Chapter 8

Cocreating SDGs Through Experimentation and Prototyping

Abstract

This chapter goes into more detail about how experimentation can be used as a strategy of innovation and how cocreation can support this strategy. It first draws out lessons from research on sustainability transitions, design thinking, and grassroots innovation for the development of experimentation. Prototyping is found to be a particularly valuable strategy for cocreating experimentation because it allows stakeholders to develop low-cost designs and to quickly improve them based on group feedback. A range of prototyping strategies are available to cocreators, ranging from mock ups to pilot projects. Finally, the chapter examines how to support, scale and diffuse cocreated experiments.

Keywords: Experimentation; prototypes; sustainability transitions; design thinking; grassroots innovation; diffusion

Introducing Sustainability Experimentation

The last chapter made the case for the importance of innovation to advance Agenda 2030. In this chapter, we focus more specifically on the role of experimentation as a strategy of innovation and the way that cocreation can support this strategy. Experimentation, and in particular prototyping, is important at the stage that lies between idea generation and full-scale roll-out of solutions. Once new ideas have been scrutinized, refined, and integrated into new potential solutions based on a clear problem diagnosis and a tentative theory of change, it is time to develop and test one or more prototypes in practice in order to see whether they work as expected and produce the desired outcomes when tried out in small-scale pilots and experiments.

Co-Creation for Sustainability, 105–119

doi:10.1108/978-1-80043-798-220220008

Many, and perhaps most, sustainability experiments are technical or natural in the sense that they aim to test new technologies or new kinds of crops. However, not all experiments are simply technical or natural, and there are an increasing number experiments with policy, administration, and governance as well. Experiments may also be "socio-technical" in that the experiment concerns how a technology functions in a particular social environment (Ceschin, 2014).

There are many types of experiments and they can be used for different purposes. Perhaps the best-known type of experiment is the randomized controlled trial (RCT), which is generally used to scientifically establish whether an intervention causes a particular outcome. For example, does this policy intervention (e.g., a new program, service, or regulation) demonstrably produce the effect that it purports to produce (e.g., reduction in poverty, improvements in agricultural productivity, or more efficient water use)? RCTs are widely used in the field of development and in many areas of sustainability research (Ansell & Bartenberger, 2016; de Souza Leão & Eyal, 2019).

Another broad class of experiments – which for convenience we will label *generative experiments* (Ansell & Bartenberger, 2016) – is less about establishing causality and more about *developing* workable problem solutions in particular contexts. This class of experiments is known under a variety of specific labels, such as design experiments, socio-technical experiments, and pilot projects. While these experiments may also be concerned about establishing the effect of a particular intervention, they typically sacrifice some "control" over experimental conditions in order to ensure that the experiment works within a specific real world context.

RCTs and generative experiments are not mutually exclusive, and they may work together in various hybrid styles. However, it is useful to know that they tend to draw their inspiration from different disciplines. Whereas RCTs draw much of their inspiration from clinical trials of medicines, generative experiments tend to draw their inspiration from the field of design. In this chapter, we are primarily focused on generative experiments rather than on RCTs.

The concept of prototyping is a design strategy that stresses that solutions to problems can be achieved at lower cost and with lower risk by developing and iteratively refining model solutions. The logic of prototyping incorporates several different principles, and especially the idea that it is useful to put solutions to the test before investing a great deal in full-scale implementation. By starting out with a low-cost or limited prototype, failure is not as costly and opportunities for learning are enhanced. Prototyping is the opposite of a one-shot, full-scale solution – it requires multiple small iterations of improvement that breakdown the barrier between innovative designs and implementation. As a strategy of problem-solving, prototyping is tolerant of "failing cheap, early and often."

Experiments and prototyping may be successfully organized in a relatively top-down technocratic fashion by experts and government. However, research on sustainability has also begun to recognize the value of more bottom-up strategies of "distributed" or "societal" experimentation, which often taps into the local knowledge of social groups (van den Heiligenberg, Heimeriks, Hekkert, & van Oort, 2017). For example, sustainable sanitation innovations promoted in a

top-down fashion have often run into resistance and have not encouraged social learning. By contrast, sustainable sanitation organized or managed by end users has led to cumulative refinement, with the lessons learned by early adopters contributing to improved sanitation systems over time (Lopes, Fam, & Williams, 2012).

Cocreation offers one version of how a more bottom-up, distributed, or societal experimentation may be advanced. Experiments can be "co-designed" through partnerships of government, community, and Universities. For example, in Kampala city, Uganda, representatives of the local parish, the city authority, Makerere University and neighborhood associations worked together to develop charcoal briquettes and bio-gas from household waste (Buyana, 2019). Community-based experimentation is increasingly seen as critical for sustainability and cities, in particular, have been recognized as important in fostering sustainability experimentation (Bulkeley & Castán Broto, 2013; Wolfram, 2015).

Cocreated experiments provide opportunities not just to learn about the effects of an intervention, but also about how to bring together actors to imagine new ways of working and living together (Von Wirth, Fuenfschilling, Frantzeskaki, & Coenen, 2019). Such experiments, for example, can foster the development of collaborative communities that encourage more ambitious efforts at sustainability, as suggested by urban resilience experiments in Dublin (Crowe, Foley, & Collier, 2016). By creating supportive communities around sustainability goals, cocreated experiments also have a potential to reinforce behavioral change in ways that can support sustainability (Ceschin, 2014).

Thus, experiments may facilitate more ambitious efforts at sustainability by supporting innovation, producing knowledge, and building vision and commitment for more sustainable ways of life. They can demonstrate the viability of certain strategies or innovations, and because they tend to be circumscribed in scope, the public may be more accepting of their failure. Cocreated experimentation can mobilize local knowledge and build community support and behavioral change for sustainability innovations.

Further exploration of the intersection between cocreation and sustainability experimentation can draw inspiration from existing research on sustainability transitions, design thinking, and grassroots innovation.

Sustainability Transitions

Experimentation has been a central concept in research on sustainability transitions (Raven et al., 2017) because such transitions depend on demonstrating the viability of more sustainable pathways. In this research tradition, unsustainable technological regimes are conceived of as being self-reinforcing and very difficult to change even if there is social and political support for change. In the language of sustainability transition research, these regimes are "locked in" by technological investments, professional training, political interests, and social conditions. Thus, reforming such regimes to enhance their sustainability is an uphill struggle, if not a mission impossible. The sustainability transitions literature has

emphasized that reform can be facilitated by allowing for experimentation in protected niches at the margins of existing regimes.

Transitions experiments are typically conceived of as "real world" experiments – that is, they take place in actual contexts rather than being confined to artificial laboratory settings (Nevens, Frantzeskaki, Gorissen, & Loorbach, 2013). A key point about these experiments is that they not only aim to learn about the socio-technical innovation in question but also seek to create – or at least to explore – the political and social change necessary to move toward a more sustainable future (Ceschin, 2014).

Sustainability Transition Experiment

In 2011, a sustainability transition experiment was launched in the poor neighborhood of Carnisse in Rotterdam. This neighborhood had been the target of many national and local programs to improve housing, security and education, etc., but the community's problems appeared resistant to change. To overcome the deadlock, the city government adopted an experimental approach and formed the Resilience Lab to promote a range of activities, including urban gardening, educational coaching, and assistance with child rearing. It also sought to mobilize residents to envision a sustainable future for Carnisse. A key condition for success was that the Resilience Lab did not try to transform the neighborhood's governance regime but rather sought to stimulate residents' awareness, skills, and solidarity, thus enabling them to advance minor regime shifts in relation to particular issues and showcase alternative ways of doing things in practice (Frantzeskaki, Van Steenbergen, & Stedman, 2018).

Design Thinking

It has been argued that design thinking offers an approach to address the SDGs, and in particular to integrate different SDGs in an effort to promote sustainability (Maher, Maher, Mann, & McAlpine, 2018). Research finds that technical sustainability experimentation that does not involve users is often missing an opportunity to gain valuable design information (Hoogma, Kemp, Schot, & Truffer, 2002). However, design ideas are not merely *tested* on end users or stakeholders, but codesigned with them (Liedtke, Baedeker, Hasselkuß, Rohn, & Grinewitschus, 2015). For example, the SusHous Project sought to use visioning exercises to work with households in five European countries to imagine new ways that traditional household practices could be reorganized to enhance sustainability (Brown, Vergragt, Green, & Berchicci, 2003). Role-playing experiments and mock ups have been used to codesign buildings with inhabitants with the goal of reducing energy consumption (Guerra-Santin et al., 2017).

Although codesign of prototypes for sustainable products and services is more common than it is for policy (Kimbell & Bailey, 2017), public sector innovation labs have also begun using design thinking (McGann, Blomkamp, & Lewis, 2018). Policies operating on a specific scale can be understood as prototypes for extension of particular policy instruments to other sectors and domains. For example, acid rain policy in the United States was a prototype of an emissions trading policy instrument that has since been widely used (Voß, 2007).

A strategic approach to design thinking will consider the needs and demands that may arise during different different stages of the innovation process. The Cape Town Sustainable Mobility project, for example, used a design approach not only to develop a sustainable mobility system for the disabled and elderly, but also to consider how to implement and scale up the project (Ceschin, 2014). This broader strategic approach provided an impetus for a codesign approach that brought together a range of actors who might be important during implementation. The Cape Town project involved actors along the entire value chain from producers to users, as well those groups who ultimately had a role in authorizing the project.

The Six Phases of Design Thinking

(1) *Observation*: problems, challenges, and behaviors are investigated from the perspective of end users and other stakeholders
(2) *Ideation*: ideas for solving problems are brainstormed and evaluated based on the needs and desires of those who will use the new design
(3) *Rapid prototyping*: the future is made concrete by quickly producing tangible models of promising solutions
(4) *User feedback*: end users and other downstream stakeholders are invited to comment on and evaluate the prototype and validate its usefulness
(5) *Iteration*: based on user feedback, the prototype is redesigned to promote desirable outcomes
(6) *Implementation*: the validated prototype is implemented at full-scale with continued monitoring of user feedback.

Source: See ideo.com

Grassroots Innovation

The grassroots innovation perspective reminds that us that bottom-up experimentation often takes the form of a loosely-structured social movements or grassroots networks and that experimentation arises out of a political critique of established practices (Grabs, Langen, Maschkowski, & Schäpke, 2016; Smith, Hargreaves, Hielscher, Martiskainen, & Seyfang, 2016). Building these networks is often a key element of innovation strategy (Hossain, 2016). Often these networks build on specific local or national traditions, mobilize existing skill sets, and

reflect a range of motivations for participating. Although these networks often start out informally, they often need to be institutionalized to a degree to develop long-term commitment and financial resources.

Experiments from grassroots mobilization may have a range of outcomes, such as fostering political critique, mobilizing communities, and advancing justice, which are not necessarily well accounted for by more conventional ways of thinking of experimentation. For example, the motivation to experiment may arise out of a political critique of established practices and a desire to identify or create more inclusive or socially just practices (Smith et al., 2016). In their conduct, grassroots experiments can illuminate existing barriers to more change and, in so doing, generate useful critical knowledge. Grassroot innovation may be particularly relevant to the SDGs because they help to ensure that innovative solutions will leave no one behind.

Grassroots innovation typically arises from civic rather than government or private sector initiatives. One approach to grassroots innovation has been dubbed "Do-It-Together" because it calls for networks of individuals who seek to innovate without central direction. Research suggests that this mode of innovation, however, can be facilitated by providing space and social and financial support for experimentation (Jaeger-Erben, Rückert-John, & Schäfer, 2015). Cocreation is an opportunity for bringing together grassroots innovation with government support for sustainability transitions.

Grassroots Innovation

UNLEASH is a global SDG cocreation network that has grown organically since its inception in 2017. By using the innovative mindset of young people and partner talents with leading companies, research institutions, foundations, non-profits, and investors, UNLEASH has organized innovation events covering more than 4,000 young people from more than 100 countries in Denmark (2017), Singapore (2018), Shenzhen (2019) and a series of digital hacks in 2020 and 2021. The 2022 UNLEASH Global Innovation Lab is held in the state of Karnataka, India.

UNLEASH sources global youth talent to engage in structured innovation events with the yearly Global Innovation Lab running over 5 days. Using the SDG Framework, local and global insights ignite new discussions and unlock new perspectives on the SDGs, followed by a problem framing and rapid ideation phase. Typically after 48 hours, the participants develop potential solutions facilitated by business model innovation and cocreation, pitching them to one or more panels of judges.

Through this structured selection process, the best solutions receive support for implementation by connecting the UNLEASH talent to capital, corporate partners, technology, and local support networks.

What began as stand-alone global events have now grown into sophisticated eco-systems of intertwined UNLEASH communities. The core is the UNLEASH alumni network, supported by UNLEASH Plus, which is a global incubation program for solutions aiming to have a positive SDG impact and UNLEASH Circle, which is the gateway to funding for promising social enterprises. As a new community initiative, UNLEASH is establishing an Ambassador Programme with a view to bringing community changemakers into a 12 month capacity development and network program. The intended outcome is to increase community leadership for SDG action and advocacy.

The key to success has been UNLEASH's ability to maintain diversity and use UNLEASH fellowships to secure equal access of youth participants to events. Furthermore, formal application processes open to everyone have secured high standards and fairness across activities and given the UNLEASH community a sense of being part of something meaningful.

A key lesson for UNLEASH is that "intrapreneurs" who move ideas forward within existing organizations or companies are just as important as entrepreneurs who create new businesses. However, experience shows that both approaches benefit significantly from an understanding of the cocreation process and the value of perseverance.

Experimentation as a Change Strategy

Community-based innovation and experimentation is critical for advancing sustainability. However, innovation and experimentation can be socially, politically, environmentally, and economically risky. Some research suggests that starting by envisioning comprehensive radical change is problematic because it tends to set the bar too high and that more incremental progress is more realistic, though these small changes do not necessary congeal to produce a major shift. Both radical and incremental change strategies may be hampered by the current regime (the institutions, people and practices associated with the dominant technology), which will often block or hinder progress toward sustainability. Therefore, in any serious change effort, there are likely to be conflicts between those who seek change and those who would preserve the current regime (Wittmayer, van Steenbergen, Rok, & Roorda, 2016).

One way to thread the needle between radical and incremental change is to build on existing efforts at experimentation in ways that magnify or multiply their effects. A Finnish project on residential energy use targeted working with individuals and communities that had already taken some initiative toward experimenting with household energy use and piggybacked on a five-city bottom-up initiative to reduce carbon emissions (Jalas et al., 2017). This project also fostered various mechanisms of peer support for innovation and sought to enhance the collective agency of many different households. These efforts helped to magnify the impact of this project.

A valuable strategy for managing the tensions inherent in sustainability efforts is prototyping. A prototype is typically a low cost, provisional effort to evaluate how well a proposed idea or solution will work in practice. The testing of prototypes for new and promising SDG solutions often requires iterative rounds of trial, assessment and adjustment before the performance and impact of the new solution is satisfactory and it is ready to be up-scaled. Successful testing of prototypes helps to bridge the gulf between decision-making and implementation. Big sustainability initiatives can be disaggregated into smaller design experiments that help manage the risk associated with implementation of large or bold policy or program changes.

Prototyping helps to make issues concrete and to surface issues that might otherwise not be voiced or even recognized, thus allowing perspectives and assumptions to be tested (Sanders & Stappers, 2014). "Quick and dirty" or "low fidelity" prototypes may provide enough information to identify issues and opportunities that can be reformed, which can then be refined by providing more specificity and working out problems and tradeoffs. For example, a project that ultimately culminated in the development of a MotionMap to provide information on multimodal urban travel began as noninteractive maps with colors indicating the busyness of certain urban areas. These maps were then converted into simple interactive maps and their functionality was tested. Eventually, the refined prototype came to focus on facilitating multi-modal travel (Valdez, Cook, Langendahl, Roby, & Potter, 2018).

As summarized in Table 8.1 below, prototyping may take several different forms in developing SDG solutions. At one end of the prototyping spectrum, prototypes may simply take the form of brainstorming exercises where participants seek to concretize their ideas in the form of workable agendas. In this case, prototyping may utilize pen-and-paper visualizations, scenarios or thought experiments, with continuous input from participants representing different interests and perspectives. Physical or computerized simulation models or mockups of proposed solutions are a somewhat more ambitious form of prototyping, allowing the representation of the full-scale solution at lower cost. A still more ambitious strategy includes pilot projects, which may produce a trial solution in a single village or region or may produce a limited or scaled-down, but still operational, version of the full-scale solution. Finally, prototyping may entail conducting design experiments with a full-scale solution in order to see how they can best be rolled out or implemented.

Thus, prototyping varies in terms of how closely the prototypes approximate full-scale roll-outs and, as a result, they entail tradeoffs for cocreators. Pen-and-paper versions of prototyping are inexpensive and rapidly conducted and allow many iterations and rapid learning, but they are also less realistic than full-scale versions. Local cocreation processes may consider employing multiple strategies, beginning with low cost, rapid iteration prototyping, and gradually working up to more costly but more realistic prototypes. Virtual or visual prototyping can help participants to identify sustainable strategies (Papahristou & Bilalis, 2017).

Scenarios are "coherent, internally consistent, and plausible descriptions of potential future trajectories of a system" (Pereira, Sitas, Ravera, Jimenez-Aceituno,

Table 8.1. Modes of Prototyping.

Modes of Prototyping	**Description**
Scenario planning	Scenario planning may use traditional strategic planning and forecasting techniques, but may also draw on more arts-based narrative and performance strategies
Paper prototyping	Using pen and paper to create low-cost, low-fidelity prototypes
Virtualization	Computer-aided design allows the creation of virtual prototypes useful for developing sustainability
Serious games	Serious games have instrumental purposes but enlist playful exploration, learning, and experimentation in a safe space. Both the codesign of the game and the playing of the game can be understood to be a type of prototying
Mock-ups	Mock-ups provide an approximate visual and physical representation of a design solution
Simulation models	Simulation models use various dynamic modeling techniques and can be used to facilitate rapid prototyping
Pilot projects	Pilot projects are attempts to learn about an idea or innovation by deploying it to a limited extent or in a favorable field setting

& Merrie, 2019, p. 2). Arts-based scenario development utilizing performance (e.g., dance or theater) or story-telling may help to mobilize imagination and draw out emotions in cocreating future scenarios, eliciting collective creative responses that allay power differences among stakeholders and free their imagination to better address uncertainty (Pereira et al., 2019). Scenarios and serious games are particularly good for representing anticipatory future-oriented knowledge and for capturing the systemic nature of sustainability challenges (Gugerell & Zuidema, 2017; Iwaniec et al., 2020). Such strategies offer many possibilities for exploring alternative sustainability strategies. A serious game, for example, was used to help citizens of Kyoto, Japan to imagine a more sustainable local food system and to develop relevant policy to bring it about (Schröder et al., 2019).

Full mock-ups or pilot projects are even more fully developed prototypes that may provide high quality information, demonstrate proof-of-concept, aid in the investigation of the real-world viability of a policy, program, product, or service, and provide a basis for further advocacy (Vreugdenhil, Slinger, Thissen, & Rault, 2010). In the Danish city of Copenhagen, for example, a prototype waste recycling collection point that would also enhance the livability of the city was introduced for a three-month period at a particular urban square (Munthe-Kaas & Hoffmann, 2017). The prototype demonstrated the possibility of combining

recycling and recreation, but also gave the community an opportunity to engage with the prototype. The result was greater political and economic support for a longer-term implementation.

Prototyping is a way to "fail early" but "succeed sooner" (Hillgren, Seravalli, & Emilson, 2011). One strategy of rapid prototyping has been called the "best bet prototype" (Bossink, 2020). It begins with a research team crafting a new sustainable technology prototype, which is then combined with proven technology. This prototype is then trialed with stakeholders and users, who help identify its potential (Bossink, 2020).

Cocreating Experiments and Prototypes

Studies of sustainability transitions find that focusing too narrowly on technical experimentation alone can ultimately hinder change. For example, a large scale experiment with the use of battery-powered electrical vehicles on the German Island of Rügen created limited networks and limited learning that went beyond technical knowledge (Hoogma et al., 2002). By contrast, an experiment with lightweight electric vehicles in the Swiss town of Mendrisio adopted a wider sociotechnical approach that created broader social support for the innovation. Ultimately, the Swiss approach proved to be more successful in fostering significant change.

Engaging wider communities in experimentation is often a way of gaining valuable information and building support. Design theory emphasizes the importance of understanding design from the perspective of the users who will ultimately experience it. Empathy with the perspective of the user enhances early learning about the downstream effects and consequences of design. From a design perspective, this learning should be brought upstream and incorporated directly into the design process itself. Prototyping can then enhance this social input. Through multiple design iterations, prototyping exploits rapid, direct, and continuous user feedback into design improvements. From a perspective of cocreating the SDGs, users include all the relevant and affected actors who must live with the outcome of problem-solving strategies.

Prototyping can be conceived of as a process of cocreation that engages stakeholders in iteratively refining ideas, innovations, and solutions. A wonderful example is the Lorena cook stove, which was designed to provide cooking and heating with less firewood, preserving forests and reducing a family's time and income spent collecting firewood. Prototypes of the cook stove were co-designed with rural Guatemalans and the innovation was then diffused throughout Guatemala by teams who would travel to a rural village and construct a prototype stove that others could then imitate. As the prototype stove design diffused, its design continued to be refined. The ultimate design of the stove consumed 50% less wood than the traditional cooking method (Murphy, McBean, & Farahbakhsh, 2009).

Prototypes have the value of providing stakeholders with a concrete reference that helps them visualize the final outcomes (Akterujjaman, Mulder, & Kievit,

2020). They can become objects of conversation, bringing people together in discussions around the prototype (Ceschin, 2014). One innovative Swiss project on soil protection filmed farmers sharing their local knowledge about soil conservation. The films became a focal point for a network of farmers concerned about soil conservation and built a sense of ownership over the program (Schneider, Fry, Ledermann, & Rist, 2009).

As focal points of cocreation processes, prototypes can facilitate the alignment of communication and interests (Crona & Parker, 2012). They are also political in the sense that they can be used to build support for particular ideas, solutions or strategies and they can become a form of social glue that holds communities together (Henderson, 1995, p. 294). Participatory approaches to prototyping can also profit from codesigned evaluation strategies and indicators, a practice already developed in the field of sustainable agriculture (Le Bellec, Rajaud, Ozier-Lafontaine, Bockstaller, & Malezieux, 2012). A value of this participatory approach – which should go beyond just end users – is that it builds support for and ownership of the prototype. Fig. 8.1 summarizes the value of cocreated prototyping.

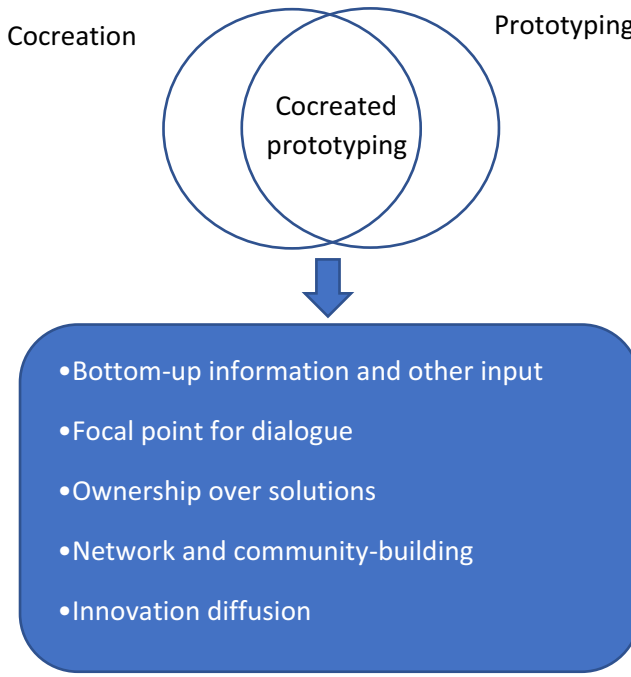

Fig. 8.1. The Value of Cocreated Prototypes.

Supporting Successful Cocreated Experimentation

The degree and quality of user participation can often make or break cocreated experimentation (van den Heiligenberg et al., 2017) and stakeholders may have a range of motives for participating in innovation and experimentation (Ornetzeder & Rohracher, 2013). One lesson of prior efforts is that participation is not necessarily itself an incentive. In other words, stakeholders rarely participate simply because there is an opportunity to cocreate or to experiment. Goals that are ambitious enough to motivate stakeholders to want to participate have been found to be important in successful grassroots innovation (Antikainen, Alhola, & Jääskeläinen, 2017). Like any other form of collective action, cocreated experimentation must be attentive to the types of motivation that participants have to participate (Leino & Puumala, 2020).

Cocreated experimentation must also be sensitive to the distribution of costs and benefits that might hamper the implementation of experiments (Ananda, McFarlane, & Loh, 2020). Careful selection of participants can help to dampen negative power dynamics and avoid excluding marginalized groups (Luederitz et al., 2017). Codesign works best when the design process is facilitated and scaffolded, when learning is facilitated and when cocreators have adequate time to conduct their experiments (Antikainen et al., 2017; Moallemi et al., 2020; Waardenburg, Groenleer, & De Jong, 2020).

Scaling up implementation of the SDGs has been seen as a key challenge (Nhamo & Mjimba, 2020) but a common criticism of sustainability experiments is that many good and successful innovations remain local, one-off experiments that fail to scale or diffuse beyond a single limited and often temporary effort. The informality of local experiments may limit their scaling or diffusion (Johannessen et al., 2019). Evaluation of Global Environmental Facility (GEF) projects indicates that only about a quarter to a third of projects are scaled or diffused beyond their initial context (Uitto & Naidoo, 2019).

This outcome may be entirely appropriate in situations where the goal is to achieve ad hoc solutions to context-specific problems. However, most sustainability problems extend well beyond a single context and successful experiments often provide leverage for more ambitious sustainability efforts (Uitto & Naidoo, 2019). Local experiments also embody cumulative learning that might be relevant for other localities, governing levels, or groups. In such cases, successful local sustainability experiments might themselves be considered prototypes to be subsequently scaled up or diffused. Scaling and diffusion of experiments, however, comes at a risk, because the implicit or explicit contextual conditions that made a sustainability experiment successful in one place or time may not hold in other contexts. Scaling and diffusion processes can thus be understood to be prototyping processes that must pay careful attention to the underlying conditions that produce success or failure.

Pilot projects may not diffuse because the lessons drawn from them are highly localized or contextual and not easily transferable to other sites (Vreugdenhil

et al., 2010). One important lesson of previous pilot projects is that a diffusion strategy needs to be built into the design of the pilot (van Winden & van den Buuse, 2017). In many cases, pilot projects may prove successful but lack support for follow up or implementation, leading to disenchantment if their promise is unfulfilled (Ameha, Larsen, & Lemenih, 2014; Massarella, Sallu, Ensor, & Marchant, 2018). When designing pilots, the WHO advises changemakers to "Begin with the End in Mind" and provides a useful checklist for assessing scalability (World Health Organization, 2011).

A key challenge in scaling up or out is that financial, political, technical, and institutional conditions are different at larger scales than they are at the more limited scale of pilots. An analysis of policy pilot projects found that supportive policies and political support are critical for successful scaling, particularly in combination with effective pilot planning and monitoring and evaluation (Nair & Howlett, 2015). Funding – and particularly public funding – is important for scaling and diffusion of successful experiments (Antikainen et al., 2017), while shifting political priorities can constrain scaling (Uitto & Naidoo, 2019). Pilots that trigger strong social learning are also more likely to diffuse and organizations that operate on multiple scales may help with diffusion and scaling (Hughes, Yordi, & Besco, 2020; Vreugdenhil, Taljaard, & Slinger, 2012).

Pilot projects developed in relatively distant or isolated spaces may be difficult to reintegrate into existing institutions and governing structures (van Popering-Verkerk & van Buuren, 2017). For example, *+cityxchange* is a smart city project in Trondheim Norway funded by EU Horizon 2020. It was designed to cocreate energy efficient neighborhoods by drawing on local demonstration projects. The project was organized outside the city's formal administrative structure, which created problems of conflicting time horizons and for integrating multiple sectors into the project (Gohari, Baer, Nielsen, Gilcher, & Situmorang, 2020). Mainstreaming of innovations typically depends on establishing robust solutions that have broad-based support that forge strong linkages with the mainstream institutions (Smith & Raven, 2012). Successful sustainability experiments build on broad and deep networks that encourage learning (van den Heiligenberg et al., 2017). Such networks support scaling and diffusion when they extend beyond the local context and can translate local knowledge into more generic knowledge while negotiating the terms of scaling and diffusing experimental results (Kivimaa, Hildén, Huitema, Jordan, & Newig, 2017; Smith & Raven, 2012). An example is provided by innovative water governance experiments in Ecuador. These experiments began locally, but were successfully diffused to the national scale by activating extra-local networks of grassroots activists and farmers (Kauffman, 2016). Capacity-building for such networks can aid the scaling and diffusion process.

Diffusion of grassroots innovations can occur through networks of committed activists, through wider networks that go beyond core groups of activists, and through support by higher level institutions and governments (Pesch, Spekkink, & Quist, 2019). Grassroots innovations that start in one

community may themselves develop into platforms that support the diffusion of innovation to other communities, and even nationally and internationally (Antikainen et al., 2017). A range of different types of network mobilization are possible. For example, a study of Finnish energy experimentation found that successful implementation was facilitated by user-run internet forums. These forums created online peer support groups for the distributed implementation, which created the possibility for scaling up the innovations (Jalas et al., 2017).

Some local communities may not have the capacity to experiment or to adopt and implement the lessons of experimentation conducted elsewhere (Johannessen et al., 2019). Agricultural innovation platforms serve to support the scaling of innovations (Totin, van Mierlo, & Klerkx, 2020). Research on successful local Finnish CO_2 emission reduction experiments found that their successful scaling depended on strong intermediary institutions that help to remove barriers to scaling (Matschoss & Heiskanen, 2017).

Aggregating lessons from across multiple local experiments is also important and is not necessarily the same as learning from a single experiment. Platforms and intermediary actors can become relevant mechanisms for helping to collect and share these lessons (Heiskanen et al., 2017). Sharing lessons can also inspire the diffusion of sustainability experiments, though it is also important to learn what has not worked. It is also important to recognize that the success or failure of sustainability experimentation is not the only important outcome, since even failed efforts may have helped to build skills, capabilities, knowledge, social capital, and imagination that can advance sustainability (Heskanen et al., 2017).

See Table 8.2 for a summary of recommendations for how to support, scale, and diffuse successful cocreated experiments.

Table 8.2. How to Support, Scale and Diffuse Cocreated Experiments.

(1) Find ways of motivating each of the participants to engage in cocreated experimentation
(2) Provide institutional scaffolding for cocreated experimentation to facilitate learning
(3) Create formal institutional support in order to scale cocreated experiments
(4) Treat successful local experiments as prototypes when scaling and diffusing them
(5) Build diffusion strategies into pilot projects
(6) Forge links between experimental environments and mainstream institutions
(7) Create platforms and network with external actors to diffuse successful innovations

Conclusion

This chapter examines the potential for experimentation and prototyping to play an important role in advancing a sustainability agenda. Although randomized controlled trials are perhaps the best known type of experiments, we draw inspiration in this chapter from the tradition of design experimentation and pilot projects. This tradition focuses on experiments as a strategy of generating and trialing solutions to specific problems. A particularly valuable concept at the heart of this design-oriented perspective is prototyping, which refers to a strategy of iteratively refining a particular design based on feedback from both designers, users, and stakeholders. As a relatively low cost approach to innovation, prototyping has great potential as an approach to developing, testing, and implementing new approaches to sustainability.

As summarized in Table 8.1, there are many types of prototyping, generally ranging from quick-and-dirty or low fidelity strategies to full-scale rollouts in limited circumstances (e.g., pilot projects). In many cases, these prototyping strategies align well with and support cocreation. Indeed, the design philosophy behind prototyping encourages iterative input from distributed users – input that can be marshalled through cocreation. On the one hand, research suggests that it is important to pay close attention to the motivation of participating citizens and stakeholders in the design of cocreated experimentation – lest the commitment to experiment falter over time. On the other hand, prototyping is itself a powerful mechanism for engaging citizens and stakeholders around a common enterprise, with the prototype becoming a point of interest, communication, and purpose.

As a strategy for generating sustainability transitions, a key challenge for cocreated experimentation and prototyping is that successful experiments often remain local, one-off efforts with limited diffusion or scale. One key piece of advice is that experiments can be designed in part with a consideration for how they might diffuse or scale *if* they are successful. While acknowledging that this kind of foresight can be difficult – especially for small communities – changemakers may especially want to anticipate the continuity of funding support for successful experiments and prototypes. They should also appreciate the importance of extra-local support networks in successful diffusion and scaling.