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Trajectories to reconcile sharing and commercialization in the maker movement

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Abstract Maker technologies, including collaborative digital fabrication tools like 3-D printers, enable entrepreneurial opportunities and new business models. To date, relatively few highly successful maker startups have emerged, possibly due to the dominant mindset of the makers being one of cooperation and sharing. However, makers also strive for financial stability and many have profit motives. We use a multiple case study approach to explore makers' experiences regarding the tension between sharing and commercialization and their ways of dealing with it. We conducted interviews with maker initiatives across Europe including Fab Labs, a maker R&D center, and other networks of makers. We unpack and contextualize the concepts of sharing and commercialization. Our cross-case analysis leads to a new framework for understanding these entrepreneurs' position with respect to common-good versus commercial offerings. Using the framework, we describe archetypal trajectories that maker initiatives go through in the dynamic transition from makers to social enterprises and social entrepreneurs.

1. Maker technologies boost social entrepreneurship

Fab Labs and makerspaces that offer internet-enabled design and production technologies—

including open source CAD software, computer-aided 3-D printers, and various other digital fabrication technologies—have brought industrial-quality product development facilities within reach of individuals and communities that lack significant financial resources. These technologies form generative mechanisms for the emergence of a 'maker movement' (Anderson, 2012; Dougherty, 2012), unlocking vast entrepreneurial opportunities that many observers and scholars believe will have significant disruptive effects on the

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incumbent industrial paradigm (Hagel, Seely Brown, & Kulasooriya, 2014; Hessman, 2015).

The maker movement has grown significantly since the first Fab Lab was founded at MIT in 2003. There are now more than a thousand labs registered on fablabs.io and nearly 700,000 uploaded designs on Thingiverse. This rapid increase in Fab Labs and shared designs shows that the maker movement is becoming more visible and, hence, more accessible to those interested in digital fabrication.

Many makers are driven by social ideals of improving the lives of underprivileged people and caring for the natural environment, often subscribing to the sharing principles of the open source movement. Many consider their social goals as being more important than commercial success. However, in order for their idea to scale up and realize its potential impact, they need financial backing, which generally implies having a product with wide appeal.

A recent and interesting example is the Superbook (Hurst, 2016). At the beginning of 2015, two independent makers developed a prototype of a laptop shell comprised of a keyboard, screen, and battery that can use the computer power of smartphones to run like a normal laptop. Their Kickstarter campaign in July 2016 was backed by over 16,000 individuals to the tune of almost $3 million. A social motivation of the project is to help remote African communities that have limited access to computers, despite many people having mobile phones that carry computer power. So, it would appear that these makers have balanced their sharing ideology with business sense by making a product that gives a boost to the disadvantaged but is also attractive to a wide audience in developed countries. However, this example appears to be the exception to the rule as, to date, relatively few highly successful maker startups have emerged.

There is a significant gap in management and social entrepreneurship literature explaining how emerging transformational technologies that are serving as generative mechanisms for maker initiatives are creating entrepreneurial opportunities. This phenomenon points to the need for an explanation of the tensions between sharing and commercialization (Besharov & Smith, 2014; Dacin, Dacin, & Tracey, 2011).

2. Maker technologies as generative mechanisms

Emerging technologies have been described as generative mechanisms, providing individuals and organizations with the means to transform industries, disrupt economic models and bring about societal change (Cohen & Amorós, 2014; Dacin, Goodstein, & Scott, 2002; van Aken, 2004). This view is in line with the idea of creative destruction (Schumpeter, 1942) as a basis for the notion of disruptive innovation, whereby new technologies allow for the emergence of a new dimension on which innovative products can gain a competitive advantage (Christensen, 1997).

According to Anderson (2012), the maker movement shares the following three characteristics that capture its transformative potential:

1. Makers create digital designs and prototype them with the help of digital fabrication tools.

2. A guiding principle is that makers share these designs and collaborate in online communities.

3. Makers use common design file standards (i.e., the designs are, in principle, compatible with commercial manufacturers systems).

2.1. Entrepreneurial opportunities and new business models

In order for such new technologies to realize disruption, entrepreneurs must develop business models that embody attractive value propositions (Demil, Lecocq, Ricart, & Zott, 2015). A business model explicates a firm's logic for value creation and capture. The business model describes how a focal firm taps into its ecosystem to perform the activities that are necessary to fulfill the perceived customer needs (Zott, Amit, & Massa, 2011).

For the purposes of this article, we are interested in business models that enable the creation of social value instead of or alongside commercial value. A significant number of entrepreneurs, including many makers, use their resourcefulness with an explicit objective: to change society for the better, whereby they attempt to efficiently meet the needs of society's underprivileged that have been failed by markets and governments (Seelos & Mair, 2005). Due to their social motivation, such social enterprises generally exhibit highly collaborative, open, and sharing work practices, far removed from the closed, protective stance of most commercial organizations.

However, such entrepreneurs and makers that strive for social value creation often face competing internal logics, which are socially constructed sets of practices, assumptions, values, and beliefs that define an organization's understanding and behavior (Thornton, Ocasio, & Lounsbury, 2012). On the one hand, in order to realize their social innovation, they make choices based on the common good; an

example of this would be sharing product designs so that other makers can build on existing work. On the other hand, in order to remain financially viable, makers make choices based on their own sustainability, such as keeping their best designs for themselves. Such competing logics can damage the organization's performance and may lead to failure (Tracey, Phillips, & Jarvis, 2011).

Besharov and Smith (2014) distinguished between multiple logics in terms of centrality and compatibility. In the case of entrepreneurs following the dual logics of striving for both common good and financial sustainability, these authors described a situation of 'contested logics.' Both are highly central to the organization's functioning, but they are incompatible in the sense that they often prescribe contradictory actions. As yet, this recent stream of research does not describe different paths that organizations can take in order to reconcile the contested logics.

A stream of literature on organizational governance describes mechanisms and models for determining and implementing strategic aims, supervising management, and reporting to stakeholders (Tihanyi, Graffin, & George, 2014). Governance mechanisms are subject to laws, regulations, and demands made by the stakeholders within which constraints the organization aims to create opportunities. However, for non-conventional organizations such as social enterprises, open source software communities, nonprofit organizations, and cooperatives, governance is highly challenging due to the need to balance economic and social objectives (Galera & Borzaga, 2009). This is leading to new forms of governance, such as the emerging Platform Cooperative model, which is a digitally mediated, democratically governed attempt to foster harmony between social and economic aims (Scholz, 2016).

In this study, our aim is to provide an answer to the following questions:

- In what way are emerging maker technologies serving as generative mechanisms for creating entrepreneurial opportunities?

- What courses of action are open to makers (or other social entrepreneurs) in order to reconcile the contested logics of sharing and commercialization?

3. Case descriptions

In order to address these questions, we carry out case analyses of five European maker initiatives. These cases were selected purposely based on their spread across two criteria. First, we sought cases that differ in scale and collaborative interaction: Some cases are focused on individual makers or small groups while others comprise very large communities of makers. Second, we also sought cases that differ in their social impact objectives, whereby some intend to solve a specific market failure while others aim for a systemic change of an entire social system.

3.1. Case 1: HRW Fab Lab

The Fab Lab at the University of Applied Sciences Ruhr West (HRW) is located in Bottrop, in the German Ruhr area. It is an example of how Fab Labs can be used for educational and inclusive purposes while being embedded in institutions of higher education. From the beginning, the HRW Fab Lab was set up to create a space for students where they can creatively apply what they learn in their studies and, as such, the HRW Fab Lab has a clear mission of education and empowerment. It is not commercially oriented and finances its activities through public funds. Nevertheless, rather than being only admissible for students, the Fab Lab is also regularly open to any interested participant (HRW Fab Lab facility manager, personal communication):

> We are open for everyone; that means really anyone can come. That shows also at the open evening [...] the age ranges from about 7 to 70 and also all kinds of different people. And we have a share of 20%—25% of students, so they are often the minority. Mostly it is people coming from the outside.

The HRW Fab Lab experiences little or no conflict between the logics of sharing and commercialization. Sharing is the single dominant logic, which is focused on education and open access. The logic of commercialization, such as how to secure private financing for the Fab Lab, is peripheral.

3.2. Case 2: Happylab Vienna

Happylab Vienna is a Fab Lab located in Vienna, Austria. It is an example of how offering these new maker technologies to nonprofessionals can become a business model in itself. Happylab Vienna originates from the two founders' experience in a project aiming to build a robot boat, which demanded the use of digital fabrication technologies. The founders realized that while a huge interest in these machines existed, people lacked an appropriate working space. Hence, the founders decided to open a working space with digital fabrication tools and teach the skills to use them to anyone interested.

The business idea development phase took place from 2008 to 2010. During this phase, the two founders received funding from an EU project. Being owned by an independent research institute for computer sciences (INNOC) in the beginning, paired with the financial support from the EU, allowed them to rent a space and to acquire the basic equipment. Happylab Vienna opened to the public in 2010. During the setup of the maker initiative, Happylab Vienna's central aim was to share the machinery and expertise about how to operate it with the local community.

Happylab Vienna's income comes from a mix of revenue streams of which membership fees make up the greatest share, allowing Happylab to sustain itself and even expand. Besides being able to invest in additional technology, Happylab opened another facility in Salzburg, Austria in 2014 and one more in Berlin, Germany in 2016.

Software used in the facility is not necessarily open source since a simple user experience for all is valued more than an open source ethos: "The [programs] that we use are simpler than others and thus also more robust. [They] are not necessarily open source; we buy them and install the full version" (Happylab Vienna facility manager, personal communication).

Happylab Vienna's prevailing logic to offer a shared workspace has been broadened by the logic to remain financially sustainable and even make a profit. Happylab Vienna has aligned the logics of sharing and commercialization. The initially dominant logic of sharing, through providing access to easily usable digital fabrication technologies and offering a network of knowledge and support, has been complemented by the commercial logic of charging for access, using advanced proprietary software for registering, monitoring, and invoicing members.

3.3. Case 3: Arduino

The Arduino project, based in Turin, Italy, comprises an ecosystem built around computer microcontrollers. A company produces and distributes these and a community uses the devices, discusses them, and further develops the technology. The first prototype board was made in 2005 and cost around $30 each. The implicit agreement of this exchange is that people using Arduino document their projects and share them on the Arduino forum. This is of special interest in the case of gadgets running on Arduino becoming a business of their own since it shows that open source technologies can create new business opportunities. In addition, since the hardware is open source, the emerging community helps to extend and improve the microcontrollers (Kushner, 2011). The decision to make Arduino boards open source was made partially out of the ideological belief in open source and partially because Arduino wanted to preserve its further development; the institute was running out of funds and facing the risk of closure, which eventually happened (Kushner, 2011). Currently, the community that interacts on the multi-lingual Arduino forum comprises 130,000 people. Given the variety of microcontrollers that exist today, Arduino's competitive advantage stems from the extensive knowledge embedded in this large community. Hence, the community itself promotes and extends the devices.

This has brought Arduino, since 2016, to a new position in which its organizational functioning is based on the sharing logic of its community, and its business model has shifted to revenues made from consulting companies and licensing Arduino compatible shields. This has helped to reduce the conflict, as the commercialization logic is less central than the sharing logic to the organization's decision making, the latter being ultimately core to the company's functioning (Arduino staff member, personal communication):

> You really need to understand what your business model is and what are your assets and protect them. Not only with lawyers, but also especially with reputation and the community. The only way to build a maker community around you is by sharing stuff.

3.4. Case 4: Create It Real

Create It Real in Aalborg, Denmark, founded in 2009, started with the open source DIY 3-D printer, Fab@Home, which aimed to create a low-cost, hackable printer to bring 3-D printers from the industry to the masses. The business model of Create It Real evolved significantly over time. Originally, the idea was to build and sell 3-D printers directly to end users through a website. Because this required the organization to master the whole value chain of 3-D printer commercialization, from production to marketing and sales, the focus changed to technology development only. The main focus was then to sell the technology to big companies such as Epson or HP. This strategy did not succeed, mostly because the big corporations did not see the value they would gain by adopting 3-D printers.

Currently, Create It Real operates as an R&D center that specializes in developing the technology behind 3-D printing and creating platform solutions to bring the full potential of 3-D printers to its

business customers. Create It Real is also very much anchored in the local environment, notably by working closely on projects with schools in Aalborg where they participate in workshops to introduce 3-D printers to children. Yet, in order to develop their organization, they have moved away from an extreme 'sharing everything' mindset to follow their perception of how makers evolve (CEO of Create It Real, personal communication):

> There seems to be a typical behavior with makers: they start as a maker and very much appreciate the open and sharing character as they need inspiration. Once they start actually creating and making themselves, they want to protect more and complain about imitation. It seems that depending on the stage of a maker's project, the sharing character changes.

Create It Real created a tagging system for 3-D printers so people who purchase a specific design can print it only once. That hardware-based digital rights management (DRM) system aims to bring this maker initiative much closer to the model of a traditional business. This is something that is highly controversial in the maker movement, if not plainly hated. The tension between internal logics has been excluded from within the Create It Real organization by making the commercialization logic dominant. As such, Create It Real has moved toward a commercial market mechanism to grow through their DRM technology, which is a generative mechanism for this business model to work.

3.5. Case 5: Regional metalworking network

In the Netherlands, the Regional Metalworking Network (RMN)[1] started as an idea generated by an industrial metalworking firm. This firm developed software to enable external parties to upload and improve designs of products that require sheet metal to be worked. Following the development of the software, they invited other local metalworking firms to join in the network, whereby the production facilities of each partner become available via the software and the participants share knowledge, market leads, and production facilities. The RMN provides access to the local vocational training school so that students can become acquainted with the networking paradigm and learn about the software and its use within a range of industry settings.

The RMN software and collaborative network may be described as a *collective awareness*

platform (Sestini, 2012), a transformative technology paired with a new way of doing business that enhances innovation and enables new business models. In particular, the RMN now has in place the necessary platform and industrial processing technology that enables all sorts of makers to scale up their production, while allowing for low quantity manufacturing and customizable production. Through this model, industrial quality production becomes accessible to all, even those with minimal resources.

Tensions within the network remain low, despite the competing logics of collaboration and sharing within the RMN network, and the commercial basis of the members. This is mainly due to different partners focusing on different market niches (RMN Coordinating partner, personal communication):

> There are companies with different backgrounds and who are not competitors, which lowers the burden to start cooperating. Each party has its own niche or market. We took that into account as well when searching for partners. We prefer complementarity above competition, because you start cooperating more easily.

Sharing by the RMN with a local vocational education institute has also not resulted in any incompatibility with commercial objectives. For example, by helping the students to learn new skills, they are developing employees for the future.

4. Cross-case analysis

Across all cases, we highlight key observations through the lens of several important dimensions for exploring maker initiatives' business generation character. In Table 1 below, we indicate for each case study the underlying technologies enabling that particular maker initiative, the type of maker activity present in the initiative, the mechanism for generating business for the initiative itself, how the initiative generates new business opportunities for participants, and the underlying sharing mechanism.

Based on these observations and further analysis, four key findings have emerged that will be discussed below. These are:

1. Technologies enable maker initiatives and their users to generate new business opportunities;

2. At some point in time, all maker initiatives experience contested logics between sharing and commercialization;

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[1] The partners involved in this case have asked to remain anonymous.

Table 1. Case summaries

Initiative	Enabling technology	Maker activity	Initiative business generation mechanism	Participant business generation mechanism	Sharing mechanism	Governance model
HRW Fab Lab	Mix of digital fabrication tools	Citizen projects and startups	Predominantly supported by higher education institution and local subsidies	Technology and location for participants to plan and execute their own projects	Sharing machines and knowledge, and providing access to students and citizens	Delegated model: University board prescribes conditions; Fab Lab manager holds decision-making power
Happylab Vienna	Mix of digital fabrication tools, plus usage registration system	Citizen projects and startups	Membership-based system	Technology and location for participants to plan and execute their own projects	Sharing machines and knowledge	Market model enabled by usage registration technology and subscriptions
Arduino	Single-board microcontroller, and online community	Basis for smart objects	Revenues from consulting companies, licensing compatible components, and board sales	Technology and community for participants to plan and execute their own projects	Open source hardware, and community for cooperation on projects and on technology development	Hierarchical model combined with a large user community contributing to product development
Create It Real	3-D printing software platform, electronics, and microchips	Customizing 3-D printers	Acting as an R&D center by further developing 3-D printing technology while customizing 3-D printers for clients	Helping clients to experiment, learn, and build for having an appropriate 3-D printing infrastructure	Hardware-based DRM technology for sharing 3-D printable designs; sharing R&D knowledge on 3-D printing	Formal commercial model focused on technology development and innovation
Regional Metalworking Network (RMN)	Collective Awareness Platform, networked design, and manufacturing technology	Fast and flexible steel product manufacturing	Developing a Regional Metalworking Network concept for further rollout across other regions	Easily accessible, fast and flexible 3-D metal product manufacturing	Community for cooperation, joint resource exploitation, and providing access to students	Network model based on a social contract among participants; coordination strongly embedded with network design software ownership

3. Tensions between institutional logics in maker initiatives are related to value creation and value capture; and

4. A reconceptualization of 'sharing' is needed.

4.1. Technologies enable new business opportunities

Each maker initiative is made possible through underlying technological developments. For example, HRW Fab Lab originates from a mix of digital fabrication technologies, while the RMN is made possible through collective awareness platform technology and networked design and manufacturing technology. Due to the opportunities afforded by these technologies, these maker initiatives are able to generate new business opportunities.

First, they generate business opportunities for themselves through their own dedicated business model. These business opportunities can be oriented toward economic impact and/or social impact. For example, Create it Real is more oriented toward economic impact and acts as an R&D center for its clients, offering technology development services in which it further develops 3-D printing technology—including a hardware DRM solution. Arduino now generates revenue through offering solutions for consulting companies and through licensing its hardware. The RMN concept enables joint resource development for entrepreneurs who need to evolve to be competitive in a smart manufacturing environment.

Second, and arguably more important and impactful in an economic sense, these maker initiatives also generate business opportunities for people and entrepreneurs engaging with them. They do that through allowing participants access to, and use of, highly advanced technologies to develop their own product ideas and to strengthen or build their own particular business model. Maker initiatives can help organizations to develop the necessary infrastructure, including appropriate tangible, intangible, and human resources; to build relevant market connections, such as receiving market feedback through early prototype building; and to realize a viable business model such as providing low cost use of high-tech apparatus and, in essence, lowering entry barriers. For example, Create It Real is helping clients to experiment and learn about 3-D printing technology and its possibilities, while also providing support for designing and building an appropriate 3-D printing infrastructure for the client's particular business. Arduino offers highly advanced open source hardware, along with a repository of designs, knowledge, and support that can be used for participants' own electronics projects and their development of smart technology innovations, whereby individuals, startups, but also larger organizations are able to quickly design and experiment with new product designs.

4.2. Contested logics

At some point in time, all maker initiatives experience contested logics between sharing and commercialization. Each maker initiative propagates a sharing mentality and develops a specific sharing mechanism that enhances the business generation impact of the initiative for both the initiative itself and especially for the participants. Many started out with this logic of sharing being their dominant mechanism. For example, Happylab Vienna started out with a mission to enable the cooperative use of many digital fabrication tools in order to provide new and engaging resources to the local community. But that is not always the case, particularly when traditional manufacturers expand their processes to connect to makers. RMN was started by a traditional firm and is based on building a community for intense cooperation, joint resource exploitation, and knowledge and resource sharing across organizations.

Whichever came first, at some point in their development, all our cases have experienced extensive conflict between the logics of sharing and commercialization. At that point, both logics are highly central to the functioning of the organization, but they point the organization in contradictory directions at the same time. This is a situation of organizational dissonance and one that is untenable. For example, when Create It Real began to work on its DRM solution, the tension it experienced increased dramatically: "Starting as a maker, it's always in the back of your mind that open source is good and closed source is bad" (CEO of Create It Real, personal communication). A commercial-minded manager will see an open source approach to technology development as giving away competitive advantage, while taking a fully proprietary approach will preserve the advantage but requires more time and resources for product development. The Create It Real CEO said: "One of the reasons why I left open source projects was because I knew the architecture was a problem for really long term development."

4.3. Value creation and value capture

Once the two logics become contested, the maker initiatives we study here experienced tension, often exemplified as difficulties with decision making or

arguments between members. Sharing objectives are generally related to developmental activities such as knowledge sharing, advice on project development, and collaborative use of digital fabrication tools for prototyping. These may be typified as value creation activities (Lepak, Smith, & Taylor, 2007). Commercialization objectives focus on the end goal of value capture, whereby rare, inimitable, and nonsubstitutable resources are utilized as a basis for competitive advantage.

An example of this is the DRM hardware solution developed by Create It Real. Tension emerges when the sharing activities, which have contributed to the commercial position of the maker initiative, are not acknowledged or compensated. Tension also emerges when the community-cultural ideals and beliefs conflict about which parties benefit from the value that has been jointly created. So, for example, Arduino ran into a major internal conflict: Who creates value, and who captures it? Problems arise when there is no balance or clear organizational answer to this tension and the unfairness of one party benefitting from the hard work and insights of other parties remains unresolved.

4.4. A reconceptualization of 'sharing' is needed

Based on our analysis of the cases, we revise the conceptualization of sharing, which is often used in the management literature without a clear definition (Botsman, 2013). There are a number of different typologies of sharing that emerge.

- *Open versus closed sharing*: There are cases in which sharing is open and public to anyone (e.g., showcasing the best products and results at Happylab Vienna and HRW Fab Lab for the wide public), while there are also cases in which sharing happens in a closed setting among participants or even between individual participants (e.g., currently restricting access to the RMN for non-competing companies). Indeed, tensions within an organization can be reduced by selectively sharing. In this way, the dangers of being too open are reduced, but the benefits of sharing with key partners are achieved.

- *Conditional versus unconditional sharing*: There are cases in which sharing is based on getting something in return (e.g., paying subscription fees to get access to a Fab Lab), while there are also cases in which sharing is happening without immediate expectation of reciprocation (e.g., sharing time as a mentor for explaining the use of machines in a Fab Lab). Often, both types

of sharing are happening in a single maker initiative given the multitude of instances in which sharing happens. It seems that the presence of conditional sharing is important when one tries to further commercialize, while the presence of unconditional sharing is important to keep the sharing and community spirit alive for attracting new participants.

- *Tangible versus intangible sharing*: The type of resources being shared can vary significantly, according to the participating organization's resources and needs. Different maker initiatives share tangible resources, such as physical elements, fabrication machines, floor space, etc., and/or they share intangible and human resources, including knowledge of technologies, maker skills, and cultural mindset.

The adequate choice by a maker initiative for a particular type of sharing across typologies seems to relate strongly to its form of governance and the underlying business model. More particularly, maker initiatives and the stakeholders involved in their governance ask themselves whether sharing a particular element (e.g., technology versus machine) or applying a particular sharing mode (e.g., open and conditional versus closed and unconditional) has positive or negative implications for the value creation and/or value capture character of their organization. When they experience negative implications, conflict between the logics of sharing and commercialization may emerge. Some governance models favor one logic over and above the other, in which cases internal conflict can be avoided by being explicit about the dominant priority and organizing for that. If an organization aims to prioritize sharing over commercialization, cooperative governance models are more appropriate whereas a commercial focus is benefitted by a traditional corporate structure and incentives. On the other hand, as we see in our RMN case with its network model of governance, appropriate agreements to prevent conflict between stakeholders' objectives can allow sharing to align with and enhance their commercial goals. It will be interesting to follow developments in multifocused governance, such as the platform cooperative model (Scholz, 2016; Sundararajan, 2016), and to see how firms and other organizations cope when harmonizing multiple strategic aims.

5. Development trajectories

As stated previously, the maker initiatives studied all experienced contested logics at a certain point

in their development. In the language of Besharov and Smith (2014), the sharing and commercialization logics are both central to the functioning of the organization but, at the same time, incompatible as they prescribe contradictory courses of action. Maker initiatives then experience organizational dissonance, or internal incoherence, and undertake strategies to adapt so that the tensions are resolved. Following this train of thought, there are four possible developmental processes that can be taken in order to remove or reduce the conflict:

1. *Reduce the centrality of one of the logics*: When only one of the logics remains core to the functioning of the organization, then the two logics can exist side-by-side in a state of moderate conflict. This can be achieved by choosing either a predominantly sharing logic, as in the case of the HRW Fab Lab, which survives on subsidy, or a predominantly commercial logic, as in the case of Create It Real's DRM solution that has the explicit goal of blocking open sharing of designs and promoting high sales volumes.

2. *Increase the compatibility of the logics*: If both logics remain core to the functioning of the organization, then they must be made compatible so that they align toward a unified objective. This may be achieved by identifying specific points of conflict and searching for alternatives. For example, in the RMN case, partners were selected to join the network based on their compatible market niches, whereby this maker initiative avoids competitive conflict that would otherwise damage the sharing activities.

3. *Reduce joint centrality and increase compatibility*: In some cases it may be possible to reduce the conflict between logics in both ways at the same time. This was achieved in our HRW Fab Lab case, which quickly gave up on any commercial aspirations and reconciled itself to a business model based on subsidy. At the same time, this maker initiative focuses on user segments, such as students, aged citizens, and refugees, which boost its subsidy potential.

4. *Live with contested logics*: It is also possible to live in conflict, whereby some workable solution is found to prevent the different courses of action from destroying the organization. This may be achieved by becoming a hybrid organization that is able to meet the needs of both logics together. None of our cases were able to maintain this position for any length of time,

but the Superbook example mentioned in the introduction may be an instance of this as they share with users in remote African villages and sell to consumers in Western countries.

In order to understand the development trajectories that maker initiatives undergo, it is important to go beyond the level of the institutional logic and understand the effects of the tensions in relation to the wishes and objectives of the organization in question, directly relating to sharing and commercialization. A maker initiative may avoid this tension by simply developing its sharing capabilities and creating some social impact, as HRW Fab Lab does in the Bottrop area, without the objective of widening its scope, which may necessitate a commercial focus. Equally, a maker initiative may begin by aiming for financial profit and be at peace with that, just like a regular business. Therefore, in order to develop our insights into development trajectories, we plot a range of possible paths on the two dimensions of sharing and commercialization, most of which were observed in our cases. Figure 1 plots maker development trajectories on two axes. First, the vertical axis denotes the progress a maker initiative makes in developing and scaling up according to the sharing logic associated with social objectives. Second, the horizontal axis depicts progress according to the commercialization logic associated with financial sustainability. We have seen that most maker initiatives begin life in the bottom, left-hand quadrant. Some move toward the upper, left-hand quadrant where the sharing logic is dominant. Others develop toward the quadrant where the commercial logic is dominant. Subsequently, some of these makers are able to reconcile both logics and develop in the direction of the upper, right-hand quadrant where the initiatives are able to function according to both logics at the same time.

In total, this new framework presents seven different development trajectories:

1. *Hobbyist*: Many makers begin as hobbyists and, although they may have great social and financial aspirations, they have not achieved much development in terms of either sharing or commercialization. Many makers never make it beyond this stage, such as the grandfather using the Happylab Vienna facilities to make a toy castle for his grandson.

2. *Commercial enterprise*: All decisions are made with the main focus on profit maximization. Some proportion of users of Fab Labs and Makerspaces may attempt to develop in this way.

Figure 1.   Development trajectories of maker initiatives in terms of sharing and commercialization logics
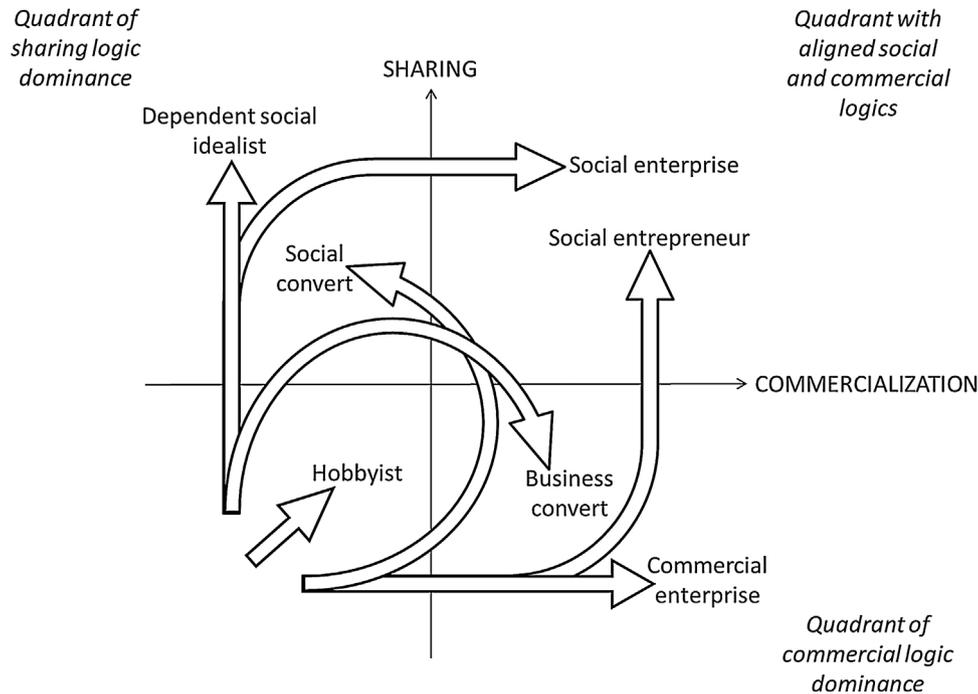
3. *Dependent social idealist*: Some maker initiatives achieve a great deal of sharing and develop their skills and competencies in this direction, very similar to the sharing that takes place within the Wikipedia community. In our cases, this is exemplified by the HRW Fab Lab example. These idealists would, in a purely market-driven environment, be unable to remain viable, and are dependent upon subsidy, voluntary donations of time, expertise or money, or other forms of shared support. Users of Fab Labs and Makerspaces often also rely on free advice and support from the lab's community and may give their product to friends and socially disadvantaged groups without a profit motive.

4. *Social convert*: A maker initiative may develop commercially only to change its course and make sharing the dominant logic. This may occur when the commercial activities remain incompatible with the feelings and ambitions of individuals within the organization, and there is no apparent way of reconciling both logics at the same time. Thus, the sharing logic takes over and the organization is likely to suffer financial losses. For example, the Arduino case experienced serious conflict when commercialization became too dominant and, eventually, the people involved agreed that their large, international community was their main focus and that the "only way to build a maker community around you is by sharing stuff" (Arduino staff member). As for

makers themselves, this path may be followed by those who fail to achieve their initial commercial objectives.

5. *Business convert*: When a maker initiative has advanced its sharing capabilities, but not its financial independence, it may revert to a commercial logic and abandon some or all of its sharing past. Create It Real is an example that started in the open source mode and has successfully switched to a closed, commercial focus. This is also typical for many maker projects that make use of the advantages of sharing for developing their ideas and knowledge, before 'going it alone' as a business venture. Typically despised by the maker community, an example of the business convert is MakerBot, which produces 3-D printers based on developments in the RepRap Project. MakerBot originally shared its resources following the free and open source model, but when it was acquired by Stratasys it stopped sharing and became a commercial enterprise.

6. *Social enterprise*: When a maker initiative succeeds in complementing its sharing capabilities and resources with commercial development, it may become a sustainable social enterprise (Chell, 2007). These makers begin as nonprofit organizations that share technological and social capital with a socially motivated goal. But then they land in the position of grant dependency

and require survival strategies for the longer term. When they successfully develop commercial, entrepreneurial capabilities without losing their sharing focus, they become self-sustaining social enterprises. Happylab Vienna appears to have developed along this path, having maintained a dual sharing and commercial position and expanded its model to other cities and countries. Again, the maker project Superbook is an example of how makers themselves can start out collaborating and develop along both dimensions to reconcile the two logics.

7. *Social entrepreneur*: It is possible for makers to start by developing commercial competencies and later adding sharing capabilities. Less common in the maker movement, this trajectory describes what is typical for social entrepreneurs or benefit corporations that, from day one, develop their own self-sustaining financial independence. In our cases, the RMN example most closely follows this type of trajectory, whereby the adoption of the sharing logic, through access to the network for local businesses and strong ties to the local vocational education institute, did not diminish the party's commercial drive.

6. Final thoughts

New digital fabrication technologies are enabling a new wave of citizen design, experimentation, and innovation. The entrepreneurial opportunities created in this way have great potential but typically suffer from the challenges of resolving motivations based around sharing and collaborative social benefit with those based around financial sustainability and commercialization. Many other organizational forms also face these tensions but, because of the sharing principles at the heart of the maker movement, maker initiatives offer a unique context for exploring strategies for coping with these tensions. The trajectories undertaken by the cases in this study offer a new framework for managers aiming to find their own path toward reconciling these competing logics.

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