the characteristics and expertise levels of the participants. The different contexts and diversity of participants helped identify conceptual, methodological, and practical challenges when innovating in a transition design context—Table 1 details the context of the design experiments. All the experiments related to the transition of the Dutch food system to cater to enough food for all with minimal waste.

Table 1. Research through design experiments.

#	Participating Group	Study type	Participants	Duration	Number of participants	Date
1	TU Delft	Project	Bachelor design students	20 hours over 3 days	60	September 2020
2	TU Delft	Project	Bachelor design students	20 hours over 3 days	60	September 2021
3	TU Delft	1 workshop	Bachelor design students	2 hours	35	May 2022
4	Design Research Society Conference	1 workshop	Design researchers and design practitioners	6 hours	12	June 2022
5	FETE Project Consortium	1 pre-interview and 2 workshops	Actors in the food system	1 hour preparation, 8 hours over 2 days	6 in workshop one, 5 in workshop two.	March 2023 - April 2023

Led by the first and second authors, all experiments provided participants with background information related to the transition challenge, activities, and process artifacts provided. During the experiments, we took notes during observations and collected the outcomes of the transition design process. This allowed us to understand the framing within the individual experiments and also compare how the framing evolved across experiments. Aligned with the technique of sequencing (Redström, 2017), our process involved combining insights learned from observations during the design experiments with relevant insights from the literature. These were then used to adapt the activities and process artifacts for the next experiment.

The literature reviewed for this study included more than 35 articles related to complex systems change. With an abductive approach, we went back and forth between literature and practice to build a stronger understanding of framing, both in terms of what processual qualities are needed to support framing in transitions and what phenomenon constitutes a useful and convincing frame (Dubois & Gadde, 2002). Given the diversity of participants, when conceptual, methodological, or practical challenges emerged from the experiments, we reviewed relevant literature to seek insights that might inform adaptations related to the specific challenges. We also reflected on whether the challenges were related to the specific participant group and their level of design expertise (for instance, in the experiments with bachelor students versus design practitioners) or if they related to conceptual challenges in the framing. These iterative cycles of experimentation, analysis, and adaption resulted in a nuanced understanding of how designers can frame system dynamics to innovate in transitions and hinted towards how this can be supported.

Overview of Experiments

This section provides an overview of the research-through-design experiments conducted as part of the FETE (From Excess To Enough) research project. FETE is a collaboration involving three Dutch universities and eight organizations within the food system that are interested in reducing food waste now and partaking in a transition to a food system that caters to enough. In this section, we first summarise experiments one to four, focusing on the framing of each experiment, supporting literature, participant activities, and key learnings related to the proposed framing. A detailed explanation of the fifth and final experiment follows, showcasing the most refined design activities and process artifacts employed. As part of the FETE research project, a vision was developed with input from all FETE partners and other experts knowledgeable of the Dutch food system (for a detailed explanation of the visioning process, see Goss et al., 2024). The vision presents a new Dutch food system that minimizes food waste by catering to people's different consumption practices, engaging consumers in consumption learning loops, adding value to food beyond nutrition, and bringing production cycles closer to consumers. This vision was used in some capacity in experiments 2 to 5—details to follow.

The purpose of these experiments is to advance our theoretical and practical understanding of the role of framing in supporting designers in navigating systems complexity, scales, and timeframes, as well as indicate what phenomena come together in a useful and convincing frame for innovating in transition design challenges. Accordingly, the specific innovation proposals of the experiments are not provided in detail and are of lesser importance as they do not constitute the main contribution of the paper. Instead, they serve as a means to evaluate and validate the proposed frame and design activity.

Experiments 1 to 4

Experiment 1

Focus of framing: This experiment focused on how the meso-level (i.e., stakeholder perspectives) can be more integrated into the framing by exploring how stakeholder value conflicts can reveal design opportunities to accelerate desired transitions.

Supporting Literature Insights: Transitions require long-term visions of the future, articulating the societal changes an intervention aims to achieve (Irwin, 2015). Transitions challenge various actors' vested interests, power structures, and business models, necessitating designers to understand these dynamics and address them through innovation (Eden & Ackerman, 1998; Loorbach, 2022; Reed et al., 2009). Analyzing and addressing conflicts between actors and desired futures (e.g., conceptualized in visions) helps to develop innovations that address the critical conflicts that hinder or facilitate systems change (Tromp & Hekkert, 2018).

Activities undertaken: Due to COVID-19, this experiment was executed using the online video platform Zoom and the online collaboration platform Miro. Participants were divided into twelve groups representing different food system actors. Each group developed a vision of a future food system that caters to enough food for all and minimizes food waste. This vision described the changes this may require in consumer behavior and lifestyle, implications for production and supply, and other new aspects needed in the system to facilitate desired changes. Using these visions as a reference, participants completed a template to assess their actors' readiness to enter and move with the transition. This template asked for an analysis of various aspects of their actor, such as their decision-making structures, drivers of innovation and change, potential contributions to the transition, possible conflicts arising in the transition, and core driving values. Next, the groups were mixed to develop an actor map, positioning the actors based on their perceived power and interest in the transition in order to discuss and identify value conflicts that could serve as entry points for innovation. Afterward, the original groups reconvened to develop innovation proposals that their actor could implement in the present to foster the transition.

Key insights related to framing: While this experiment tried to connect future stakeholder values in the transition to their current values, the framing lacked directives for repositioning actors based on future dynamics. The absence of a shared vision during joint actor mapping led to a lack of shared understanding and no common reference to address conflicts and design innovations for intended systems change.

Experiment 2

Focus of framing: This experiment focused on how to bring value to all system levels (for citizens, organizations, and the system) over time in the framing (i.e., connect current values with future values).

Supporting Literature Insights: Engaging actors in creating shared visions supports building collective commitment and mobilizing action in transitions (Loorbach, 2010; Mok & Hyysalo, 2018). To effectively drive systems change, designers need to adopt a societal perspective, understanding both the salient user and stakeholder concerns that exist and emerge in the current context, as well as the systems interdependencies and overarching societal concerns in the present and the future (Tromp & Hekkert, 2018). Recognizing different levels of value—value for users, organizations, ecosystems, and society—is crucial in this context (Den Ouden, 2012). This understanding can enable a strategic focus on leveraging organizational strengths, shifting the focus from assessment to active engagement in joint innovation for systems change (Goss et al., 2021; Mason & Rychard, 2005; Nogueira et al., 2019).

Activities undertaken: Participants were divided into twelve groups representing different food system actors. They were provided with the FETE research group's vision of a future food system. This vision was developed by a design agency in collaboration with FETE partners and other food system actors. It presents a Dutch food system that minimizes food waste while envisioning new roles between consumers, retailers, and producers. In this experiment, the vision was explained in terms of the new system's dynamics, focusing on food production, processing, purchasing, and consumption. After reviewing the vision, each group completed a template to assess their actors' position within the transition and their readiness to respond within the transition. The templates provided in Miro were divided into three abstraction levels (individual-, organization-, and system level) that explored distinct aspects of the transition.

The analysis at the individual level focused on identifying practices that hinder the transition to less food waste and value conflicts in consumer behavior, such as short-term versus long-term health goals. This level indicated current system trends and practices and, in light of the vision, anticipated future trends and practices, helping to contextualize actor behavior. For instance, a food manufacturer might increase single-sized portion production due to a rise in single homeowners. At the organizational level, the focus was on identifying potential barriers for the actor to enter the transition towards a food system that caters to enough. This level reveals how actors currently operate and examines their dynamics and alignment with transition goals, highlighting potential conflicts and barriers. For example, it revealed how current innovation processes might need to evolve to support the transition. Lastly, the system-level analysis focused on understanding the competencies of each actor in relation to others within the system. Specifically, it involved mapping key relations between actors and identifying their potential capitals of power (human, structural, relational, financial, reputational, resource, and cultural), helping to anticipate which organizational qualities could be leveraged to accelerate the transition. By assessing the readiness of each actor and their respective capitals and conflicts, this level provided crucial input for strategies to accelerate the transition towards a food system that ensures sufficiency.

Key insights related to framing: While this experiment tried to make the investigation into the values offered to citizens, organizations, and the system in the transition more explicit and manageable, analyzing the different levels independently overlooked their interconnectedness. This resulted in innovations that did not integrate insights from all levels of the system and led to incoherent design reasoning. For instance, innovations that conflicted with the future dynamics or innovations that failed to consider the potential consequences to business models and roles of actors if joint innovations were pursued.

Experiment 3

Focus of framing: This experiment focused on how the interactions within the meso-level (i.e., between organizations) can be better integrated into the framing, and how to utilize relationships at the meso-level to ensure actors remain relevant in the near and far future.

Supporting Literature Insights: Innovation strategies need to extend beyond an actor's individual network to consider the broader networked environment in which they operate (Planko et al., 2016). By collectively adapting the system, actors can create a fertile ground for innovation, developing new relationships that facilitate wider innovation adoption. This highlights the important role of collaboration in creating environments conducive to innovation. Establishing consensus on which behaviors to foster through innovation in the future is crucial for generating momentum and aligning innovation efforts within a network in a transition (Roorda et al., 2012).

Activities undertaken: Participants were assigned a food system actor and were shown a video of the FETE vision that explained how the envisioned future food system provides enough food for all while minimizing food waste. The video highlighted the system's core values and dynamics, including 1) prioritizing vitality and effectively governing illness prevention, 2) embracing and highlighting flexibility, 3) celebrating and valuing the food journey, and 4) utilizing technology to gain insights about people both as individuals and as a society. Subsequently, each participant individually completed a template similar to that used in Experiment 2 to assess their actor's readiness to respond within the transition. However, the analysis at the individual level focused on linking the practices envisioned in the future system more explicitly to their respective actor. Participants were asked to articulate which consumer-level practices complement or hinder their actor's alignment and mobility in the transition. They also identified existing patterns of behavior and system dynamics that hinder societal progress toward the envisioned future. Following this, participants were randomly paired with a peer representing a different actor. Together, they collaborated to develop an innovation that was attractive to both actors' networks in the present and aligned with the future system dynamics conceptualized in the vision.

Key insights related to framing: By explicating the future values for stakeholders through systems principles, this experiment facilitated participants in developing joint innovations that effectively addressed each actor's interests and expertise, making them relevant both now and in the future. However, the resulting innovations were reasoned only in terms of their contribution to reducing food waste. The framing lacked support for developing innovations that extended beyond merely addressing the current problematic behavior of food waste to align with the necessary behavioral adaptations reflected in the future, such as fostering flexible behaviors to reduce food waste or promoting behaviors aligned with health and vitality to reduce food waste.

Experiment 4

Focus of framing: This experiment focused on how to onboard the meso-level to effectively engage stakeholder interests in the framing, ensuring that design innovations implemented by stakeholders align the everyday lives of people (micro-level) with the broader system aims (macro-level) over time.

Supporting literature insights: Different types of actors are reflected in societal systems and are also important in light of transitions. Some actors operate outside the dominant system constraints, driving radical innovations and pioneering disruptive changes. Others are embedded within the current system, which may be resistant to change, but their involvement is crucial for scaling up and integrating new practices within the existing system. Some actors shape the external pressures and opportunities for change, influencing the broader context in which the transition occurs (Geels & Schot, 2007). By considering these different types of actors and their potential roles, designers can develop innovations that can be implemented within the existing system while driving it toward desired alternatives. Analyzing how actors relate, depend on, and interact with one another (inter-actor analysis) and within their own organizations (intra-actor analysis) supports insights into system robustness and adaptability. This understanding enables designers to navigate and mitigate conflicts while leveraging synergies and maximizing actor buy-in and participation (Jonas et al., 2018).

Activities undertaken: Participants were divided into three groups and provided with the same FETE vision as in Experiment 3 (Goss et al., 2024). Each group was asked to choose a different type of actor but one that they were familiar with: one group chose an actor that is outside the dominant food system, one group a dominant and established actor within the current food system, and one group an actor that influences the cultural norms and political environment of the food system. First, the groups applied Causal Loop Diagramming (Hirsch et al., 2007) to understand the system and identify and conceptualize innovation opportunities. Causal Loop Diagramming, originating from system dynamics, is a method that visually represents the feedback loops and interactions among variables within a system, helping to understand and analyze the system's behavior over time (e.g., Hirsch et al., 2007). Next, participants completed four mini-analyses—vision, inter-actor, intra-actor, and transition readiness—to identify innovation opportunities for their chosen actor in the transition. For each aspect, they were provided with a guiding question and relevant keywords. In the vision analysis, they examined the key qualities of the vision, focusing on behavior, practices, and value conflicts. The intra-actor analysis explored how the actor operates and innovates, using keywords such as the actor's function, driving forces, and capability to adapt. The inter-actor analysis investigated the actor's network and unique capabilities, emphasizing capital of power, dependencies, and relationships. For the transition readiness analysis, they assessed the actor's preparedness for the transition, focusing on system barriers and conflicts, and system dependencies and relationships. They were not required to follow a specific order in their analyses but were encouraged to deepen their understanding of each aspect as new insights emerged. After presenting their analyses, new groups were formed, including representatives of all three actor types. The new groups were tasked with conceptualizing joint innovations toward the future system dynamics defined by the vision—i.e., embracing flexibility, putting vitality first, celebrating the food journey, and using technology to learn—in a way that was strategic for their actor and ensured they remained relevant in the future system.

Key insights related to framing: While this experiment supported participants in negotiating their actors' interests when discussing joint innovation directions, the framing was ineffective in supporting participants in reasoning toward more concrete innovation proposals. This was because the actors' position in the transition and their readiness to enter and accelerate the transition differed when considering the four principles of the vision (e.g., when discussing dynamics related to flexibility vs. vitality). These differences in barriers, relationships, and dependencies when relating to the systems principles both in the present and toward the future made it challenging to propose a single innovation that related to all future system dynamics, thereby complicating the design reasoning.

Experiment 5:

The FETE Innovation Process and Outcomes

Experiment 5 was the final experiment and presented the most refined framing from the study. The following describes the activities and supporting process artifacts used in the experiment. Figure 2 provides an overview.

Preparation for 1st Workshop

The first author performed desk research to create Transition Readiness Profiles (TRPs) for each of the stakeholders participating in the experiment. These profiles describe how ready the stakeholder is to enact the transition given 1) its position and stake in the current system, 2) its adaptability and capacity to transform, and 3) its direction and alignment with the transition trajectory reflected in the vision. This included activities such as reviewing the organization's website (including yearly reports), other professional profiles (e.g., LinkedIn), studies performed by the consortium partners, and social media presence (e.g., Instagram). After the TRPs were drafted, the first author presented them to the representative of the respective organization. This was followed by a one-hour semi-structured interview to verify the TRPs' accuracy and make any adjustments based on the participant's feedback.

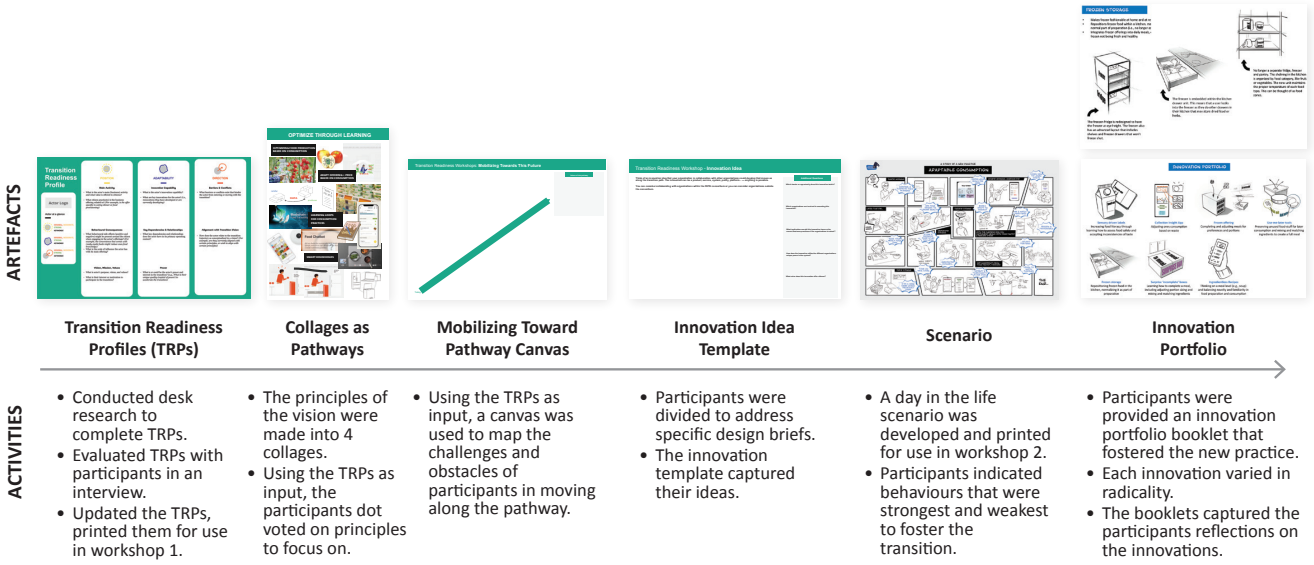


Figure 2. Overview of activities and process artifacts used in experiment 5.

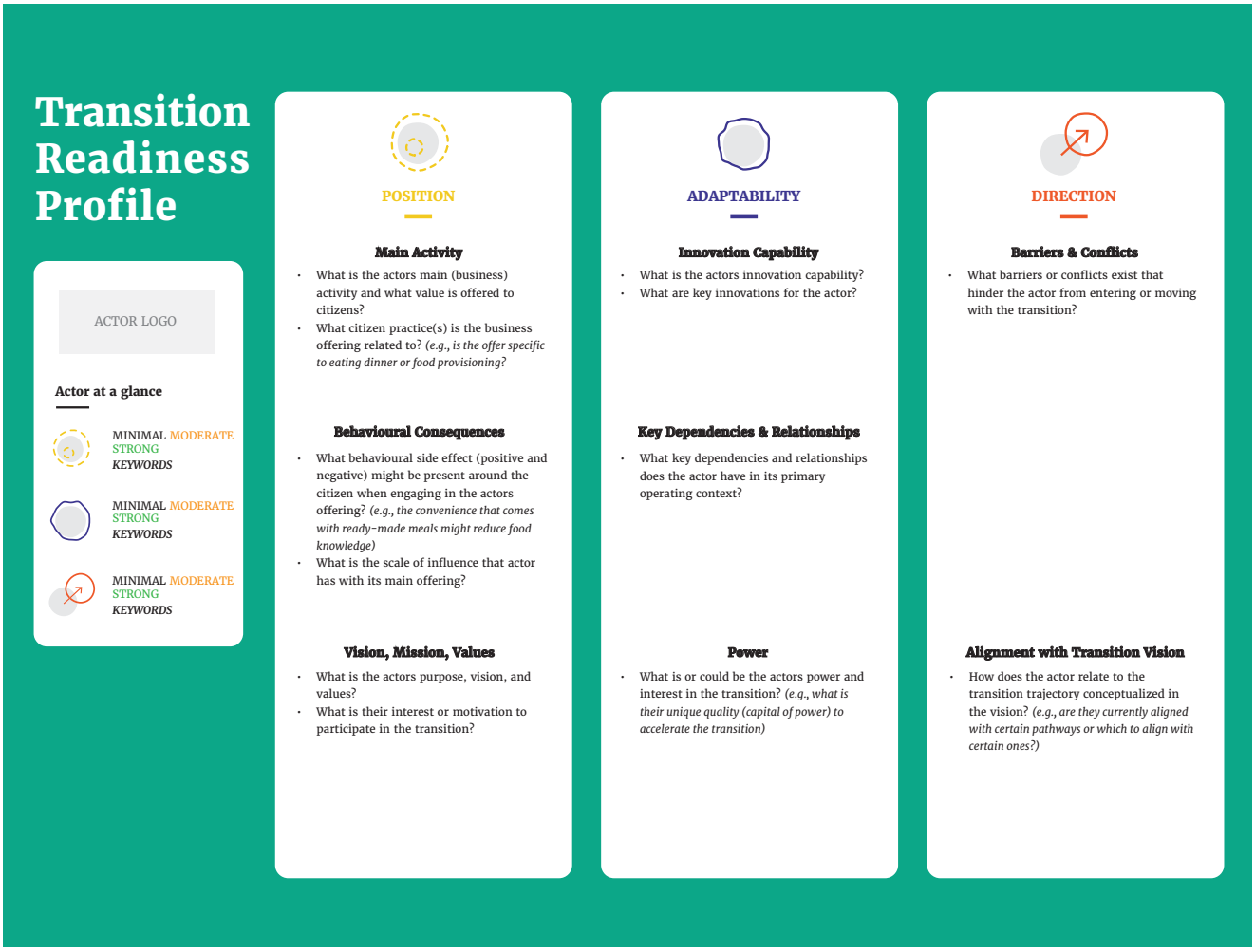


Figure 3. Template of the Transition Readiness Profiles in Experiment 5.

Workshop 1

In the first workshop, participants (i.e., the representatives of the organizations) selected one of the vision's systems principles to focus on and discussed how their innovation efforts aligned to it. To support this selection, collages were created that gave participants a visual representation of the impact the principles would have on people and the wider system. Through dot voting, the principle of *Embracing Flexibility* was chosen as the most crucial and relevant pathway for the transition given the contexts of the participating organizations. Using the TRPs, the participants identified challenges and opportunities their organizations might face moving along this pathway. In addition, they explored how their organizations could support each other in aligning with the pathway and overcoming shared challenges.

While exploring the pathway of Embracing Flexibility, participants reflected that the emphasis and prioritization of food safety in the Netherlands is a key factor to address since it contributes highly to the amount of food being wasted and limits innovation opportunities for fostering the transition. The strict regulations to ensure the safety of food products are causing waste of still nutritious foods and restricting the space to experiment with sustainability measures. One participant reflected, "to really transition to a sustainable food system, we need to let go a bit of control." This highlighted the need for the Dutch food system to realign the values of food safety, food quality, and sustainability to foster the transition. A relatively higher prioritization of sustainability in relation to food safety would allow more resilience and risk-taking in society. Based on this discussion, the participants were divided around two design challenges: one focusing on societal organization and regulation of food, and one focusing on the household and their dealings with food. The first design brief brought together representatives of a national nutrition center, a food waste foundation, and a waste collector. They discussed facilitating more risk-taking behaviors by removing labels from packaging to gauge acceptance of potential risks (e.g., health, taste inconsistencies, quality, and well-being). They also discussed stimulating such behaviors through personal waste management and incentives. The second design brief brought together representatives of a food manufacturer and a meal delivery service company. They discussed the facilitation of more flexibility in cooking through a Surprise Box intervention offering incomplete meals complemented by a monthly starter box to supplement the recipes with items with a long shelf-life, like pasta, beans, and frozen ingredients.

Preparation for the 2nd Workshop

Building on the outcomes of the first workshop, the authors designed a new practice called *Adaptable Consumption*, focusing on embracing flexibility to cater to enough. When designing the practice, the authors looked into the far future to consider how adaptable consumption can become the norm. The designers reframed the original design challenge from fostering a food system that runs on enough to design a new practice that fosters flexible and waste-free behavior in daily life while also driving systemic changes. To communicate the practice, the authors, in collaboration with a student assistant, developed a scenario depicting a consumer going through their week while engaging in the behaviors of the new practice (Figure 4). They also visualized an innovation portfolio consisting of seven innovation concepts (Figure 5), with each innovation being conceptualized in three variations ranging in radicality to illustrate how the practice could develop and evolves over time (Figure 6). This highlights the value of the behavior (i.e., sub-practice) now and in the future.

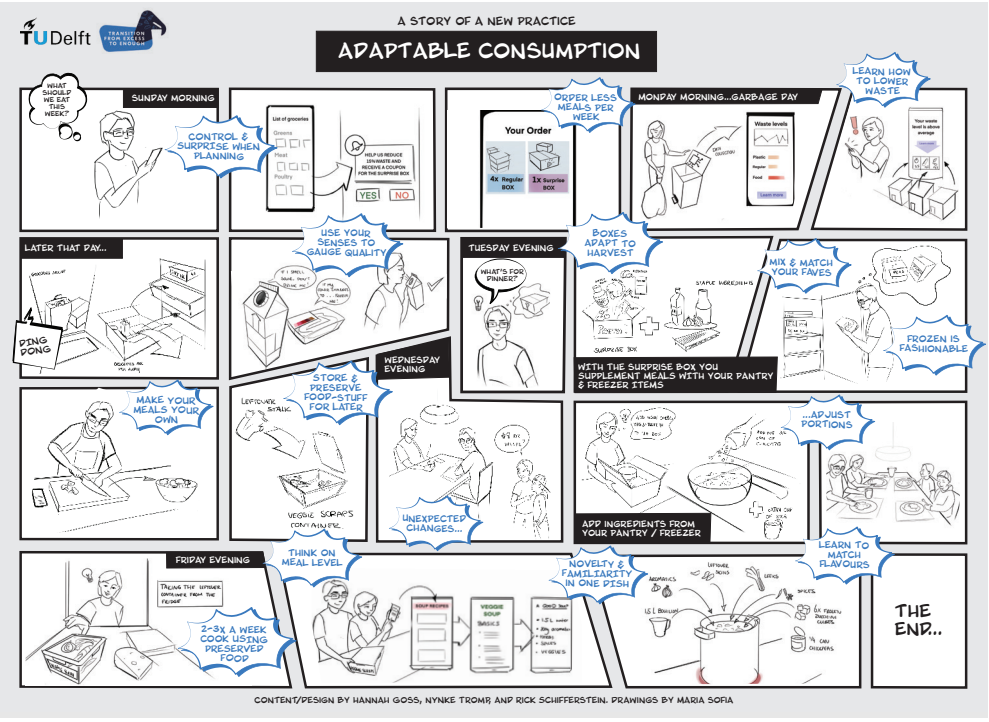
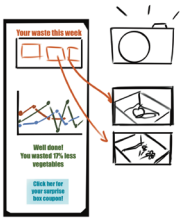


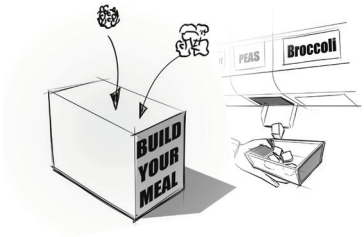
Figure 4. A comic strip communicating how Adaptable Consumption manifests in daily life in the future (drawings by Maria Sofia)**.**

INNOVATION PORTFOLIO

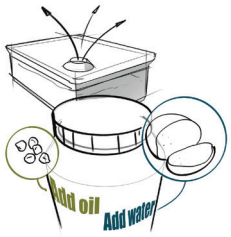
Sensory driven labels
Increasing food literacy through learning how to assess food safety and accepting inconsistencies of taste



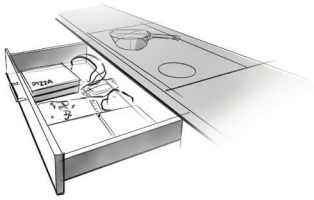
Collection Insight App
Adjusting one's consumption based on waste



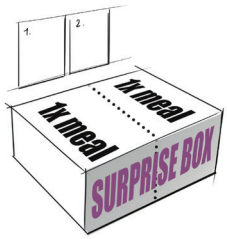
Frozen offering
Completing and adjusting meals for preferences and portions



Use-me-later tools
Preserving unused food-stuff for later consumption and mixing and matching ingredients to create a full meal



Frozen storage
Repositioning frozen food in the kitchen, normalizing it as part of preparation



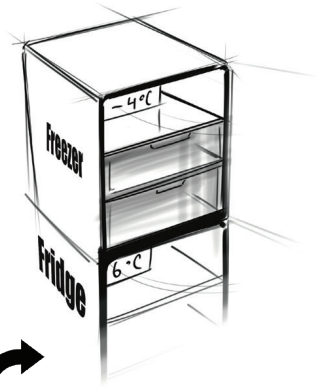
Surprise 'incomplete' boxes
Learning how to complete a meal, including adjusting portion sizing and mixing and matching ingredients

Ingredientless Recipes
Thinking on a meal level (e.g., soup) and balancing novelty and familiarity in food preparation and consumption

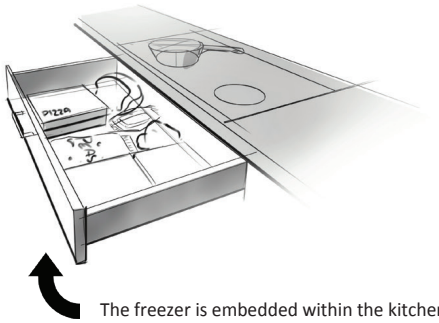
Figure 5. Overview of the seven innovations that support the practice of Adaptable Consumption (drawings by Maria Sofia).

FROZEN STORAGE

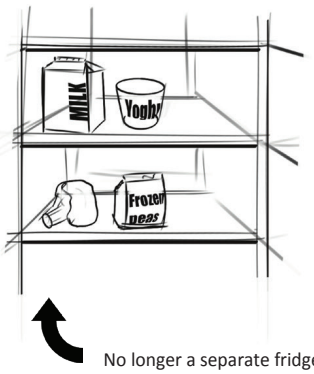
- Makes frozen fashionable at home and at retailers.
- Repositions frozen food within a kitchen, making the consideration for frozen food a normal part of preparation (i.e., no longer as after thought).
- Integrates frozen offerings into daily meals, challenging frozen food myths such as frozen not being fresh and healthy.



The freezer-fridge is redesigned to have the freezer at eye height. The freezer also has an advanced layout that includes shelves and freezer drawers that won't freeze shut.



The freezer is embedded within the kitchen drawer unit. This means that a user looks into the freezer as they do other drawers in their kitchen that store dry food (e.g., pasta, rice, canned products).



No longer a separate fridge, freezer and pantry. The shelving in the kitchen is organised by food category, like fruit or vegetables. The new unit maintains the proper temperature of each food type. This can be thought of as 'food zones'.

Figure 6. Example of an innovation varying on levels of radicality in the practice, with least (left) **to most** (right) **radical options** (drawings by Maria Sofia).

Workshop 2

The second workshop evaluated and further refined Adaptable Consumption from a societal and business perspective. First, participants were presented with the scenario (Figure 4) and reflected on which behaviors they considered strongest and weakest to support the transition through embracing flexibility towards less food waste. Next, participants were given a booklet outlining the innovation portfolio. After being presented with all innovations, the participants examined the innovations individually, reflecting on three questions: which innovation(s) they considered most interesting for their organization; how they could improve the success of the innovation(s); and what role they could play in experimenting with the innovation(s) to assess the potential of the new practice. The session concluded with a collective discussion about the most promising innovations and how the consortium might proceed with experimentation.

Findings and Discussion

Through a research-through-design approach, we wanted to understand how designers can use their framing expertise to navigate system dynamics when innovating in transitions and how to support this. By iteratively analyzing and reshaping the design process, activities, and process artifacts and evaluating outcomes in relation to the proposed frame in the five experiments, we gained insights into the specifics of framing system complexity in transition contexts. These insights come together in a conceptual framework that supports reasoning toward innovation opportunities that achieve desired impacts. This understanding is particularly relevant for supporting innovation across various system scales and timeframes.

Framework for Framing System Dynamics

From the literature, we saw that framing system dynamics for innovation in transition challenges is complex due to navigating across different system scales (micro, meso, macro) and timeframes (now, near future, far future). Although the literature showed insufficient conceptual and methodological support for understanding how to intervene in the lives of people in such a way that it fosters desired transition and system dynamics, researchers working in transitions point towards social practices and using language and visualizations that contextualize system changes in everyday life as promising directions. Yet, challenges remained in how to articulate the current system influence in light of a transition trajectory, as well as how to relate the meaning offered to people to the wider business context for organizations to act upon. In response to these challenges, we developed a design process supported by several artifacts:

- To relate to the future system, we used a vision and offered pathways for organizations to take in the transition and, at the same time, described what is meaningful to people. This came together in the systems principles.
- To relate to stakeholders, we used the Transition Readiness Profiles to onboard stakeholders into the transition in a way that repositioned them within a pathway and supported responses for new organizational roles.
- To relate to the daily lives of people, we used scenarios which presented new behaviors and capabilities for people supported by new products and services. We viewed the behaviors and capabilities beyond individual choices or actions and rather as part of a practice.

Our findings converge into a proposed conceptual framework (Figure 7), highlighting key concepts for designers to frame system dynamics in a way that supports innovating in transitions. The framework highlights that considering a future practice that is defined by new systems principles, new organizational roles that organizations take now, and new behavior and capabilities people could adopt tomorrow, is a fruitful way to frame system dynamics in transitions. Through this framing, designers are supported in identifying short-term innovation efforts to foster longer-term systemic changes. It encourages thinking across different system scales (micro, meso, macro) and timeframes (now, near future, far future) to align innovations with transition goals. In the next section, we elaborate on our findings, presenting evidence from our research-through-design experiments. Although we developed and applied various design activities and process artifacts throughout the experiments, we focus the discussion on how they supported our investigation into framing for transitions, rather than insights related to the specific form of the artifacts.

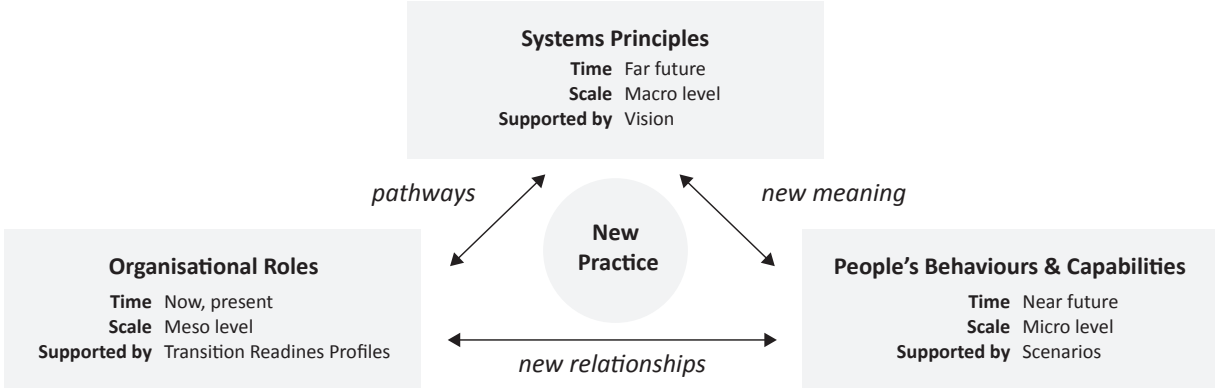


Figure 7. Conceptual framework highlighting systems principles, organizational roles, and people's behavior and capabilities as valuable concepts of a design frame. This frame supports designers in aligning short-term innovation efforts with long-term systemic changes.

Relating to the Future System

A key observation from our experiments is the importance of the handling of the vision—what to focus on in the vision and how this interacts with stakeholders in the current system. We found that the vision needs to describe dynamics that have implications for both stakeholders and people. This was challenging as focusing more on one or the other has downsides. If the vision does not indicate what meaning is offered to people in the future, it leads to innovations that lack, or superficially reflect, this meaning. While if the vision presents concrete innovations for stakeholders, it leads to solutions that lack consideration for system dynamics.

- For instance, in Experiment 1, a group representing a catering company developed the following vision: "a future where catering promotes conscious eating habits by offering less variety and smaller portions while informing consumers about the current food waste situation and encouraging them to actively change their habits." In response, they proposed an enough day, where the caterer uses only their nearly expired food for meals at a reduced price once a week. The catering locations would display the amount of food wasted by customers and suggest how customers can consume differently. Although the concept allows the organization to make better use of their ingredients, the reduced price might lead to a reduction in revenue, and the brand image would likely be negatively affected due to the blaming strategy employed, suggesting the consumers, not caterers, need to act differently.
- In Experiment 2, the vision used in the transition design process was developed through a multi-stakeholder process led by a design agency (Goss et al., 2024). The way in which the vision was communicated already depicted potential design solutions to illustrate innovation directions for stakeholders (e.g., a refrigerator box outside the house to receive groceries). However, such direct imaginations of elements of a future system did not support the more systemic discussions on the role stakeholders should play in (transitioning to) the new system. Therefore, while concrete design interventions support the imagination of possible future practices and, as such, may work to use as a reference for innovation, they run the risk of stakeholders selecting only a part of the system to focus on without considering the larger system dynamics that need to change for the transition.

Another key observation was the challenge of communicating the vision in a way that engaged stakeholders while also moving to the level of use. When the vision focused on components like food production, processing, and purchasing, innovations tended to superficially reflect stakeholders' business contexts with little deepening of what it meant for people or how they related to the new system dynamics. When the vision articulated principles that drive the system, it helped to define pathways to onboard stakeholders in the transition while at the same time understanding what the transition means for people in day-to-day life. Therefore, we found that the vision needs to provide a coherent and meaningful narrative for how potential innovation can foster the system dynamics reflected in the far future.

- In Experiment 2, one group representing an IT consultancy firm proposed implementing AI cameras in retail to analyze the quality of products and reduce prices on nearly expired food to increase sales. While this innovation reflects the stakeholder's expertise in data and technology, it does not align with the vision to shift away from traditional supermarkets or its goal to reduce overall food production and consumption.
- Experiment 3 represented a critical step in the process and use of the vision. The system's principles we defined were: 1) putting vitality first and governing the prevention of illness properly, 2) embracing flexibility and highlighting its benefits, 3) celebrating and valuing the food journey, and 4) using technology to learn about ourselves as individuals and as a society. These principles refer to dynamics between key stakeholders (in our case, producers, retailers, and consumers) and imply new actions from each. For example, putting vitality first involves implementing holistic health programs and repositioning food purchases into a larger set of vitality and wellbeing-focused lifestyle offerings (new stakeholder dynamics). Services are offered by sports facilities, municipalities, and retailers as part of their commitment to a vitality consortium. As such, it repositions retailers from food companies to care companies (new business models). This helps consumers work towards a lifestyle that makes them feel balanced and strong by providing personalized meals, identity-exploring food experiences, and app-monitored consumption patterns reviewed by personal vitality coaches (meaning to people).

Relating to Stakeholders

An important objective was to relate design innovation to organizational drivers in framing. Our experiments varied in how to support this reasoning, and we experienced various conflicts in trying to connect user value, organizational value, and system value over time. In this study, we found that relating to stakeholders and their wider business context and concerns needs to support speculating about what new roles they can play to move along a pathway. Additionally, it should redefine current and possible relationships within the system using this position to drive innovation opportunities. To incorporate their business concerns in a way that considers their potential in light of the transition, we developed the Transition Readiness Profiles (TRPs) (see Figure 3).

- In Experiments 1 to 3, the participants conducted desk research to complete the templates to reflect the business context. However, this knowledge was limited to what was publicly available and, in some cases, lacked an understanding of what was within the scope of the business. For instance, one group represented a food wholesaler and wanted to promote more seasonal consumption. Their innovation proposal involved retailers displaying produce based on whether they were in or out of season and focusing supply on seasonal food. While seasonal eating is something the wholesaler values and wants to promote, it remains unclear if they have the leverage to shape the retailer's in-store displays and offerings and what it would entail (e.g., financially and procedurally) to implement such an intervention.

- In Experiment 4, we decided to ask design researchers and practitioners to represent specific stakeholders in a group setting. While we were afraid that once the represented stakeholders were at the table they would respond conservatively, we found that by onboarding them through the template, they were able to speculate more about potential future roles. When innovating using causal loop diagramming, innovations remained close to the current system (e.g., a multinational retailer offering greater variation in package size to reduce food waste). However, when using the template, innovations were more systemic, and new roles and relationships were considered necessary to move in the transition trajectory. For instance, the participants explored how a multinational retailer might need an entirely new business model to align with a vision that does not focus on selling as much food as possible. They negotiated and reasoned from their stakeholder perspective, proposing that an initial step could be forming partnerships with sustainable co-ops and using their retail space as pop-ups to begin this shift in focus and customer base.
- In Experiment 5, we prepared and verified the TRPs with the corresponding stakeholders before the co-creation sessions. The stakeholders were onboarded to relate their organizations with the transition trajectory and act from this potential future state rather than responding to the current business context. The TRPs helped the stakeholders and designers in assessing how far along the pathway each stakeholder could be positioned considering their relationship to the transition, their current direction, and their adaptability for change. By bringing the stakeholders together, the group could begin to envision new organizational roles within the collective, leveraging each other's opportunities, challenges, and knowledge. For instance, the national nutrition center started to hypothesize how it might have a bigger role in steering the ministry's research agenda to promote the concept of the flexible consumer, such as setting up research focused on positive risk-taking with support from the food waste foundation. They began hypothesizing how this would result in them needing to loosen up about how they currently think about and communicate health, safety, and sustainability-related information (e.g., what if there was less attention to the wheel of five?).

Relating to People

A key observation from our experiments is the importance of relating to people's behaviors, identifying what behavior to support in the present that builds the behavioral adaptation needed in the future. We found that if innovations focus on addressing narrow user problems, actions, or choices without sufficiently considering how the innovations empower consumers to adopt and sustain the lifestyles central to the envisioned future, they will fall short in supporting the adoption of new system dynamics. By discussing the user context in terms of multiple behaviors and new capabilities as part of a practice that can be adopted over time, we started to build a more complex view of behavior change and opened up opportunities for joint innovation in light of the transition.

- In Experiment 2, participants developed innovation proposals by adopting the perspective of a single stakeholder, aimed at addressing a specific consumer behavior that hinders the transition toward less food waste. One such innovation proposed the concept of a retailer shifting away from the traditional storefront model to offer a pre-portioned 7-day meal package that customers ordered online. While this idea diminishes food waste at the retail level, it might inadvertently lead to an increase in food waste within homes. It also removes the opportunity for consumers to develop skills in gauging their meal requirements due to the predefined nature of the meal packages. As such, the concept conflicts with many aspects of the desired future system as conceptualized in the vision.
- Experiment 5 represented a critical step in the process and use of scenarios to depict user practices that yield joint innovation opportunities. This involved identifying and connecting several user behaviors that could reduce food waste as a practice, understanding how these behaviors influence the system along a pathway, conceptualizing joint innovation that could mediate these, and depicting a person engaging in the practice in daily life (Figure 4 and Figure 5). For instance, by shifting consumer thinking from specific ingredients to overall meals, consumers can become more skilled at mixing various ingredients and flavours (user behavior). This flexibility enhances their resilience to changes in food supply and promotes more efficient use of partially consumed food (system influence). Innovations like an ingredient-less recipe book can be implemented and supported by a national nutrition center and a food waste foundation (joint innovation).

Exploring the innovations along varying degrees of practice radicality helped the designers better understand their potential impact. This also supported discussions around challenges stakeholders must overcome to make the innovations realistic for their organization, proposing new collaborations among the stakeholders, and shaping possible experiments to test elements of the practice.

- In Experiment 5, innovations were developed within a limited time frame. Therefore, the emphasis was on highlighting the innovation's potential to shape the practice rather than its manifestation, like details around form or materiality (Figure 6). For example, one innovation aimed to enhance food literacy by enabling consumers to use their senses to determine food quality through the redesign of food packaging. One articulation of the innovation is to have packaging without any labels, suggesting a future where consumers are skilled enough at assessing food quality that standard use by and best before dates become obsolete. A less radical version suggests labels with sensory cues (e.g., if I smell like eggs, don't eat me) and dynamic suggestions (e.g., it's time to freeze me) to help consumers assess the food and act in alignment with this. A participant noted that the strength of this (sub)practice lies in its ability to reduce the cognitive burden currently placed on consumers and supports behaviors that reduce food waste while simultaneously

improving food literacy. Whereas another participant voiced regulatory challenges in changing labels and current work being done to overcome these challenges in some product categories (e.g., some labels needing to be identical in Dutch and Belgian markets).

General Discussion

This paper contributes to the understanding of how framing expertise is situated in transition design challenges, specifically in innovating to drive desired systems changes (Gaziulusoy & Ryan, 2017a, 2017b; Loorbach, 2022). Transitions are multi-stakeholder settings in which multiple and varied innovations implemented by numerous actors at different levels of the system are needed to drive systems changes. Discussions in design have emphasized the need for stakeholder participation and engagement when tackling complex societal challenges (Jones & Van Ael, 2022; Sangiorgi, 2011). It has been proposed that this engagement should move beyond mere involvement in design processes to also facilitate a deeper systemic understanding essential for designing innovations that foster systems changes (Carvalho & Goodyear, 2018; Jones & Van Ael, 2022). We demonstrate that engaging selected stakeholders in the innovation process supported the designers in navigating the business context and gaining a more nuanced understanding of the systemic context. However, it is key to support stakeholders in thinking about possibilities for the future rather than being focused on the restrictions of their current business activities, as we achieved through the Transition Readiness Profiles. The innovations developed in these experiments were not off-the-shelf solutions but intentionally designed for the specific transition challenge and actor network. They involved careful alignment with the transition pathway, the stakeholders' interest, and the value for people in their day-to-day lives.

In hindsight, we see that choosing one transition pathway to focus on and working with a smaller selection of stakeholders allowed us to temporarily simplify the system's complexity, making it manageable to design for. This simplification of selecting and limiting the number of system elements being considered at one time has been applied by other researchers working in transitions. For instance, Gaziulusoy and Ryan (2017a) and Hyysalo et al. (2019) focus on specific changes, such as technological or political, and specific system levels, such as a neighborhood or city, to design innovation opportunities or transition pathways. This deliberate reduction in complexity allows designers to alleviate cognitive overload, freeing up mental space for imaginative exploration and exploring possibilities for new meaning (Dorst, 2019; Gaziulusoy & Ryan, 2017a; Goss et al., 2023; McGrail et al., 2015).

Transitions result in mainstream practices becoming outdated and being replaced by new, ideally more sustainable alternatives. As such, this study contributes to discussions regarding the role of design and innovation in reshaping and reconfiguring current practices (Gaziulusoy, 2015; Gaziulusoy & Brezet, 2015). Shove (2010) describes practices as comprising three key elements: meanings (social expectations and symbolic interpretations), materials (tools and objects essential for practice), and competences (skills and knowledge required for practice). When the interaction between these elements persists, routines and habits are sustained, while disruptions can act as catalysts for change within established practices. In the field of Transition Management, four types of activities foster new practices: strategic activities (cultivating a shared vision and potential pathways), tactical activities (building foundations for collaboration and common agendas), operational activities (engaging stakeholders to implement the vision), and reflexive activities (evaluating and reassessing practices, interactions, and discrepancies) (Loorbach & Rotmans, 2010). Therefore, when designing for transitions and explicitly framing system dynamics for innovation, we see that focusing on systems principles, organizational roles, and people's behaviors and capabilities hints toward new practices that serve as stepping stones toward sustainable alternatives. Systems principles establish norms and cultures (i.e., meaning, strategic, and reflexive activities), organizational roles direct new products and services (i.e., materials, tactical, and reflexive activities), and people's behaviors and capabilities reflect new skills and knowledge (i.e., competences, operational, and reflexive activities). By framing system dynamics through these concepts, we show that designers can reveal which current practices ought to be reinforced and which ought to be dismantled (Loorbach et al., 2017; Olstad & Kirkpatrick, 2021). While our study reports on findings that support the earlier proposed potential of practices to foster new systems, the application of social practice in design processes remains primarily descriptive (Fam & Mellick Lopes, 2015; Kuijer & De Jong, 2012; Shove et al., 2015; Watson & Meah, 2012). As such, more research is needed to understand how to intervene on the level of practices and how this can be supported.

The proposed conceptual framework (Figure 7) is valuable because it helps designers understand the complex system they are working within to align short-term innovation efforts with long-term systemic changes. It articulates important concepts to consider and explore when innovating in transition design contexts. In other words, it helps designers understand the system they wish to intervene in and reason from desired impacts to innovations to be designed (Dorst, 2015). While we acknowledge that this framework is not exhaustive and research is ongoing to understand how it relates to other concepts of complex systems and transitions, we offer reflections and speculations on its relevance to these concepts in its current state. Notably, the framework's inclusion of various time horizons facilitates a deeper understanding of learning loops, sensitivity to current conditions, and the mechanisms of emergence that can, might, or ideally will take place (Ladyman et al., 2013). This involves identifying promising practices for desired systems changes and exploring strategic design interventions to support and amplify these practices through mechanisms such as self-organization or infrastructure (Van der Bijl-Brouwer et al., 2024). Although the framework delineates boundaries within systems analysis—focusing on systems principles, organizational roles, and people's behaviors and capabilities—we recognize the interconnected and relational quality of these boundaries, highlighted by the two-way arrows in the framework that define potential pathways, new meanings, and new relationships. These interactions suggest

that through continuous feedback, designers can gain deeper insights into both specific system components and the system as a whole. However, to integrate these feedback loops effectively and to frame system dynamics without perpetuating unjust and unsustainable structures, cultures, and practices, designers must continuously employ a high degree of systems reflexivity (Fitzpatrick et al., 2024; Vink, 2023). Additionally, while the process artifacts outlined in the framework, such as using a vision, day-in-the-life scenarios, and Transition Readiness Profiles, offer valuable support for designers in framing system dynamics, they are not the only possible options. Other design activities or artifacts may support the exploration of the key concepts, such as speculative design (Dunne & Raby, 2013), role-playing (Vink & Koskela-Huotari, 2022), and giga-mapping (Sevaldson, 2011). Nevertheless, by highlighting the specific qualities needed for effective framing, we provide guidance and support for selecting or adapting the application of alternative ways to assist designers in navigating complex systems for innovation.

The specificity of our research context and approach has implications for our findings. This study, and notably the proposed final experiment, adopted a relatively top-down and sequential approach in applying the concepts within the conceptual framework: first adapting the vision into a workable form by identifying systems principles, then engaging stakeholders to secure interest and understand how they can contribute to the desired future through new organizational roles, and finally, integrating the user context to support the development of new behaviors and capabilities. While this was done pragmatically, we speculate that a simultaneous exploration of the conceptual framework among organizational stakeholders and user groups might also be possible and perhaps better resonate with the inherent nature of design since it allows integrating the user context earlier in the process. Future research should, therefore, investigate the implications of varying the integration of these concepts within the transition design process and if or how that affects the framing of the system dynamics. Similar to other transition design projects that take a pragmatic approach to stakeholder selection, either through accessible networks motivated in the transitions or predetermined consortia (Gaziulusoy & Ryan, 2017b; Hyysalo et al., 2019), our process was also top-down, in that it engaged a select group of stakeholders with an direct interest in reducing food waste. While stakeholder engagement is logical, given that they need to implement innovations into the system, we did not explicitly engage consumers in the experiments or co-creation sessions. While we believe this would not change the framework, we believe that involving consumers earlier in the process might have led to innovation conceptualizations that are more attuned to people's day-to-day lives and the needed skill adaptation for proposed practices.

Conclusion

This paper explores how framing expertise can be applied in transition design challenges to support designers in making design decisions and developing strong reasoning for what innovations to propose to foster desired transitions. Our findings indicate that considering a future practice that is defined by new system principles, new organizational roles that organizations can take now, and new behaviors and capabilities people can adopt tomorrow is a fruitful way to frame system dynamics. By applying an iterative research-through-design approach, we show that this framing supports designers in thinking across different system scales and timeframes, helping them to reason from desired system dynamics in the far future to activities organizations can engage in in their current context to deliver new and meaningful concepts for people in the near future. Further research is needed to assess the proposed framing beyond the context of the experiments (i.e., the food system).

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