Codesign for transitions governance: A mid-range pathway creation toolset for accelerating sociotechnical change

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Vision building, pathway construction and experimentation are key processes in the management of long-term sociotechnical transitions. The need to accelerate transitions and to adapt transition management to new country contexts calls for new means to catalyse these processes. We improved the path creation toolsets and procedures of transition management to create more detailed pathways and analyses of pathway step interrelations. Our path creation system uses magnetic elements that could be easily moved around a large metallic board, a set of procedures and a digitalized counterpart of the board for out-of-the-workshop commentary and reporting. The system has facilitated and anchored well the discussions by participants with cross-sectoral backgrounds. Overall, the redesigned system underscores the potential that codesign for sustainability transitions holds.
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Climate change and increasing resource scarcity are exerting growing pressure to make thorough changes in several sociotechnical systems such as energy, transport and water use. The unsustainable patterns of production and consumption within these systems cannot be adequately remedied by single design solutions or one-time policy measures. Instead, long-term sustainability transitions comprised of hundreds of complementary actions are required (IEA, 2018; IPCC, 2018; Köhler et al., 2019).[1]

Since the late 1990s, several multidisciplinary lines of research have investigated the steering and governance of such long-term systemic transitions. It has become evident that single alternative design solutions cannot compete against the inertia created by the 'sociotechnical regimes' built over the decades by interlinkages in industry structures and production technologies, investment patterns, scientific

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bases, institutions and policies, market mechanisms, user preferences and cultures of consumption (Geels, 2004; Geels & Schot, 2007). Strategic niche management research shows that to be able to substitute or reconfigure such regimes, the alternatives need to first mature in 'niches', where innovations can develop without facing the full impact of existing market conditions. The support measures that nurture, empower and shield niche innovations, such as feed-in-tariffs and funding for experiments and pilots, can be gradually removed when the niche innovations mature and their production processes become cost-competitive (Hoogma, Kemp, Schot, & Truffer, 2002; Kemp, Schot, & Hoogma, 1998; Kivisaari, Lovio, & Väyrynen, 2004; Smith & Raven, 2012). At the same time, measures such as new policies such as carbon pollution pricing and legislative carbon bans need to be set in place to destabilize the currently incumbent regimes and make room for change (Kivimaa & Kern, 2016; Weber & Rohracher, 2012). Long-term transitions also require direction and guidance beyond the political cycle of elections. To this end, Transition Management began in the Netherlands in the 2000s, and has since developed methodology for setting long-term visions, creating change pathways and identifying experiments to start such pathways of change (Frantzeskaki, Wittmayer, & Loorbach, 2014; Kemp, Loorbach, & Rotmans, 2007; Loorbach & Rotmans, 2010).

In recent years, design for sustainability transitions has entered into transition research and the governance scene, particularly as regards experimentation with new solutions and improving the means for future envisioning. Design research has generated experiential future scenarios and change pathways (Gaziulusoy & Ryan, 2017a; 2017b), and has pursued sustained, local experimentation engagements aimed towards low carbon transition, drawing from community design and practice theory (Jalas et al., 2017; Manzini & Rizzo, 2011). It has further built anticipatory strategic design initiatives in order to target the critical aspects of evolving transitions (Mok & Hyysalo, 2018). Design agendas have also been proposed that resonate with designing for sustainability transitions, such as transition design (Irwin, 2015; Irwin, Kossoff, Tonkinwise, & Scupelli, 2015), designing for environmentally sustainable social innovation (Jégou & Manzini, 2008; Manzini, 2014), designing with intent for sustainable behavioural change (Lockton, 2017) and designing for one-planet lifestyles (Lettenmeier, 2018).

Other disciplines have begun to notice the potential of design research, and, for instance, codesign has been mentioned as one of the fields contributing to Transition Management (Ferguson, Brown, Frantzeskaki, de Haan, & Deletic, 2013). However, to deliver on its promise, design research now needs to build convincing real-life projects and show the value that different types of design research can provide in designing for long-term sociotechnical transitions. Our work is positioned in this effort, exemplifying what codesign for sustainable transition can offer when taken seriously.

More specifically, we address the *acceleration challenges* that visioning in transition research and transition-related policies and interventions currently face. Transition management has been geared towards a long-term focus of 40–80 years, but in terms of climate change and energy transitions, most countries have already pledged carbon neutrality in a 30–40-year time-span, and have visions and long-term climate roadmaps. The problem remains, however, that actions in the mid-range time-span are keenly contested, and it remains arguably more difficult to reach consensus, as difficult measures can no longer be postponed. The traditional way in which long–term pathways are built in transition management (Frantzeskaki, Broto, Coenen, & Loorbach, 2017; Roorda, Frantzeskaki, Loorbach, Van Steenbergen, & Wittmayer, 2012) results in broad–scale pathways that remain relatively unspecific for guiding mid-range concretization from experiments to mid-range goals. Hence, to better equip participants for creation and deliberations upon mid-range transition pathways, we developed new design toolsets and associated procedures. This toolset supports multi-actor deliberation in fast-paced workshops and allows participants to directly engage in pathway construction processes without necessary recourse to system analysts. In doing so, it continues the long design traditions of creating representational artefacts to foster multi-stakeholder visualisation (Cooney, Stewart, Ivanka, & Haslem, 2018) and developing these into more encompassing templates, proceduralisations and toolsets, to further advance such collaboration among participants (Eriksen, Brandt, Mattelmäki, & Vaajakallio, 2014; Muller, Wildman, & White, 1993).

In the remainder of the paper we contextualise the pathway creation tools and their design challenges, along with our research through design methodology. We then introduce the final mid-range pathway creation toolset and present the outcomes of its use in the transition implementation arena in Helsinki in 2017, along with the participant and facilitator evaluations of the system and the subsequent uptake of the toolsets. We end with conclusions and further research avenues.

1 The rationale and design challenges for mid-range pathway creation toolset

The focus of Transition Management is on long-term policy design with relevant groups of "frontrunner" stakeholders. Transition Management practices happen through creating spaces for searching, learning and experimenting on the transformation of the current system. It aims, on the one hand, to equip frontrunners with visions, concepts and seeds for thought that can be utilised in political decision making beyond the political cycle of elections. On the other hand, transition management focuses on identifying settings for sociotechnical experiments and learning from them so that the experiments can be strengthened, scaled up, and eventually displace the problematic aspects of previously dominant regime (Kemp et al., 2007; Loorbach & Rotmans, 2010).

Transition management further emphasizes the process of constructing pathways for meeting the long-term vision and specific transition goals. A further aim lies in creating a perspective on intersectional dynamics that can encourage transitional chance: "The general approach is one of nurturing and growing rather than planning and controlling long-term societal change." (Voβ, Smith, & Grin, 2009, p. 277). In order to plan for long-term change, the focus is not only on the positive expectations for change, but also on negative ones that may prevent or hinder the change goals from unfolding (ibid p. 280). The schematic overview of transition management is as follows (Loorbach & Rotmans, 2010; Voβ et al., 2009):

1. Establishing a transition arena (or arenas)
2. Developing a common vision
3. Pathway development through backcasting techniques
4. Experimenting with pathway options
5. Monitoring, evaluation and revisions to pathways and experiments

Transition management as an approach for long-term policy design has faced some challenges over the years it has been practised. Voβ et al. (2009) provide an overview of the policy design challenges it faces. A common denominator that Voβ et al. (2009) identified is that "[Transition management] as a concept for policy lacks effective provisions for inclusive participation and fair deliberation within 'transition arenas'" (p.287) where visions and pathways are constructed. They further argue that the original principles have veered, in practice, towards the domination of powerful incumbent actors in arenas, a somewhat instrumentalist focus, and limited width and depth of civil deliberation. Voβ et al. (2009) seek to remedy these aspects through increased civil society participation and ensuring a broader sustainability focus.

Our design response is originally anchored in Finnish energy transitions, and seeks to address some of the critique of Voβ et al. through seeking to anchor the transition arena vision and goal setting phases in the local country context (Heiskanen, Kivisaari, Lovio, & Mickwitz, 2009), which in this case means explicit linkages to Finnish parliamentary long-term climate roadmap for 2050, a mid-range climate plan for 2030, and energy and climate strategy for 2030 in order to foster higher legitimacy for the process in conjunction to existing democratic processes. We further explicitly link the pathways of change to the over hundred energy transition related experiments that are already running so as to give voice and visibility to civil society, the public sector and business actors who are already active in transitions. The participants in the arena were carefully selected from among 90 Finnish change makers, known through the wide networks that the organizers and their close collaborators had in energy and climate

governance. The final selection was based on participants' competences and complementarity regarding the Finnish energy system. The 23 persons selected formed a group that covered Finnish political, civil servant, business, and civil society actors regarding energy transition. Together they provided a wide variety of angles with which to examine the topic (Hyysalo et al., 2019a).

The transition arena process in Helsinki was carried out over six 3-h workshops held at one-month intervals. During these workshops participants could comment on refined results from the previous workshop in the closed website of the arena. The schedule was as follows:

Workshop 1. The drivers, challenges and contingencies for transition;
Workshop 2. Vision and transition goals for 2030;
Workshop 3. Formation of pathways, part 1;
Workshop 4. Formation of pathways, part 2;
Workshop 5. Immediate actions for launching the pathways;
Workshop 6. Completing the results and commenting on the final report.

The design challenge regarding mid-range transition pathway toolset and procedures for workshops 3, 4 and 5 comprised of six interlinked aims and seven further specifications:

1. To allow a small group of 3–7 co-located participants from different walks of life to deliberate and effectively form a path to a mid-range transition goal from the current state;
2. To provide participants with clear means to analyse the interrelationships between pathway steps and the timing of needed actions;
3. To help participants to evaluate the realism of the suggested steps and the range of actions (regulatory, investment, business, technology development, civil society, research, behavioural change etc. actions) through which the pathway steps can become realised or their realisation supported;
4. To help participants to recognise pathway and step interlinkages and the most critical steps in which societal choices have to be made;
5. To help participants to highlight alternative transition paths with respect to the most important change drivers and uncertainties;
6. To consider the effects of the most important uncertainty and contingency factors in the pathways and the steps therein.

The nature of the arena process set the following further specifications for the final design:

a. The working time with one pathway is limited to one or two half-day workshops;

b. The participants will be busy, and they thus should quickly understand how to use the tool without extra training sessions;
c. The tool should be flexible so that it can be modified during the pathway creation process if needed; the openness of the arena process may lead to goals and directions that were not planned beforehand;
d. The elements of the path creation should be easily recognizable so that the participants do not confuse them with each other, even in the hectic pace of the arena workshops;
e. The materials should be easily movable over the game board;
f. The materials should enable feeding the needed information into the process as well as incorporating the information created during the process without truncating it;
g. The contents should be easily digitized;
h. Game boards should allow at least four persons to work on an individual pathway at a time.

2 *Research through design in creating the mid-range pathway creation toolset*

In designing the mid-range pathway creation toolset we drew from designing tools for codesign (Ehn & Kyng, 1991; Muller et al., 1993), participatory design games and their development (Eriksen et al., 2014; Vaajakallio, 2012) and game design (Zimmerman, 2003). Our design decisions were based on several testing and codesigning sessions within the design team, and with a broader set of colleagues who were not involved in the design. The very final iterations were made between the two workshop sessions of the transition arena process. Each time the pathway tool prototype and instructions were enacted akin to playtesting (Zimmerman, 2003), and the designers observed the situation, made notes, and asked questions and design ideas from the participants. After the testing sessions they adjusted the design to get to the next prototype version. The design team had a further division of responsibilities in testing and iterative design. Author 1 held responsibility over the overall concept development and balancing of different priorities in each iteration. Author 2 explored the material choices and ideated design alternatives to be tested in iterations and together with Author 3 responsible for the detailed design and productization of the mid-range transition toolset. Author 4 acted as substance expert on energy systems and relayed information about issues and participants to the rest of the team. The design team was further helped by a public deliberation expert who participated in all testing sessions and kept a continuous eye on the quality of the deliberation that the tool and its procedures may foster, as well as the on the validity of the design with respect to more traditional backcasting methods in futures research. These different competencies and perspectives fostered productive dialogue about the solutions and issues to be considered in the process.

3 The overview of the mid-range pathway creation toolset

3.1 Outline and key elements

The mid-range transition pathway toolset is premised on a set of predefined forms and categories. These are used in constructing change pathways and were designed to give sufficient visibility to both content and form for all the participants during the process and also to both ease the movement of the elements and transforming the pathway in the course of the pathway construction.

The pathway creation work takes place on a 240 cm × 150 cm metallic board, onto which only a white print with light hexagonal grid has been permanently printed to give structure. All other elements are magnetic to allow flexibility in moving timelines and elements around as pathway construction progresses. The magnetic elements – pathway steps, arrows and pathway step realization actions, timeline elements and supplementary materials – all have a writing surface on which participants can add content with markers. The magnetic elements allow the easy manipulation of pathway interrelations and the markers allow the easy modification of content as text can be wiped out with wet cloth. The size and height of the vertical board is designed to allow 3–5 people to work effectively on elements, both independently and in a group, and to allow them to reach to the top of the board (at 230 cm) and the bottom (at 79 cm, see Figure 1).

The primary elements of the pathway creation system are the "pathway step" and "pathway-step action" elements. Both have the same structure: upmost, the designator of the form (e.g. *pathway step* or *investment*, then four rows for describing the step content, followed by timing (in years), the key actor(s), and the scale(s) which this element concerns: a national issue, a regional issue, on the suburb/village scale or concerning individual buildings and consumers (Figure 2). To differentiate the elements a combination of distinctive symbol, text and colouring is used for each.

The pathway-step action elements concretize how each pathway step can be realised or facilitated. These are specific to the domain area in question and thus feature some variation. When working with energy transition the pathway-step action elements are: energy production, business, end consumption, regulation, investment, other, technology, pilot (Figure 3, left-hand side). We also designed a set of organizer elements to guide the work. "Fact elements" are used to render visible key milestones and facts about the pathway (see more below) and the question mark, exclamation mark and quotation mark are used to point out missing or insufficient pathway steps regarding change targets, critically important areas and needs for new research

Figure 1 Pathway creation in its early stages

respectively, with the aim of focusing participant attention on these areas (Figure 3, right-hand side). The choice of hexagon-shaped elements, descriptive labels and colour coding was based on their common use in countless board games and ideation systems (Hodgson, 1992).

The interrelations between elements can be clarified with magnetic arrows (which allow writing onto them) to show how one pathway step leads to another. Once the pathway is completed on the board it is rendered digitally, which allows further commentary, cleaning and the opening of all content to full sentences that are understandable to those beyond the participants in the path creation (see Figure 4 for a completed pathway).

Prior to the pathway construction, participants are given a 4–6 page information package related to the pathway and domain, that condenses the current state, the envisioned pathway goal, basic facts in the change domain, known challenges and some of the evident basic calculations such as what would be the carbon reduction from different likely measures to be considered. The information in the package is also partially rendered visible on the board through placing key facts and pilots tentatively on the board as prefilled fact and pilot elements (see the block green and blue elements in Figures 3 and 4) as well as attaching a data-derived "persona" (Cooper, 2004) to focus attention on the concrete peoples that need to take the change actions – such as a Finnish family living in 2030, implicated by the pathway (Figure 5).

Figure 2 A pathway-step element and an example of a filled-in pathway step

3.2 The procedure of pathway construction

From the starting position, the participants begin by discussing the target and pathway on a general level. The facilitator urges them to write down their thoughts about pathway step elements whenever an obvious step is identified. As steps accumulate, discussions begin to include their interrelations and potential missing steps. In all the paths created thus far, the elements were rearranged several times and sub-pathways emerge, either from the onset or through the branching of paths (see Figure 4). At some point, the deliberation tends to veer towards considerations of whether each step is needed,

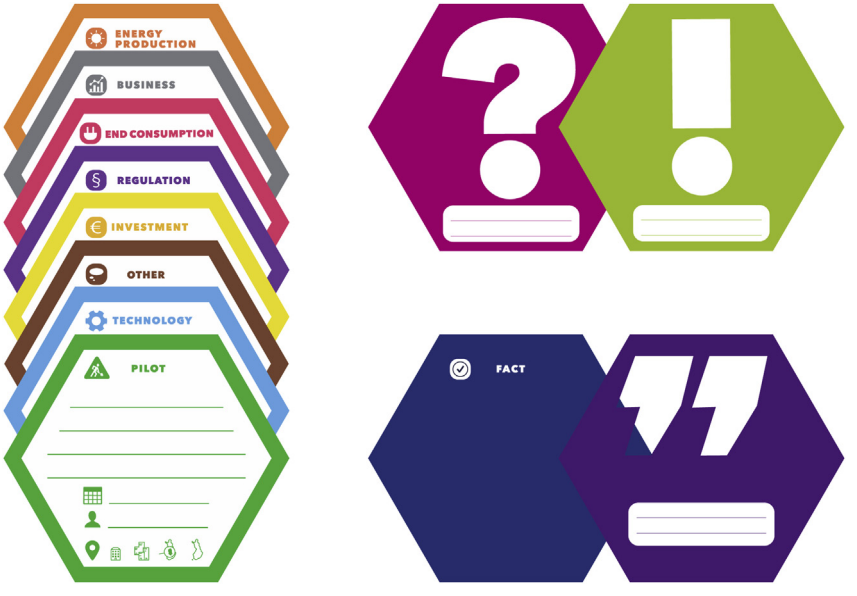

Figure 3 On the left are pathway-step action elements: energy production, business, end consumption, regulation, investment, other, technology, pilot. On the right are organizer elements: a fact, an attention marker, a missing action marker and a research marker

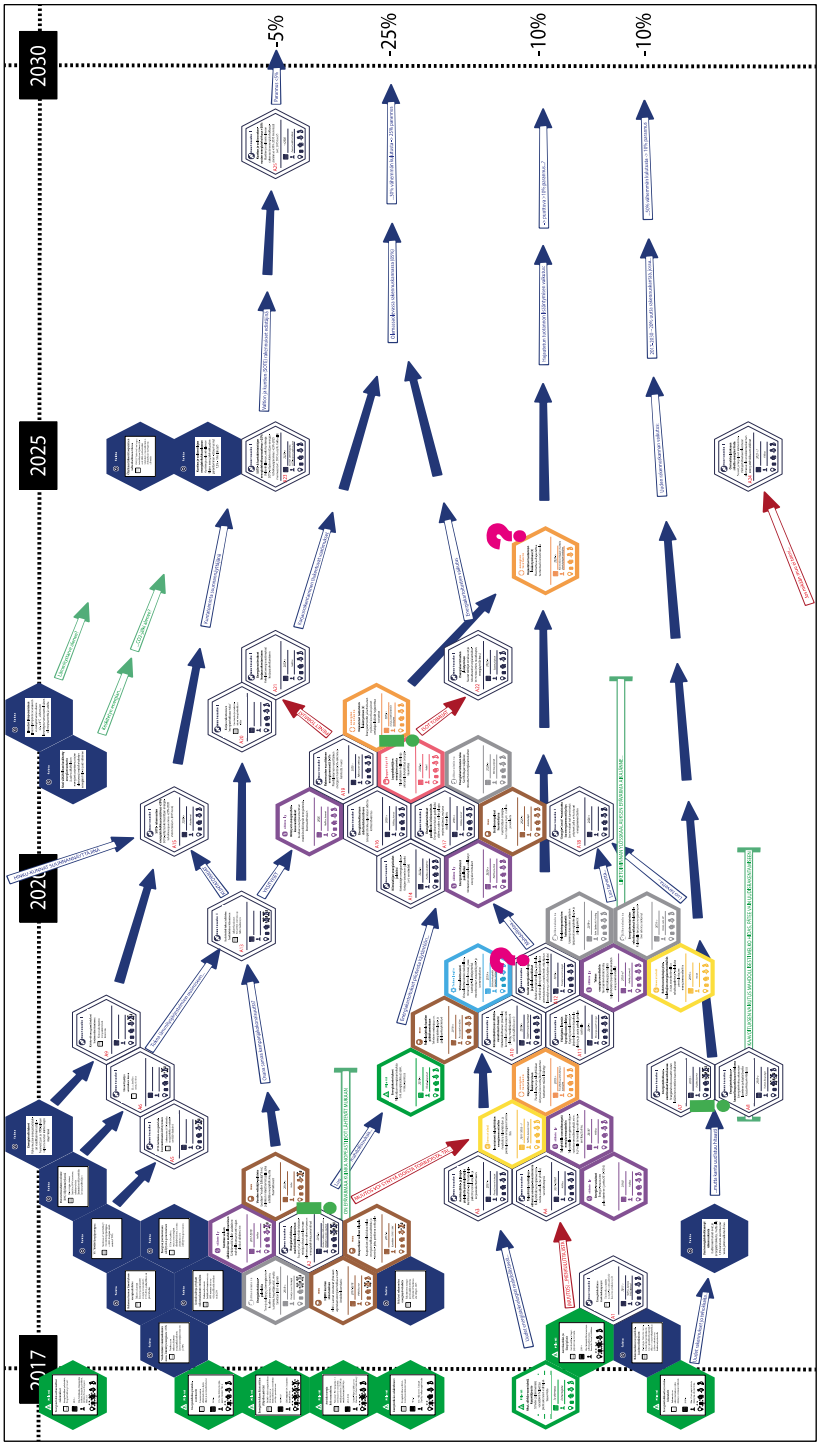

Figure 4 The digitized path for halving a building's net-energy use by 2030

VISION PERSONA

Smart Energy Transition

FAMILY KUKKONEN & JOKINEN

SOFIA KUKKONEN: 48 years
Teacher, 3600€/month

ARI JOKINEN: 46 years
Teacher, 3500€/month

LINDA KUKKONEN: 8 years
Grade schooler

LIVING

Centre of Oulu, Torikatu, 82m2 apartment building, built 1972.
Sofia is in the board of housing cooperative together with Erkki 74 years, Markku 78 years and Lasse 55 years.

ENERGY CONSUMPTION AND USAGE

Heating: District heating, indoor air temperature 22-24C
Electricity: 2400kW per year

FREE TIME

Each family member has their hobbies in the centre of Oulu.

TRANSPORTATION

Own car and public transport in the centre of Oulu

INTEREST

– Improve the real estate energy efficiency cost-effictively.
– Save in expenses, support climate friendly energy.

ASSUMPTIONS RELATING TO PATHWAY IN 2030

"Reducing household energy consumption by change in behavior by 15%"

A) Pipe and roof repairs planned for the house, window repair in 10 years' timeframe. Sofia has suggested the housing cooperative that everything should be done simultaneously. She has also proposed for 20m2 solar panels, 30m2 solar heat collectors, extra insulation, forced ventilation and connecting the house in remote controlled demand response system for heating. The rest of the board is doubtful about how can the residents finance big repairs. The middle age of residents of the house is 63 years.

B) Sofia has ordered a preliminary review from ESCO company, but the role of its actions in the middle of other repair projects is unclear.

Figure 5 One of the personas created to portray implicated people in the envisioned mid-range 2030 goal

whether some steps are realistically attainable and whether all the steps in all the sub-pathways together amount to sufficient change regarding the transition goal.

Once the main pathway steps have found a more or less steady and mutually agreed form, the participants move to identifying the most important and most crucial steps as well as what blocking points may occur in the pathway. This constitutes the first phase in the pathway construction. At this point the first documentation round happens through participants being asked to explain to the video camera the key features of the pathway and new insights they gained during the path construction.

The second phase of the pathway creation process is a more detailed examination of the most important steps. The actions needed to realize each pathway step (technology development, regulation, changes in consumer behaviour, pilots, investments et cetera; see Figure 2) are discussed and marked down (for illustration see Figure 6). At this point it is common that some pathway steps become merged and some new steps are added in, or the status of a pathway step is changed to be one of action needed for realizing another pathway step. At the end of the second phase, the participants video the detailed concretizations to ensure that the ideas written down on cards are sufficiently elaborated.

The third phase of the process progresses into uncertainties and contingencies. At this point the facilitator changes from blue marker pens and blue arrows to green ones and adds in probability markers of varying lengths (Figure 7). The participants then go through each step and examine the likelihood of the steps; can they occur sooner or later and how uncertain are they? The overall uncertainty factors are already identified in the second workshop of the series and can now be used to gauge the uncertainties related to specific pathways. The participants then add potential contingency responses, which are marked with green arrows, and green-stickered and green-written pathway steps. The outcome is again videorecorded. The very final phase of the pathway creation is that of considering the alternative, mutually exclusive change pathways to the original pathway. These are identified with red-stickered steps, red texts and red arrows. This step is done last because alternative paths typically require rearranging the original paths and thus the originals must have been first documented without interference from mutually exclusive paths or steps.

Once the entire pathway is complete it is digitized and uploaded to the password-protected support website, which gives the participants the opportunity to further comment and refine the pathways after the workshop. If pathway construction is spread to multiple workshops, incomplete pathways can also be digitized and shared in the platform to allow between-sessions commentary.

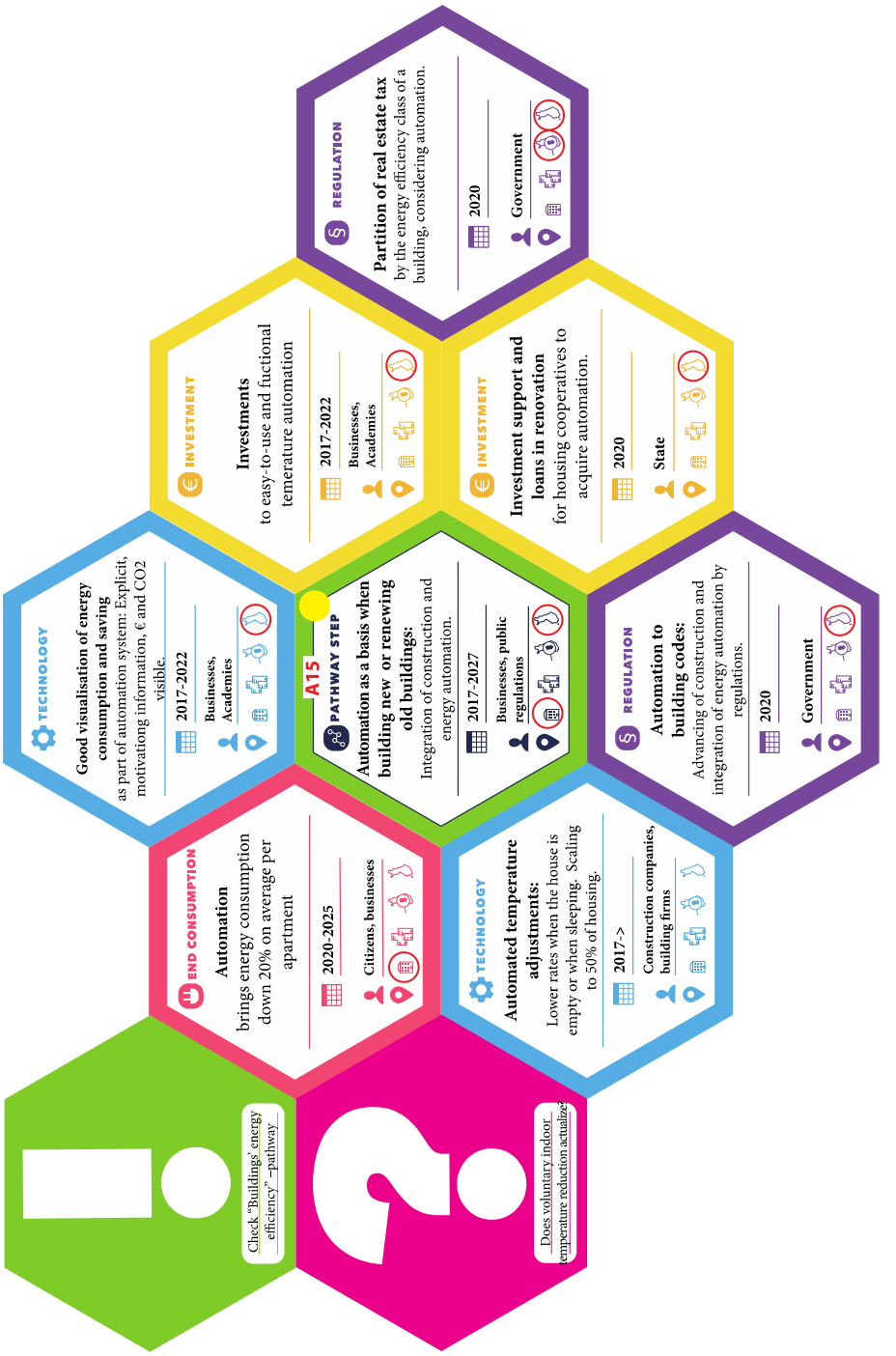

Figure 6 An example of a pathway step for which the facilitating actions have been explored in detail (translated by the authors)

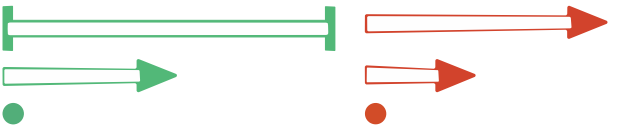

Figure 7 Uncertainty arrows, probability markers and stickers (left) and alternative arrows and stickers (right)

Pathway creation relies on following the procedures, facilitator assistance and her or his actions to keep both the participant discussion and path construction actions on track. To aid this, both detailed participant instructions and facilitator instructions were created, along with a guide for how to transfer the physical board's state into a digitized environment in a unified way. We have found it useful to use both facilitator and a note taker who both participate in digitizing the contents, but have also ran the workshops with single facilitator. The digitalization is done using Adobe InDesign and Illustrator using ready-made templates that can, in turn, be directly used in the final reporting format of the arena process.

4 *The outcomes and participant evaluation of the pathway creation toolset*

4.1 *Process outcomes*

The initial mid-range transition arena succeeded in creating a range of outcomes: articulating a more ambitious and inspiring energy and climate vision for Finland in 2030; creating an understanding of the change drivers, impediments and uncertainties in achieving an ambitious energy vision; identifying thirty intermediate goals for 2030; and, most importantly for us here, creating eight detailed pathways of change for the most important transition goals and identifying over one hundred immediate actions to be taken along these pathways. The amount of information which the transition implementation area creates is considerable. Even when heavily condensed, the Helsinki process amounted to a 200-page report.

The 2030 pathways that were created were as follows: coal is phased out by 2030; creating 2000 MW in demand–response capacity in electricity; creating 2000 MW in demand–response capacity in heating; halving building net-energy use; reducing household energy use by 15% with behaviour-change measures; having 750 000 alternative energy vehicles on Finnish roads by 2030; reducing total mileage by 10% through mobility as a service; and doubling the clean energy technology exports of Finland. Some of these transition goals were such that there was a fair number of background studies that could be used to ground the work and the participants had already made exercises related to some of them, such as the promotion of electric cars. Some others, such as the ambitious 15% energy consumption reduction through

behaviour change and the doubling of cleantech exports, featured greenfield aspects. These paths thus included new ideation over what pathway steps might be sufficient and feasible (even in principle) in order to reach the transition goal. This took more time than anticipated and in such paths the resilience analysis based on contingency factors had to be reduced.

The final report was released in November 2017. It was handed over to a Minister of the Finnish Government and its key messages were discussed in a panel by four members of the Finnish Parliament together with the head of the board of the largest Finnish public financing agency in an event in which one hundred invitees from ministries related to energy transition, businesses, civil society and academic organisations participated. The report was featured on headline TV news, morning TV and in 16 newspaper articles, which basically covers all the relevant major Finnish media. It further received 250 posts in a "new energy policy" social media discussion group and 30 related blogs and several columns appeared. Some of the ambitious actions proposed in the change pathways are also underway. As an example, the Ministry of Transport and Communications published its transport pathways report in the end of 2018, where it had raised the 2030 target of alternative motive force vehicles to 800,000 from an earlier number, 300,000, in line with the pathway formed in the transition arena process for 750 000 vehicles with many same pathway steps and step-actions (Hyysalo et al., 2019a).

Thus far three new transition arenas have already been launched with preliminarily positive outcomes. There has also been considerable interest from other actors and several discussion invitations have followed both from incumbent business and policy actors as well as actors working with alternative niche solutions. Whist this is promising, it is still too early to speak of the research's societal impact apart from it evidently having nudged the transition somewhat forward and gaining some attention and interest in the process.

4.2 Evaluations of the mid-range pathway creation toolset

The mid-range transition pathway toolset was evaluated by both the arena participants and the facilitators after the arena process. Twelve statements and an open commentary field were used. The most positive aspects received an average of 4 or above on a 1−5 scale from both participants and organizers; and these were for statements 1, 4, 6, 8, 9 (see Figure 8), which all deal with the overall experience and quality of deliberation in using the mid-range transition pathway toolset. The statements least agreed with were 12, 11, 10 and 5 (see Figure 8 and the discussion below). Statement 7 featured high variation in participant responses and we suspect this to have resulted from ambiguity in the Finnish wording as open-ended questions received mostly affirmative responses on this topic.

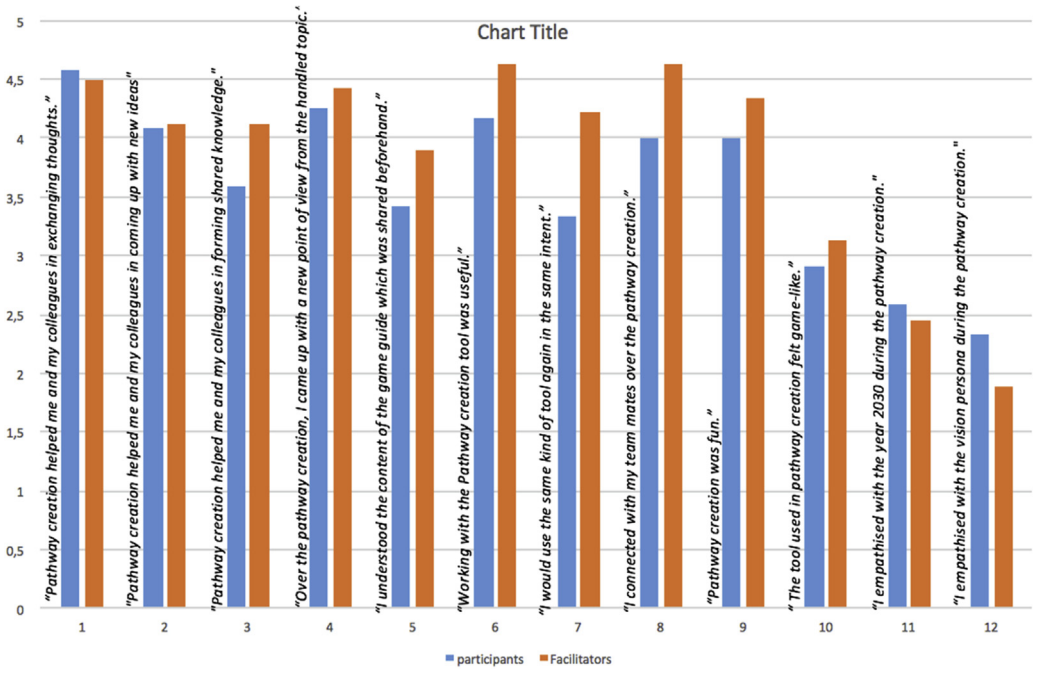

Figure 8 Participant and facilitator evaluation averages of twelve statements about the mid-range transition pathway toolset

The relatively low scores given to statements 11 and 12 regarding empathizing with 2030 and the vision personas reveal that our attempts at generating a more experiential near future were either not experiential enough or not seen as relevant given that the focus of the arena was on system-wide actions and the whole mid-range time span. Also our primary aim with the personas had also been to convey cognitive information about the goal state in 2030 rather than generating empathy.

Responses to statement 10, about the toolset being experienced as a game by and large matched the design team's intention: to borrow elements from game design but retain the toolset as a collaborative envisioning tool that would not become too playful or be seen as a simulation game. A simulation game would have likely curbed the openness of deliberation among participants. Finally, the averages between 3.5 and 3.7 for statement 5 (on the provided manuals for the process) draws attention to the time limits that some of the busy, highly-positioned participants had when familiarizing themselves with the tasks beforehand — the design team's pictorial guide received positive feedback from many participants but it could not be internalized in just two minutes, as some clearly expected to do, but rather in ten to 15 minutes.

In the final feedback discussion and in open-ended responses, the participants emphasized that the real innovation in the mid-range transition pathway

toolset was that it had forced them to create concrete pathways and be able to notice how difficult it is to carry out such a process and prioritize single, truly relevant steps. The participants were happy about the facilitation of the process and regarded the pathway creation as good facilitation technique which did not feel like 'traditional workshopping, but focused work' (as one participant phrased it). The facilitators' insistence on coming up with documentation instead of talk and on concrete solutions was seen as valuable, as well as the emphasis on identifying causal connections and system interrelations. Several participants also suggested that the process could be applied for several other purposes if it was customised.

> *[The mid-range transition pathway toolset] illustrated the complexity of issues outstandingly, as well as the need for a concrete operation path along with a long-term vision in order to take things in the right direction. The pathway creation toolset could/should also be utilized in policy and strategy planning. (participant feedback)*

Some critical considerations were raised. One participant felt the pathway building process took longer than expected, another felt that the goals, steps, means, immediate changes and measures resulted in too much complexity and a somewhat disorganized way of working. A final critical remark concerned the division of work: could the participants not just give short, insightful presentations to each other and then just use free conversation among each other to reach the pathways? This implies that the pathways would then be constructed by the organizers and only be subjected to commentary by the participants – a direction which the design team specifically wished to avoid as they wanted to give as much direct first hand agency to participants in constructing the pathways as possible.

The transition arena workshop series drew its facilitators and note-takers from a pool of experts in a larger consortium project. These 16 organizing team members' appraisal of the tool was mostly positive, and the tool was voiced to be logical, visually ambitious and pleasant. One facilitator thought that possibly the biggest end result for pathway creation was the new way of working. The qualities of the tool were seen as inseparable from the overall process though:

> *[Visualizing the pathways] worked well, although it was important that the structure supported iterations since some structuring had to be made. Often success was thanks to the good facilitators and well-selected participants. (an organizational team member)*

This also pointed to difficulties in the facilitation process in two groups in which the whole structure of the pathway changed several times, causing plenty of work for the facilitator and note taker. It was also sometimes difficult

to distinguish which actions were supposed to be categorized as *pathway steps* and which as actions supporting those steps. Finally, some facilitators were concerned that maybe the pathway creation did not support raising 'extra innovations', but rather guided attention to explore the systemic change with steps and solutions that were already known to participants.

Overall, the feedback indicates that the mid-range transition pathway toolset was appraised positively and that it helped the pathway concretization process, the sharing of expertise and the generation of new insights. The limited time frame for creating complex pathways led both the participants and organizers to recognise that some steps and ideas required more refinement, and whilst some refinement could be made for the final report (through rounds of commentary to the digitalized pathways), the participants continued to express willingness to go deeper into the topics after the process. The high level of expertise among the participants and facilitators was a key factor to successful work in a very fast-paced process, but, at the same time, these same qualities led to a scarcity of time for the process for some participants.

5 *Conclusions*

In the course of the current paper, we have discussed how codesign for sustainability transitions can help improve the means used in transitions governance. The redesign of path creation toolsets and procedures rendered the transition arena work better suited for mid-range planning; this enabled more effective participant interactions and deliberation, and elaborated on one way of adjusting transition governance to the specificities of country contexts (contexts that feature important variations).

The participant and facilitator feedback showed that our design addressed well the design challenges for the pathway creation system outlined in Section 2. The notation, elements and procedures and guides we developed were sufficient for fast-paced multidisciplinary teamwork in the arena. Regarding shapes, hexagons are used in, for example, countless board games and their affordances for combinations (as well as potential future alterations) are thus well known. The dimensioning of elements and the metallic board also worked well and produced the kind of conditions for small group work that we envisioned. Opting to use off-the-shelf materials that could be easily altered, shared and ordered has allowed us to easily tailor the arena elements for the different contexts in which we currently use the toolset. To aid documentation and commentary, we paired the physical tools with digital templates onto which the form and content could be relatively easily transferred, and these digital elements worked sufficiently well for documentation and commentary. Regarding procedures and facilitation, the creation of a clear procedures and participant and facilitator guides proved useful in the arena process. However, the mid-range transition pathway toolset does

not work as a stand-alone kit (at least, not yet): it requires facilitation and package of domain-specific background information, and is greatly improved if facilitators have domain knowledge that allows them to take the initiative in shaping the unfolding path on the pathway board. All these design measures draw from the long tradition of participatory and collaborative design in supporting participant action and interaction with carefully crafted materialities and procedures (cf. Ehn & Kyng, 1991; Erikssen et al., 2014; Agid, 2018).

The mid-range pathway toolset has wider import for both design for transitions and design for governance more generally. Regarding designing for transitions, our work illustrates that there is much important work designers and design researchers can pursue to enhance transition governance processes. Although transitions governance has a considerable multidisciplinary community and a history of analysing and fostering long-term systemic change (and it may well be illusory for design researchers to seek to ideate replacements for these models), the means used to facilitate these complex processes benefit from more targeted design (Cf. Gaziulusoy & Ryan, 2017a, b). Particularly drawing from the design traditions of creating mediating representational artifacts, toolsets and procedures for multi-stakeholder participation appears to hold potential for improving participant's use of time, for catalysing higher quality outputs and for giving participants more and more direct agency in the transition governance processes (Cooney et al., 2018; Eriksen et al., 2014; Hyysalo et al., 2019a, b; Agid, 2018).

Sustainability transitions affect wide constituencies of society and, as Voβ et al. (2009) point out, this calls for wide societal engagement. In other words, it calls for various forms of designing for wide societal participation, governance and social change, indeed an area of rising design research interest (e.g. Agid, 2018; Hyysalo & Hyysalo, 2018; Julier & Kimbell, 2019). It is vital to better understand the relations that design holds for more traditional forms of governance in envisioning sociotechnical change (Umney & Lloyd, 2018) and to envision the generic processes of social design research (Julier & Kimbell, 2019), yet our experience underscores that designing for governance greatly benefits from, even requires, deep multidisciplinary collaboration. The Helsinki arena process was pursued within a large research consortium together with experts in political science, policy analysis and sociotechnical change, who also provided crucial insights into the design of the arena and the design of the mid-range pathway toolset (Hyysalo et al., 2019a). The in-depth understanding of policy processes, actor remits, and persistent and current challenges in different governance institutions was vital for our design, as was the accumulated first-hand experience in interacting with relevant civil servants, politicians, business people, and NGOs. This domain knowledge was used to anticipate the issues that needed particular attention, tuning workshop facilitators, and estimating participants' available time allotments, attainable

goals and so on (Hyysalo et al., 2019a). Storming in with just a team of designers would have been far less likely to succeed.

Regarding further research the mid-range transition pathway toolset provides an example of the manifold contributions that codesign can offer the many multi-stakeholder deliberation processes that are necessary in the governance and advancement of transitions. The knowledge that collaborative design has developed over decades in terms of means, procedures, skills, power dynamics and related sensitivities in fostering participation in design can help not only in redesigning transition arenas, but also in inventing new deliberative formats suited for the different loci and foci of transitional change, in empowering the communities that foster transitional alternatives, and in facilitating experiments in new technical, social and (inter)organizational arrangements (Agid, 2018; Eriksen et al., 2014; Hyysalo & Hyysalo, 2018; Jalas et al., 2017; Smith & Iversen, 2018). At the same time, designing for transitions presents new contexts and challenges for codesign in terms of scope, longevity, ownership and types of outcomes sought, which all point to an important new research area. The same applies to designing for sustainability transitions more broadly: despite all the recent pitches, educational programmes and schematics, only a handful of concrete design projects can as yet be found. It is time to roll up our sleeves, as there is no shortage of the design contributions that can support sustainability transitions.

Conflicts of interest

Declaration of conflicts of interests DesStu ms Codesign for transitions governance: a mid-range pathway creation toolset for accelerating sociotechnical change.

Authors do not declare any conflicts of interests.

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Notes

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