FabLab – a new space for commons-based peer production

Isabelle Liotard

FabLab – a new space for commons-based peer production[1]

Isabelle LIOTARD
Université Paris 13
CEPN
99 avenue JB Clément, 93430 Villetaneuse
Isabelle.liotard@univ-paris13.fr

Key words: FabLab, innovation, collaborative economy, Do It Yourself

****

Over the last 20 years, companies' innovation practices have been revolutionised with the emergence of Web 2.0 and the possibilities offered by digital technology. Having paved the way with the concepts of open innovation (OI), Chesbrough (2003, 2006) and Von Hippel (2006) have conceptualised a trend that radically alters our classic design and research model. Challenging the traditional principle of innovation, which is internal and "closed", the concept of OI has shed light on brand new practices that aim to boost a company's innovative capacity through its relations and exchanges with the exterior. Even though this concept alone does not cover completely new tools (licence agreements or partnerships and networks are well-known mechanisms), it nonetheless remains that Open Innovation promotes new mechanisms that enable companies to open up to the outside world (in the widest sense of the term). Internet-based digital tools make it possible to create intermediation platforms and websites for companies whose aim is to seek out knowledge, skills and expertise beyond their own borders and beyond their well-identified circles of more or less direct partners (Liotard & Revest, 2017). The great strength of Web 2.0 is, then, to open the company up to the exterior, in the broadest sense because the "the exterior" now includes everyone (Internauts, students, employees, etc.), with the unprecedented characteristic of their having no previous connection with the company in question. Crowdsourcing now gives access to a great number of innovative proposals[2], and contributes to bottom-up forms of innovation.

However, these new practices are not the only ones to emerge, and other formats are now radically transforming innovation's traditional foundations. In particular, spaces known as FabLabs (FL) are currently springing up all over the world. This wave, instigated in 1998 by MIT professor Neil Gerhenfeld, has become widespread, and has led to the constitution of a network of FabLabs in both developed countries and the Global South[3]. Notably, these collaboration spaces, stemming from a desire to share knowledge and openings, call into question production (which becomes local), intellectual property (more open, based on open source files and pooling material), hierarchy (peer communities enable projects to be carried

[1] This research takes place in EnCommun program financed by AFD

[2] Flowers, Von Hippel, de Jong & Sinozic (2010), measuring rising innovations, esteem that there are probably 2 or 3 times more innovations originating from consumers than from industries themselves.

[3] Since 2003, spaces have been created in India, Kenya, Togo, Norway, etc. (Bosqué et al, 2014).

out and FabLabs are emerging as non-hierarchical, horizontal spaces), and lastly, the role of the individual in a certain number of initiatives.

These digital manufacturing spaces make digitally-controlled machines and 3D printers available, representing not only a possibility for decentralised production and design for individuals but also offering open production spaces for both small and large companies, which also go there to seek training.

The aim of this paper is to shed light on this new type of space and to define the different business models. It is based on a series of interviews we conducted between January and April 2017 with FabManagers from the Paris area and other regions in France.

1) FabLabs – where it all began: MIT's stroke of genius

In the beginning, the *Fabrication Laboratory* was devised at MIT by Professor Neil Gerhenfeld in 1998 and set up in 2001 with the help of his laboratory, the Center for Bits and Atoms. The aim of this initiative, (which at the start was a training module called *How to make (almost) anything*, teaching students how to use digitally-controlled equipment), was to pool in a single site equipment to craft and machine materials, and design electronic circuits and microprocessors. The idea, therefore, was based on learning how to use digitally-controlled equipment to manufacture other machines. It was an immediate success, and to Neil Gerhenfeld's surprise, the course attracted not only engineers but also architecture students and artists (Capdevila, 2015; Bosqué et al, 2014; Menichinelli et al, 2015; Mérindol et al, 2016).

Its origins are fundamental. On the one hand, the FabLab network was to spread beyond the United States, in particular to developing countries (in India and Africa), thus allowing populations who were not necessarily pro-digital to appropriate this type of space. On the other hand, the founders of MIT's FabLab were to spearhead an architecture created from scratch to organise and manage these third places, going on to set up the FabFoundation and FabAcademy[4], the two pillars supporting the network. The first structure streamlines and manages projects, publishes international FabLab conference archives online and is responsible for coordinating the different spaces; the second manages MIT's training programme for the community so that everyone shares the same grammar and the same principles. In this context, MIT trains the trainers (known as gurus) who will be responsible for training other people in a cascade model. In view of its two structures, MIT plays a central role in the global network of FabLabs. It is the driving force behind the MIT Charter, requested by countless spaces. From the very beginning, the training mission was selected as the system's cornerstone. In addition, MIT is involved in the conferences that are held on the subject every two years. In this way, the community of practice generated by MIT appears to be driven by a dynamic of institutionalisation insofar as the MIT model spreads to and is adopted by the whole world (Lhoste & Barbier, 2016).

[4] http://fabacademy.org/ and http://fabfoundation.org/

The MIT Charter

Four basic conditions are required to become an FL under the MIT's umbrella: (1) allowing public access to the space: FabLabs must make technology and equipment accessible to everyone. (2) subscribing to the FabLab charter (see Box 1) (FabFoundation). (3) sharing tools (a minimum is required, including 3D printers) and procedures. (4) being part of the global community of FLs and not remaining isolated. (http://fabfoundation.org/).

The MIT Charter (which can be found everywhere including on the FabFoundation site) covers a certain number of points. Having given a definition of the space, the Charter explains what should be found in the FabLab and the organisational and governance conditions of this space (what the responsibilities involve and who can use the space). In general, the stated objective of an MIT FabLab is not commercial, even though there are a few cases of projects developed in these spaces that have led to setting up companies. The charter stipulates that knowledge should be made available via open source and open design so that it can be used by anyone, and not bound by IP and patents. Commercial activity is possible, but there are conditions: "*Commercial activities can be prototyped and incubated in a fab lab, but they must not conflict with other uses, they should grow beyond rather than within the lab, and they are expected to benefit the inventors, labs, and networks that contribute to their success*".

There is no formal authorisation from MIT accepting a space as being connected with this charter. As a rule, spaces are asked to register on the Fab Foundation site and self-evaluate their compliance with the four criteria required by the Charter (Botollier-Depois et al, 2014). In actual fact, a FabManager we interviewed stressed the importance of peer recognition and cooptation for FabLab candidates. In order to receive this "approval" or "knighting", the space's founder has to be recognised by other FabManagers. The same goes for the team involved in the candidate site. Peer validation ensures the coherence of the site with regard to the Charter's expectations, and constitutes acceptance. As such, the international conferences held every two years are very important because they enable FabLabs to make themselves known to others and forge relationships with people in the community.

2) The FabLab: a workshop in the middle of town

A FabLab is a workshop designed to be open, shared and collaborative. Its objective is to offer a physical space with digital tools for shared use so that individuals can design and invent. This space thus means that extremely diverse objects can be designed, prototyped, manufactured and tested. The target for this type of workshop is very wide because, potentially, individuals, researchers, students, designers, artists and companies can come to the FL[5]. The workshop is offered so that individuals can progress rapidly from the concept to the prototype and then perfect a single product or series of products, sometimes with commercial perspectives (Eychenne, 2012; Rumpala, 2014; Bouvier-Patron, 2015). Digital manufacturing (in a general or specialised space) can have a great many applications and

[5] As we shall see later in the article, although the original FabLabs (MIT Charter) are destined for non-professionals, some of them target a more select public such as start-ups or even company employees (Company FabLab/Fablab d'entreprise, the Cap Digital project with avec EdFab, Draft and ICI Montreuil).

numerous sectors are concerned (Morel & Le Roux, 2016) including for robots, 3D printers, accessories, artistic objects, games, prosthetic devices and implants, the building trade and the arms industry. At the moment, the term FabLab is widely used – and sometimes misused… It can be confused with other types of spaces with a similar philosophy but different users or business models (Vallat, 2016) (Box 1). Likewise, within the large family of FabLabs, they may be differences among the spaces, which do not all integrate the same realities. We shall return to this point a little later.

Box 1: FabLab, Makerspace, Hackerspace, Techshop, Living Lab: Do-It-Yourself Spaces

The term FabLab has now become a common noun designating any digital design space (Bosquet et al, 2014). Nevertheless, it can assume several forms targeting various publics and objectives and thus take on different terminology. People also talk of HackerSpace, TechShop, MakerSpace, or co-working space (Eychenne, 2012, Capdevila, 2015, Bouvier Patron, 2015). For Mérindol et al (2016), Makerspaces and Hackerspaces are "open community spaces in which technology enthusiasts implement creative projects, discuss and learn in an often-digital universe designed to be open for appropriation or reappropriation by the user". It is a physical space for technological DIYers to exchange knowledge and skills and produce their own designs. TechShop is on a larger scale than a FabLab. It is a private space (and thus run by and for companies) where access is not open to everyone but granted via membership. Its equipment is more sophisticated. TechShop does not have a publication website as FabLabs do and each member is free to publish on his/her own website. Menlo Park TechShop in the United States is an example. In France, the Leroy Merlin TechShop opened in 2015. Living Lab is a real-size laboratory in which a group of multidisciplinary experts develop, deploy and test new technologies and strategies in response to global transformations. It involves more than just digital manufacturing, and encompasses spatial and social projects (Mérindol et al, 2016; Berthou & Picard, 2017). The aim of co-working spaces is to overcome independent workers' isolation and these spaces are often included in FabLabs' package of services (Vallat, 2016).

With the FabLab and Makers movement being relatively recent, it is too early to present the effects of this different form of innovation and production. As Menichelli et al (2014) point out, there are 4 possible levels of interpretation. (1) FabLabs can be seen as private spaces whose users are a handful of makers rebelling against the standard production format; (2) They can be considered as an innovation in technological education, allowing for "learning through practice"; (3) These spaces can be interpreted as a fun and contemporary crossroads between art, science and engineering; (4) Lastly, according to Anderson (2012) and Rifkin (2011), FabLabs represent the "new industrial revolution" with, as their mainstay, the aim of empowering individuals and automating objects, abandoning mass production in favour of limited, local productions and offering individuals the freedom to participate in scientific research. From this perspective, this type of space helps reduce the head-on opposition between "knowing" and "doing", leading Monpère (2016) to evoke the notion of augmented craftsmanship: FabLabs, as micro-factories in the middle of town, allow designers and craftsmen and women to appropriate digital knowledge to rethink their practices, and to work jointly with specialists from other fields (engineers, coders, etc.).

The exponential growth of the number of FabLabs proves a keen interest in these spaces, whether from cities, companies or universities; the number of FabLabs in the world has greatly increased over recent years. Nevertheless, data are still somewhat irregular because some studies include all FabLabs in general while others count only those that fall within the scope of the MIT Charter. The FabFoundation site points out the existence of a network of 1,092 FabLabs in approximately 40 countries[6] (this figure doubles every 18 months according to one of our contacts). The Makery site declared 551 of them in February 2017[7] and the report by Mérindol et al (2016) counted 364 of them in 2015.
France ranks second for the number of FabLabs, behind the United States (Menichelli et al (2015), Makery site). This is confirmed by the figures supplied by the FabFoundation, according to which, in 2017, the United States had 145 sites, France 138 and Italy 131. In Europe, some of the first FabLabs to be set up launched a movement that became widespread, as illustrated by the initiatives developed in Barcelona, Toulouse and Grenoble. The first European FabLab appeared in Barcelona in 2007 under the auspices of Tomas Diez (architect) in collaboration with the IAAC School of Architecture (Bosqué et al, 2014). The main idea involves implanting different FabLabs in several districts in the city to encourage entrepreneurship and innovation. Since then, the project has taken off in the city and now represents the notion of FabCity, in which digital manufacturing spaces serve the city and its needs in terms of energy, construction, etc., and work on ways for Barcelona to be self sufficient for a certain number of elements. One of the famous examples is the FabLab House, a self-sufficient building capable of producing its own energy and food. There are now 4 FabLabs in the city, each with a specific theme (energy production, building smart hives, etc.).
Artilect and the Casemate were the first FabLabs in France (2009), set up in Toulouse and Grenoble. Artilect is a pre-incubation site whose aim is to offer the space economic viability (by leasing its machines and services). It currently has approximately 800 members including students, engineers, technicians, architects and biologists (Bosquet et al, 2014; Menichelli et al, 2015).

3) The project: digital manufacturing, exchange, learning commons and training

The "political" project of this type of system should be seen in conjuncture with the pooling of knowledge and skills between FabLab users, usually via open source. The goal is to encourage interactions between individuals; exchanges are numerous and enriched by the experience and knowledge of others. FLs therefore contribute to DIY insofar as they provide material assistance and an IT ecosystem to those who come with nothing but their ideas and intuition, and who proceed to realise them themselves (Box 2). Ultimately, with spaces such as these, the "inventor" re-appropriates his/her invention and control of it by personally

[6] http://www.fabfoundation.org/index.php/fab-labs/index.html
[7] http://www.makery.info/map-labs/

supervising the transition from the idea to its production in a limited series (Anderson, 2012). He/she becomes a consumer-producer (Rifkin, 2014), the main actor in its creation and production, and thus experiences empowerment. In this way, FabLabs encourage creativity and innovation (Suire, 2016; Mérindol et al., 2016; Lhoste & Barbier, 2016). Another prevailing aspect of FabLabs depends on their local dimension and integration in an area (Manzo & Ramella, 2015; Rumpala, 2014). Very often, the objective is to deploy local resources to satisfy a local need for production and training. This is true to an even greater extent in FabLabs in the Global South: for example, sites in French-speaking parts of Africa set up major training programmes for young people and schoolchildren in the aim of introducing them to what could become a source of employment in the future, helping them move away from the aimlessness, poverty and delinquency of their neighbourhoods. Other African FabLabs focus on training for women so that they create employment and economic activity (these spaces assume a strong economic and social dimension). This aspect is emphasised in the MIT Charter according to which *“labs enable invention by providing access to tools for digital fabrication”* (Menichelli et al, 2015). Beyond this, in some African countries, FabLabs are a key factor to an approach that makes innovation possible in difficult or even hostile conditions, being based on resourcefulness (see Togo’s FabLab[8] based on recycling to make 3D printers) (see Radjou & Prabhu, 2015, for an analysis of frugal innovation). In this way, these spaces - in addition simply to making digital tools available to facilitate design and innovation efforts - also represent another development path to which Global South countries have access (World Bank Report, 2014).

FabLabs are therefore not only technical platforms but also assume a social and economic dimension, and are capable of shaking up traditional production formats. As Rumpala (2014) points out, with FabLabs, we are witnessing a kind of deconcentration of production: smaller units are being created, unlike 20th century industrial workshops. Large investments are no longer mobilised thanks to the performance of digital equipment and the possibilities now offered by 3D printers. An “economy of contribution” is said to be emerging (Bosqué et al, 2014). Production can now be carried out at a lower cost with the help of technologies (processing, storage, data transmission) that have reduced marginal costs and the constraints of communications between individuals (Altman, Nagle & Tuschman, 2013). To summarise, this third space is a space that enables people (i) to make (ii) to bring to fruition their ideas (iii) to pool knowledge, resources and skills (iv) to make the most of training and teaching tools and (v) to solve problems on a local scale (Le Roux & Morel, 2016).

[8] The Woelab in Togo was created in August 2012. Its founder, Sénamé Koffi Agdodjinou, is still its manager. The objective is to offer a space devoted to design and manufacture that helps launch start-ups (11 have already been incubated). Sénamé is from the world of design, history of art and architecture. In 2010, he set up the Africaine d’architecture, the aim of which is to promote creations in this field. The current team is made up of 3 people who take it in turns to fill the different roles of executive manager, fabmanager and community manager. The project had no financial backing. In the beginning, the FabLab was equipped with a RepRap (self-replicating 3D printer), computers and small DIY tools. A few 3D printers, made using RepRrap, complete the equipment. The space is open to anyone and totally free. It offers courses for children in 3D printing and coding.

Box 2: Commons-based projects

A FabLab workshop is made up of a set of pooled digital machines available to the public in the aim of offering professional material to amateurs (Eychenne, 2012). For example, the workshop will have CAD and CAM software, laser cutting machines (for parts in wood, chipboard, leather, cardboard, etc.), digital milling machines (for sculpting complex objects in thick materials), digital rippers (more powerful than milling machines), 3D printers (for making complex parts from plastic and bioplastic, moulds and models), vinyl cutting machines (for cutting paper, card, vinyl, textiles, copper film for circuit boards) and sometimes even more specific equipment (plasma cutter, electronics workshops, machines to prototype circuit boards, and 3D scanners; Diwo-Allain, 2015). Some spaces are better equipped than others. Some of these machines mean that MIT Charter certification can be obtained. ICI Montreuil is one of the largest spaces in the Paris region (1800 m²) and, for example, is equipped with a great many highly-specialised machines for many different trades. What's more, since FabLabs are part of a network, other types of commons-based projects can be implemented. Saclay's Digiscope mainly receives students working on research projects, and functions as a network with other spaces such as Stanford's FabLab, for example. Our interviews underscore the cooperation between these FabLabs, especially for educational projects and training. For example, EdFab offers training sessions in digital manufacturing jointly with the ICI Montreuil's FabManagers who are already well ahead in this field. Rennes' LabFab responded to a call for tender from the Paris Region and the Paris City Council jointly with ICI Montreuil to develop a five-month vocational training course with MOOC.

FabLabs' commons-based components and files: Arduino, RepRap, Raspberry Pi, Jerry Do-It-Together in Africa

With FabLabs being part of a network and supported by a community, founding projects play an important role in the network's structuring and development, as illustrated by the RepRap and Arduino projects. The principle is to share files within the network to form the basis of future innovations that are constantly being improved.

Arduino is an open source device. It is a miniscule circuit board combined with a microcontroller that enables amateurs and professionals to build devices that interact with their environment using sensors and actuators. The aim is, therefore, to give intelligence to objects such as thermostats, watering systems, irrigation, and artistic installations. Arduino plans can be used for free by anyone. The technology costs only 3 euros. From the very beginning, Massimo Banzi, whose project it was, wanted something simple to allow anyone simply to use the technology. Arduino enjoys the support of a strong community and documentation in all languages so that it can be transmitted. It is also used to build, for example, 3D printers, milling machines and laser cutters. Online courses are available so that people can learn how to use the equipment.

The RepRap project makes files available that enable a 3D printer to print most of the parts for another 3D printer. It therefore involves the principle of replication (this also exists for

other machines). De Jong and de Bruijn (2013) conducted a survey of the RepRap community and its 384 members. The study highlights the fact that members who are very connected to the community and have a lot of experience in building machines are those that innovate the most. The transmission of innovations in the community correlates strongly with the profile of the member instigating the innovation.
Raspberry Pi is a minimalist computer. It is reduced to a single circuit the size of a credit card and can be connected to any screen, keyboard, or mouse (developed by the University of Cambridge). It has proved to be extremely useful for a great many applications in agriculture, home automation, heath and communications. Raspberry Pi users have created all kinds of things such as game consoles, alarm systems, etc. (Radjou & Prabhu, 2015; Bosqué et al, 2014). An inexpensive variant is the Jerry computer developed in Africa (our interviews; Fagbohoun, 2016): placed in a jerrycan (hence its name), the computer has a very simple design and is mainly intended for use in schools.

4) FabLabs' economic models

The interviews[9] we conducted give us a better understanding of the FabLab environment, their diversity, and their different economic models, corroborating existing studies that state this reality. The report by Bottolier-Depois et al (2014) for the Ministry of the Economy, Industry and Digital Technology, based on a survey carried out in France and abroad, draws attention to a wide diversity in terms of legal frameworks[10], the type of target public, the type of workshop and the mode of funding. Eychenne (2012) categorises FabLabs into three groups. According to the author, FabLabs are (i) educational, (ii) "private business", or (iii) "general public pro/amateur".

(i) Educational FabLabs are linked to higher education establishments, e.g. the University of Cergy's FacLab (Nedjer-Guere & Gagnebien, 2015) or Rennes' LabFab. The target public is mainly students but these sites also receive all types of public (e.g. young or retired people) during an open and free slot in the week (Open Labs). These sites have an MIT Charter reference.

(ii) "Private-business" FLs are spaces supporting the interests of the companies that set them up, whether well-established firms, start-ups or even self-employed entrepreneurs. Several companies have now opened their FabLabs internally, e.g. Renault's Creative People Lab or EDF's I2R. These company FLs (Lo, 2014) are based on the need to cultivate employees' collective intelligence or collective innovation. In this type of space, only the company's employees (and not the general public in the widest sense) are invited to collaborate amongst themselves and foster innovative potential with their ideas. In the rest of our study, we shall not take into consideration this type of site, being limited to the perimeter of the company. The aim of these initiatives is to stimulate exchanges between different members of staff and encourage creative approaches that will undoubtedly give rise to projects. These company

[9] The interviews were conducted from January – April 2017 with 5 FabManagers of sites set up in the Paris Region and provinces. The data we gathered was supplemented by analyses of reports and studies.
[10] In terms of legal frameworks, 46% of FabLabs are associations, 17% are set up in universities, 23% by private companies and 4% are run by local authorities.

FabLabs also contribute to the development of knowledge management and knowledge transfer between employees (Nonaka & Takeuchi, 1995).

(iii) “General Public and Pro/Amateur” type FabLabs are sites backed by governments, development institutes or local authorities and private financers. They are neither situated within universities nor companies. They are open to the local area for various users and are set up in the middle of cities to be as close as possible to its needs. They offer services that may be either free or fee-paying, following a hybrid economic model.
It is worth looking at this last category of third spaces more closely because, as we have seen in interviews, they are extremely diverse. FabLabs can be distinguished by target public, surface area, type of equipment on offer, type of membership, the possibility or not of free slots for everyone and the type of funding used to open the space. Some of them are not open to the general public and do not, therefore, offer free slots (ICI Montreuil, Usine IO, and Draft). Some FabLabs are created under the auspices of a competitiveness cluster but are also not open to the general public (EdFab). Funding sources may be different from one FabLab to another and may be hybrid (Draft). Lastly, some FabLabs play an incubation role (Usine IO).

5) Initial analyses

The diversity of FabLabs and their different characteristics help draw attention to the sites' various economic models. Without an economic model, they cannot survive unless they receive permanent public funding. The configurations we observed during our interviews (Table 1) point to two major possible models: (i) the free, educational, MIT Charter FabLab; (ii) the fee-paying FabLab, focused on start-ups, projects and training. Nevertheless, certain FabLabs combine the two formats by setting up some services that are free (e.g. free Open Lab days to publicise the site) and some that charge fees (Eychenne, 2012).

Hybrid funding to set up sites

Our interviews show that spaces often combine their sources of income (public and private funding), thus corroborating the study conducted in 2014 by Bottollier-Depois et al. In the sample of respondents taken into account in this study, half had benefited from public subsidies and half had not. The majority of workshops had been funded by the founders' own funds (53%). 47% of the workshops had received donations (from their close networks). 22% had received funds via crowdfunding, 18% had received funds from partner companies and 16% from investment funds.

The interviews we conducted drew attention to hybrid funding solutions among the various possible sources of funding. An interesting example is the Draft workshop in Paris. The two founders of the site (opened in 2014) obtained hybrid funding of 130,000 euros to set it up: own funds, classic bank loan, leasing for the machines, zero-interest loan and fundraising via KissKissBankBank (KKBB). ICI Montreuil, which opened in 2012, received very little public funding (5% from Montreuil's local council) at the start of the project. Its founder contributed private funds to the tune of 20% of the total amount and the rest was covered by Love Money from large companies, banks and artists (including SG, Bouygues, Renault and Sony). A grant was also obtained by winning a contest via France Active.

For spaces that received public funding, the study conducted by Mérindol et al (2014) highlights the fact that the French Tech programme launched in 2013 to support France's digital ecosystem enabled Usine IO, for example, to benefit from public funding. This FabLab, set up by three founders in 2014, provides an example of yet another combination using funding from an angel investor and large companies. FabLabs are set up with help from public authorities that guarantee their funding, especially at the start of the project. Nonetheless, the sites must plan how they will then sustain themselves and find their own means of funding. The University of Cergy's FacLab set up a fee-paying University Diploma (3,000 euros per person) connected to a new profession (facilitator), the enrolments for which make up a large share of the site's funding. It also received financial support from the Orange Foundation and appeals for donations via its website. Rennes' LabFab, set up in 2012, received the backing of Rennes Métropole, which provided both financial and human resources. It also counts on developing MOOC and on partnerships for specific requirements (responding to calls for tender in collaboration with other FabLabs).

A differentiated public

The widespread view that FabLabs are open to anyone needs to be confronted with the reality of the facts. Although educational FabLabs have a genuine desire to be open to every category of the public, this is not the case for private structures. More specifically, the vocation of the former is to welcome a wide public (pupils, young people, students, retired people, job seekers, employees, etc.) so that they can discover digital manufacturing, try out machines, exchange knowledge, even tinker/hack, and to allow people changing careers to regain their self-confidence. This type of site therefore assumes an educational and social dimension. It creates a bridge between the world of digital manufacturing and the general public, offering training sessions given by members of the FabLab's team or by people using the site. In this way it forges bonds and fosters exchange. Users are thus users of the site but also occasionally its trainers. Giving one's time, running a workshop, contributing to a training course, and helping assemble a machine are a few examples of tasks that a FabLab contributor is likely to carry out in exchange for using the site. The aim of the space is to create connections by enabling people to meet, transmit their knowledge, and come together to work on projects (to design, make and learn collectively, as the FabLab announces). Open Lab slots are scheduled so that anyone can come and experiment with digital manufacturing.

The vocation of the second category of FabLabs (fee-paying, with a specific public), on the other hand, is to run a workshop for projects to create start-ups and companies, and providing training opportunities. As soon as membership is payable rather than free (there are menus of fees depending on the type of services on offer)[11], these sites are not open to a wide public but to: (i) people wishing to develop their idea and prototype it; (ii) artisans and artists wishing to use the equipment and exchange with people from other professions to enrich their projects; (iii) freelance professionals (e.g. designers and architects); and (iv) employees of large companies coming to train in digital manufacturing and possibly produce limited series of objects. Usine IO hosts 300 projects a year: 70% are startups, 20% are collaborators from large corporations and 10% are independent users (designers, architects, students, etc.). Collaborators from large corporations come to develop their projects and prototype them. At ICI Montreuil, there are 63 skills (craftsmanship, design, etc.) and approximately 150 residents, spread over a space of 1800 m². EdFab, set up by the competitiveness cluster Cap Digital, opened its doors in March 2017. Located in La Plaine Saint Denis in MSH Paris Nord premises, EdFab's mission is to host companies (large and small, as well as start-ups) and other professionals (schools, etc.).

Fee-paying services central to the business model v. raised awareness of local needs

Educational spaces such as the FacLab or LabFab do not ask for a membership fee from participants, or only a symbolic sum. Cergy's FacLab asks a €5 enrolment fee, for example. This approach squares with the desire to be an accessible space for as many people as possible, including schoolchildren. Supported by public funding, these sites nevertheless have also found a sustainable business model by means of associated fee-paying diplomas (see above) and projects set up with local actors such as city councils (introduction to digital

[11] http://www.icimontreuil.com/les-tarifs ; https://ateliers-draft.com/paris/forfaits-abonnements ; https://www.usine.io/abonnements/

manufacturing for schoolchildren, etc.). These sites can also act as the interface between external requests for services and FabLab participants. The space works as a go-between for a request (company, public stakeholder, etc.) and the skills of its contributors. The contributor is remunerated and the site takes a commission from the sum paid by the buyer.
Private spaces offer equipment rental, the possibility of privatising the space and production on demand, a range of services (in response to requests from companies for training or production: Draft, ICI Montreuil), co-working space, etc. They offer training sessions and courses. Assistance may be given to advise companies for prototyping, or to provide support for incubator projects or respond to national or international calls for tender. All these services are fee-paying and can be found on the FabLab website's price list. These sites thus assume an economic dimension and are developed according to well-defined business models that help ensure their sustainability. In addition to standard training to teach people to use digitally-controlled equipment, other very "business-focused" training may be offered (how to draw up a business plan, setting up public relations, how to carry out a digital project, design thinking, etc.) as is the case at ICI Montreuil and EdFab. These training courses are offered either by FabLab staff and residents depending on their skills and knowledge (ICI Montreuil[12]) or partly by external trainers (Draft, Usine IO). Some FabLabs even play the role of incubator and provide specialised support for people with projects, as illustrated by the case of Usine IO. The stated objective is to support the transition from the idea through to its industrialisation and accelerata project hardware[13] and offer contacts with manufacturers who may be interested in the project. This expertise raised 40 million euros in 2016. Other fee-paying services supplement the business model, such as leasing co-working space, leasing rooms, providing contacts with the network of FabLab manufacturers, etc. Draft offers training in digital manufacturing for employees of large companies who wish to create small series for marketing or promotions, depending on the needs of their structure. EdFab has a dual objective: (i) to offer advice and support to people with projects from the training and education sector. EdFab supplies the site, equipment (two 3D printers and a laser cutting machine, command post for modelling software), training, and the opportunity to benefit from a panel of testers for prototypes; (ii) to act as the interface between companies requesting training for their employees and suitable service providers (from the centre's network of 1,400 members).

Partnerships and projects

Rennes' LabFab team is at the cutting edge for setting up MOOC for digital manufacturing. There are currently around 36,000 people enrolled throughout the world for these training courses, with a completion rate of 16%. The lab also works in partnership with ICI Montreuil and the Petit FabLab de Paris (following a call for projects from the Paris Region and the City of Paris) to devise professional training sessions (in partnership with Pôle Emploi). For 5

[12] At ICI Montreuil, training is given by residents themselves depending on their skills and knowledge (wood, metal, leather, paper, plastic, etc.). ICI is responsible for linking those offering training (residents) and those requesting it: remuneration for the training is divided with 2/3 for the trainer and 1/3 for ICI.
[13] To date, these projects developed in FabLabs have taken off: Timescope (virtual binoculars so that a site can be seen as it was in the past); Stanley Robotics prototyped its automated car garage system for Aéroport de Paris.

months, partly classroom-based and partly distance learning (MOOC), people will be able to train in different fields (maker entrepreneur, embedded computer coding, modelling, electronics, how to use equipment, connected devices, etc.) with the possibility of specialising afterwards.
ICI Montreuil also helps other partners, e.g. Cap Digital for training courses, or Usine IO.

Specific structures

FabLabs are of different sizes and thus require different organisational structures. Spaces such as the FacLab Draft are small spaces in which the founders, the FabManagers, play a major role in the system and have a small permanent team (reception, training, contact with external stakeholders etc.). Larger FabLabs (Usine IO or ICI Montreuil) have larger teams and have institutionalised certain practices. At Usine IO (16 permanent staff and 8 experts), the post of expert was created (they can be identified on site by their orange jackets) to provide support for people with projects so that they can benefit from the experience gained by the experts in the past when they themselves created start-ups or carried out projects.
The structure of each site is based on a certain number of rules to be respected, whatever the size of the FabLab. There are "hard" rules and soft ones. Safety regulations are indispensable when using potentially dangerous equipment such as laser cutters, milling machines and 3D printers. When receiving a new person, the FabManager checks his/her competence to use the machines and may even ask for a level of certification (for very specific machines at ICI Montreuil e.g. when working with steel). Training sessions are offered at this stage. After this, organising safety regulations can be left to each FabLab workshop to define. For example, ICI Montreuil's wood and steel workshops are in charge of their own safety measures and manage this in accordance with the principle of trust. People who work there take responsibility for keeping a well-meaning but watchful eye on the correct running of the workshop. In addition, other types of regulations (hours, use of space, use of equipment, tidying up, etc.) complete the organisational structure.

Conclusion

Based on these initial findings, it can be observed that numerous FabLab models exist, and therefore a wide range of structures and economic models. Many sites are also halfway between being for-profit and not-for-profit organisations. These initial findings (which would be worth developing in greater depth with further interviews) are in line with the analysis by Menichinelli (2015) for which 4 main economic models coexist: (i) The facilitator model; (ii) The educational model; (iii) The incubator model; and (iv) The duplicated network model. In light of our preliminary observations, free, open, MIT-Charter FabLabs generally fall under the category of a model that is both facilitator and educational. Fee-paying FabLabs generally follow an incubator model but also have an educational and training objective. The borders between categories are porous.
Research will continue by analysing the connection between FabLabs and learning commons. Although some sites appear to resemble learning commons (with equipment made available, courses organised to spread knowledge, work carried out jointly to install equipment or carry out a project, open access and network documentation), this is not necessarily the case for other FabLabs, which have a less open and more mercantile approach.

References

Altman, E, Nagle, F, Tushman M (2014) innovating without information constraints: organizations, communities, and innovation when information costs approach zero, WP 14-043, Harvard Business School
Anderson, C (2012) Maker : the new industrial revolution, Crown Business.
Bosqué, C., Noor, O., Ricard, L. (2014) Fablabs, etc…Les nouveaux lieux de fabrication numérique, Eyrolles.
Bottollier-Depois, F. (2012) Fablabs, makerspaces : entre nouvelles formes d'innovation et militantisme libertaire, Cahier de recherche de l'observatoire du Management Alternatif, HEC., août
Bottollier-Depois, F. , Dalle, B., Eychenne, F., Jacquelin, A., Kaplan, D., Nelson, J. , Routin, V. (2014) Etat des lieux et typologie des ateliers de fabrication numérique, FING, conseil et recherche, rapport d'étude pour la DGE.
Bouvier-patron, P. (2015) Fablab et extension de la forme réseau : vers une nouvelle dynamique industrielle ? Innovations, n°41
Burret (2014) Étude exploratoire des Tiers-Lieux comme dispositif d'incubation libre et ouvert de projet, XXiiie conférence de l'AIMS
Capdevila, I. (2015) Les différentes approches entrepreuneuriales dans les espaces ouverts d'innovation, Innovations, N°48
Diwo Allain, S (2015) Propriété intellectuelle et fablabs : quelle gestion de la propriété intellectuelle dans les fablabs et plateformes ouvertes de création numérique : propositions de pistes de réflexion, in La propriété intellectuelle et la transformation numérique de l'économie, INPI.
Eychenne, F. (2012) Fab Lab tour d'horizon, FING
Fagbohoun, S. (2016) innovation frugal, effectuation et fablabs : pour penser l'innovation différemment, Innovations, n°3, pp 27-51.
Flowers, S., Von Hippel, E., De Jong, J., Sinozic, T. .(2010) Measuring user innovation in the UK, NESTA
Gershenfeld, N.A. (2005) Fab : the coming revolution o your destok-from personal computers to personal fabrication, Basic Books.
Hiescher, S., Smith, A. (2014) Community-based digital fabrication workshops :a review of the research literature, SPRU working paper series, 2014-08
Is there Room for a Hybrid Innovation Ecology?
Le Roux, S. (2015) The intangible economy: fablabs "individualized production of objects". A stage in liberating the function of innovation, Journal of Innovation Economics & Management, vol 2 n°17, pp99-116.
Lhoste, E. et Barbier, M (2016) Fablabs : l'institutionnalisation de tiers-lieux du « soft hacking », Revue d'anthrologie des connaissances, vol 1, pp 43-69.
Lo, A. (2014) Fablab en entreprise : proposition d'ancrage théorique ; XIIIe conférence de l'AIMS
Manzo, C. et Ramella, F (2015) Fab Labs in Italy: goods in the sharing economy, Stato e Mercato, n°105, décembre.
Menichinelli, M. , Bosqué, C., Troxler, P., Raspenti, C. , Neves, H. (2015) Fab Lab, la révolution est en marche, Pyramyd.
Merindol, V. et XXX (2016) le livre blanc des Open Labs, Paris School of Business

Monpère, B. (2016) L’artisanat augmenté : conceptions, enseignements et pratiques d’un art numérique appliqué aux métiers de l’artisanat, Réalités Industrielles, mai, p 62-65.
Morel, L, Le Roux, S. (2016) Fab Labs l’usager-innovateur, ISTE editions.
Nedjar-Guerre, A. et Gagnebien, A. (2015) Les FL étude de cas : le faclab de Cery-Pontoise (Agora) n°69
Radjou, N, Prabhu, J (2015) L’innovation frugale, comment faire mieux avec moins, Diateino.
Rifkin, J (2011) The Third industrial revolution, Pelgrave MacMillan.
Rumpala, Y. (2014) Fab labs et makerspaces : entre innovation et émancipation ? Revue internationale de l’économie sociale, n°334
Suire, R (2016) La performance des lieux de cocréation de connaissances : le cas des fablabs, Réseaux, vol2 n°196, pp81-109
Troxler P. (2010) Commons-based Peer-Production of Physical Goods
Troxler, P (2013) Making the 3rd Industrial Revolution : The Struggle for Polycentric Structures and a New Peer- Production Commons in the Fab Lab Community
Troxler, P , Wolf P (2010) Bending the rules: the fablab innovation ecology
Vallat, D. (2016) Que peut-on apprendre des tiers-lieux 2.0 ?, XXVIe conférence de l’AIMS, juin, Lyon, France.
Garcia Saez, C (2016) (Presque) tout reste à faire ; un regard social et éducatif sur les fablabs et le mouvement des makers, Fondation Orange