

DEVELOPING A DESIGN-BASED UNDERSTANDING OF LEARNING IN TRANSITIONS: A MULTIPLE CASE STUDY

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ABSTRACT

In sustainability transitions, experimentation and learning are addressed as key processes that facilitate implementation, diffusion and scaling of transition mindsets and actions. In this paper, we argue that design acts as a means for this action-based transition learning. Contributing to design for sustainability transitions literature, this paper proposes a design perspective on learning in transitions which enables analysing the multifaceted ways, depths and scales of learning that design mediates. Through a multiple case study on sustainable community settlement initiatives, we examine and discuss the roles of design in facilitating interactive learning, and thus in orienting and accelerating sustainability transitions.

INTRODUCTION

Sustainability transitions require deep structural changes that can reconfigure the functioning of environmental, economic, social, cultural and technical systems, their interrelationships and complex-adaptive dependencies (Loorbach et al., 2017). Societies need to build cognitive, practical and affective competencies for such large-scale societal change processes, and develop strategies and mechanisms to proceed with their transitions. For individuals, transitions might mean adapting to emerging circumstances and finding new ways to meet daily needs. For policy makers, it might mean configuring and applying structural changes in order to align adaptations of individuals and societies with sustainability targets. At a larger scale, transitions mean reorganising socio-

technical, socio-institutional, socio-ecological and cultural systems collectively for societies.

Systemic changes necessitate applying multiple change actions iteratively and making continuous reflection on action, hence, pursuing action-led learning. Learning in transitions is multi-faceted (van Mierlo & Beers, 2018; Ison et al., 2015; Popa et al., 2015) and multi-dimensional (Öztekin and Gaziulusoy, 2019). It involves understanding what the existing situation is, how else this situation might and should be, and which actions can be performed to deliver desirable changes (Pohl and Hirsch Hadorn, 2007). Therefore, framing, questioning and reframing actions of change, as well as their intentions, purposes, meanings and rationales are part and parcel of action-led learning in transitions contexts. Learning in transitions requires more than formal learning approaches and programmes that mostly proceed with fixed and predefined objectives. Rather, learning that couples large-scale societal change processes are open-ended, social-driven and action-based, and furthermore informal and emergent in everyday life (Pahl-Wostl, 2009). Therefore, collaborative processes, such as of planning, experimenting, and sense-making, can further accelerate learning in transitions (Moser, 2016; Beers et al., 2019; König, 2018; Manzini, 2015, 2017).

In this paper, we argue and present evidence that design acts as a means for this action-based transition learning and thereby we contribute to design for sustainability transitions literature. With the aim of developing an empirically-grounded design-based understanding of learning processes that orient and accelerate transitions, we will scrutinize the roles of design in the implementation, diffusion and scaling of transition mindsets and actions. We will present a multiple case study on community-led sustainable settlement initiatives that explore novel configurations of settlement systems, infrastructures and services as well as alternative practices and cultures of the everyday, aiming at establishing change towards sustainability. We interpret these initiatives as *grassroots laboratories* which, in networks, experiment with systemic interventions and

innovations that include but are not limited to renewable energy systems, low-carbon technologies, water management approaches, local food production practices, collaborative making cultures, community ownership models, their interrelations and integrations.

In the following section, first, we briefly introduce two theoretical perspectives on learning and transitions: one from transitions studies and the other from learning sciences. Then, we propose a design perspective on learning in transitions which elaborates on the ways, depths and scales of learning that design processes facilitate while implementing, diffusing and scaling transition mindsets and actions. In further sections, we describe our case study methodology, present our analytical insights, and finally discuss, with this evidence-bases, the roles of design in orienting and accelerating transitions with the interactive learning processes that it mediates.

PERSPECTIVES ON TRANSITIONS AND LEARNING

A TRANSITIONS RESEARCH PERSPECTIVE ON LEARNING

Transitions studies put value in niches - applied alternatives to dominant socio-technical, socio-institutional or socio-ecological systems- for learning. Niches represent experiments, actions and interventions that manifest innovative system configurations, transitions approaches and strategies in real-world contexts (Kemp et al., 1998; Geels and Schot, 2007; Loorbach, 2007). Niches, on one hand, enable assessing framed solutions and set assumptions (Luederitz et al., 2017), and, on the other hand, enable co-production of knowledge by forming multi-stakeholder interactions and collaborations (Frantzeskaki and Rok, 2018). Emergence, accumulation and empowerment of niches can challenge and disturb mainstream systems, cultures, and practices, and lead to substantial systemic changes (Geels and Schot, 2007; Loorbach et al., 2017). In short, transitions studies highlight the importance of introducing niches and building networks between and around niches to accelerate the diffusion of sustainable alternatives.

Niche actions, experiments and interventions can facilitate multiple processes of learning for transitions. Transitions literature addresses three systemic learning processes that relate to niches (von Wirth et al., 2019). (i) *Local embedding*: adopting, implementing and developing a niche in real-world contexts, by configuring its design, elements, approaches and outcomes are referred to as local embedding (von Wirth et al., 2019). Embedding enables building context-specific and deeper understandings of transitions dynamics, transitions actions and their consequences (van den Bosch and Rotmans, 2008). At the level of individual, group or organization, it mediates developing place-based and practice-based competencies for transitions by facilitating

learning-by-doing (Barth and Michelsen, 2013; Singer-Brodowski et al., 2018).

(ii) *Translation*: When learnings from niches are deployed in building new transitions actions, experiments or interventions in other contexts, it is referred to as translation (von Wirth et al., 2019). Translation builds relations and networks between niches and enables diffusion and broadening of sustainable alternatives (van den Bosch and Rotmans, 2008). It involves analysing, reinterpreting and recontextualizing previous actions, their rationales and elements. When undertaken by a network of actors, organisations, and sectors, it mediates interactive learning between different domains of knowledge and action (Barth and Michelen, 2013; Singer-Brodowski et al., 2018).

(iii) *(Up)scaling*: When niches, in order to increase their impact on transitions, get developed into wider scales, with increased complexities and larger stakeholder networks, this is referred to as (up)scaling (von Wirth et al. 2019; van den Bosch and Rotmans; Naber et al., 2017). Scaling requires tackling a significantly more complex and wider-scale problem. This requires deeply reflecting on and reframing the normative directions and strategic approaches that are guiding transition actions. Such transdisciplinary collaboration facilitates integrative thinking, co-production of knowledge and transformative learning (Mauser et al., 2013; Barth and Michelen, 2013; Singer-Brodowski et al., 2018).

In short, niches might trigger different interrelated processes of learning for transitions. Design is a crucial practice in these processes because it is determinant on how and to what extent approaches, models, processes and contents from previous actions, experiments and interventions shall be transferred, modified and utilized in the formulation of emerging niches. In other terms, design can be framed as a latent *netweaving* practice and process that links together multiple transitions mindsets and actions, experiments and interventions, and their learnings.

Niche-based conceptualizations of learning in transitions are useful to address how different processes that relate to niche actions, experiments and interventions (i.e. local embedding, translation, or scaling) might trigger distinct learning interactions (i.e. organizational, intersectoral, transdisciplinary, etc.), and can contribute to different transitions dynamics (i.e. local transformations, horizontal diffusions, or systemic coevolutions). Nevertheless, this conceptualization seems to fall short more specifically in distinguishing how each learning process might attend to various depths of reflection and reframing.

A LEARNING SCIENCES PERSPECTIVE ON TRANSITIONS AND LEARNING

There are multiple theories of learning developed in learning sciences (LS). We present here Illeris' (2009) work, which categorizes diverse approaches to learning emerging from LS in four distinct types:

- *Cumulative or mechanical learning*, where previously shaped learning element, mental scheme and pattern continues to be recalled;
- *Assimilative or learning by addition*, where a new element is linked to an existing mental scheme and pattern;
- *Accommodative or transcendent learning*, where learning element is broken down to its parts and modified and relinked creatively to respond to another situation;
- *Significant, expansive, transitional or transformational learning*, where, rather than the learning elements or their relations, the whole cluster of schemes and patterns are restructured and reorganized.

This categorization fundamentally signifies that learning is a social, interactive and everyday process (Illeris, 2009). The four types of learning mentioned manifest different versions of how previous actions or actions of others can be analytically reflected on and reinterpreted for new actions. This categorization further distinguishes how different depths of reflection and interpretation might deliver different depths of change in behaviours, motivations and actions.

Transitions research perspectives on learning can benefit from this categorization because it particularly contributes to building an understanding of how different approaches to learning might provide different depths of

knowledge exchange and integration, reflection and reconfiguration. For instance, when a niche is to be locally embedded, to be translated into another context, or to be scaled up, its design can be approached (1) as a mere *replication task* (a previous niche experiment is applied as is), (2) as an *additive task* (necessary elements and features could be affixed or removed to meet needs), (3) as an *interpretative task* (systemic relations between elements and features can be analysed, and creatively and integratively interpreted), or (4) as a *transformative task* (underlying mindsets, philosophies, meanings and intentions can be questioned and reframed). In other words, design of niches can reach to different depths of analytical reflection and creative (re)interpretation, and thus can facilitate different types of learning in transitions.

A DESIGN PERSPECTIVE ON TRANSITIONS AND LEARNING

Design scholars who have integrated theoretical and conceptual frameworks from transitions studies and design research, similarly conceptualize several levels in design. These levels represent differing scopes, approaches, goals, matters and contexts that design activities might attend to. For instance, Young (2008) conceptualizes three nested and interdependent contexts of design activities: (1) design in context refers to design at the level of products and artifacts, (2) designing context refers to design at the level of systems and services, (3) design of context refers to design at the level of policy, ideology, purposes, values and norms. Ceschin and Gaziulusoy (2020), on the other hand, distinguish between design attitudes (1) at product level, (2) at product-service system level, (3) at spatio-social level, and (4) at socio-technical system level.

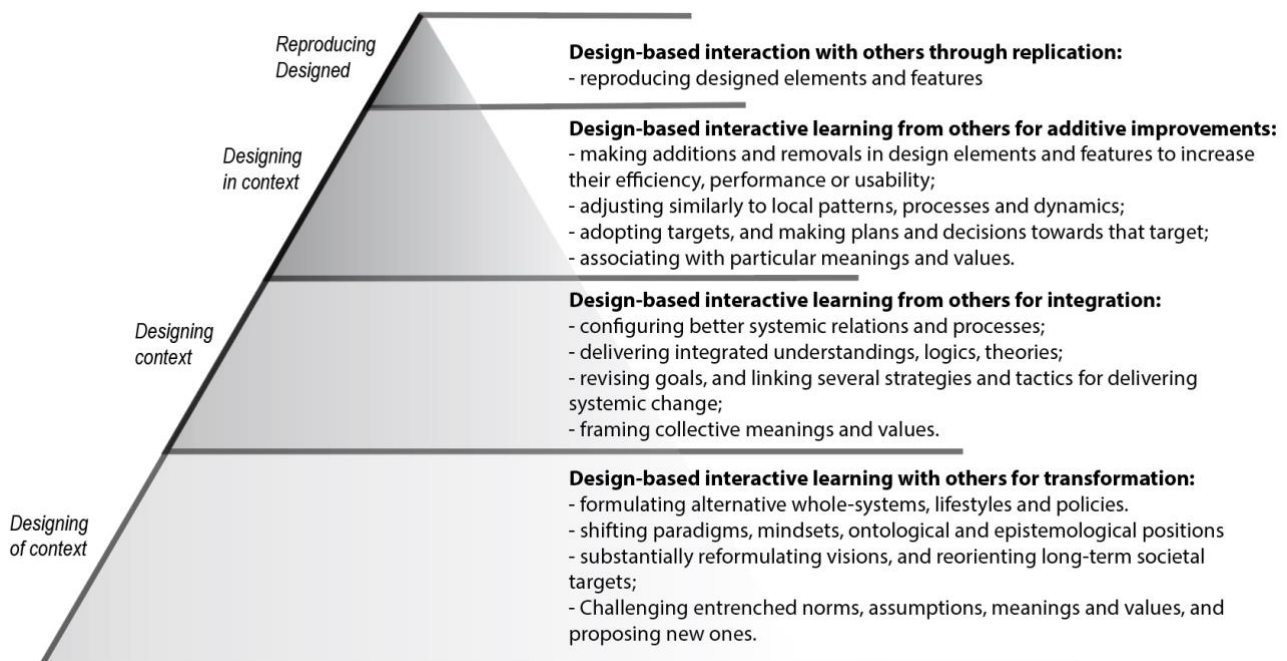


Figure 1: A conceptual framework for design-based interactive learning

Perspectives from transitions studies and learning sciences on learning establish a fertile ground to explore how design, as a netweaving practice, mediates interactive learning processes in transitions. Integrating insights from transitions research, learning sciences and design studies, we propose that design-mediated interactive learning in transition can be understood in four levels of depth and scale (see Figure 1).

(1) At the surface, design-based interaction corresponds to a mere replication process. Directly mimicking design solutions, outputs and practices contains either very little or no reflection and interpretation processes.

Consequently, no changes, modifications or improvements - in other words, no significant contributions to transitions - might be observed at this level. Nevertheless, through this interaction, transition actions, interventions and experiments might be transferred from one context to another, however without acknowledging their problem and solution framings, their rationales, meanings and purposes. Thus, this level might evoke mechanical and behavioural learning about reproduction practices, but it is insufficient to facilitate interactive learning on the basis of design.

(2) At the second level, design activity targets making improvements in design features and elements, such as for increasing their usability, effectivity, or performativity. Making improvements in features and elements require considering what can be added, removed, modified or changed (Hyysalo et al., 2017), and, thus, pursuing analytical reflections and design interpretations. However, design at this level does not target making substantial changes in wider system relations and processes where design actions are situated, nor in the overarching values, intentions and philosophies for which design actions might serve. In the context of sustainability transitions this level of design learning might evoke incremental and small-scale changes but, most probably, will fail to facilitate systems coevolution and large-scale transformations.

(3) At the third level, design activity includes creatively synthesizing features, elements, systemic processes and causal relations in order to reconfigure whole systems. This is a highly integrative task, because it requires analytically reflecting on previous configurations and reordering (Buchanan, 1992, 2001) them in novel ways so that design might fit in new contexts and situations, or respond to new problems. Design at this level might deliver better comprehensions of current systems, their positive and negative assets, and how else they might be formulated. Hence, it might pose novel and more comprehensive contributions to learning in transitions.

(4) At the fourth level, design activity includes reflecting on deep sets of references of design, and transformatively reframing worldviews, values, rationales and visions that guide design approaches. Such deep reflections and reframings can create substantial shifts in system

trajectories and fundamentally alter wholes of societal systems, including its cultural, technical, institutional and ecological dimensions.

In the following sections, through a multiple case study on community-led sustainability transitions initiatives, we empirically evaluate the conceptual framework and elaborate on how interactive and collaborative design processes facilitate learning in transitions. By utilizing this conceptual framework, we aim to develop an empirically-grounded design-based understanding of learning in transitions.

METHODOLOGY

We have conducted a qualitative multiple-case study (Yin, 2003), through which learning processes that design mediates for transitions are explored. We studied three sustainable community settlement initiatives that have designed and implemented system innovations and interventions for transitions. Aiming to illustrate a variety of approaches, the selection follows a contextual (urban (U), rural (R)) and an organisational taxonomy (bottom-up (CL), community-led hybrid (CLH)) (see Table 1). Hence, these settlements are situated within different environmental, social, cultural, political contexts, and they demonstrate differing solutions, strategies and approaches to transitions. One of the main criteria for including cases in this selection has been their participation in interactive design processes either in peer networks collaborating with other community initiatives or in multi-stakeholder networks collaborating with multiple sectors, research and/or policy institutions.

Data has been collected from each settlement primarily through participant observation. The first author spent specific periods of time in each settlement to experience and observe organisational functioning of these initiatives, their processes of transitions, their everyday practices of living and working. Semi-structured interviews are conducted with community members, to gather historical and up-to-date information about collective design and learning processes in various episodes of the settlement. Additionally, ethnographic interviews were conducted with inhabitants, short-term visitors, volunteers about individual experiences and perceptions about collaborative problem-solving, decision-making and collective sense-making processes that cases demonstrate. Furthermore, mapping and co-creation workshops were designed and conducted to collect additional data about the actors and processes of design-based interactions. Collected data were documented in audio-visual forms, in field notes and memos. Table 1 presents more specifically forms and quantities of data collected from each settlement.

First, we analysed processes of settlements to conceive the occurrence and progression of events, actions, ideas and thoughts in each settlement. Analysing processes enables studying the emergence, change or sequence of

Table 1. The meta data of case study

	Tamera (Case 1)	Understenshöjden (Case 2)	Suderbyn (Case 3)
Name and type of the organisation	Peace research and education centre	Housing cooperative and urban ecovillage	Permaculture ecovillage and non-profit NGO for research, education and networking
Context and Location	Rural, Portugal (Est. In 1995)	Urban, Sweden (Est. In 1989)	Rural, Sweden (Est. In 2008)
Sizes	160-220 people	44 households	12-25 people
Data collection period	2018-2019	2018-2019	2019-2020
Data collection methods and Data Set	Participant observations (9 days) Interviews (5) Published documents Public Speeches (12)	Participant observation (5 + 4 days) Interviews (8) Published documents	Participant observation (15 days) Interviews (8) Mapping and co-creation workshop (5 participants) Published documents

occurring actions or their strategic implementation through time (Saldaña, 2013). We utilized this analysis to generate descriptive timelines that picture the continuous formation, development and evolution of each case. These timelines laid the groundwork for identifying the significant episodes and anchoring design decisions and actions that have been influential on the progression of each settlement.

Next, the learning processes prior to or following these anchoring design decisions and actions were analysed with references to the conceptual framework developed. Data has been thematically analysed and visually schematized with references to the dimensions and depths of design learning outlined in the proposed framework. Finally, these analyses were utilized to assess and reflect on the potential impacts of design processes in diffusing transitions mindsets and actions, and in accelerating and reorienting transitions trajectories.

COMMUNITY-LED NICHE EXPERIMENTATION AND LEARNING FOR SUSTAINABILITY TRANSITIONS

A CASE OF LOCAL EXPERIMENTATION AND COMPETENCE DEVELOPMENT: TAMERA

Having its roots in the student movement in Germany of 1970s, Tamera started in 1995 as a social experimentation project on 200 hectares of land in the rural areas of Portugal. Shortly after moving to Portugal, the community struggled with severe water shortages. Although the community had previous experience with community lifestyles and do-it-yourself settlements, they didn't know how to manage land-water in Mediterranean climates. Searching for solutions, they reached out to several experts. Holzer (2015) offered an alternative perspective on natural water systems and proposed his water retention landscapes model to restore Tamera's microclimate and local ecology. This model aimed to support rainwater catchment by morphing the land and to raise ground-water levels by cultivating natural

vegetation and supporting green and gray water cycles. The community then undertook a huge task of planning and constructing a water retention landscape. In their case, it required building multiple lakes, distributed swales to 'slow, spread and sink' rainwater, and multiple land-terraces at several levels to provide space for planting and producing food.

As Figure 2 illustrates, many emerging endeavours for transitions in Tamera can be said to be evoked by the implementation of this water retention landscape model and adoption of a novel water management approach. It can be interpreted as an adoption of a one-system logic, which has initially mediated only in-context interactive learning for Tamera.

However, this system implementation acted as an experiment, through which achievements, points for improvements, and consequences of this approach could be assessed. The community of Tamera observed immense improvements in the environmental conditions on its land. Experiencing these changes inspired the community to experiment with further system interventions and integrations, and to explore regenerative sustainability at larger scales. Consequently, this very first step into transitions gave rise to more comprehensive, experimental and action-based learning processes for the community.

By deeply reframing their visions, actions, rationales and meanings in the context of sustainability transitions, the community expansively reframed sustainability norms and policies of everyday lives. They refined their long-term visions and intentions; and, they associated new roles and meanings to local experimentations for wider-scale societal transformations. These deep reflections positioned local experimentation, whole systems change and regenerative sustainability at the core of Tamera's research focus. Since 2009, they are running a solar test field, where they have been building and experimenting with mutually supportive energy, water, and food

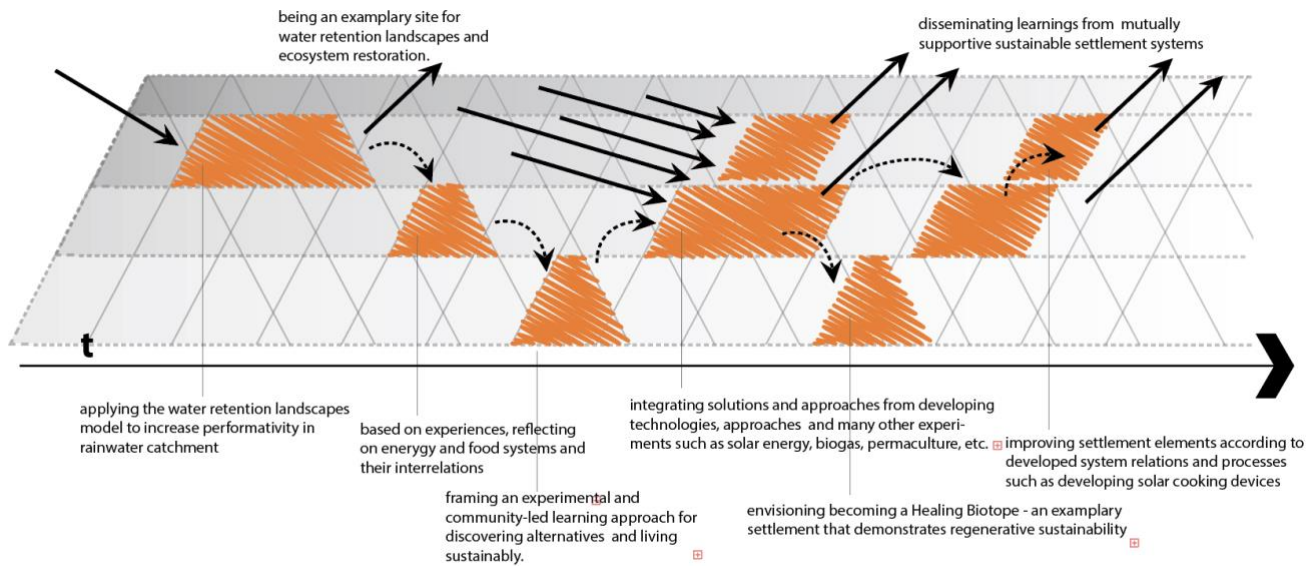


Figure 2: The design-based interactive learning processes of Tamera

systems. Taking an experimental approach enabled the community to develop innovatively integrated systems, technologies and philosophies. Tamera disseminated its design approaches and learnings, innovations and practices to its own peer network and to multiple other settlements through publications, seminars, volunteering programmes and workshops.

A CASE OF URBAN EXPERIMENTATION AND MULTI-STAKEHOLDER COLLABORATION: UNDERSTENSHÖJDEN

In 1989, Understenshöjden started as a group named Ecological Building in Björkhagen (EBBA), which had an idea to recontextualize the ecovillage model in the urban peripheries of Stockholm. Their idea addressed an alternative solution to the economic and housing crises of the era and was aligned with the latest decisions and policies of the City of Stockholm that supported ecological building and self-construction practices. In an exceptionally short period of time, the City of Stockholm supported the project and provided land to EBBA. City's support came with the condition of collaborating with HSB (Cooperative Housing Association) and SMÅÅ (Small cottage agency of Stockholm City), which were well-established organisations that have long-term recognition and experience for planning and building in Sweden. Such a collaboration ensured shared responsibility for the continuation and realization of the project. Furthermore, this collaboration equipped the project with different expertise, resources and perspectives, and became a means to explore collaborative ways of planning, decision-making and building.

As Figure 3 demonstrates, Understenshöjden was initially envisioned from aggregated - abstracted and accumulated - knowledge about ecovillages and rural sustainable community settlements. The founding group, members

and stakeholders of this project neither had no prior knowledge nor hands-on experience about the topic. Undertaking a multi-stakeholder collaboration, then, has been a keystone in the development of the project, because, it settled the design approach and organisational work culture of the community.

The project proceeded with working groups that focused on five topics: (i) sewage system, (ii) energy system, (iii) landscape, ecology and environment, (iv) waste management, (v) architecture. Alternative systems, infrastructures, and design elements were researched by each working group; expert opinions were shared through invited talks; then, topics were discussed in the larger group; and further planning and decision-making were realized on a consensus basis. Analysing previous and relevant projects and reinterpreting their system logics, systemic relations and processes for an urban context was an indispensable part of design. Design activities targeted integrating cutting-edge sustainable technologies and modern infrastructures with whole-system design principles that ecovillages demonstrated. Consequently, through collaborative thinking and decision-making, all members started building knowledge about design principles and rationales, and the system performances, processes and relations that they delineate.

Being situated in the urban context and being involved in a multi-stakeholder collaboration enabled the community more easily disseminate its learnings across sectors and contribute to large-scale societal learning. The design principles and rationales that Understenshöjden demonstrate were carried to multiple different locales, institutions, and projects. For instance, right after its completion, one project leader was employed by HSB to manage and revitalize the sustainability and ecology department. This enabled transferring the design-based

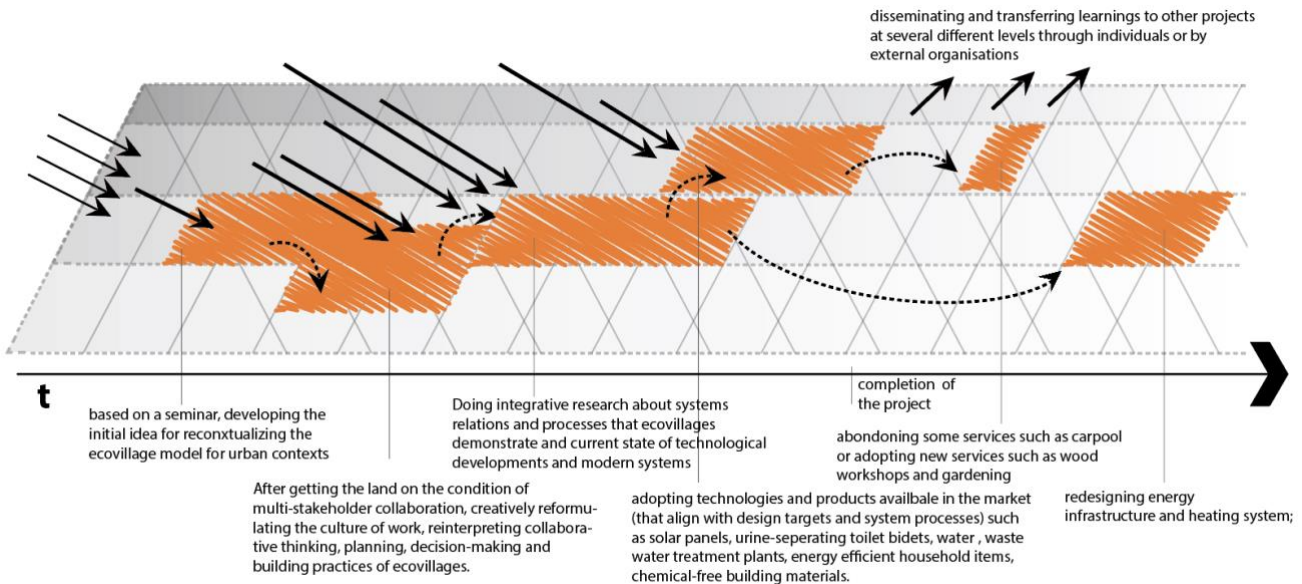


Figure 3: The design-based interactive learning processes of Understeshöjden

learnings of Understeshöjden to emerging projects, such as in the development of Hammarby Sjöstad in Stockholm. This also enabled scaling Understeshöjden's design actions to wider scales, such as in multiplying car-sharing services nationwide. After more than 25 years of its completion, it might be observed that Understeshöjden has posed multiple direct and indirect contributions to urban transformations and sustainability transitions.

A CASE OF TRANSDISCIPLINARY EXPERIMENTATION NETWORKS: SUDERBYN

Suderbyn is a relatively recent initiative, which started with the intention of building an ecovillage by two people. Before founders started up an ecovillage, they were already members and contributors of Global Ecovillage Network (GEN) - an institutionalized peer-network of ecovillages. Through this network, they got acknowledged about the sustainability experiments that ecovillages pursued as well as different sustainability solutions, systems and practices that they developed and integrated. But more significantly, as could be seen in Figure 4, being engaged with GEN for a long-term period, founders have internalized the worldviews, intentions and meanings that ecovillage movement shared and represented.

After purchasing the land, Suderbyn was challenged with attracting people and forming a community. Suderbyn developed a European Voluntary Service (EVS) programme, which offered young and interested individuals hands-on practical experience about sustainable lifestyles on their site. This was one of the first in ecovillages to develop and undertake a project under a governmental funding. Then, it became an exemplary project for its facilitation of dialogue and collaboration between governmental institutions and local community initiatives of ecovillages. Many other

ecovillages, which got informed about this project either through GEN network or through informal networks, started being partners of this programme. Following many years of its recurrent applications, this programme is a regular practice and strategy nowadays that can be observed in numerous ecovillages.

After positioning transdisciplinary collaboration and inter-sectoral dialogue as its core approach to sustainability transitions, in 2016, Suderbyn hosted the Closed Loop project, which was developed in collaboration with Finnish Natural Resource Institute (LUKE) and Baltic Sea Conservation Foundation. As part of this project, a biogas-based closed loop system was planned and implemented in Suderbyn. Suderbyn community was acknowledged about appropriate technologies and community practices of biogas through Tamera's experiments (see above). Nevertheless, by installing a novel biogas system and infrastructure, this project marked the research focus of Suderbyn as alternative energies of biogas.

Suderbyn got commissioned to many research and education projects until then, with roles ranging from research leader to partner, or as a demonstration and experimentation site. For example, in last couple of years, Suderbyn received LEADER funding for three different research projects, all of which research on energy technologies or practices that relate to biogas. In Off Grid project, the largest coalition among these three, Suderbyn collaborates with research and education centres in this project as well as local action groups (LAGs) and local practitioners in Sweden, Latvia, Lithuania, and Estonia. In these projects, while Suderbyn learns through transdisciplinary collaboration, it also transfers its learnings and experiences back to peer community initiatives and ecovillages, facilitating proliferation of similar collaborative projects.

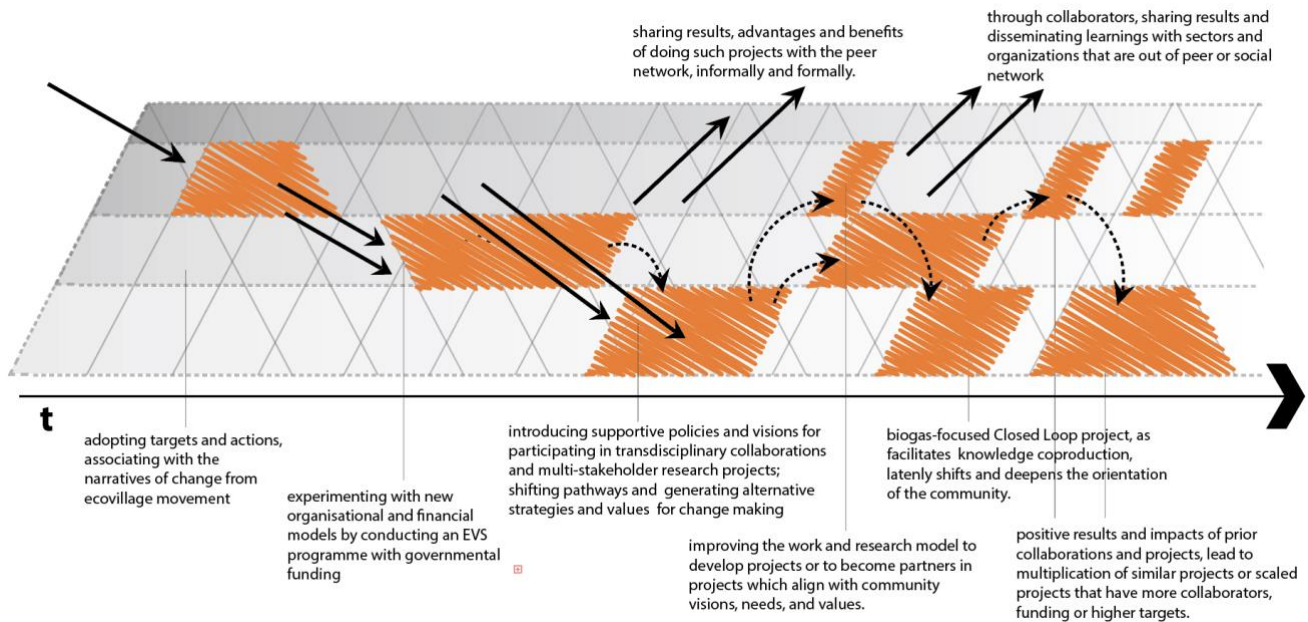


Figure 4: The design-based interactive learning processes of Suderbyn

DESIGN-BASED INTERACTIVE LEARNING PROCESSES, AND THEIR IMPACTS ON SUSTAINABILITY TRANSITIONS

Transitions encompass different depths of interactive learning processes which are, explicitly or implicitly, formally or informally, mediated by design. One of our major findings is that design continues to mediate interactive learning after the planning and implementation of interventions, with the evidences, experiences and reflections it generates. Prior to the implementation of interventions, while formulating design actions, interactive learning is facilitated through the collection, interpretation and synthesis of dispersed transition actions and solutions. After the implementation of interventions, design contributes to interactive learning processes and transitions dynamics by manifesting, exemplifying and disseminating developed transition actions and solutions. Therefore, transitions require interweaving learnings from previous transitions actions in ongoing design processes, but also require interweaving gained local learnings to emerging transitions actions elsewhere.

For instance, by developing new community strategies, organisational and financial tactics, Suderbyn exemplifies how community-led sustainability initiatives can actively contribute to building intersectoral, interdisciplinary, and international integrations, and, thus, to collective action. On one hand, the approach of Suderbyn has inspired similar community initiatives to explore new ways of working with organisations, institutions and funding agencies towards societal transformations and sustainability transitions. Suderbyn demonstrated how, by participating in transdisciplinary programmes, local communities can enhance their active roles in societal processes of change making. On the other hand, the active involvement of Suderbyn in transdisciplinary projects has

been illustrative for organisations, institutions and funding agencies of how change makers can be mobilized in knowledge co-creation and policy making.

Design-based interactive learning does also emerge in the aftermaths of design actions, once generated experiences, consequences, risks and tensions can much clearly be observed and understood. Multi-stakeholder collaborations of Understeshöjden revealed how settled local policy regulations and practices might conflict with alternative settlement systems and proposed design solutions that tend to be more sustainable. Despite the tensions that such conflicts generate, these instances are important to discover the structural limits and barriers to change and to build communication between different parties. Such dialogic interactions present evidence that bottom-up organisations and top-down steering mechanisms can supportively interact and contribute to generative change.

Another major finding is that levels of design-based learning are not mutually exclusive or separate from one other; on the contrary, they are fairly embedded and fluid. Different levels of design-based learning need to be dynamically managed and connected to deepen local transformations and expand sustainability transitions. For example, Tamera started its transitions at the level of design-based interactive learning for additive improvements, by implementing a developed water retention landscape model and water management approach. While experiencing transitions on its land, the community of Tamera reflected on the values, rationales and visions within which community actions were framed. These reflections flourished multi-faceted learning processes in Tamera, at multiple levels. It should be noted that reflective methods and mechanisms, which Tamera developed and practiced for enhancing

community cohesion, had a crucial role in facilitating and managing long-term learning processes of the community. Tamera's competence in reflective thinking and dialogic decision-making enabled deeper, open-ended and explorative learning processes to emerge during their transitions.

In short, design-based interactive learning from others for additive improvements might initially seem to deliver limited learning outcomes and to lead only incremental advancements. But, such as in Tamera, if learning is expanded and deepened through well managed reflective and interpretative processes, it might lead to transformative learning processes in the long-term, and pose major contributions to transitions. In other words, an initial design task and its corresponding level of learning do not bound future learning processes. Design tasks act as entry points, which later open up highly complex, interactive and multifaceted learning processes.

To sum up, depths and levels of interactive learning can be fluidly interrelated with one another, either when design is led by one community endeavour such as in Tamera, or by multiple stakeholders such as in Understanshöjden, or by transdisciplinary collaborations and international research consortiums such as in Suderbyn. It is difficult to make general and direct correlations between the organisational complexity that determines the size and scale of interactive networks, and the processes and depths of learning they might lead to. However, *netweaving by design* seems to have direct influences on the depths of learning that design processes might mediate. Hence, netweaving between multiple domains of action and knowledge, across time and space, seems to be an important (leadership) practice to develop new understandings and actions, to generate deeper learning and transformations, and to accelerate societal change and sustainability transitions.

CONCLUSIONS

Design is not a practice which develops its actions and solutions in isolation. As much as reflecting on what is being designed, designing includes analysing previous actions and solutions, and reflecting on how previously demonstrated features, processes, or approaches might be beneficially reinterpreted for developing novel actions and solutions. This is not different in the contexts of sustainability transitions. Undertaken either as a profession or as an everyday act, then, design is an interactive learning process.

In this paper, we looked into three cases that exhibit distinct approaches to designing sustainable community settlements and implementing systemic change. Presented cases have reinterpreted solutions and actions elsewhere, recontextualized and integrated them to formulate their particular settlement design and lifestyles, and to delineate their transition actions, worldviews and visions. Whichever their initial design approach and depth of

interpretation might be, continuous and collaborative reflection and action has been fundamental to deepen their design-based learning. Our findings signify that design-based learning might be attained internally at the level of community and lead to deepening in local transitions actions and ideas (Case 1); it might be accomplished in collaboration with different organisations and sectors, and lead to diffusion of transitions actions and ideas (Case 2); or it might be carried out through transdisciplinary consortiums and projects, and lead to building interactive networks of action and knowledge (Case 3). Despite their different learning journeys, studied cases and similar community initiatives commonly practice reflective methods, techniques and procedures to facilitate deep and continuous learning along with design processes, such as regular group discussions, collective decision making, community work and living. Reflective, collaborative and interactive approaches, thus, can further enhance design-based learning and accelerate sustainability transitions.

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