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Make digitalized places for experimentation work: unravelling and governing transformative dynamics of FabLabs and Makerspaces

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ABSTRACT

While maker platforms, such as FabLabs and Makerspaces, are commonly perceived as drivers for transformative trajectories, little is known about how the dynamics of experimental collective agency are mobilizing transformative capacities that foster change on the local level. This paper contributes to the understanding of collective innovation dynamics of maker platforms that aim to support collective experimentation and translate novel practices to incumbent institutions on the local level. By drawing on the strategic niche management literature, a comparative case study of six maker platforms in Germany is conducted. Findings indicate three relevant modes of translation that could be identified: Firstly, translation by active shielding and institutionalized adaption emphasizes the role of harbouring universities in fencing off market pressures and offering events as well as workshops to regime actors. Secondly, translation by enabling learning mechanisms highlights the effect of implementing proper formats for assessment and learning on mutual translation. Thirdly, translation by sustained cooperation and coordination between maker platforms and local institutions stresses capacities for cooperation and a demand-oriented coordination between maker platforms and incumbent institutions.

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1. Introduction

Revolutionary technological innovations are supposed to be salient for assigning transformative forces and trajectories to manufacturing, markets and societies (Godin 2006, 2015; Fagerberg, Mowery, and Nelson 2011). Prominent examples that are said to merge both innovation and transformation are Fabrication Laboratories (FabLabs) and Makerspaces. These digitalized workshops were born out of technological advances in 3D printing and individual ingenuity. The advent of digital fabrication equipment, especially and most prominently 3D printing, has blurred existing boundaries of experimenting and manufacturing. By turning digital data into materialized artefacts and

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sharing it online, so-called makers have been supposed to revolutionize manufacturing by making innovation-oriented processes more user-centric and openly collaborative (Gershenfeld 2007, 2012; Rifkin 2014; Aryan, Bertling, and Liedtke 2021).

Internationally renowned FabLabs and Makerspaces, such as the FabLab Barcelona, have inspired its overtly transformative capacity that consequently resonates in a continuously growing number of digitalized workshops globally (Menichinelli and Gerson Saltiel Schmidt 2020). However, understanding about conditions that allow transformative capacities of collaborative agency and digital fabrication to unfold empirically is scarce (Lhoste 2020; Mersand 2021; Menichinelli and Gerson Saltiel Schmidt 2020; Rosa et al. 2017). This is partly because of a technology-based perspective on urban development and innovation. It tends to neglect aspects of social innovation spanning across novelty in value-driven practices, concepts, organization and decision-making processes that ultimately initiate and propel transformative capacities (Smith et al. 2013; Smith 2017).

Generally, FabLabs and Makerspaces can be defined as community-based workshops that provide open and shared access to a variety of equipment, including technologies for digital fabrication, and infrastructure for collaborative prototyping, experimentation, knowledge creation and sharing. While these digitized workshops share common features, their local adaptation significantly influences their purpose and functionality. FabLabs and Makerspaces thus are focal points for local as well as global communities by providing platforms for novel approaches to collective and commons-based agency. Online platforms allow local maker communities to exchange information and collaboratively create artefacts on a global scale by enabling an open, decentralized network structure (Anderson 2012; Smith 2017; Chiappini and Törnberg 2019; Lhoste 2020).

Research in the past covered transformative capacities of FabLabs and Makerspaces from mainly two perspectives. On the one hand, researchers focused on the participative and collaborative aspects of tinkering and co-creation. By opening up and deliberating design and fabrication processes, it is argued that FabLabs and Makerspaces can contribute to bottom-up solutions tailored to local challenges (Smith, Fressoli, and Thomas 2014). On the other hand, various publications consider FabLabs and Makerspaces as agents for change in the context of economic geography and knowledge economy (Cohendet, Grandadam, and Suire 2021; Birtchnell, Böhme, and Gorkin 2017; Suire 2016; Troxler 2013). Even when examined from different perspectives, the ability to give novel collective agency on the grassroots level a protective space that nurtures transformative capacities is a consistent feature of FabLabs and Makerspaces in the literature (Chiappini and Törnberg 2019; Galvin, Burton, and Nyuur 2020). However, little is known about how FabLabs and Makerspaces bring change to local contexts. The way how community-driven platforms are entangled into transformative processes on the local level by altering existing socio-institutional practices of knowledge creation and production has remained widely uncovered. There is a demand for studies that specifically analyse translation processes between those platforms and actors representing incumbent practices. A small number of publications recently pointed to this gap undermining its relevance especially for governance approaches to community-based regional development and diversification for entrepreneurial capabilities (Rumpala 2023; Hildebrandt et al. 2022; Rumpala 2023; Menichinelli and Gerson Saltiel Schmidt 2020; Chiappini and Törnberg 2019).

In this study, maker platform (MP) is used as an umbrella term for different conceptual models that can be assigned to the definition of FabLabs and Makerspaces as outlined above. Thus, instead of generalizing a single conception, sensitivity is given to the plurality of MPs, as local contexts crucially and individually shape the adoption of a prefigurative conception. Consequently, the role of MPs in changing actor-related, structural and institutional conditions of innovation processes is plural. Transformative capacities are defined as cognitive, normative and cultural capabilities as well as social relations that are able to provoke radical innovations with the potential to disrupt existing sociotechnical systems (Stirling 2011; Bos and Brown 2014; Stirling 2014). These innovations are perceived to be related to social dimensions and can challenge established practices, norms and structures, aiming to bring about significant changes on multiple levels, including individual, organizational and sectoral levels. Consequently, transformative capacities aim at providing radical alternatives to dominant or incumbent institutions and institutionalized practices that are assessed as being disruptive (Bulkeley and Castán Broto 2013; Smith 2017; Pesch, Spekkink, and Quist 2019).

The aim of this study is twofold. Firstly, this paper contributes to the understanding of the emerging collaborative dynamics of MPs and its ability to alter existing institutions by guiding prototyping, knowledge creation and the production of artefacts. Secondly, insights lifted from a comparative case study will contribute to proposed governance approaches that aim to support transformative capacities of MPs. Consequently, the following research question guides this study:

> What modes of translation between maker platforms and actors representing incumbent regimes on the local level can be detected, and what does this say about transformative capacities of maker platforms?

To this end, the first part will cover the theoretical approach. It results in a description of the conceptual model that is applied to the empirical phenomenon of MPs. Methodological implications can be found in the second part of the study and will be followed by the comparative case study and a discussion of the results generated. In the final section of the study, the conclusion will follow.

2. Research approach– reconsidering strategic niche management

The conceptual model of this study is built upon the strategic niche management (SNM) approach. Essentially, SNM promotes that the development of path-breaking innovation demands temporary protection to allow for learning processes while experimenting with novel sociotechnological practices. Thus, a proof context, called a niche, is needed that protects experimental practices. Without protection, selection pressures by established sociotechnological practices would crush emerging innovation. Selection pressures are linked to dominant societal practices and technological infrastructures, called sociotechnological regimes (Kemp et al., 1998; Geels 2002; Raven 2005; Schot and Geels 2008). In reference to a later strand in the transition literature, a niche is perceived as a safe context for novel sociotechnological practice. Here, the focus lies upon on configurations of human agency and technological artefacts that foster development according to coevolutionary processes (Witkamp, Raven, and Royakkers 2011; Seyfang and Haxeltine 2012; Dóci, Vasileiadou, and Petersen 2015; Pesch, Spekkink, and Quist 2019; Pel et al. 2020b).

The success of protecting path-breaking innovation is bound to three processes: (1) shielding, (2) nurturing and (3) empowering. 'Shielding' primarily aims for stemming the tide of pressure from sociotechnological regimes. It refers to blocking off a niche from selection pressures to allow for experimentation. 'Nurturing' is linked to processes that support the development of novel sociotechnological options inside the niche. The literature describes three niche internal processes as being pivotal for nurturing: building social networks, articulating expectations and stimulating as well as supporting shared learning processes (Kemp, Schot, and Hoogma 1998; Raven 2005; Schot and Geels 2008; Boon, Hessels, and Horlings 2019). 'Empowerment' refers to outward-oriented processes that allow sociotechnological novelties to either compete with or alter incumbent sociotechnological regimes. Processes of empowerment thus contribute to the credibility and strength of a path-breaking innovation. Thus, increasing niche empowerment is covering forms of dynamic interactions with actors that represent incumbent regimes ranging from political activity to narratives being deployed (Smith and Raven 2012; Barrie, Zawdie, and João 2017). In the end, successful niche management depends on the dynamic interrelatedness of shielding, nurturing and empowerment over the course of time. It is assumed that iterative and co-produced experimental processes lead to the creation of new rule-based practices that support the stability of a niche innovation (Raven 2005; Smith and Raven 2012).

For practitioners and decision-makers that aim to foster transformative capacities of niche innovations, the matter of understanding and actively governing the institutionalization of niche practices is a crucial one. Thus, by using SNM as the analytical vehicle, operative aspects of managing niche innovations can be lifted. In the recent past, the SNM approach was used as a management tool for various path-breaking innovations. Applications range from sustainable transportation (Weber and Truffer 1999; Hoogma et al. 2002; Pandis Iveroth et al. 2013) over renewable energy (Verbong, Geels, and Raven 2008; Al-Sarihi and Cherni 2018) to social entrepreneurship (Witkamp, Raven, and Royakkers 2011). While being predominantly applied to sustainability transitions, SNM in the recent past has contributed to research topics beyond a focus on sustainability by supporting systemic and evolutionary network perspectives on innovation (Caniëls and Romijn 2008; Giganti and Falcone 2022).

In consequence, SNM serves as a proper analytical as well as operative tool for investigating local dynamics of collaborative prototyping and experimentation linked to MPs. In contrast to earlier applications of SNM as mentioned above, this study is not focusing on a particular technology or niche-product. MPs as local and community-based, digitalized workshops are perceived as niches for novel and radical social innovations covering prototyping, knowledge creation and networked production of artefacts. Understanding the role of MPs in contributing to a transformation of institutionalized social structures that are relevant to innovation is the point of departure for both the conceptual model and the empirical investigation.

2.2. Conceptual model

2.2.1. Approaching maker platforms as sociotechnological niches

A niche can take different forms. Prominent examples are subsidized R&D laboratories or market niches. Local societal initiatives, such as FabLabs and Makerspaces, also can

fulfil the role of niches. These initiatives may contribute to novel alternative solutions on a community-based, grassroots level (Seyfang and Smith 2007). Thus, for the conceptual model applied, local MPs are perceived as sociotechnological niches that enable heterogeneous communities to experiment with digital fabrication methods and novel forms of collective agency (Aryan, Bertling, and Liedtke 2021; Chiappini and Törnberg 2019). Especially their open and experimental way of creating prototypes underscores the social components of innovation processes (Smith et al. 2013). The connectivity of local and global MPs paves the way for new networked social structures of so-called open innovation (Aryan, Bertling, and Liedtke 2021). Analytically, this study follows Pesch, Spekkink, and Quist (2019) that differentiate between 'simple' and 'strategic' niches. While the former is not seeking for altering existing institutions, the latter is promoting it and implies diffusion benefits of novel sociotechnological practices. Consequently, the approach given is addressing strategic niches.

2.2.2. Approaching existing institutions as incumbent regimes

Niches are embedded in and opposed by so-called incumbent sociotechnological regimes (Kemp, Schot, and Hoogma 1998). Incumbent regimes essentially maintain dominant sociotechnological configurations including societal practices, technological design and functionality. Regimes add stability to existing sociotechnological systems, as they allow for the reproduction and structuration of rule sets (Schot and Geels 2008; Smith and Raven 2012). Rules include mainly cognitive routines, shared beliefs, competencies, user practices, regulations and institutional arrangements that affect local practices. Thus, regimes intersect with a broad variety of social domains, including cultural, political, scientific, market and industrial dimensions (Scott 2014). Regime rules that coordinate and guide activities of social groups represent higher levels of structured practices, but are present at the local level (Geels 2011; Köhler et al. 2019). For the approach given, established institutions in a formal sense, such as universities, city administrations, companies or associations, are seen as representing established rule sets. Local institutions adjacent to regimes have institutionalized local practices, for instance by legislation, contracts and the promotion of cultural and normative values, and thus affect how novel practices related to collective prototyping are adopted locally (Seyfang and Smith 2007; Seyfang and Haxeltine 2012; Pesch et al. 2017). Alternative practices of knowledge creation and production developed in shielded places, such as local MPs, are not easily adopted by local institutions, as a strict alignment between alternatives and institutionalized practices is enforced (Pesch, Spekkink, and Quist 2019; Geels 2012).

Transferring the incumbent regime heuristic to the conceptual model outlined, the study focuses on actors representing incumbent regimes on the local level. Given the plural and encompassing efforts of MPs, a broad perspective on local regime actors representing dominant institutions is applied. It includes actors from local associations, the educational sector, urban administration and the economic sector (e.g. enterprises and business development agencies). Relevant actors depend on a MP's target groups and collaborative efforts. The pivotal interest of this study lies in gaining an understanding about the localized dominant rule sets institutionalized by intersecting institutions (Grin, Rotmans, and Schot 2011; Geels 2002).

2.2.3. Outcomes of translations as niche–regime interactions

The transformation of institutionalized practices that are relevant to innovation processes on the local level results from longitudinal, coevolutionary and multidimensional dynamics (Dolata 2014; Köhler et al. 2019; Pel et al. 2020a). Any attempt to investigate dynamic interactions between MPs and incumbent regime actors thus need an analytical focus. Having said that, it is followed Smith (2007), who perceives niche–regime interactions as translations (see also Raven et al. 2011; Ingram et al. 2015). Translations are defined as formal and informal interactions that in the course of time result in reconfigurations of sociotechnological practices by indicating mutual (re-)alignment of MPs and incumbent regime actors.[1] Ultimately, the outcome of translations can entail novel practices to which both niche and regime actors aligned to. The outcome of mutual translations covers a broad field of practices, which cannot be further defined or limited. There is no approach on translations between MPs and incumbent regime actors available that could serve as a landmark (Menichinelli and Gerson Saltiel Schmidt 2020). Research in the past though conceptualized the outcome of translations as the establishment of (trans-)local networks, the replication of ideas and practices or the translation of novel niche activities into policies or business strategies (Smith 2007; Raven et al. 2011; Pesch, Spekkink, and Quist 2019; von Wirth et al. 2019).

One opportunity to trace processes of translation is to analyse interactions between a niche and local institutions by referring to rules. Following Geels (2005), the coordination of interactions among actors can be conceptualized as rules. There are formal and informal rules that structure the behaviour of actors. According to Scott (2014), three dimensions of rules can be differentiated: (I) The 'regulative' dimension covers formal rules and regulations, such as government regulations, laws, standards, incentive structures or bureaucracy systems. (II) The 'cognitive' dimension refers to processes that constitute reality and meaning by building upon visions, images and cognitive frames. Examples are knowledge paradigms, search heuristics, priorities or problem–solution agendas. (III) The 'normative' dimension pertains norms and values, expectations, codes of conduct as well as duty. Rules from any of the dimensions mentioned do not exist as single entities. Rather, various rules are linked together forming semi-coherent sets of rules that stabilize social system processes and continue to exist in the course of time (Geels 2005; Geels 2012). Note that sets of rules emerge not only out of formal and informal interaction but will also be changed by these interactions (Koppenjan and Klijn 2004). For the empirical inquiry, Scott's (2014) rule dimensions will be adopted to perceive niche–regime interactions comprehensively on various dimensions of agency.

Finally, the identification of shared and rejected rules between MPs as niches and incumbent regime actors is expected to lead to a better understanding about interaction processes and thus the outcome of translations. Empirically, it is focused on formal as well as informal forms of translations between local MPs and incumbent institutions by identifying shared and rejected rules on the rules-related dimensions mentioned. Consequently, shared rules or sets of rules indicate an outcome of translations that contributed to a bridging between niche and regime actors. On the contrary, rejected rules or sets of rules indicate an outcome of translations that did not help to bridge the gap. As mentioned earlier, the dynamic interrelatedness of the niche-related processes of shielding, nurturing and empowerment is affecting the outcomes of translations and

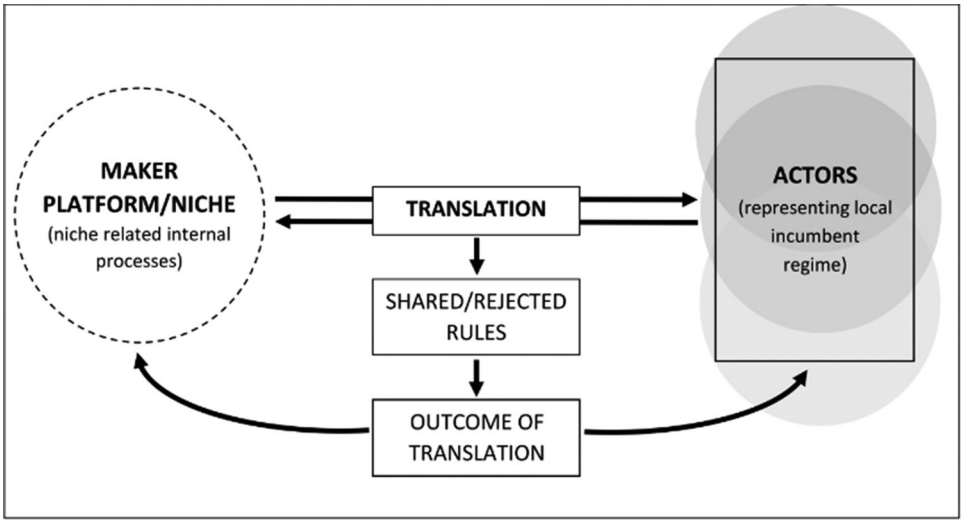

Figure 1. Conceptual model used for this study.

the way how a niche is aligning with translations. Processes supporting the nurturing of a niche are of pivotal interest. Figure 1 provides a depiction of the conceptual model described in the preceding sections. It encapsulates how outcomes of translations are the result of dynamic interactions between a MP and incumbent regime actors, which can be investigated in accordance with sets of rules that are shared or rejected. Eventually, the outcome of translations provides feedback to both a MP and incumbent regime actors that in turn adapt to it.

3. Research strategy, case selection and methodology

The research design for this study is based on a comparative case study approach (Yin 2010). It was accomplished by using qualitative data.

It was decided to use qualitative data as they correspond with the research objective of focussing on processes of emerging interdependencies among heterogeneous actors. Beyond that, a qualitative approach is consistent with the theoretical conception, as SNM appends to the constructivist tradition of innovation studies (Smith and Raven 2012; Kemp, Schot, and Hoogma 1998).

Cases were selected deliberately based on three selection criteria. Firstly, it was only focused on MPs in the German state of North Rhine-Westphalia delimiting the number of possible cases. Secondly, in reference to Pesch, Spekkink, and Quist (2019), MPs that were set up as an end in itself ('simple niches') without the aim of collaborating with local actors, networks as well as maker communities were excluded from the sample. Thirdly, the cases selected had to be existing for at least 3 years to allow for claims about processes of translation. The online platform 'fablabs.io' was used for pre-selecting and acquiring primary information. In the end, a total of six MPs were selected for investigation and comparison. See Table 1 for a depiction and further information about the case selection.

Data were collected by conducting a total of 19 semi-structured interviews with the managers in charge of each MP and, if possible, with key stakeholders collaborating

Table 1. Overview of case sample.

Case #	Name	Governance model	Affiliation	Active since	Source
1	Dezentrale Dortmund	Independent club/ collaboration with research institute	Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT	2013	https://dezentrale-dortmund.de/
2	FabLab Bottrop	Affiliated to university/research institute	Ruhr West University of Applied Sciences	2013	http://hrw-fablab.de/
3	FabLab/Green FabLab Kamp-Lintfort	Affiliated to university/research institute	Rhine-Waal University of Applied Sciences	2015	http://fablab.hochschule-rhein-waal.de/ https://fablab.green/wp/
4	GarageLab e.V. Düsseldorf	Independent club	*None*	2011	https://garage-lab.de/
5	Halle1-Makerspace Gelsenkirchen	Affiliated to university/research institute	Westphalian University of Applied Sciences	2018	https://halle1wh.de/
6	Makerspace Bonn e.V.	Independent club	*None*	2018	https://makerspace-bonn.de/

with the local MPs selected. Interviews were conducted between September 2020 and January 2021 by the author of this article and lasted between 60 and 75 min. All interviewees representing a MP are the original initiators of the platform. Thus, it was assured that the interviewees had in-depth knowledge about the local trajectory of each MP. Key local stakeholders include actors from the academic, economic and administrative sectors representing local incumbent institutions. Among stakeholder interviewees are representatives of universities hosting a MP, local economic promotion agencies, urban planners and employees of an IT company. The transcription and coding of the data gathered followed a coding tree based on the conceptual model outlined earlier. Coding was done by the author and another researcher to ensure intercoder reliability procedures by following O'Connor and Joffe (2020) as well as MacPhail et al. (2016). Additional data were collected by investigating written records such as prototype documentations, newspaper articles and information posted on websites and social media channels of the MPs selected. Moreover, triangulation was enabled by presenting the case study results at a feedback workshop attended by all interviewed managers of the MPs investigated. Table 1 provides an overview of the case sample.

4. Comparative case study: detecting translations between maker platforms and incumbent regime actors

In the following, the results of the empirical analysis will be outlined in two steps. Firstly, results about niche-related processes will be reported. In the second step, the results of the analysis on modes of translation are outlined.

4.1. Niche internal processes

The outcome of translations is essentially affected by niche internal processes (see Section 2.2.4). Thus, relevant attributes and patterns related to building social networks,

articulating expectations and supporting learning processes across the six MPs will be elaborated in detail.

4.1.1. Building networks

Developing social networks is essential for having access to different forms of resources both material and immaterial. MPs tend to draw on basically two types of network formats. On the one hand, maker communities adjust to local networks. On the other hand, connections to translocal or transnational networks can also be observed. Translocal networks preferably are connected vía online platforms. The global FabLab community is a representative example of this network type. This community includes international events, such as conferences and exchange programmes (e.g. Fab Academy[2]). As noted in the literature, translocal networks are important in creating a collective political voice and narrative supporting the development of a collective movement. In addition, translocal connectivity enables the exchange and access to knowledge resources (Pel et al. 2020b). Thus, local and translocal connectivity can be of central importance for processes of empowerment at the local level (Smith and Raven 2012). However, as the data collected show, translocal network processes are only of limited use in coping with local challenges. Especially when it comes to expanding an operative network. Crucially, two types of networks are present at the local level. Firstly, there is the local maker community itself including those responsible for a MP and its community. Apart from those being in charge of administrative functions, the community is dynamically assembled by different societal actors and is often anything but a constant group of people. The second network type can be described as an operative network. It primarily has the aim to maintain cooperation with outside actors to coordinate knowledge transfer processes in the broadest sense. The case sample shows that operational networks can be established more easily when a MP already belongs to an existing institution, such as a university. It can provide access to pre-existing local and regional networks. Case FabLab Kamp-Lintfort (C#3) shows that institutional linkage fosters empowerment processes by establishing coordination mechanisms among relevant institutions on the local level. The Fab-managers and decision-makers of the university initiated a steering committee as well as an advisory board mirroring the local and region consent of economic, political and educational institutions. Thus, bureaucratic capacities have supported a deliberate use of FabLab Kamp-Lintfort (C#3) targeting structural challenges on the local level. In this regard, a university certainly can function as an anchor point for local and regional coordination efforts. In contrast, club-based MPs that have been established independently of existing institutions find it harder to gain traction locally.

4.1.2. Articulation of expectations

The articulation of expectations primarily fulfils two functions. Firstly, expectations contribute directionality to collective learning processes. Thus, the development of temporary and long-term objectives can be supported. Secondly, expectations help to generate attention, which may lead to an expansion of the support network. In the literature, it is emphasized that expectations are ideally shared by as many niche-related actors as possible (Smith and Raven 2012). In the case of MPs, expectations and visions are initially influenced by its founding members. Here, two aspects were mentioned specifically. Firstly, it is emphasized that infrastructure is necessary to experiment and learn by

drawing on the possibilities of digital technologies. Secondly, space should be created for collaborative approaches in which people with diverse interests and competencies can meet and exchange freely by creating prototypes. In addition, MPs in regions affected by structural change serve the expectation of constructively supporting a socioeconomical transformation. In this context, MPs are supposed to fulfil the role of incubation rooms, which may boost creativity and business ideas. Having said that, the expectations mentioned illustrate an initial translation between MPs and the incumbent context. Accordingly, MPs are constituted in opposition to incumbent regime actors on the local level. All the expectations mentioned are problems that regime actors seem not to be addressing sufficiently. Consequently, problems linked to regime actors have been translated to MPs and effected the creation of it. Additionally, the promotion of educational formats and teaching is a central concern. Here, the aim is to foster competencies of young professionals for the sake of the local economy by bringing new impulses to existing as well as emerging companies.

Two challenges are linked to robust and effective expectations being articulated. Firstly, expectations and visions need to be negotiated within as well as with actors of the environment to ensure that the same goals and directions are pursued. A mechanism is needed that adapts expectations and visions to a dynamic and thus changing maker community. Secondly, expectations and visions must not only be defined and coordinated but also be articulated between different networks on a horizontal level. The data underscore that the way in which communication and language are used is not negligible to successfully address target groups. Both aspects are relevant to go beyond an initial translation of problems linked to regime actors.

4.1.3. Learning processes

Generally, learning processes can be analysed on various levels. Thus, it can be differentiated between the micro level, i.e. personal or project-related learning, and the collective level. The latter is covering a MP as an organizational unit including administrative functions and decision-making mechanisms. Primarily, the quality of learning processes depends on the organizational capacities as well as the MP's main activities. In the case of MPs related to universities, projects are commonly realized that correspond to a certain educational mandate. Based on research contracts, third-party funded projects and other services, there are defined objectives that can serve as evaluation criteria. Club variants on the other hand are less often obliged to provide documentation to third parties. In addition, principles of the maker community, such as the Fab Charter[3], state that the results of completed projects are put online and thus made available to everyone. Certainly, those standards imply processes of documentation and reflection about project outcomes.

As MPs are used for various and sometimes very different paths of experimentation, it is not a trivial task to find suitable formats for assessment as well as learning. Apart from the aspects mentioned, the promotion of learning processes interferes with a far more important feature, namely the preservation of free experimentation and creativity. The data generated show that both documentation and assessment criteria are not among the factors that contribute constructively to experimentation and learning activities in MPs. On the contrary, evaluation mechanisms are rather perceived as an obstacle for approaching problems 'differently' by experimenting in a free manner. Ultimately,

managers of MPs are primarily concerned with the protection of low-threshold and free experimentation from conventional evaluation models. The organizational structure itself is often an object of experimentation, as it needs to adapt to a changed environment in the course of time. Even if conventional evaluation criteria are not necessarily prioritized, it can be assumed that learning processes and assessments are applied in a much more informal and intuitive way, by promoting a 'learning by doing' priority.[4] Although standards in the maker community state to share knowledge about project-related outcomes, this is practically not always done. Learning processes that evaluate the various activities of a MP are often fragmented. This is partly due to the dynamic character of the community and the preference for experimental formats of collaboration. MPs are no exception. MP's organizational structures often do not correspond to a conventional organization in a narrow sense. MPs see themselves more as an open community that can grow organically while being shaped by flat hierarchies. Consequently, it can be challenging to implement mechanisms that support collective learning and coordination. In this regard, the data generated underscore the necessity of MPs to improve collective learning and self-reflection. Based on relevant insights that cover niche-related processes, the following section will describe findings on translations between MPs and incumbent regime actors.

4.2. Identifying modes of translation

As pointed out earlier, translations are the result of dynamic interactions between a MP and incumbent regime actors, which can be perceived by investigating sets of rules that are shared or rejected. The following section will describe relevant outcomes of translations along three dimensions of rules.

Starting with shared rules and the regulative dimension, it firstly is necessary to differentiate between MPs that administratively belong to universities and those being governed as independent associations. The former are established for curricular use and additionally provide an informal environment for collaborative prototyping. Also, MP-related knowledge resources and technical infrastructure support spin-off efforts aimed at by students. The benefit of being linked to a university is given by having access to financial and material resources. The financing concept is decisive for the regulatory framework. Generally, university affiliation supports practices of MPs to become formalized rules due to curricular fixation as well as research utilization. On the other hand, MPs that are governed as associations are not tied to existing institutional structures. Consequently, there are freedoms in terms of agency and organization. Concerning cooperation with companies in particular, legal restrictions are much lower. Thus, the club variant allows for a broad scope of services to work, for instance, specifically on prototypes without neglecting competition law. Apart from that, it is emphasized that club-operated MPs can experiment more freely and adapt quickly to mutual translations.

On the cognitive level, MPs perceive positive reception due to their capacities for transferring knowledge and approaching problems collectively. A low-threshold and collaborative property of experimentation in maker facilities was mentioned particularly. The added value of experimental collaborative processes is linked to forms of co-creation and so-called open innovation (Obradović, Vlačić, and Dabić 2021). While some universities set-up curricular formats for inter- and transdisciplinary projects, collaborative

processes additionally happen by chance due to regular 'open for all' events. Both co-creation and open innovation processes are also demanded by entrepreneurs and local companies in the form of workshops. Workshop formats mainly focus on ideation and prototyping and problem-solving approaches. The possibility of working casually on prototypes allows for breaking out of common heuristics and routines. Also, temporary and continuous collaborations between maker communities and companies were mentioned indicating that local companies use collaborations with MPs as an external knowledge resource. The format of workshops and deliberate collaborations indicate the translation of sociotechnical practices between MPs and actors of incumbent regimes.

On the normative level, the importance of community-based knowledge production is perceived as being relevant for addressing local societal challenges. For this purpose, transdisciplinary formats for knowledge transfer are expedient. Additionally, MPs are supposed to act as a vehicle for coping with structural change. Maker communities should strengthen the creative class and promote entrepreneurial opportunities in addition to educational activities. However, a dedicated plan or strategy, which assigns MPs within existing innovation clusters to a specific role or function, has not been revealed. Nevertheless, findings on the normative level confirm empirical insights of expectations articulated by MPs described earlier (see Section 4.1.2). Thus, socioeconomic problems in the local context are translated into expectations as well as visions of MPs serving as a common ground for both niche and regime.

Continuing with rejected rules on the regulative dimension, there are three main barriers of MPs being affiliated to a university. Firstly, cooperations with companies are legally constrained due to competition law in Germany. As various interview partners have explained, it is not uncommon for companies to expect a cooperation that is supporting the development of a product. For managers of the MP, this implies a balancing act between legitimate product development and competition-distorting measures, which is neither feasible for the MP nor for the company. Secondly, the bureaucratic requirements of a university are associated with potential for conflict. Interviewees often mentioned that MPs are characterized by a certain degree of freedom in terms of organizational design and flexibility in project realization. These properties do not always complement the requirements of the bureaucratic higher-level administration. Thirdly, MPs belonging to universities are usually tied to third-party funding. Thus, the focus of the work can depend on funding projects. As a result, the prerequisites for long-term translations are only partially met.

The club variant on the contrary names the bureaucratized approach of local incumbent institutions, such as universities or municipal administrative actors, as an obstacle to possible cooperation. In addition, a lack of connection to established local institutions can be identified as a barrier for translation. At this point, the university and club variants differ significantly due to varying context conditions.

Rejected rules on the cognitive level refer on the one hand to offers provided by MPs. These offers are often ambiguous or unsuitable perceived. Interview partners representing incumbent institutions explained that language alone can already lead to a negative attitude among potential stakeholders. Modern or trendy terminology does not necessarily lead to acceptance by the addressed target group. On the contrary, the 'wrong' language can lead to misunderstandings or a lack of orientation. Local institutions, such as city administrations, can have very divergent ideas about the purpose of a MP

Table 2. Summary of findings on translations along the regulative, cognitive as well as normative dimensions and across the six maker platforms (MPs) covered.

	Regulative dimension	Cognitive dimension	Normative dimension
Shared rules	– Research utilization, curricular fixation of MP (university-affiliated MPs) – deployment as knowledge resources, technical infrastructure to support spin-off efforts (university affiliated MPs) – cooperations with and services to companies (club-operated MPs thus lower legal restrictions)	– Workshops and events for prototyping, ideation (low-threshold, experimental collaborative processes) – Collaborations with communities of MPs that serve as external knowledge resources – MPs as structural assets for so-called open innovation on the local level	– Community-based, experimental knowledge production to address local societal challenges, socioeconomic transformations – MPs to promote creative class and local entrepreneurial opportunities – MPs as vehicles for coping with structural change
Exemplary cases	FabLab/Green FabLab Kamp-Lintfort (C#3), Makerspace Bonn e.V. (C#6)	Dezentrale Dortmund (C#1), FabLab Bottrop (C#2), Halle1-Makerspace (C#5)	Halle1-Makerspace (C#5), FabLab/Green FabLab Kamp-Lintfort (C#3), Makerspace Bonn e.V. (C#6)
Rejected rules	– Collaborations, esp. with companies, are limited due to legal constraints (third-party funding, competition law) – Bureaucratic standards of universities (university-affiliated MPs) – Lack of connection to established local institutions (club variant of MPs)	– Opposing knowledge paradigms and search heuristics (co-creation, peer-to-peer processes) – Lack of congruence with standards (e.g. protecting intellectual property rights)	– Lack of professionalism when realizing collaborations – Cerebral and less practice-related approaches
Exemplary cases	FabLab Bottrop (C#2), GarageLab e.V. Düsseldorf (C#4), Halle1-Makerspace (C#5)	Halle1-Makerspace (C#5), FabLab Bottrop (C#2), Makerspace Bonn e.V. (C#6)	Makerspace Bonn e.V. (C#6), GarageLab e.V. Düsseldorf (C#4)

and thus favour different strategic aims to address local problems. In addition, there are certain expectations that favour a certain knowledge paradigm and corresponding search heuristics. However, forms of co-creation, collaborative innovation or peer-to-peer processes in general cannot simply be measured according to its monetary potential. Representatives of local economic development institutions also mentioned the problem of protecting intellectual property rights. From a business perspective, the added value of open experimental formats does not necessarily meet the expectations of conventional product development processes. Consequently, there are incumbent actors that demand a translation in the sense of a professionalization.

On the normative level, two outcomes of translations can be identified essentially. Firstly, MPs are associated with the assumption of a certain lack of professionalism that does not correspond with the standard for innovation and technology development. Another normative barrier relates particularly to stakeholders from the handcraft sector. It was mentioned that MPs at universities are associated with cerebral and less practice-related approaches. Skilled craftspeople may have a distanced attitude especially towards university operations, as the practical and acute added value is not immediately recognizable. Table 2 provides an overview of the findings.

5. Discussion of the results

In the previous sections, outcomes of translations between MPs and incumbent regime actors on the local level were analysed. Now, the main findings are discussed.

The comparative case study outlined in this article reveals the three most relevant modes of translation between MPs and local incumbent regime actors.

(I) *Translation by active shielding and institutionalized adaption*

Results clearly indicate the outcome of translation that results from active shielding and institutionalized adaption. It refers to university-affiliated MPs. Active shielding from financial or market-based pressures could be achieved by implementing MPs for educational reasons in the first place. By doing so, MPs were established as incentive structures and infrastructure capacities for the curricular programme at harbouring universities. Technical infrastructure and knowledge resources were then additionally used to support individuals beyond the university in realizing ideas and projects, such as local spin-off efforts aimed at by students and entrepreneurs. In the course of time, MPs as collaborative and open spaces for prototyping activities became established within and beyond the academic context. Workshops and tailored events allowed regime-related actors, such as companies or city administrations, to learn about prototyping and ideation utilized by digital devices. Consequently, maker-related sociotechnical practices (e.g. rapid prototyping, experimental approaches, and co-creation) could be translated into contexts of regime actors. Mutual adaption of MPs and regime actors could be fostered vía collaborative intermediate projects. Thus, regime actors have used MPs as community-based knowledge resources to tackle local challenges, such as urban transformation or economic growth. Localized problems related to incumbent regimes that affected the constitution of MPs. Findings clearly indicate mutual adaption between niche and regime in the course of time as MPs could be nurtured and empowered. For instance, opposing knowledge paradigms or legal constraints made the managers of the respective MPs to find new formats and strategies for a sustained translation.

(II) *Translation by enabling learning mechanisms:*

Findings confirm the importance of learning processes for niche–regime translation. Both the micro, i.e. the individual and project related, as well as the organizational and interorganizational levels demand effective mechanisms for learning when realizing collaborative projects within experimental settings. Even though guaranteeing for learning processes on both levels by implementing evaluation criteria and organizational structures among other aspects has been described as being challenging, it nevertheless indicates one mode of translation. There is one crucial aspect in this regard. The higher the challenge for maker facilities to implement proper formats for assessment and learning, the bigger the effect on mutual translation with regime actors. That is because criteria and structures for the assessment of collaborative projects need to be defined together with participating actors, which represent incumbent regime actors. Implementing a learning mechanism affects translation on both the project related and the collective, interorganizational level between niche and regime actors.

(III) *Translation by sustained cooperation and coordination between MP and local institutions:*

MPs crucially are community-driven phenomena drawing on local as well as translocal networks. Results of the empirical study underscore the importance of local networks, respectively, operative networks for processes of coordination of joint action (see Section 4.1.1). This network type primarily links the activities of MPs with the interests and support of local stakeholders by coordinating knowledge transfer processes. A representative example of successful operative network building is provided by the case FabLab Kamp-Lintfort (C#3). Both, decision-makers of the university and the affiliated FabLabs initiated a steering committee as well as an advisory board integrating the local and region consent of economic, political and educational stakeholder groups. In consequence, capacities for sustained cooperation and coordination allow a MP and incumbent regime actors to mutually adapt to contextualized challenges for collective innovation dynamics. Mobilizing capacities for cooperation and a demand-oriented coordination of MPs and local stakeholder groups are thus a central and the most targeted modes of translation.

Concluding for the moment, the main findings confirm the highly dynamic nature of translation as mutual adaption between niche and regime actors. The three most relevant modes of translation identified contribute substantially to the understanding about the interrelatedness of MP, respectively niche, related processes and mutual interactions with local actors representing incumbent regimes. Contrary to the dominant narrative, which portrays MPs as replicable instruments for radical sociotechnological transformations (Chiappini and Törnberg 2019), findings stress the importance of contextualized dynamics MP need to adapt to. In the end, MPs and its transformative capacities are configurational phenomena including various factors ranging from equipment, legal structures, business models, educational programmes, methods and fluid networks of actors that dynamically emerge relative to conditions in the local context. As indicated by the modes of translation identified, contextualized factors shape mutual interactions between MPs and regime actors.

7. Conclusion

This study set out to investigate which modes of translation between MPs and incumbent regimes on the local level can be detected and what does this say about the transformative capacities of it. For doing so, the study referred to the SNM approach as an analytical heuristic to conduct a comparative case study of six MPs in Germany. Next to the internal processes of MPs, the research approach put emphasis on translation as dynamic and mutual interactions between MPs and established institutions on the local level. Results refer to a total of three most relevant modes of translation that could be identified: Firstly, translation by active shielding and institutionalized adaption emphasizes the role of universities in fencing off market pressures and offering events as well as workshops to regime actors. Thus, maker-related sociotechnical practices could be translated into their contexts. Secondly, translation by enabling learning mechanisms highlights the effect of implementing proper formats for assessment and learning on mutual translation with regime actors. Thirdly, translation by sustained cooperation and coordination between MP and local institutions is stressing capacities for cooperation and a demand-oriented coordination between MPs and incumbent institutions. It is the most targeted mode of translation.

Contrary to mechanistic perspectives that broadly perceive MPs as replicable instruments for local or urban transformation in the digital age, findings highlight various modes of translation that are mutually non-exclusive. MPs are dynamically emerging configurations including heterogeneous networks of local actors, equipment, legal structures, business models, methods for prototyping and thus a collectively shaped vision of experimentation. For urban planners, managers of MPs or makers that want a MP to contribute to local development, one guiding proposition can be derived from the empirical study conducted: Collective experimentation should not be carried out in the maker facilities solely. Rather, capacities are necessary that enable local incumbent institutions to experiment 'with' a MP itself. Identified modes of translation confirm this statement.

Even though this study contributes considerably to the understanding of modes of translation between MPs and incumbent institutions on the local level, it entails some limitations. Firstly, as a comparative case study puts constraints on the explanatory scope of the research, it is likely that there are more modes of translation to be identified in the empirical context. Future research could go beyond the cases investigated and expand across the German context. Secondly, the reliability of the data used is limited, as only managers of MPs were interviewed. This limitation could be addressed by realizing in-depth case studies covering a broader data sample. Thirdly, as the given research article has an empirical focus, its contributions to theoretical perspectives on translation are beyond the scope. Future research could contribute to existing theory on translation by critically reflecting on existing findings spanning across sociotechnical niches in various domains.

Notes

1. Originally, translation can be traced to Actor Network Theory by Callon (1986). Accordingly, objectives are transferred from one actor to other actors that are getting recruited into the network environment of the primary actor. The given approach is going beyond that conception in a sense that MPs being adjunct to local and global networks of heterogeneous actors (off- and online) are interacting with multiple actors representing incumbent regimes of the MPs' systemic surrounding. The (re-)alignment between multiple actors of both conceptual domains is the result of mutual translations. Dynamic interactions are understood to be linked to emergent and thus coevolutionary processes that share properties of complexity (Juarrero and Rubino 2010). An empirical analysis that is tailored to the understanding mentioned would go beyond the span of the approach given. Thus, outcomes of translations are covered mainly, which maybe let translations processes be traced.
2. The Fab Academy serves as an educational program for students or professionals with various disciplinary backgrounds. Being designed as a 5-month program, participants engage with digital fabrication, electronics programming and web design. FabLabs that provide the educational program are part of a global Fab Academy network. Here, participants are connected globally vía an online campus that allows for content sharing and interactive video classes. Thus, the individual labs become so-called nodes (local hubs) for local participants. Fab Academy is said to be a model for globally distributed education (see FABACADEMY 2021).
3. The Fab Charter defines basic guidelines for the operation of a FabLab as part of a global network. Guidelines cover aspects such as responsibilities of individuals, security measures, access to a lab as well as legitimacy of business purposes. Note that the Fab Charter is non-compulsory (FabCentral (2021).
4. According to Ayas (1996), the prioritized *learning by doing* can be described as situational learning.

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References

Al-Sarihi, A., and J. Cherni. 2018. "Assessing Strengths and Weaknesses of Renewable Energy Initiatives in Oman: An Analysis with Strategic Niche Management." *Energy Transitions* 2: 15–29. doi:10.1007/s41825-018-0008-9

Anderson, C. 2012. *Makers: The New Industrial Revolution*. 1st ed. New York, NY: Crown Business, pp. 257.

Aryan, V., J. Bertling, and C. Liedtke. 2021. "Topology, Typology, and Dynamics of Commons-Based Peer Production: On Platforms, Actors, and Innovation in the Maker Movement." *Creativity and Innovation Management* 30: 63–79. doi:10.1111/caim.12392

Ayas, K. 1996. "Design for Learning and Innovation." *Long Range Planning* 29: 898–901. doi:10.1016/S0024-6301(97)82828-2

Barrie, J., G. Zawdie, and E. João. 2017. "Leveraging Triple Helix and System Intermediaries to Enhance Effectiveness of Protected Spaces and Strategic Niche Management for Transitioning to Circular Economy." *International Journal of Technology Management & Sustainable Development* 16: 25–47. doi:10.1386/tmsd.16.1.25_1

Birtchnell, T., T. Böhme, and R. Gorkin. 2017. "3D Printing and the Third Mission: The University in the Materialization of Intellectual Capital." *Technological Forecasting and Social Change* 123: 240–249. doi:10.1016/j.techfore.2016.03.014

Boon, W., L. Hessels, and E. Horlings. 2019. "Knowledge co-Production in Protective Spaces: Case Studies of Two Climate Adaptation Projects." *Regional Environmental Change* 19: 1935–1947. doi:10.1007/s10113-019-01517-4

Bos, J., and R. Brown. 2014. "Assessing Organisational Capacity for Transition Policy Programs." *Technological Forecasting and Social Change* 86: 188–206. doi:10.1016/j.techfore.2013.09.012

Bulkeley, H., and V. Castán Broto. 2013. "Government by Experiment? Global Cities and the Governing of Climate Change." *Transactions of the Institute of British Geographers* 38: 361–375. doi:10.1111/j.1475-5661.2012.00535.x

Callon, M. 1986. "The Sociology of an Actor-Network: The Case of the Electric Vehicle." In *Mapping the Dynamics of Science and Technology*, edited by M. Callon, J. Law, and A. Rip, 19–34. London: Palgrave Macmillan UK.

Caniëls, M., and H. Romijn. 2008. "Actor Networks in Strategic Niche Management: Insights from Social Network Theory." *Futures* 40: 613–629. doi:10.1016/j.futures.2007.12.005

Chiappini, L., and P. Törnberg. 2019. "Deus ex Machina: Makerspaces in Milan and Their Transformative Potential." In *The Production of Alternative Urban Spaces. An International Dialogue*, edited by J. K. Fisker, L. Chiappini, L. Pugalis, and A. Bruzzese, 73–92. London, New York: Routledge Taylor & Francis Group.

Cohendet, P., D. Grandadam, and R. Suire. 2021. "Reconsidering the Dynamics of Local Knowledge Creation: Middlegrounds and Local Innovation Commons in the Case of FabLabs." *Zeitschrift für Wirtschaftsgeographie* 65: 1–11. doi:10.1515/zfw-2020-0042

Dóci, G., E. Vasileiadou, and A. Petersen. 2015. "Exploring the Transition Potential of Renewable Energy Communities." *Futures* 66: 85–95. doi:10.1016/j.futures.2015.01.002
Dolata, U. 2014. *The Transformative Capacity of New Technologies: A Theory of Sociotechnical Change*. London, New York: Routledge Taylor & Francis, pp. 139.
FABACADEMY. 2021. *What is Fab Academy?* Accessed November 10, 2021. https://fabacademy.org/about/#what-is-fab-academy.
FabCentral. 2021. The Fab Charter. The Center for Bits and Atoms. Accessed October 20, 2021. fab.cba.mit.edu/about/labs/.
Fagerberg, J., D. Mowery, and R. Nelson. 2011. *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, pp. 656.
Galvin, P., N. Burton, and R. Nyuur. 2020. "Leveraging Inter-Industry Spillovers Through DIY Laboratories: Entrepreneurship and Innovation in the Global Bicycle Industry." *Technological Forecasting and Social Change* 160: 120235. doi:10.1016/j.techfore.2020.120235
Geels, F. 2002. "Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study." *Research Policy* 31: 1257–1274. doi:10.1016/S0048-7333(02)00062-8
Geels, F. 2005. *Technological Transitions and System Innovations*. Cheltenham, UK: Edward Elgar Publishing.
Geels, F. 2011. "The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms." *Environmental Innovation and Societal Transitions* 1: 24–40. doi:10.1016/j.eist.2011.02.002
Geels, F. 2012. "A Socio-Technical Analysis of Low-Carbon Transitions: Introducing the Multi-Level Perspective Into Transport Studies." *Journal of Transport Geography* 24: 471–482. doi:10.1016/j.jtrangeo.2012.01.021
Gershenfeld, N. 2007. *Fab: The Coming Revolution on Your Desktop – from Personal Computers to Personal Fabrication*. New York, NY: Basic Books, pp. 278.
Gershenfeld, N. 2012. "How to Make Almost Anything: The Digital Fabrication Revolution." *Foreign Affairs* 91: 43–57.
Giganti, P., and P. Falcone. 2022. "Strategic Niche Management for Sustainability: A Systematic Literature Review." *Sustainability* 14: 1680. doi:10.3390/su14031680
Godin, B. 2006. "The Linear Model of Innovation." *Science, Technology, & Human Values* 31: 639–667. doi:10.1177/0162243906291865
Godin, B. 2015. *Innovation Contested: The Idea of Innovation Over the Centuries*. London: Taylor and Francis, pp. 370.
Grin, J., Rotmans, J., and J. Schot. 2011. *Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change*. New York, London: Routledge, pp. 397.
Hildebrandt, L., S. Zadow, L. Lange, M. Langhammer, M. Moritz, T. Redlich, and J. Wulfsberg. 2022. *What are the Role and Capabilities of Fab Labs as a Contribution to a Resilient City? Insights from the Fab City Hamburg*. Hannover: Publish-Ing.
Hoogma, R., Kemp, R., Schot, J., and B. Truffer. 2002. *Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*. London: Spon, pp. 212.
Ingram, J., D. Maye, J. Kirwan, N. Curry, and K. Kubinakova. 2015. "Interactions Between Niche and Regime: An Analysis of Learning and Innovation Networks for Sustainable Agriculture Across Europe." *The Journal of Agricultural Education and Extension* 21: 55–71. doi:10.1080/1389224X.2014.991114
Juarrero, A., and C. Rubino. 2010. *Emergence, Complexity, and Self-Organization: Precursors and Prototypes*. Litchfield Pk: Emergent Publ.
Kemp, R., J. Schot, and R. Hoogma. 1998. "Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management." *Technology Analysis & Strategic Management* 10: 175–198. doi:10.1080/09537329808524310
Köhler, J., F. Geels, F. Kern, J. Markard, E. Onsongo, A. Wieczorek, F. Alkemade, et al. 2019. "An Agenda for Sustainability Transitions Research: State of the Art and Future Directions." *Environmental Innovation and Societal Transitions* 31: 1–32. doi:10.1016/j.eist.2019.01.004
Koppenjan, J., and E.-H. Klijn. 2004. *Managing Uncertainties in Networks*. London: Routledge.

Lhoste, E. 2020. "Can Do-It-Yourself Laboratories Open up the Science, Technology, and Innovation Research System to Civil Society?" *Technological Forecasting and Social Change* 161: 120226. doi:10.1016/j.techfore.2020.120226

MacPhail, C., N. Khoza, L. Abler, and M. Ranganathan. 2016. "Process Guidelines for Establishing Intercoder Reliability in Qualitative Studies." *Qualitative Research* 16: 198–212. doi:10.1177/1468794115577012

Menichinelli, M., and A. Gerson Saltiel Schmidt. 2020. *First Exploratory Geographical and Social Maps of the Maker Movement*, pp. 35–62/European Journal of Creative Practices in Cities and Landscapes, Vol 2, No 2 (2019): The New Spaces of the Common: Spatial and Political Models of Making. doi:10.6092/ISSN.2612-0496/9640

Mersand, S. 2021. "The State of Makerspace Research: A Review of the Literature." *TechTrends* 65: 174–186. doi:10.1007/s11528-020-00566-5

Obradović, T., B. Vlačić, and M. Dabić. 2021. "Open Innovation in the Manufacturing Industry: A Review and Research Agenda." *Technovation* 102: 102221. doi:10.1016/j.technovation.2021.102221

O'Connor, C., and H. Joffe. 2020. "Intercoder Reliability in Qualitative Research: Debates and Practical Guidelines." *International Journal of Qualitative Methods* 19: 160940691989922. doi:10.1177/1609406919899220

Pandis Iveroth, S., A.-L. Vernay, K. Mulder, and N. Brandt. 2013. "Implications of Systems Integration at the Urban Level: The Case of Hammarby Sjöstad, Stockholm." *Journal of Cleaner Production* 48: 220–231. doi:10.1016/j.jclepro.2012.09.012

Pel, B., A. Haxeltine, F. Avelino, A. Dumitru, R. Kemp, T. Bauler, I. Kunze, J. Dorland, J. Wittmayer, and M. Jørgensen. 2020. "Towards a Theory of Transformative Social Innovation: A Relational Framework and 12 Propositions." *Research Policy* 49: 104080. doi:10.1016/j.respol.2020.104080

Pel, B., J. Wittmayer, J. Dorland, and M. Søgaard Jørgensen. 2020. "Unpacking the Social Innovation Ecosystem: An Empirically Grounded Typology of Empowering Network Constellations." *Innovation: The European Journal of Social Science Research* 33: 311–336. doi:10.1080/13511610.2019.1705147

Pesch, U., W. Spekkink, and J. Quist. 2019. "Local Sustainability Initiatives: Innovation and Civic Engagement in Societal Experiments." *European Planning Studies* 27: 300–317. doi:10.1080/09654313.2018.1464549

Pesch, U., A.-L. Vernay, E. van Bueren, and S. Pandis Iverot. 2017. "Niche Entrepreneurs in Urban Systems Integration: On the Role of Individuals in Niche Formation." *Environment and Planning A: Economy and Space* 49: 1922–1942. doi:10.1177/0308518X17705383

Raven, R. 2005. *Strategic Niche Management for Biomass: A Comparative Study on the Experimental Introduction of Bioenergy Technologies in the Netherlands and Denmark*, 329 pp.

Raven, R., G. Verbong, W. Schilpzand, and M. Witkamp. 2011. "Translation Mechanisms in Socio-Technical Niches: A Case Study of Dutch River Management." *Technology Analysis & Strategic Management* 23: 1063–1078. doi:10.1080/09537325.2011.621305

Rifkin, J. 2014. *The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism*. New York, NY: Palgrave Macmillan.

Rosa, Paulo, Federico Ferretti, Ângela Guimarães Pereira, Francesco Panella, and Maximilian Wanner. 2017. *Overview of the Maker Movement in the European Union.*

Rumpala, Y. 2023. "'Smart' in Another Way: The Potential of the Fab City Approach to Reconfigure Urban Dynamics." *Urban Research & Practice* 16: 271–293. doi:10.1080/17535069.2021.2009551

Schot, J., and F. Geels. 2008. "Strategic Niche Management and Sustainable Innovation Journeys: Theory, Findings, Research Agenda, and Policy." *Technology Analysis & Strategic Management* 20: 537–554. doi:10.1080/09537320802292651

Scott, W. 2014. *Institutions and Organizations: Ideas, Interests and Identities*. Los Angeles, London, New Delhi, Singapore, Washington, DC: Sage, pp. 345.

Seyfang, G., and A. Haxeltine. 2012. "Growing Grassroots Innovations: Exploring the Role of Community-Based Initiatives in Governing Sustainable Energy Transitions." *Environment and Planning C: Government and Policy* 30: 381–400. doi:10.1068/c10222
Seyfang, G., and A. Smith. 2007. "Grassroots Innovations for Sustainable Development: Towards a new Research and Policy Agenda." *Environmental Politics* 16: 584–603. doi:10.1080/09644010701419121
Smith, A. 2007. "Translating Sustainabilities Between Green Niches and Socio-Technical Regimes." *Technology Analysis & Strategic Management* 19: 427–450. doi:10.1080/09537320701403334
Smith, A. 2017. "Social Innovation, Democracy and Makerspaces." SPRU Working Paper Series SWPS 2017-10. University of Sussex, Falmer. doi:10.2139/ssrn.2986245
Smith, A., M. Fressoli, and H. Thomas. 2014. "Grassroots Innovation Movements: Challenges and Contributions." *Journal of Cleaner Production* 63: 114–124. doi:10.1016/j.jclepro.2012.12.025
Smith, A., Hielscher, S., Dickel, S., Soderberg, J., and E. van Oos. 2013. "Grassroots Digital Fabrication and Makerspaces: Reconfiguring, Relocating and Recalibrating Innovation?." SPRU Working Paper Series SWPS 2013-02. University of Sussex, Falmer. doi:10.2139/ssrn.2731835
Smith, A., and R. Raven. 2012. "What is Protective Space? Reconsidering Niches in Transitions to Sustainability." *Research Policy* 41: 1025–1036. doi:10.1016/j.respol.2011.12.012
Stirling, A. 2011. "Pluralising Progress: From Integrative Transitions to Transformative Diversity." *Environmental Innovation and Societal Transitions* 1: 82–88. doi:10.1016/j.eist.2011.03.005
Stirling, A. 2014. "Transforming Power: Social Science and the Politics of Energy Choices." *Energy Research & Social Science* 1: 83–95. doi:10.1016/j.erss.2014.02.001
Suire, R. 2016. "Place, Platform, and Knowledge Co-Production Dynamics: Evidence from Makers and FabLab." *Regional Studies* 53: 939–950. doi:10.2139/ssrn.2830526
Troxler, P. 2013. "Making the 3rd Industrial Revolution – the Struggle for Polycentric Structures and a new Peer-Production Commons in the FabLabs Community." In *FabLab. of Machines, Makers and Inventors*, 1st ed. Transcript, edited by J. Walter-Herrmann, and C. Büching, 181–198. Bielefeld.
Verbong, G., F. W. Geels, and R. Raven. 2008. "Multi-niche Analysis of Dynamics and Policies in Dutch Renewable Energy Innovation Journeys (1970–2006): Hype-Cycles, Closed Networks and Technology-Focused Learning." *Technology Analysis & Strategic Management* 20: 555–573. doi:10.1080/09537320802292719
von Wirth, T., L. Fuenfschilling, N. Frantzeskaki, and L. Coenen. 2019. "Impacts of Urban Living Labs on Sustainability Transitions: Mechanisms and Strategies for Systemic Change Through Experimentation." *European Planning Studies* 27: 229–257. doi:10.1080/09654313.2018.1504895
Weber, M., and B. Truffer. 1999. *Experimenting with Sustainable Transport Innovations: A Workbook for Strategic Niche Management*. Enschede: Universiteit Twente, pp. 96.
Witkamp, M. J., R. P. Raven, and L. M. Royakkers. 2011. "Strategic Niche Management of Social Innovations: The Case of Social Entrepreneurship." *Technology Analysis & Strategic Management* 23: 667–681. doi:10.1080/09537325.2011.585035
Yin, R. K. 2010. *Case Study Research: Design and Methods*, 4th ed., Los Angeles, CA: Sage, pp. 219.

Appendix

1. Semi-structured interview script
   Dimensions:

   A. Self-conception
   B. Niche internal processes
   C. Niche–regime interactions

A. Self-conception

– How did the Maker Platform (MP) come about?
– What goals and visions have been linked to the establishment?
– Are there specific local/regional problems that should be addressed with the stated goals and visions of the MP?
– Do the activities in the MP have a thematic focus?
– Which target group or target groups are to be addressed by the MP´s activities?
– How is the MP financed?
– Are there defined standards or a 'Code of Conduct' for the activities in the MP?

B. Niche internal processes

– What are the organizational structures that characterize the MP?
– Have organizational structures changed over time?
– What are the decision-making processes regarding organizational, content, or legal issues?
– Which people are involved in the decision-making processes?
– Has the way decisions are made changed over time?
  • Establishment of networks:
– Are there formal/informal barriers to becoming part of the MP team? If so, what are they?
– Has there been any attempt to build a network/community around the MP? If yes, how has this been done? If not, why not?
– Have attempts been made to date to consult MP internally about how to increase the network or community on the local level? If yes, how has this been approached?
  • Articulation/adjustment of visions and expectations.
– Is there agreement within the team on the goals and expectations of the MP? If not, how are differing visions and resulting conflicts handled in this regard?
– Have the goals and visions of the MP changed over time? If yes, why?
– To what extent have attempts been made to communicate the goals and visions of the MP to institutions/stakeholders locally?
  • Establishment of learning processes
– Are the projects supervised in the MP documented? If so, how is information about them made available?
– Are the projects supervised in the MP also evaluated in terms of progress, outcome and the actors involved in them?
– Does the MP have a concept that evaluates its own activities, i.e. organizational issues, workshop offerings, etc.? If so, how is the evaluation designed and how is it communicated?

C. Niche–regime interactions

– Which people are interested in the opportunities and offers of the MP? Do these people tend to represent civil society, the economy, the education sector or urban administration or politics?
– Has it been possible so far to reach the people who have also been defined as the target group for the MP? If not, at which points were there hurdles and difficulties?
– Are there concrete cooperations with companies, the urban administration, associations or educational institutions on a local level? If so, what is the focus of these collaborations?
– Which aspects of the MP´s concept are of particular interest to actors that represent the institutions mentioned?
– Are there concrete support structures for inventors/makers to develop a business model from a prototype?
– In your opinion, what would have to change regarding collaborations with actors that represent the institutions mentioned to mobilize the potential of the MP for urban transformation or development?