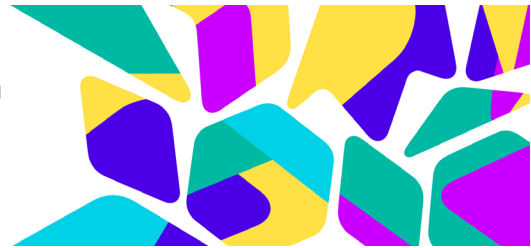




DRS2020
BRISBANE, 11–14 AUG
SYNERGY



Designerly Living Labs: Early-stage exploration of future sustainable concepts

Martin SJÖMAN^{a*}, Mia HESSELGREN^a

^a KTH School of Industrial Engineering and Management, KTH Royal Institute of Technology, Stockholm, Sweden

* Corresponding author e-mail: martsjo@kth.se

doi: <https://doi.org/10.21606/drs.2020.307>

Abstract: It is increasingly clear that the sustainability transitions needed to counter climate change depend on lifestyle changes. However, the task of encouraging a shift to more sustainable lifestyles is highly complex. This paper describes an emerging design research method to explore possible pathways towards such sustainable transitions. We describe a living labs-approach based on design practice, developed within Green Leap, a design and sustainability research group at KTH Royal Institute of Technology. We refer to this method as Designerly Living Labs. Based on empirical learnings from four such Living Labs we present eight key characteristics. We then highlight some important aspects that affect how future concepts and solutions can be explored in connection with the lifestyles and material contexts on which they depend. One finding is that ‘living the change’ may be needed to identify potential positive, and often social gains from more sustainable practices.

Keywords: living lab; practice-based design; sustainable transition; sustainable lifestyles

1. Introduction

Everyday routines and choices result from complex connections of lifestyles, identities and societal norms, as well as technologies, societal institutions and structures (see e.g. Jackson & Smith, 2018; Spaargaren & van Vliet, 2000). Transition to a more sustainable society requires a co-evolution of developments within all these fields (see e.g. Loorbach, 2010). In recent years, research has focused on understanding the underlying complexity of real-life contexts in which everyday choices are made, and more or less sustainable practices performed (Cairns et al., 2014; Shove et al., 2015). As Spaargaren has shown (2011), benefits of more sustainable solutions are not likely to be realized if those solutions are designed without considering related user practices.

Designing products, services or policies for sustainable outcomes requires “a higher order of inquiry” on the level of socio-technical systems (Scott et al., 2012). Similarly, drawing on results from the field of transition design research, Ceschin (2013) suggests that real-



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

life socio-technical experiments are needed to develop solutions that can lead to more sustainable ways of living. Experiments provide incubation for new concepts or niches, as well as ‘safe spaces’ for people to try out new behaviors (Sengers et al., 2016; Ceschin, 2014). In recent years, large investments have been made in developing settings for experimentation. Living Labs in various shapes have been described as promising setups (Liedtke et al., 2015; Marvin et al., 2018).

However, early stage exploration of sustainable concepts is difficult. Since this kind of concepts inherently challenge existing structures and lifestyles (Ceschin & Gaziulusoy, 2016), users and other stakeholders are not always willing to try them in the context of their daily lives and current operations. Scott et al. (2012) point out that such experiments require the ability to imagine and construct “entirely new complexes of behaviors, values and things”. As these three tend to co-evolve over time, asking people to try out future things today can be challenging, and especially if this is in conflict with their current values and practices.

In this paper, we describe an emerging approach to Designerly Living Labs as experimental settings for early stage exploration to inform the development of concepts that may enable more sustainable practices, and to explore potential use and integration of such concepts in society. This approach differs from common descriptions of living labs, and we argue that it is especially useful when there is not yet enough knowledge or stakeholder support to set up more targeted innovation infrastructures. We provide intermediate empirical findings from four implementations, aiming to answer the following research question:

What characterizes real-life socio-technical experiment setups that are suitable to inform early-stage development of future sustainable concepts?

Drawing on several different perspectives on how disrupting everyday practices may facilitate user experimentation, reflection and change, we develop guiding principles for planning Designerly Living Labs. We end this paper by providing some suggestions for how this method can be further developed.

2. Background

2.1 Practice-based and practice-oriented design research

Cross (2001) describes “designerly ways of knowing”, and how designers are known to approach problems in ways that differ from most other professions: Design is constructive, and designers create knowledge by *doing and making* in that they “bring ideas to life in ways that encourage speculation and ‘what if?’ questions.” (Coyne, 2005). By prototyping and visualizing things that do not yet exist, designers may engage in reflective dialogue with proposed objects or scenarios (Schön, 1983), thereby exploring and iteratively improving the situation at hand (Simon, 1996). It has been argued that such “designerly” approaches are well suited to tackle complex and open-ended questions (Coyne 2005; Buchanan, 1992), often referred to as ‘wicked problems’ (Rittel & Webber, 1973). In the face of complex societal issues and challenges, there has been rising interest in designerly approaches to

perform research, using terms such as Research through Design and Practice-Based Design Research (see e.g. Koskinen et al., 2012; Redström, 2018; Hesselgren, 2019).

Co-design can be described as a deliberate effort to enable co-creation (Sanders & Stappers, 2008) actively involving stakeholders as experts (Björgvinsson, Ehn, & Hillgren, 2010).

Design can facilitate co-creation by making physical artefacts that help users make sense of a situation and create ideas (Sanders & Stappers, 2014; Vaajakallio & Mattelmäki, 2014). However, user-centered and behavior-based design have been described as inadequate approaches to design for sustainable outcomes (Shove et al., 2007). Viewing human behavior as static or given, and therefore designing around human behavior is limited as this does not take into account the dynamics of how “design, production and consumption are embedded in and constitutive of contemporary routines and habits” (Watson & Shove, 2008, emphasis added). User needs depend on existing practices and norms, which can be influenced by design.

Many have argued that practice-oriented design holds opportunities for addressing sustainability issues (see e.g. Hesselgren, 2019; Kuijer, 2014; Shove & Watson, 2006).

Designerly Living Labs build on both these design research perspectives.

2.2 Current Living Labs typology and definitions

The term ‘living labs’ has come to include a collection of very different approaches. Described by Cheyne (2013) as “a nebulous term for a number of different approaches which do not share much in common other than they seek to develop knowledge through experimental, practical application”. Burbridge and Morrison (2017) define a living lab as “a real-life place for user co-creation of innovations in knowledge, products, services and infrastructures”.

The European network of Living Labs (EnoLL) also define living labs as a user co-creation approach, but highlights their role as collaborative platforms set “in real life communities and settings” or “open innovation environments attracting inwards investment”¹. In this view, the “lab” may be a city or a region, hosting a collaborative project to engage citizens and diverse stakeholders in creating and testing solutions to selected societal issues.

The SusLabNWE project (Sustainable Labs North-Western Europe) proposes Sustainable Living Labs (SLL) to engage academia, citizens and other stakeholders in co-creating solutions to reduce environmental impacts of our society. SLLs have this far centered on understanding how users appropriate technologies (especially ICT in the home) potentially enabling more sustainable lifestyles (van Timmeren & Keyson, 2016; Romero Herrera, 2016). SLLs place a strong focus on Product Service Systems (PSS) as a promising approach to reduce material consumption, and Liedtke et al. (2015) describe a three-stage method for developing such PSS. SLLs have a user-centered approach inspired by design, with an emphasis on users self-reporting their practices and taking some part in co-creating solutions (ibid., see also Romero Herrera, 2016a).

1 See <http://www.enoll.org/> Retrieved on 2019-10-18

In literature describing EnoLL and SusLabNWE, references are often made to niche-management (Markard et al., 2011; Schot & Geels, 2008) and socio-technical experiments, as described by Ceschin (2012, 2014). Living labs are described as open innovation infrastructures for such experiments. Similarly, in a recent anthology describing Urban Living Labs (ULL), these are defined as not being “a stand-alone set of interventions”. Instead, a city or region may use a portfolio of experiments to govern urban sustainability development (Marvin et al., 2018). Also, all these similar approaches often emphasize later stages of the innovation process, using terms such as “test facilities”, “pilots” and “upscaling” (ibid.).

In the design field, Scott et al. (2012) describe small-scale explorative living labs based on practice-oriented design and “enabling practitioners to challenge existing norms”. The proposed Designerly Living Labs share many similarities with this approach.

3. Designerly Living Labs

Our approach to setting up living labs has aimed to explore possible sustainable futures and communicate their potential. As described in section 1, when designing for sustainability, users’ behaviors and needs cannot be regarded in isolation, but must be explored in conjunction with lifestyles, as well as social and material contexts. All four living labs described in this article have aimed to explore different perspectives on sustainable mobility, but living labs to explore sustainable transitions in other fields have also been discussed and one such living lab is currently being developed.

The four Designerly Living Labs have all been based on interventions into people’s everyday lives. These interventions have been the introduction of possible future technologies, regulations or services, but not with the purpose to test or validate these innovations. Instead, we consider the interventions ‘provisional concepts’ that function as starting points for learning, and their detail design is not a central issue.

The four living labs have all been *designerly*, using practice-based design research approaches, and with research activities carried out by design practitioners.

3.1 Introducing the four Living Labs

LIVING LAB 1: “A CAR-FREE YEAR” (HENCEFORTH CAR-FREE)

In this living lab, three carefully selected and highly motivated households agreed to live without their car for one year. Instead, they were supported by the project to replace it with various rented Light Electric Vehicles (LEVs). All their travel was logged using a mobile phone app (Moves2) and the participants reflections were supported by printed travel diaries. The resulting travel data was visualized and used as trigger material in a series of in-depth interviews. The aim was to explore the transition to car-free lifestyles, in order to identify perceived barriers, as well as changed practices and possible value gained.

2 An activity tracking app developed by Facebook. Discontinued in July 2018.

LIVING LAB 2: “KTH LEV-POOL” (LEV-POOL)

This living lab was centered around offering a workplace pool-service using LEVs during six to nine months. Employees at two workplaces were recruited as “caretakers” which included leasing a LEV (a quadricycle) using it freely for travel in their spare time, as well as to and from work. The cost of the vehicle was subsidized by the project since colleagues could book and use the vehicles for travel during the workday. The living lab aimed to explore the new service concept and emerging practices from several perspectives, including caretakers, daytime users, employers and the pool service operator. One specific point of interest concerned whether the service would support daytime users to leave their own cars at home, and go to work by public transport.

LIVING LAB 3: “FUTURE PLAYING-RULES FOR EVERYDAY MOBILITY” (PLAYING-RULES)

Nine randomly selected participants were introduced to three types of economic incentives, designed to encourage more sustainable mobility choices. For six months, all their travels were logged using a mobile phone app (TravelVU3). Furthermore, the app functionality was also extended to present the actual, full cost of driving their private cars, after each ride. The incentives were designed so that more sustainable mobility choices would lead to savings, that were duly repaid using monthly bank transfers. The living lab aimed to trigger reflection and experimentation with changed travel practices, to explore underlying factors that influence mobility choices. Travel data was visualized and used to create scenarios to facilitate reflection.



Figure 1 From Living Lab 4. Work-hub participants from several different employers.

3 See <https://en.trivector.se/it-systems/travelvu/>

LIVING LAB 4: “WORK CLOSER AND TRAVEL SMARTER” (WORK CLOSER)

In this living lab, a local office space (work-hub) was set up in a suburban residential area and access was offered as a service to people with long daily commutes. This study is still ongoing at the time of writing, with 62 active participants. The work-hub was designed as a fully equipped office with 14 desks, 3 phone-booths and a meeting room. Booking of desks and rooms was made available in a web-app where the service is offered in combination with various accessibility and mobility services. The aim is to explore individual, social and professional aspects of working closer to home, as a way to reduce travel. Table 1 provides data about the living lab setups and research designs.

Table 1 Short facts about the research design in the four Designerly Living Labs.

Participants	Participant recruitment	Data-collection methods	Duration and place
“A Car-Free Year”			
3 families. In total 5 adults and 6 children.	Self-recruited through advertising on Facebook. 3 out of 72 applicants selected for motivation and contribution to heterogeneity of sample.	6 rounds of bi-monthly semi-structured in-depth interviews, travel-diaries used as trigger-material, travel-data collection app.	12 months 2014-2015. Stockholm, Sweden.
“KTH LEV-Pool”			
2 separate setups at two large Swedish employers, with a total 16 caretakers and approx. 70 active service users.	“Care-takers” were self-recruited using internal communication channels. The service was open for all employees and used by approx. 10 and 7 % of employees	2x2 rounds of semi-structured in-depth Interviews, 2x2 user and stakeholder workshops, facilitated production of user-created short-movies	2 x 12 months, in 2016 and 2017. Stockholm and Älmhult, Sweden.
“Future Playing-Rules for Everyday Mobility”			
9 individuals in 7 suburban households with different accessibility options. All owning a private car.	25 individuals randomly approached outside the main food-stores in selected suburbs. After mapping all travel for one test-month, a heterogenous group was selected.	2 short structured interviews to get basic data. 3 semi-structured in-depth Interviews using scenarios and other trigger materials. Use of travel-data collection app	1 + 6 months, 2018. Stockholm, Sweden.
“Work Closer, Travel Smarter”			
62 participants at the time of writing. All with full-time employment and relatively long commutes.	25 users self-recruited through advertising in a local Facebook-group. 42 were recruited through three large employers, offering the service to employees living near the work-hub.	2-3 rounds of participant Interviews. Data from travel-diaries and booking-app, Stakeholder interviews and 2 stakeholder workshops (planned).	18 months, 2019 - 2020. Stockholm, Sweden.

4. Main characteristics of Designerly Living Labs

In this section we present eight characteristics of the four Designerly Living Labs. Together, they describe the approach, when, why, and how it is used, and what separates it from the common, open-platform-type living lab approaches outlined in section 2.2.

4.1 Early-stage

We suggest Designerly Living Labs as experimental setups for early-stage exploration to inform the development of concepts or policies that may lead to more sustainable behaviors. All our living labs were designed as part of a longer chain of developments, and next steps have been planned. The labs have aimed at identifying issues for our own further research, generating input for the development of new service concepts, or been part of working towards scaling up the results.

4.2 Explorative

We propose that Designerly Living Labs are distinctly explorative. In line with Pierce et al. (2015) we found that as our interventions were not designed based on user needs, it was of little interest to evaluate them as such. We have not aimed to answer specific and well-defined questions. Instead, our living labs emphasize open exploration of pathways to change, and how new solutions may fit in the context of everyday practices.

4.3 Interventionist

We position Designerly Living Labs as an *interventionist* approach. The interventions were not solutions to be tested and validated, but instead served mainly to *trigger* responses – encouraging user experimentation and reflection. Trigger materials or probes are frequently used in design practice to elicit reflection and responses from users (Kankainen et al., 2012; Mattelmäki, 2008). The interventions served to explore future concepts and the participants' responses, as well as possibly unknown factors that affected people's ability to adapt or change their practices.

4.4 Holistic

The living labs' real-life settings means having to include (and deal with) the full complexity of everyday practicalities and the surrounding society. This makes a Designerly Living Lab inherently *holistic* (e.g. planning the work-hub in *Work Closer*, required handling as diverse issues as municipal policy, workplace regulation, activity-based offices, e-meeting and Wi-Fi technologies). Furthermore, all the labs have shared a stated ambition to explore not just user responses to a new phenomenon, but also business aspects, social consequences, side-effects and rebound.

4.5 Participatory

We argue that Designerly Living Labs are *participatory*. Participants were invited as “collaborators in discovering new meanings and values” (Pierce et al., 2015). Drawing on Brown, Reeves, and Sherwood’s (2011) conclusions from field trial methods, we consider the living lab participants not as passive subjects to be studied, but as “active investigators of their own practices”. This requires facilitating participant reflection, as well as securing an open dialogue and to act on participant feedback during the living lab.

4.6 Flexible and open-ended

Being an explorative approach, the research design of all four living labs was deliberately held mostly *open-ended*. We find that Designerly Living Labs must be *flexible*, as unexpected findings or practical problems have in several cases lead to changed research questions, design of new interventions or data-collection methods. This is supported by Russel’s (2010) claim that in open and critical inquiry, flexibility is required to let the study “remain open to revisions in response to new information”.

4.7 Close

The Designerly Living Labs have aimed to facilitate an open and trustful relation with the participants. For this, we found that a well-coordinated research team and personal level of communication was needed. The interventions also required many practical engagements with the participants, including the provision of physical resources, instructing and facilitating. The desired level of closeness would be difficult in an open innovation arena or infrastructure where many stakeholders take part. Furthermore, actively involving commercial stakeholders has proven difficult, as early-stage exploration of an issue rarely connects with their core operations.

4.8 Longitudinal

Finally, we propose Designerly Living Labs to be set up as longitudinal studies. In the common European practice of open-platform-type living labs, the research infrastructures are long-lived, but the experiments or demonstrations included are in many cases shorter. To allow iteration and still give new practices time to evolve and become part of everyday life, all four Designerly Living Labs have stretched 6 months or more. This has proved to be important, as in several cases distinct behavior changes have occurred after several months, and seasonal lifestyle changes have proven to have a major impact.

5. Learnings – how the Designerly Living Lab characteristics have emerged and been handled in practice

In this section we present findings regarding how the living labs unfolded. We expand upon some of the key characteristics and describe how variations in living lab methodologies may have influenced research results.

5.1 Interventionist approaches of disturbing and triggering

The interventions were designed to explore motivations, opportunities and barriers to change, by intervening in, or disturbing participants current practices. The idea of disturbing practices to facilitate experimentation and reflection is a recurring theme in many different research areas from psychology to experiments in social sciences (Kurz et al., 2015).

Within the design field there are many similar interventionist approaches: Sengers et al. (2005) describe Reflective Design as “[expanding] on reflection-in-action by not waiting for surprise to occur but intervening to create or stimulate these reflection triggers”, and ‘technological probes’ as using new technology “as a stimulus or probe for understanding larger social practices”. Junginger and Sangiorgis (2009) describe Service Designers as taking “[the role of] ‘enabler’, ‘facilitator’ and ‘connector’ for certain behaviors and configurations to emerge”.

In Social Practice Theories, Reckwitz (2002) describes disturbance strategies as generating potential “crises of routines” aiming to make people consciously reflect on their behaviors. Spaargaren (1997) describes ‘de-routinization’, as events that allow an individual to examine routine behaviors from a new perspective. Kuijer (2014) further develops the use of Social Practice Theories in design, and describes an elaborate method for the design of ‘proto-practices’. This essentially means facilitating the co-creation of alternative ways for “how things could work”. For Kuijer, proto-practices take a disturbing role: “a proto-practice should trigger non-everyday instances of improvisation or experimentation” (ibid.).

The interventions in our Designerly Living Labs took a similar role by enabling and triggering the participants to invent or imagine new practices. Hence, the interventions were not proto-practices per se, but enabled and facilitated proto-practices to emerge.

5.2 Different ways to balance strict and soft interventions

Our interventions were designed to trigger reflection and experimentation, challenging otherwise unconscious habits, norms and understandings. As described by Hesselgren et al., (2017) we found that the level of strictness of the interventions was a crucial factor for the level of experimentation.

In *Car-Free*, the participants agreed to have their cars removed for a full year. This very strict intervention left them with no choice but to adapt to the new situation. This required experimentation with new modes of travel, and in some cases changing or giving up travel-dependent practices. *Car-Free* participants also described finding it hard to go against the norm, e.g. when they received help from car-owning friends and could not reciprocate (Hesselgren et al., 2016). Strict interventions thus require large efforts from the participants. In the case of *Car-Free*, this was possible since the self-recruited families had strong, personal motivations to get rid of the car (ibid.). In *LEV-Pool*, the “caretakers” volunteered to take care of and use a LEV, which proved to be a very strict intervention. The vehicle had to be taken to work every day since colleagues may have booked it and left their private car at home. The *LEV-Pool* study duly identified this responsibility as a barrier to wider uptake (Sopjani

et al., 2020), and the concept was adjusted when the service concept was later scaled up commercially.

In contrast, *Playing-Rules* was designed to explore everyday mobility by use of soft, behavioral interventions. During the living lab, the participants were informed of the full cost of each car-trip, and offered discounts and monetary rewards for more sustainable travel choices. In this living lab it was deemed important that the participants did not volunteer for the study (e.g. not to recruit for engagement in environmental issues). Therefore, a more random recruitment method was selected (see table 1). Since these interventions were soft, and as travel is deeply integrated with other practices and lifestyles, very few changes were made. Two participants made limited attempts to obtain the discount offered for using public transport off-peak. However, without making more substantial changes to their daily routines, they could only avoid the peak hour either going to or from work, but not both ways. In this case, the price model constructed for this intervention resulted in very limited savings, and they returned to their previous routines. In *Playing-Rules*, it was also clear that alternative solutions that still included a car, such as carpools or buying a smaller car, were considered when other alternatives were not. Likely because alternatives that still involve a car would allow other practices such as shopping habits and kids activities, to remain unchanged. In *Playing-Rules*, soft interventions and little personal motivation to change current practices led to very limited experimentation. The participants still reflected deeply upon their travel-habits, misunderstandings of travel costs and possible alternatives, but there is likely potential to learn more about a projected future if the participants do experiment with new practices. In *Car-Free*, on the other hand; to accept a strict study design that required substantial changes to their practices, motivated forerunners had to be specifically recruited. (This was also the case in a similar study in Finland, see Laakso, 2017).

In *Work Closer*, the local work-hub was offered as a way to reduce travel. The participants were self-recruited to ensure that the service offering would be used. This intervention was also of a softer nature. Before joining the work-hub, participants typically worked from home one day a week. Interviews revealed that in many cases the only change to their weekly routine was to spend that day at the work-hub, leaving their daily practices largely unchanged. The new service would only be used to improve their comfort or working performance, without challenging workplace norms and policies, and likely with little effect on lifestyles. To counter this, we have tried a different method, provisionally called 'Challenges'. This means that a researcher, in a personal way, *asked* participants to try changing a current practice more substantially for a limited time-period, while taking notes of learnings such as problems encountered, or adaptations needed.

Results of the challenges are not yet fully analyzed, but one preliminary finding involves identifying *value gained*. In *Car-Free*, the participating families faced many challenges to cope without the car, but also found unexpected values, such as kids becoming more independent when learning to use public transport, or quality family-time on the train to the country house. In *Work Closer* such positive gains have been prominent, and participants have described having time and energy left after work, for visiting elderly parents or to go

out for a run. Many have mentioned reduced stress-levels and allowing for more time with their children as positive value gains. A preliminary finding from the Challenges is that some positive gains were connected to changing *surrounding* practices. We find that positive gains, like rebound effects, can result from unanticipated chains of changes and are therefore hard to foresee without actually 'living the change'.

5.3 Challenges building closeness in larger living labs

As previously discussed, Designerly Living Labs are participatory and as such require some efforts from the participants. In all four living labs many personal contacts were needed during recruitments and set-up. Through the labs we have strived to be open about the purpose of the research, thus intentionally involving the participants as co-researchers. Finally, in three of the living labs the number of participants was small. These factors allowed building closeness: a closer relation and a sense of responsibility that prompted the participants to perform their part diligently.

in *Work Closer*, the number of participants recruited was much larger than in the earlier labs, to ensure the work-hub would be populated. This in turn required using web-based application forms, resulting in less personal contacts during the recruitment process. Also, the research team was larger, and an employed host was added as a service layer between the work-hub users and the researchers.

There are indications that this has led to lower levels of involvement. In *Playing-rules*, the nine participants spent a lot of time correcting faulty data in the tracking app, and in two cases volunteered to take notes when it temporarily did not work. One participant could not take part after an app update did not support her old phone, but asked to re-join the study after having purchased a new phone. In *Work Closer*, seemingly smaller app-related difficulties caused several participants to voice irritation, and a few skipped using the service at all. Also, compared to the earlier three labs, it has been harder to book interviews, and fewer participants have taken the time to fill in a provided travel-diary in detail.

Limited involvement in larger groups is described as 'diffusion of responsibility' in psychology (Darley & Latane, 1968). For example, it has been shown that employees email responses are more helpful and elaborate when they are personally addressed (Barron & Yechiam, 2002).

We found that the participants' engagement and level of effort to fulfil expectations depend on a close relation with the researchers, and whether participants are addressed as individuals. Also, being addressed as co-researchers has led to higher levels of engagement and reflection, connecting the participatory and closeness characteristics of the labs.

5.4 Early-stage experiments encounter and identify structural barriers

Staging a possible future societal change or service concept is not a trivial matter. As described earlier, the real-life setting means having to deal with the complexity of the surrounding societal context, which makes Designerly Living Labs inherently holistic.

In most cases the interventions have required detailed planning and several months of practical arrangements. Setting up future service concepts such as *LEV-Pool* or *Work Closer* involved challenges similar to managing a start-up company. As described in the introduction, these services fit Ceschin's (2014) description of sustainable PSS as inherently radical innovations. As such, they encounter – and thereby identify – barriers on both cultural, corporate and regulative levels. For example, a corporate research partner in *Work Closer* needed a several months long internal process to allow employees to work at the hub. Workplace-safety regulations and union agreements were found to influence corporate policies for working from home, and were therefore investigated.

As our interventions have in several cases been perceived as radical concepts challenging existing structures it has often been hard to involve stakeholders' core operations. Instead, our early-stage exploration helped establish contacts, and often revealed barriers to more active engagement. We have found that corporate structures may limit the experimentation and learning processes needed to reach sustainability goals, which may be a barrier to reaching sustainable results (see e.g our earlier project, developing mobility services at a large Swedish corporation, Hesselgren et al., 2019).

6. Conclusions

The knowledge produced in Designerly Living Labs is rich in qualitative detail and shares some general characteristics. Prototypes in early phases of a design process are often designed to be generative rather than evaluative. As a 'fuzzy front end of research', we find that our living labs produce generative and actionable results, suitable to inform development in next steps, specifically mapping out barriers and opportunities. Also, we find that Designerly Living Labs tend to uncover many unanticipated issues, often reframing challenges and connecting to several different fields of research. This may require a multi-disciplinary research team to effectively analyze and evaluate the results.

As opposed to the approaches described by Scott et al. (2012) and Kuijer (2014), Designerly Living Labs do not aim to design proto-practices as such. Instead, new concepts and solutions are designed to *disturb*, thereby learning from the participants' reflection and experimentation. Still in line with this distinction, we see opportunities for more participatory approaches: In an upcoming living lab we consider asking participants to partake in envisioning and co-creating new concepts and solutions, with the specific aim of enabling more sustainable practices.

Hesselgren et al. (2017) have described soft interventions as adding, and strict interventions as taking away. Considering all four labs we find that other aspects need to be considered. The level of strictness must be balanced against the degree to which an intervention challenges current lifestyles and values, which is in turn connected to participant motivation and therefore, recruitment strategies. Structural interventions like the LEV-pool or the work-hub may enable new and more sustainable practices, but when the LEV-pool has a strict design requiring a caretaker to use it daily, the work-hub was merely an offer. In *Work Closer*,

to learn more, we have tried Challenges: simply asking participants to use the service more than they would otherwise have done.

All four living labs have been aimed at exploring more sustainable practices, which in many cases are at odds with current lifestyles and norms. Strict interventions have led to challenging experimentation with new practices – but also to unexpected positive, and often social value. This supports the view that pro-social and pro-environment lifestyle choices could be connected (Jackson & Smith, 2019). In *Playing-rules*, changes were never made, which may be a reason why the participants viewed more sustainable travel practices as merely limiting or inconvenient. Sustainable lifestyles are commonly associated with reducing, cutting down, and withdrawing from common behaviors (see e.g. Spaargaren, 2011). We believe Designerly Living Labs are well positioned to meet calls to explore and create richer images of sustainable lifestyles.

Acknowledgements: Although this paper refers to four living labs, the analysis and development of this paper was mainly founded by The Swedish Foundation for Strategic Environmental Research, Mistra, and the last two living labs were part of the Mistra SAMS research programme. Funding has also been provided by ITRL Integrated Research Lab at KTH, the Swedish Transport Administration, KTH Royal Institute of Technology and the Swedish National Road and Transport Research Institute VTI.

7. References

- Barron, G., & Yechiam, E. (2002). Private e-mail requests and the diffusion of responsibility. *Computers in Human Behavior*. [https://doi.org/10.1016/S0747-5632\(02\)00007-9](https://doi.org/10.1016/S0747-5632(02)00007-9)
- Björgvinsson, E., Ehn, P., & Hillgren, P. A. (2010). Participatory design and “democratizing innovation.” *ACM International Conference Proceeding Series*. <https://doi.org/10.1145/1900441.1900448>
- Brown, B., Reeves, S., & Sherwood, S. (2011). Into the wild: Challenges and opportunities for field trial methods. *Conference on Human Factors in Computing Systems - Proceedings*. <https://doi.org/10.1145/1978942.1979185>
- Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*. <https://doi.org/10.2307/1511637>
- Burbridge, M. (2017). If Living Labs are the Answer - What’s the Question? A Review of the Literature. *Procedia Engineering*. <https://doi.org/10.1016/j.proeng.2017.04.335>
- Cairns, S., Harmer, C., Hopkin, J., & Skippon, S. (2014). Sociological perspectives on travel and mobilities: A review. *Transportation Research Part A: Policy and Practice*. <https://doi.org/10.1016/j.tra.2014.01.010>
- Ceschin, F. (2013). Critical factors for implementing and diffusing sustainable product-Service systems: Insights from innovation studies and companies’ experiences. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2012.05.034>
- Ceschin, F. (2014). Sustainable Product-Service Systems Between Strategic Design and Transition Studies. In *Futures*. [https://doi.org/10.1016/S0016-3287\(99\)00098-1](https://doi.org/10.1016/S0016-3287(99)00098-1)
- Ceschin, F., & Gaziulusoy, I. (2016). Design for Sustainability: An Evolutionary Review. *DRS2016: Future-Focused Thinking*. <https://doi.org/10.21606/drs.2016.59>
- Cheyne, C. (2013). Cities and Low Carbon Transitions. *Urban Policy and Research*. <https://doi.org/10.1080/08111146.2013.845133>

- Coyne, R. (2005). Wicked problems revisited. *Design Studies*. <https://doi.org/10.1016/j.destud.2004.06.005>
- Cross, N. (2001). Designerly Ways of Knowing: Design Discipline Versus Design Science. *Design Issues*. <https://doi.org/10.1162/074793601750357196>
- Darley, J. M., & Latane, B. (1968). Bystander Intervention in Emergencies: Diffusion of Responsibility. *Journal of Personality and Social Psychology*. <https://doi.org/10.1037/h0025589>
- Hesselgren, M., & Hasselqvist, H. (2016). Giving car-free life a try: Designing seeds for changed practices. *Proceedings of DRS 2016, Design Research Society 50th Anniversary Conference*. Brighton, UK.
- Hesselgren, M., Hasselqvist, H., & Sopjani, L. (2017). Design strategies for exploring and bridging: Intersections of everyday life and decisionmaking for sustainability. *Conference Proceedings Of The Design Management Academy*, 189-205.
- Hesselgren, M. (2019) Designing for sustainability practices: RE-DO Design Doings, Strategies and Postures. *Doctoral thesis*. TRITA-ITM-AVL, 2019.
- Hesselgren, M., Sjöman, M., & Pernestål, A. (2019). Understanding user practices in mobility service systems: Results from studying large scale corporate MaaS in practice. *Travel Behaviour and Society*.
- Kankainen, A., Vaajakallio, K., Kantola, V., & Mattelmäki, T. (2012). Storytelling Group-a co-design method for service design. *Behaviour and Information Technology*. <https://doi.org/10.1080/0144929X.2011.563794>
- Koskinen, I., Zimmerman, J., Binder, T., Redström, J., & Wensveen, S. (2012). 5 - Field: How to Follow Design Through Society. *Design Research through Practice*. <https://doi.org/http://dx.doi.org/10.1016/B978-0-12-385502-2.00005-5>
- Kuijter, L. (2014). *Implications of Social Practice Theory for Sustainable Design*.
- Kurz, T., Gardner, B., Verplanken, B., & Abraham, C. (2015). Habitual behaviors or patterns of practice? Explaining and changing repetitive climate-relevant actions. *Wiley Interdisciplinary Reviews: Climate Change*. <https://doi.org/10.1002/wcc.327>
- Laakso, S. (2017). Giving up cars – The impact of a mobility experiment on carbon emissions and everyday routines. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2017.03.035>
- Liedtke, C., Baedeker, C., Hasselkuß, M., Rohn, H., & Grinewitschus, V. (2015). User-integrated innovation in Sustainable LivingLabs: An experimental infrastructure for researching and developing sustainable product service systems. *Journal of Cleaner Production*. <https://doi.org/10.1016/j.jclepro.2014.04.070>
- Loorbach, D. (2010). Transition management for sustainable development: A prescriptive, complexity-based governance framework. *Governance*, 23(1), 161–183. <https://doi.org/10.1111/j.1468-0491.2009.01471.x>
- Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. *Research Policy*. <https://doi.org/10.1016/j.respol.2012.02.013>
- Marvin, S., Bulkeley, H., Mai, L., McCormick, K., & Palgan, Y. V. (2018). Urban living labs: Experimenting with city futures. In *Urban Living Labs: Experimenting with City Futures*. <https://doi.org/10.4324/9781315230641>
- Mattelmäki, T. (2008). Probing for co-exploring. *CoDesign*, 4(1), 65–78. <https://doi.org/10.1080/15710880701875027>
- Pierce, J., Sengers, P., Hirsch, T., Jenkins, T., Gaver, W., & Disalvo, C. (2015). Expanding and refining design and criticality in HCI. *Conference on Human Factors in Computing Systems - Proceedings*. <https://doi.org/10.1145/2702123.2702438>

- Reckwitz, A. (2002). The status of the “material” in theories of culture: From “social structure” to “artefacts.” *Journal for the Theory of Social Behaviour*. <https://doi.org/10.1111/1468-5914.00183>
- Redström, J. (2018). Making Design Theory. In *Making Design Theory*. <https://doi.org/10.7551/mitpress/11160.001.0001>
- Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences*. <https://doi.org/10.1007/BF01405730>
- Romero Herrera, N. (2016a). *In-situ and mixed-design interventions* (Living Lab; D. V. Keyson, G. M. Morrison, C. Baedeker, & C. Liedtke, Eds.). https://doi.org/10.1007/978-3-319-33527-8_12
- Romero Herrera, N. (2016b). *The emergence of living lab methods* (Living Lab; D. V. Keyson, G. M. Morrison, C. Baedeker, & C. Liedtke, Eds.). https://doi.org/10.1007/978-3-319-33527-8_2
- Jackson, T. & Smith, C. (2018). Towards Sustainable Lifestyles (The Cambridge Handbook of Psychology and Economic Behaviour, pp 481-515, Lewis, A.)
- Russell, J. Y. (2010). A philosophical framework for an open and critical transdisciplinary inquiry. In *Tackling Wicked Problems: Through the Transdisciplinary Imagination*. <https://doi.org/10.4324/9781849776530>
- Sanders, E. B.-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign*. <https://doi.org/10.1080/15710880701875068>
- Sanders, E. B. N., & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three approaches to making in codesigning. *CoDesign*. <https://doi.org/10.1080/15710882.2014.888183>
- Schon, D. A. (1983). The Reflective Practitioner: How Professionals Think in Action (Arena). In *Basic Books*.
- Schot, J., & Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technology Analysis and Strategic Management*. <https://doi.org/10.1080/09537320802292651>
- Scott, K., Bakker, C., & Quist, J. (2012). Designing change by living change. *Design Studies*. <https://doi.org/10.1016/j.destud.2011.08.002>
- Sengers, F., Berkhout, F., Wieczorek, A. J., & Raven, R. (2016). Experiments in the city: Unpacking notions of experimentation for sustainability. *The Experimental City*.
- Sengers, P., Boehner, K., David, S., & Kaye, J. (2005). Reflective design. *Critical Computing - Between Sense and Sensibility - Proceedings of the 4th Decennial Aarhus Conference*. <https://doi.org/10.1145/1094562.1094569>
- Shove, E. A., Hand, M., Ingram, J., & Watson, M. (2007). *The Design of Everyday Life*. Berg.
- Shove, E.; Watson, M., (2006). Practice oriented product design manifesto. Leaflet [online]; at: <http://www.lancaster.ac.uk/fass/projects/dnc/wkshpjul06/popd%20manifesto.pdf> (retrieved 12 Nov 2019).
- Shove, E., Watson, M., & Spurling, N. (2015). Conceptualizing connections: Energy demand, infrastructures and social practices. *European Journal of Social Theory*. <https://doi.org/10.1177/1368431015579964>
- Simon, H. A. (1996). The sciences of the artificial. In *Cambridge, MA*. [https://doi.org/10.1016/S0898-1221\(97\)82941-0](https://doi.org/10.1016/S0898-1221(97)82941-0)
- Sopjani, L., Janhager Stier, J., Hesselgren, M., Ritzén, S. (2020) Shared mobility services versus private car: Implications of changes in everyday life. *Journal of Cleaner Production*, 259. <https://doi.org/10.1016/j.jclepro.2020.120845>
- Spaargaren, G. (1997). *The ecological modernization of production and consumption: essays in environmental sociology*. Wageningen: Landbouwniversiteit Wageningen.

- Spaargaren, Gert. (2011). Theories of practices: Agency, technology, and culture: Exploring the relevance of practice theories for the governance of sustainable consumption practices in the new world-order. *Global Environmental Change*, 21(3), 813–822. <https://doi.org/10.1016/j.gloenvcha.2011.03.010>
- Spaargaren, G., & Van Vliet, B. (2014). Lifestyles, consumption and the environment: The ecological modernisation of domestic consumption. In *Ecological Modernisation Around the World: Perspectives and Critical Debates*. <https://doi.org/10.1080/09644010008414512>
- Vaajakallio, K., & Mattelmäki, T. (2014). Design games in codesign: As a tool, a mindset and a structure. *CoDesign*. <https://doi.org/10.1080/15710882.2014.881886>
- van Timmeren, A., & Keyson, D. V. (2016). *Towards sustainable living* (Living Lab; D. V. Keyson, G. M. Morrison, C. Baedeker, & C. Liedtke, Eds.). https://doi.org/10.1007/978-3-319-33527-8_1
- Watson, M., & Shove, E. (2008). Product, competence, project and practice: DIY and the dynamics of craft consumption. *Journal of Consumer Culture*. <https://doi.org/10.1177/1469540507085726>

About the Authors:

Martin Sjöman holds an MFA in Industrial Design and is currently a PhD candidate and design lecturer at KTH Royal Institute of technology. Martin's research has a focus on design as a catalyst for radical innovation and interdisciplinary collaboration.

Mia Hesselgren is a postdoctoral researcher in design for sustainable mobility. Her research is transdisciplinary and uses collaborative design methods to engage with other research disciplines as well as with citizens, stakeholders from public and private sectors, and civil society.