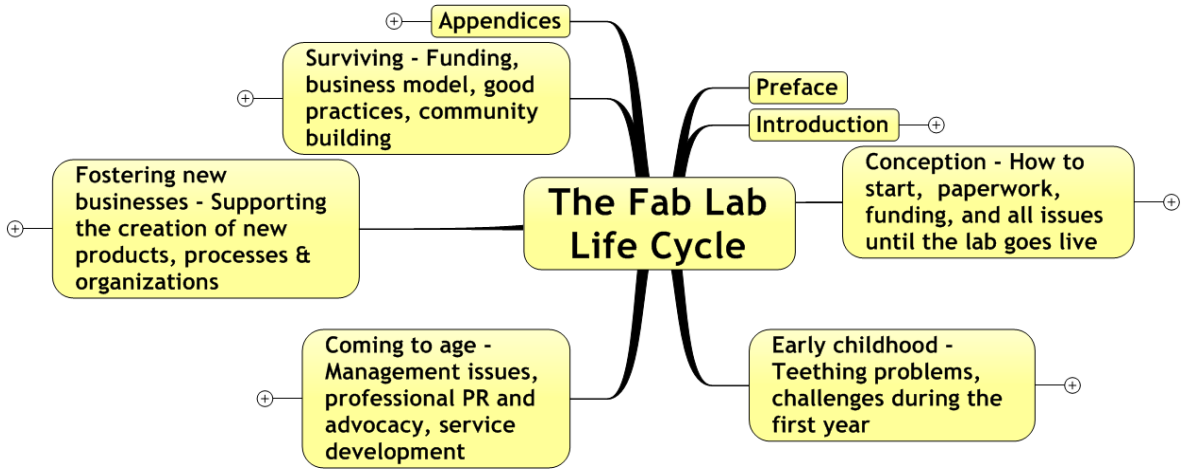

The Fab Lab Life Cycle

Report of the FAB10 Workshops

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Preface

During the 8th International Fab Lab Conference FAB8 in Wellington (New Zealand) (2012), Victor Freundt, Beno Juarez, Lindi Mophuti and Pieter van der Hijden created and facilitated a "Fab Lab Life Cycle Workshop". For the FAB10 conference in Barcelona (Spain) in July 2014, Pieter van der Hijden and Beno Juarez developed an updated version of this workshop. It was run twice during Fab10: once for participants involved in local Fab Labs, once for participants from a World Bank group involved in education policy making and large scale projects in developing countries. Pieter van der Hijden facilitated both editions. Beno Juarez acted as a mentor, together with Enrico Bassi, Klaas Hernamdt, Massimo Menichinelli, Dirk van Vreeswijk, and Anna Waldman-Brown. These mentors served as resource persons for the different stages of the Fab Lab Life Cycle.

Both editions of the workshops resulted in many notes, conclusions, and comments. We combined and edited them and filled some blanks, with this report as result. It might be of interest for non-participants as well.

We focus on the average Fab Lab, i.e. a Fab Lab with an initial investment in machines, tools and materials / components of 50,000-100,000 USD. Grassroots Fab Labs often have to work with only a fraction, say 10% (!), of this amount of money. Although some of the concepts we are dealing with may sound exaggerated for grassroots Fab Labs, we are convinced that in the end this report might be of value for them as well.

The report starts with a chapter "Introduction". It summarizes the Fab Lab background, concept and network. The report continues with five chapters, one for each of the Fab Lab life cycle stages we distinguish:

- Conception - How to start, paperwork, funding, and all issues until the lab goes live;
- Early childhood - Teething problems, challenges during the first year;
- Coming to age - Management issues, professional PR and advocacy, service development;
- Fostering new businesses - Supporting the creation of new products, processes and organizations;
- Surviving - Funding, business model, good practices, community building.

In the Appendices, you will find the References and some Workshop details.

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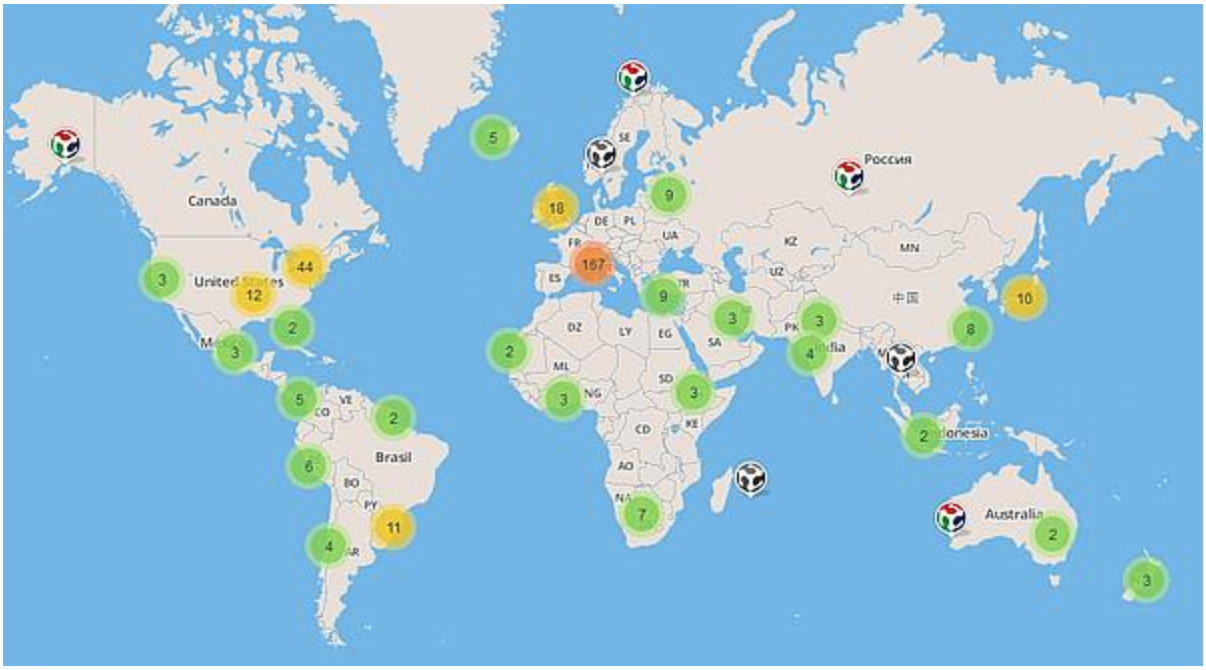
1 Introduction

Picture: Vigyam Ashram, Pabal, Pune, India - one of the first Fab Labs (http://vigyanashram.com/)

This chapter recalls the history of the Fab Lab, presents the Fab Lab concept and related concepts in the "maker movement", and gives an overview of the Fab Lab network consisting of people, Fab Labs, and supporting organizations at regional or global level.

1.1 Background



Screenshot: Fab Labs World Map (6 September 2014); http://www.fablabs.io/map

In 2001, the Center for Bits and Atoms (CBA) at the Massachusetts Institute of Technology (MIT), led by Prof. Dr. Neil Gershenfeld, started a study into the computational capacities that are inherent to physical systems. For that reason it set up a first laboratory for digital fabrication, also known as "Fab Lab" (Fabrication Laboratory). As an interdisciplinary educational outreach programme, the CBA supported the setting up abroad of a small number of similar Fab Labs, to be able to do further

research into the effects and possibilities of making accessible the computational capabilities of the physical layer. The Fab Lab concept quickly became popular among users outside the research domain, and an international network of similar Fab Labs came into being that were all active in the areas of research, education and application of personal digital fabrication. These Fab Labs cooperate with local communities, universities and (international) governments. Neil Gershenfeld described his work in "Fab: The Coming Revolution on Your Desktop - from Personal Computers to Personal Fabrication" (Basic Books, 2007).

Ten years later (2011), the international Fab Lab network consisted of over 50 Fab Labs in 16 countries, made possible by hundreds of staff members (paid and volunteers). Again three years later (2014), 373 Fab Labs have been registered in 63 countries. These Fab Labs use more-or-less the same tools and processes and maintain an international infrastructure for co-operation in digital design and fabrication. Many local staff members have attended the "Fab Academy" (http://www.fabacademy.org) on "How to make (almost) anything)" directed by Neil Gershenfeld and distributed worldwide via teleconferences and local Fab Lab sessions every year.

In the meantime related concepts developed, like maker spaces, hacker spaces, techshops, maker faires, repair cafés and tools libraries:

- **Makerspaces** (http://makerspace.com/) originate from the Make Magazine (http://makezine.com/). The same is the case with the (Mini) Maker Faires (http://makerfaire.com), the Makercon conferences (http://makercon.com) and the Maker Shed web shop (http://www.makershed.com/). For more information on makerspaces, see "Makerspace Playbook, School Edition" (http://makerspace.com/) and "The Makerspace Workbench" by Adam Kemp (http://it-ebooks.info/book/3134/).
- **Hackerspaces** started out as software-focused, but these days many of them operate more like makerspaces or fab labs, although they generally don't have official affiliations with other networks (http://hackerspaces.org/wiki/). For more information, see "How to start a hackerspace" by Eric Michaud (http://bit.ly/hackerspace-howto).
- **Techshops** are commercial workshops (http://www.techshop.ws/). Compared to Fab Labs, they have an extensive set of machines and tools and offer many courses to their visitors. Techshops charge their visitors a monthly fee of USD 100 and gives them free access to the machines and workshops and to their courses in return.

Together, the growing list of Fab Lab related concepts are called the "maker movement". In “Making It; pick up a spot welder and join the revolution” Evgeny Morozov sketched a critical historical perspective starting with the (American) Arts and Crafts movement (The New Yorker, 13 January 2014); see http://nyr.kr/1AQl4Zk. Deloitte, a worldwide consulting group, analysed this movement and published "A movement in the making" in 2013 (http://bit.ly/1qaQUys) and "Impact of the maker movement" in 2014 (http://bit.ly/1vt81im). The Economist refers to it now and then and focuses on the underlying technologies of digital fabrication. See "The third industrial revolution", an often cited section in The Economist of 21 April 2012 (http://econ.st/XokGEK), and followed by "Rise of the robots" on 29 March 2014 (http://econ.st/1sXHjMs).

A recent development and partially spawn from the maker movement are the biohackers with their "Wet Labs", i.e. open life sciences communities lab. See "Biohackers of the world, unite" in The Economist of 6 September 2014 (http://econ.st/1uDAgrK). CBA/MIT is involved with this mutant as well. It is planning a second Fab Academy program titled "How to grow (almost) anything” by George Church (Harvard) and David Kong (MIT Lincoln Lab), starting 2015.

1.2 Fab Lab concept

Screenshot: Video "What is a Fab Lab in three words" by Susarottenmeier, 2009;
http://youtu.be/nOPGJ2VBCPo

The Fab Charter in the text box below gives a detailed view on the central concepts.

FAB CHARTER

What is a Fab Lab? - Fab Labs are a global network of local labs, enabling invention by providing access for individuals to tools for digital fabrication.

What's in a Fab Lab? - Fab Labs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared.

What does the Fab Lab network provide? - Operational, educational, technical, financial, and logistical assistance beyond what's available within one lab.

Who can use a Fab Lab? - Fab Labs are available as a community resource, offering open access for individuals as well as scheduled access for programs.

What are your responsibilities?

- *Safety: not hurting people or machines;*
- *Operations: assisting with cleaning, maintaining, and improving the lab;*
- *Knowledge: contributing to documentation and instruction.*

Who owns Fab Lab inventions? - Designs and processes developed in Fab Labs can be protected and sold however an inventor chooses, but should remain available for individuals to use and learn from.

How can businesses use a Fab Lab? - 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.

Textbox: The Fab Charter; Neil Gershenfeld; draft October 20, 2012;
http://fab.cba.mit.edu/about/charter/

1.3 Fab Lab Network

Picture: The Fab Lab community in 2010; Frosti Gíslason

The Fab Lab network or ecosystem is an ever changing and adapting and not always clear complexity of people and local, regional and global organizations. The text in the following paragraphs originates from the website of the International Fab Lab Association, http://fablabinternational.org, and was updated by the authors.

People

People are the most important drivers of the Fab ecosystem. They run the Fab Labs, the regional and the worldwide organizations. Some of them are paid, others are volunteering. For all of them Fab Labs are important, although the reasons why might differ. To mention just a few: digital fabrication, the triumph of technology, tools to the people, empowerment, open design now, community development, inventing new products to solve global problems, connecting scholars, promoting standardization, hands-on learning and raising interest for Science, Technology, Engineering and Mathematics (STEM) education. Some people focus on their own Fab Lab only; many take part in cooperation between Fab Labs and/or the activities at a regional or worldwide level.

Fab Labs

The core processes of the Fab ecosystem take place in the Fab Labs and in the local organizations with which they directly interact, both their target groups and their partner organizations. The target groups are organizations like community centres, schools, local associations of crafters, local guild of inventors etc. They, as well as individuals, use the services from the Fab Labs. The partners are organizations like the municipality, Chamber of Commerce, a museum, etc. who help the Fab Labs and/or their services up and running.

Picture: The Fab Lab House, Barcelona, Spain (http://fablabhouse.com)

Regions

A range of organizations supporting Fab Labs exist at regional levels. These organizations might be formal, like USFLN, the United States Fab Lab Network (http://usfln.org/) and the Foundation Fab Lab Benelux (http://fablab.nl), or informal, like the Fab Lat, the Group of Latin-American Fab Labs.

World

The following organizations of the Fab Lab network operate at a global, worldwide, level:

- **Fablabs.io** is a community website containing a list of Fab Labs (http://fablabs.io); more lists of Fab Labs exist at the moment; they will be screened and merged into fablabs.io.
- **Fab Foundation** with Sherry Lassiter as part-time director and Neil Gershenfeld chairperson of the board (http://fabfoundation.org). The Fab Foundation is involved with the annual Fab Academy, the annual Fab conference, the FabEd (Education) group (http://www.fabfoundation.org/fab-education/) in cooperation with TIES (http://www.tiesteach.org) and more to come.
- **Center for Bits and Atoms** (CBA) at MIT with Neil Gershenfeld as director and Sherry Lassiter as program manager (http://cba.mit.edu). Also the name Fab Central is used (http://fab.cba.mit.edu).
- **Fab Academy**, the annual global program on "How to make (almost) anything" (http://www.fabacademy.org).
- **Iceland Wiki** is a wiki for and by the whole fab community, hosted by NMÍ Kvikan (http://wiki.fablab.is/).
- **FAB9**, the website of the ninth International Fab Lab Conference, Yokohama, Japan, 2013 (http://www.fab9jp.com).
- **FAB10**, the website of the tenth International Fab Lab Conference, Barcelona, Spain, 2014 (http://www.fab10.org).
- **Fab Folk** was set-up as a community organizer, at the moment its main activity is maintaining an e-mail service "@fabfolk.org".
- **International Fab Lab Association** was established as an association for individuals committed to and involved with Fab Labs; today it is less active (http://fablabinternational.org).

A growing number of research papers on Fab Labs and the maker movement in general are becoming available. See: Research on the maker movement, edited by Anna Waldman-Brown (http://bit.ly/researchmakermovement).

2 Conception - How to start, paperwork, funding, and all issues until the lab goes live

Picture: Fab Lab Kamakura, Japan

This chapter explains how to start a Fab Lab. It stresses the importance of starting bottom-up and creating local ownership. It advocates the use of a project management method and to develop a "business model".

2.1 Create bottom-up ownership

Infographic: Bottom-up innovation: strengths and weaknesses

Successful innovation often starts bottom-up. Enthusiastic individuals find each other, "believe" in a new approach and find some means to start something new, e.g. a Fab Lab. They are not too much bound by rules and regulations and as long as they keep it cheap, they have or take the freedom to create solutions quickly. On the other hand, the initiative might be short-lived when the volunteers change their priorities or work like amateurs. Even success could become a threat when the initiative grows faster than the initiators can handle at that moment.

You cannot start a Fab Lab on your own. The amount of work and the set of skills required simply extend the capacities of an individual. At least, you need a group of friends with a shared vision on the new Fab Lab. But even that is not enough. As you certainly will have a target group in mind, or even more than one, you need to involve them right from the start. This means organizing meetings with the local community, establishing (and maintaining) relationships with local workshops, maker spaces / hacker spaces, small and medium enterprises, schools, government agencies, etc. If they "buy" the Fab Lab concept and feel "ownership", you have to work out a way to keep them informed and to let them participate. Possibly, they can act as a kind of user council, while a small core team does the real work. Persons with in depth knowledge of the area are also more than welcome of course.

Bottom-up processes need their time and space. Managers, board members and politicians should not interfere. Nevertheless, the "top" can help in a modest way: offer the initiators access to expertise, organize meetings where various initiatives might meet each other and exchange experiences, offer initiators visibility, etc.

Positive or negative experiences might trigger the need for a top-down intervention at some point. From then, the original initiators have to realize that they are no longer alone. Managers, board members, politicians may give their support, but certainly will require some change.

Infographic: Top-down innovation: strengths and weaknesses

The major risk once innovation goes top-down is that the "top" takes some firm decisions and loses its interest subsequently. To become sustainable, the new Fab Lab has to be secured, e.g. established as an independent legal entity or embedded into a permanent organization, included into an annual budget mechanism, etc.

2.2 Introduce convenient project management

Setting-up a Fab Lab by simply copying an existing one or by following some generic blueprint does not work. Indeed, Fab Labs have a lot in common. However, local contexts, social economic conditions, budget and local culture might vary greatly. A group of volunteers taking an initiative to set-up a Fab Lab often likes to re-invent the Fab Lab from scratch (makers!) by trial and error. This ad hoc approach may lead to failure, frustration and spoiling scarce resources (time and money). Project management is an approach that helps to make a complex process with more than enough uncertainties manageable. If only because of the paperwork required to establish a secure funding, project management could be of great help. See Project in a box, a free toolkit for project management based on the Prince2 project management method; http://www.projectinabox.org.uk/. Don't worry about the "richness" of such a method. You can start in a light way and learn and improve over time.

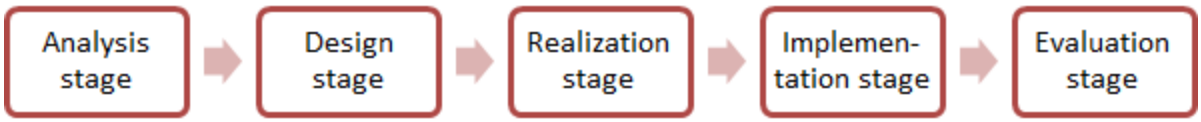
Principles

The main principles of project management are:

1. Identify a **client for the project**, e.g. senior management in case of an embedded Fab Lab or representatives of stakeholders (a council of future users?) in case of an independent lab.
2. Consider the core team as a **project team**.
3. Write down a preliminary and modest **"business case" for this project** (developing the Fab Lab). This business case should be justified and updated over time. Go for realistic figures instead of wild dreams. The “business case” describes”:
    a. Your inputs (time, money),
    b. Your intended outputs (how is time and money spent),
    c. Their outcomes, e.g. what does the project deliver to future users and other stakeholders, like a new Fab Lab (small, big?), community ownership (yes, mixed, no?), etc.,
    d. The effects (on longer run).
4. **Learn form (earlier) experiences** (elsewhere), e.g. the importance of user participation for project success! Reflect regularly on your own progress and identify what you learned and how you are going to apply that.
5. Divide the whole project of setting-up the Fab Lab into **subsequent stages** or phases, and plan, monitor and control stage by stage (see below).
6. **Focus on products** that have to be realized during the project (e.g. a Newsletter sent out, a machine ready-to-use).
7. Through all stages, pay attention to the following **seven themes**: business case, project organization, quality, plans, risks, changes and progress (see below).

If you work this way, you give potential sponsors some evidence that you are a serious candidate for funding. If you document your project on the go, potential sponsors can ask you whatever paperwork they like, you did your homework already.

Stage



Infographic: Possible stages of a Fab Lab development project

One of the principles of project management is to divide the project into subsequent stages or phases, and plan, monitor and control stage by stage. At the end of a stage any loose ends are dealt with and the next stage is planned in detail. Possible stages for developing a Fab Lab are:

A. **Analysis** - Study your potential "market", people, organizations and their potential interest in the services the Fab Lab could offer, visit Fab Labs nearby, talk with them about their experiences, and explore how you can collaborate. See "Setting-up a Fab Lab; Fab Lab LIMA report" by Beno Juarez (http://bit.ly/limareport), or "Setting-up a Fab Lab" (http://www.fabfoundation.org/fab-labs/setting-up-a-fab-lab/).

B. **Design** - Specify your (initial) set of machines, and anything else you need to buy and/or develop (housing, workspace, staff, utilities, organization, service management, knowledge management, technical infrastructure management).

C. **Realization** - Buy and make whatever is needed, install, test and make it ready to use.

D. **Implementation** - Start the operations,

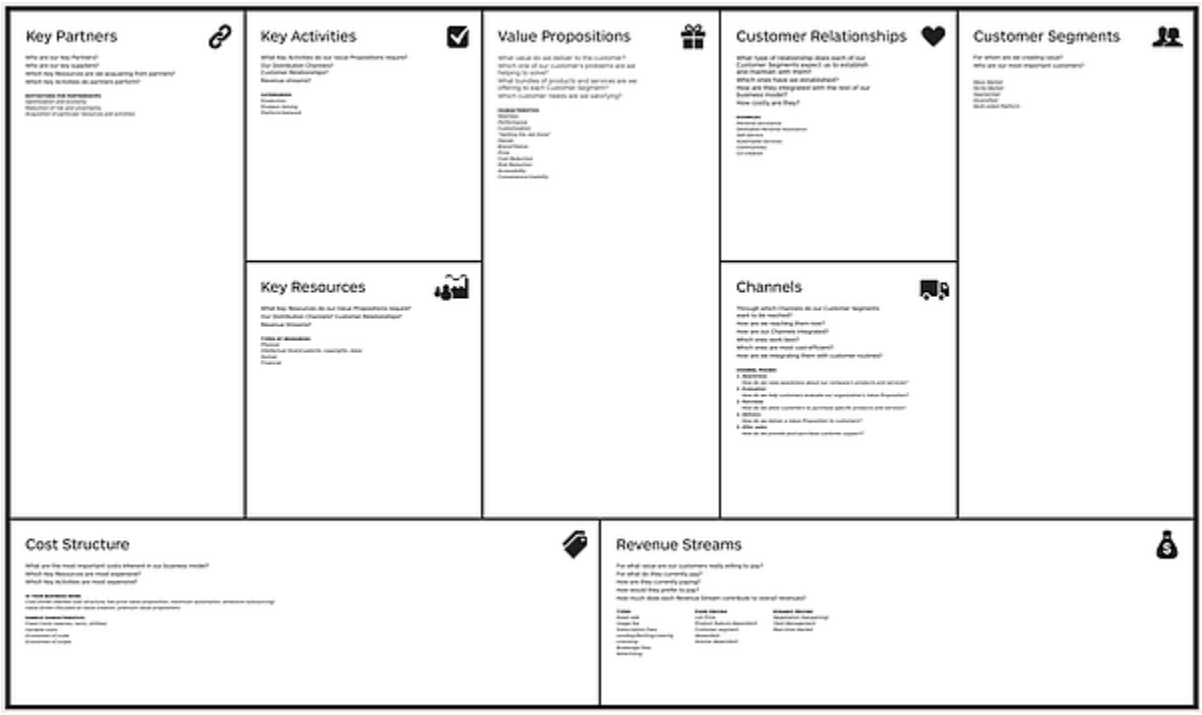
E. **Evaluation** - Look back at the whole project.

Themes

Through all stages attention should be paid to the following seven themes:

1. **Business case** - are your assumptions about inputs, outputs, outcomes and effects for this project (developing the Fab Lab) still correct?
2. **Project organization** - is everybody well informed and still on board? How about your relation and cooperation with the intended future users, the local community, and the Fab Lab network?
3. **Quality** - are you meeting your own standards?
4. **Plans** - does everybody know what to do?
5. **Risks** - are there any new or pending issues?
6. **Changes** - when change proposals come up, are they properly handled, communicated and documented?
7. **Progress** - is the project on time, within budget and meeting the quality standards?

2.3 Develop business model



Infographic: The business model canvas; source: Business model generation; Alexander Osterwalder et al.; designed by Business Model Foundry AG

Whether your goal is to set-up a small Fab Lab for USD 10,000 - 20,000 (machines and initial supplies only) or a Fab Lab complying to the CBA specifications for USD 50,000 - 100,000 (machines and initial supplies only), at least in rough form it should be clear which target groups ("customer segments") the new Fab Lab will address: community based (ORG), university/education based (EDU), business/industry based (COM); or will it be a mix of these, and, if so, which mix? Further, it is relevant which services ("value propositions") the Fab Lab is going to offer them, which internal activities have to be in place, which partners might contribute, where will the money come from and where will it go. Although most Fab Labs are not-for-profit, they still have to make the ends meet. It is good practice to write your assumptions down and refine them over time, based on new observations and insights. Together they form the business model for your Fab Lab.

Book and website "Business Model Generation" by Alexander Osterwalder et al. (http://www.businessmodelgeneration.com) offer valuable information and tools to build a business model, like the "canvas" in the infographic above. A free preview of this book (72p!) is available via http://bit.ly/previewbmg. See also: Sustainable Fab Labs by John Boeck and Peter Troxler (http://bit.ly/1oTQY1q); Innovation labs, a do-it-yourself guide by Unicef; http://bit.ly/unicefdiy; Makerspaces + community by Christina Hug (http://slidesha.re/1yaUG0l); Business models for Fab Labs by Massimo Menichinelli (http://bit.ly/1qYv8gk).

In the following paragraphs we describe shortly the services (and target groups), activities, resources and finance of Fab Labs.

Services

It is possible to differentiate seven basic services for Fab Labs. In practice, most Fab Labs deliver a mix of these services. The following table lists for each basic service, its possible target groups and the revenue streams they could generate. Your Fab Lab can use it to make a selection. And do not worry, you can start small and focused and extend your services later.

Basic service	Target group	Revenues stream
1. Giving access to the machines	• Tinkerers • Technopreneurs (students, professionals, companies)	Free on some days, paid on other days; better than free services is asking some change in kind, like documenting or cleaning.
2. Organizing tours or short activities for one time visitors, like museums do	• General public • Schools • Community organizations	Free, small fee or voluntary gift
3. Teaching and facilitating tinkerers; offering a range of courses and workshops on all aspects of design and making, especially in using the Fab Lab facilities; these might be part of formal education as well	• Tinkerers (from all ages and backgrounds) • Technopreneurs • School groups • Corporate groups • Master classes for professionals • Executive course for managers, policy makers	Contract with school, vouchers from school, tuition fee
4. Coaching inventors; helping to develop new prototypes and guiding them to the market	• Individual technopreneurs (students, professionals, companies) • Project groups of technopreneurs	Based on fixed price proposal, paid by hour, paid by government agencies via distributed vouchers
5. Participating in research and development projects with other Fab Labs; the Fab lab network is a global distributed research and development system	• Main contractor and its client	Depending on sub-contracts Grants and aid, especially related to development or disaster relief
6. Consulting to other Fab Labs in how to set-up the lab; consulting to the external world, in fact acting as an engineering consulting firm	• Fab Labs • Schools • Companies • Government agencies	Based on fixed price proposal (or in kind); paid by hour
7. Producing for the external world, using the machines to produce.	• Wholesale	Wholesale price for products sold

Table: Basic services of Fab Labs, their target groups and revenue streams

Looking at the target groups, you may distinguish:

- one-time visitors (for a tour or event),
- recurring tinkerers (for training and personal production),
- "technopreneurs" (developers of new products, new processes, new businesses).

Your marketing efforts might be focused on these target groups as individuals, i.e. you are attracting them one by one. More efficient, however, is trying to attract other organizations which can bring groups of people (e.g. museum, school, Chamber of Commerce, existing incubator). A challenge is also to try to "convert" some one-time visitors into recurring tinkerers and some of the latter into technopreneurs.

Activities

Which activities is a Fab Lab carrying out?

- Service management is the most visible one, because it delivers services to the outside world;
- Knowledge management, should be included, because it helps the Fab Lab and its visitors to know the state-of-the-art, to reflect on their own experiences, and to make their lessons learned available for other visitors and outsiders;
- Technical infrastructure management is indispensable as keeping the machines up and running, as well as the computers and the software is essential for daily operations.
- General management includes the external representation, public relations, marketing, human resource management, housing, finance etc.

Resources

The most important resources of a Fab Lab are its staff and its technical infrastructure, i.e. the machines.

Staff - In theory, a Fab Lab complying with the CBA specifications, and operating full-time, would require about 4 staff members at master and/or bachelor level and from different backgrounds. However, in practice, the variance between Fab Labs in number of staff, qualifications and status (paid versus volunteer) is rather large. As no all-round Fab Lab staff training program exists, there will always be a need for learning and training of your staff; this will cost time and money.

Technical infrastructure - The technical infrastructure of a Fab Lab consists of the machines and tools and an initial supply of materials and components. The following table refers to three different inventories. Many Fab Labs follow the Fab Lab Inventory by Neil Gershenfeld (CBA), and even extend the common base set with dedicated machines corresponding to their "signature", e.g. embroidery machines in one case, a large metal workshop in another.

Picture: FabFi antenna in Jalalabad, Afghanistan
(http://www.fastcompany.com/1761891/afghanistans-amazing-diy-internet)

Fab Lab scale	Price indication (USA)	Reference
Fab Lab Inventory by Neil Gershenfeld (CBA), updated regularly; machines, tools, materials, components; everything to have the technical infrastructure in place to run Fab Academy and distributed R&D projects of Fab Lab network	USD 50,000 - 100,000	http://fab.cba.mit.edu/about/fab/inv.html
High School Makerspace Tools & Materials (Makerspace), 2012; based on 25 students using the space for 70 to 100 hours; consumables; excluding utilities and staff	USD 15,000 - 50,000	http://bit.ly/makerspaceinventory
Small Fab Lab Suite by Bart Bakker (Mini Fab Lab Utrecht), 2014; machines only	USD 10,000 - 20,000	http://www.minifablab.nl/?page_id=424

Table: Fab Lab inventory price indication by scale

Finance

The **initial costs** of a Fab Lab mainly are housing, workspace and installations, machines and tools (including computers), an initial supply of materials / components, office facilities and other costs (e.g. the costs of the project itself). The initial costs of machines and materials may vary from USD 5,000-10,000 for a grassroots Fab Lab, up to USD 50,000 - 100,000 for a Fab Lab complying with CBA specifications (and much more for super Fab Labs at university level).

Initial funding may come from grants, loans (preferable soft ones), gifts in kind (office furniture, older machines from other Fab Labs, the time spent by volunteers!), crowdsourcing (also may enforce community binding), participations (e.g. give free access to machines in return), and in the case of embedded Fab Labs, the budget of the embedding organization.

Once, the Fab Lab is ready to go (and the development project ends) it is good practice to prepare a **balance sheet**. A balance sheet shows the financial health of the Fab Lab at a single point in time, i.e., the day the Fab Lab starts its operations and later at regular moments, usually 31 December of every year. The balance sheet contains two columns, listing the Fab Lab's Assets and its Liabilities. The second column also lists the Fab Lab's equity, i.e. the difference between the total assets and the total liabilities. So Total Assets = Total Liabilities + Fab Lab's Equity, which brings the whole in balance. See the table below for an example of the format.

Fab Lab Balance sheet as of (date)			
Assets	**USD**	**Liabilities**	**USD**
Machines	...	Loans to repay	...
Inventory	...	Accounts payable to supplier	...
Bank account	...	**Total liabilities**	...
Cash	...		
Accounts receivable	...		
Total assets	**...**	**Fab Lab's Equity**	**...**

Table: Fab Lab balance sheet for a certain point in time; Assers – Liabilities = Equity

The **annual costs** are the eventual amortization of machines etc., housing and workspace (rent, electricity, gas, water, internet, cleaning, maintenance), marketing and communications, travel and shipping, service management (a.o. development costs, outreach activities, consumables), knowledge management (a.o. literature, international exchange, attending conferences, study tour), technical infrastructure management (additional investments, maintenance, replacement), materials and components, office supplies, staff (salaries, in-service training, allowances for volunteers, facilitating Fab nomads) and other costs (office, insurance, representation, accounting).

The **annual revenues** come from paid services, sales of materials, eventual income from production, and possibly the same sources as generated the initial funding. Regarding the latter, when Fab Labs receive initial funding from (local) government, it is often for 1-3 years, i.e. initial costs plus 1-3 years recurring costs. They then have to be self-supporting after that time (see "Surviving").

It is good practice to prepare a **budget for the coming period**, usually the next calendar year, based on a realistic estimation of income and expenses. At the end of that period you then can prepare the Fab Lab's **Income Statement**. See the table below for an example of the format.

Fab Lab Income Statement (from - to)		
	Debit (USD)	**Credit (USD)**
Revenues from services		…
Revenues from products		…
Interest income		…
Total revenues		…
Transport costs	…	
Housing costs	…	
Sales costs	…	
Other costs	…	
Depreciation of machines	…	
Depreciation of inventory	…	
Total costs	**…**	
Profit		**…**

Table: Fab Lab income statement for a certain period of time

Fab Labs either create a **legal entity** of their own, e.g. a cooperation, association, foundation or even a (social) enterprise or another organization like a school will embed them. It heavily depends on local law (taxes!), policies and funding perspectives which entity type is most optimal for a given Fab Lab. Also the format for bookkeeping is regulated by law.

3 Early childhood - Teething problems, challenges during the first year

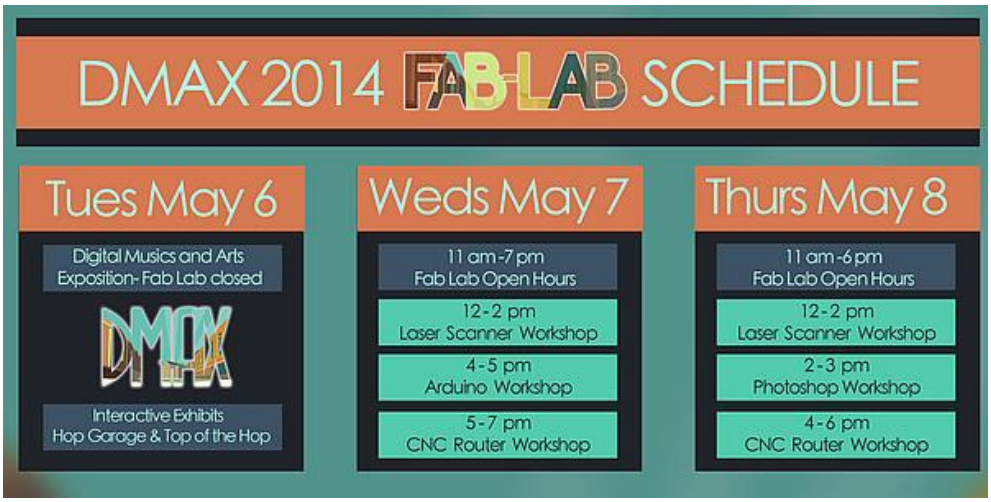
Picture: FabLabMET, Museo Metropolitano de Lima (Perú); source: https://www.facebook.com/fablabmet

This chapter is about a Fab Lab that just booted. It pays attention to the daily operations, the organisational health and safety and other risks, and the need to build a "learning organization".

3.1 Improve daily operations

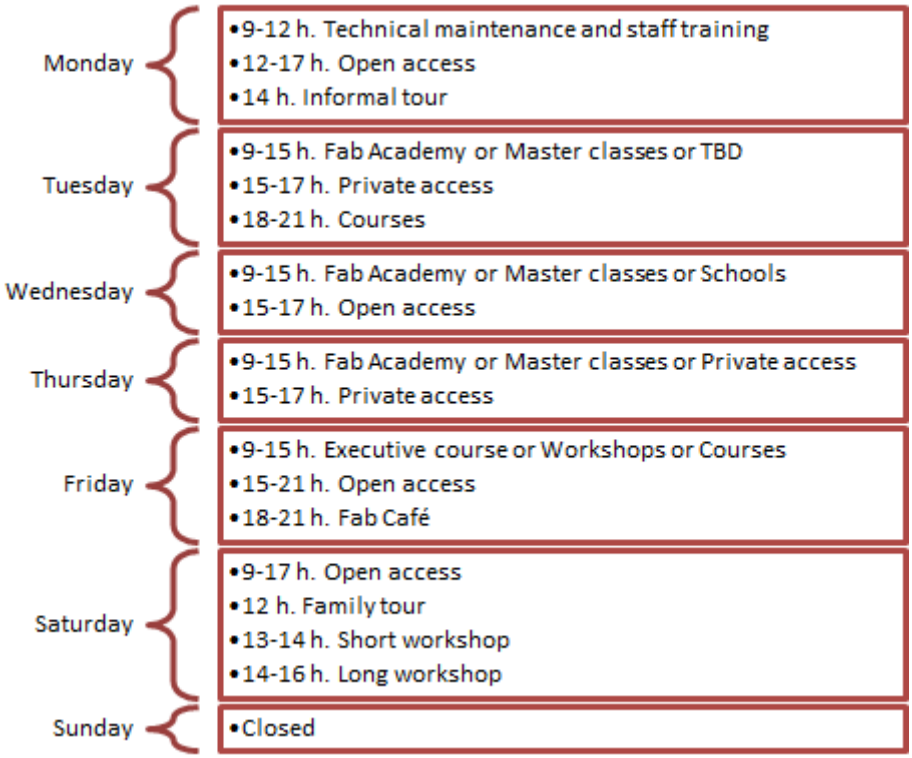
In the case your Fab Lab is embedded into another organization, e.g. a school, a lot of systems and processes like housing, utilities, personnel, Internet and LAN, finance, planning & control, and organizational health & safety might be in place already. But even then, the Fab Lab has to organize the following daily operations in a smooth way:

- **Opening/closing the lab** (check emergency exits and alarms); managing facilities like cleaning and catering.
- **Checking in/out people** (staff, visitors), usually one time visitors only have to sign the guestbook (for statistics), recurring visitors did register some personal details in the past and can easily check-in/out when they return; tip: use online forms for easy processing;
- **Checking in/out raw materials and components**, managing the warehouse; tip: set a minimum inventory level for each item and re-order in time;
- **Handling post and payments**, managing archive and bookkeeping;
- **Monitoring, maintaining** (machines, tools, software) and cleaning;
- **Managing today's activities** (setting-up, running, cleaning up);
- **Managing knowledge** (providing the visitors with the right information, asking them to document their work).



Picture: Fab Lab Schedule (http://www.cs.dartmouth.edu/~dmax/fablab.html)

These processes are not isolated from each other. As an example: you can ask an entrance fee from your visitors and treat it as a surety. In return for certain services, like documenting their work and cleaning their workspace, you will pay them their surety back when they leave. This example illustrates that for every process you need policies, maybe even systems or tools, and, trained staff to apply them. You further need mechanisms to monitor and control each process, and a way to store relevant data for accountability and future policy making.



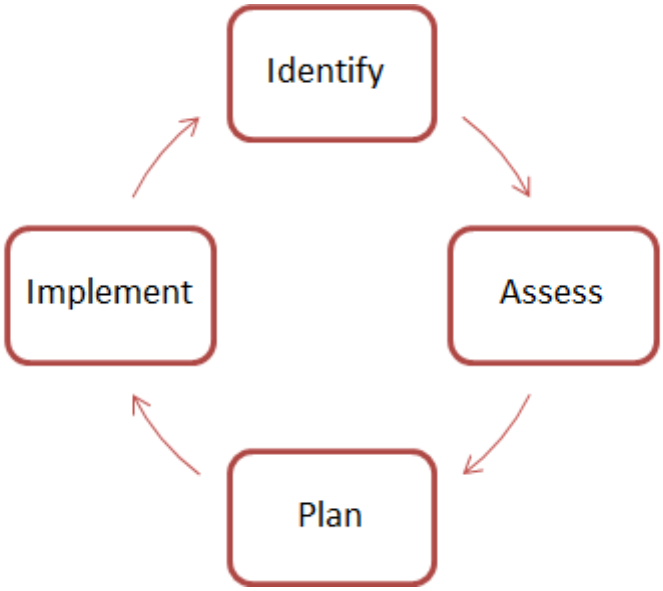
Infographic: Example of a weekly Fab Lab schedule with a mix of activities

To make your day even more challenging: many Fab Labs offer a mix of services. To keep it simpler, you can schedule different types of activities on different days of the week. The infographic above shows an example.

3.2 Manage your risks

Picture: Safety measures in Fab Lab Tulsa; source: newson6.com (http://bit.ly/Wbs7OL)

Many risks may slow down or even halt the daily operations of a Fab Lab. The most important risks are those related to health and safety of the Fab Lab visitors, the staff and the people in the environment. Especially the visitors are often not aware of the dangers inherent to the machines and materials they are working with. Other risks might are operational (materials out of stock, staff absence), technical (machine failures), legal (failing to follow the rules) and commercial (negative publicity, loss of revenues).



Infographic: Risk management: a cyclic process of four steps

The management of all these risks should be a continuous task in Fab Labs. A good practice is:

- **Identify** - Start with identifying any risks, their impact, probability and proximity (long term or short term).
- **Assess** - Determine for every risk how serious it has to be taken (combination of impact, probability and proximity).
- **Plan** - Plan your risk strategy: should the risk be avoided, should its cause and/or its effect be mitigated, should the risk simply be accepted, should the responsibility for the management of the risk be transferred to another organization? And which contingent response do you plan? Who will be responsible? A part of the measures you plan will be focused on the attitude of the Fab Lab staff. They also have to act as a role model for the visitors, to monitor what is happening and to intervene eventually. Feedback on how the Fab Lab is performing in this sense might also strengthen the right attitude.
- **Implement** - Do whatever your risk strategy requires and be prepared for contingencies.

Risks also might have a positive impact. We usually call them opportunities then. You also can identify opportunities and assess, plan and implement subsequently. (Negative) risks you will try to avoid, opportunities you will try to exploit!

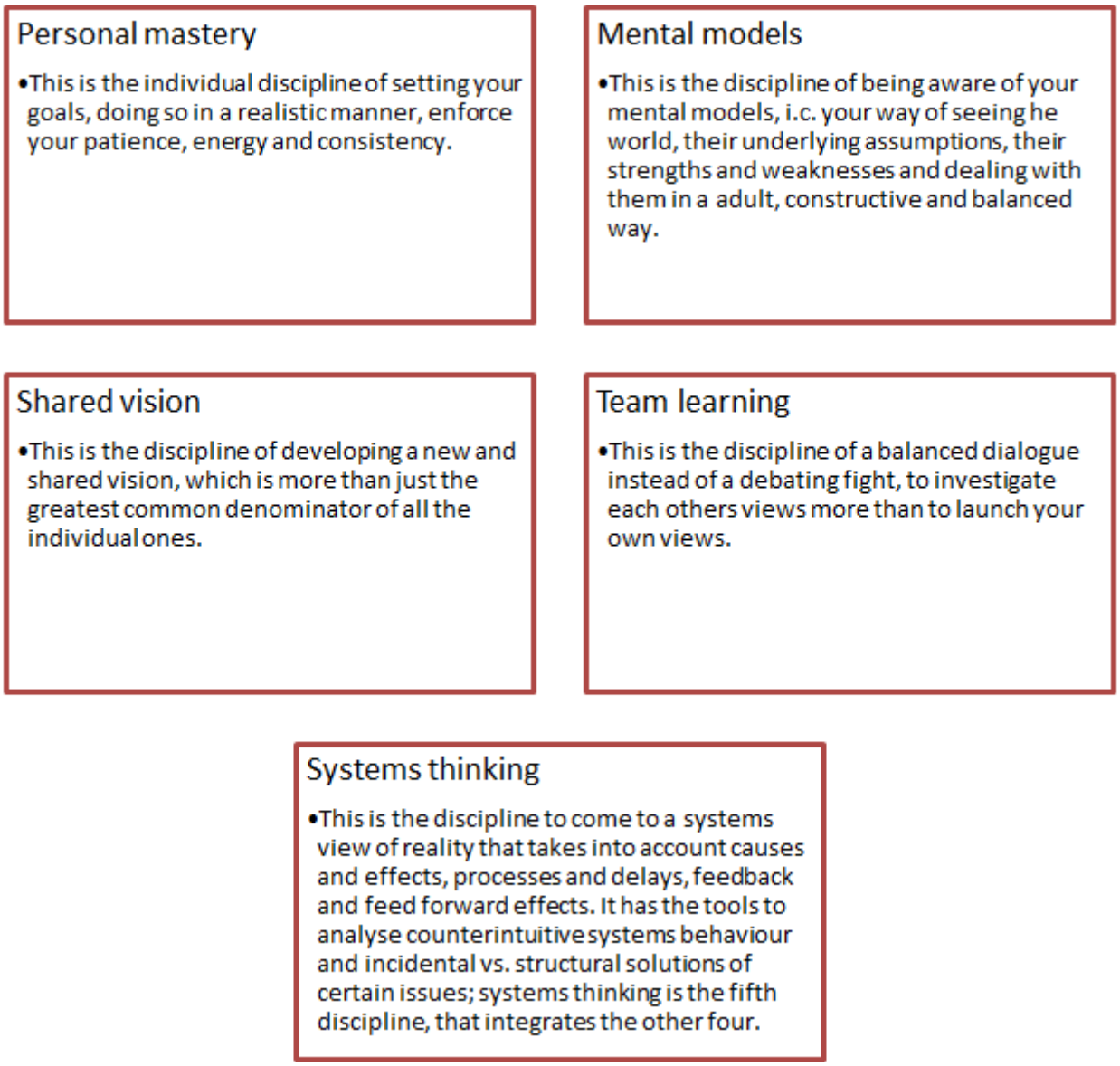
In many countries, organizational health and safety in the workplace is regulated by law. Be sure you know the minimum requirements in your case. If your Fab Lab is embedded into an organization (e.g. a school, a public library) this also might have impact on the legal requirements. The rules may also clarify who will be held responsible in certain cases, the Fab Lab board, the manager, the staff and/or the visitors themselves. It could be wise to cover your responsibility with insurance.

It is possible that health and safety regulations do not apply to your Fab Lab, because its number of paid staff members is lower than a certain minimum. Note, that even if your Fab Lab has no formal responsibility, it might have a moral one!

3.3 Build a learning organization

The times that an organization has a single gifted leader who oversees its position and takes all important decisions alone have gone. It is important that a Fab Lab builds a good team out of staff and eventual volunteers, with a reflective attitude. Learning by doing, not only applies to the visitors, but also to the team!

Learning organizations foster five disciplines: personal mastery, mental models, shared vision, team learning and systems thinking.



Infographic: the five disciplines of a learning organization; interpretation of "The fifth discipline" by Peter Senge

A learning organization knows and appreciates the contributions of its members, is open to look at the world and can handle and act upon new events and conditions adequately. It has the tools to handle internal problems, e.g. arising from the mix of personalities in the team, and/or external ones, e.g. changes in the characteristics of the visitors who are frequenting the Fab Lab, keeping the community engaged, keeping the machines running, knowing how to be heard, anticipating the funding, motivating people to work on collaborative projects, etc.

A balanced and professional Fab Lab team is an asset in itself. It can even become an additional source of income for the lab, by helping to set-up other Fab Labs or by acting as a professional engineering consulting firm.

4 Coming to age - Management issues, professional PR and advocacy, service development

Picture: MIT Mobile Fab Lab at the the White House Maker Faire (Source: Infosyncratic.nl; http://bit.ly/whitehousefab)

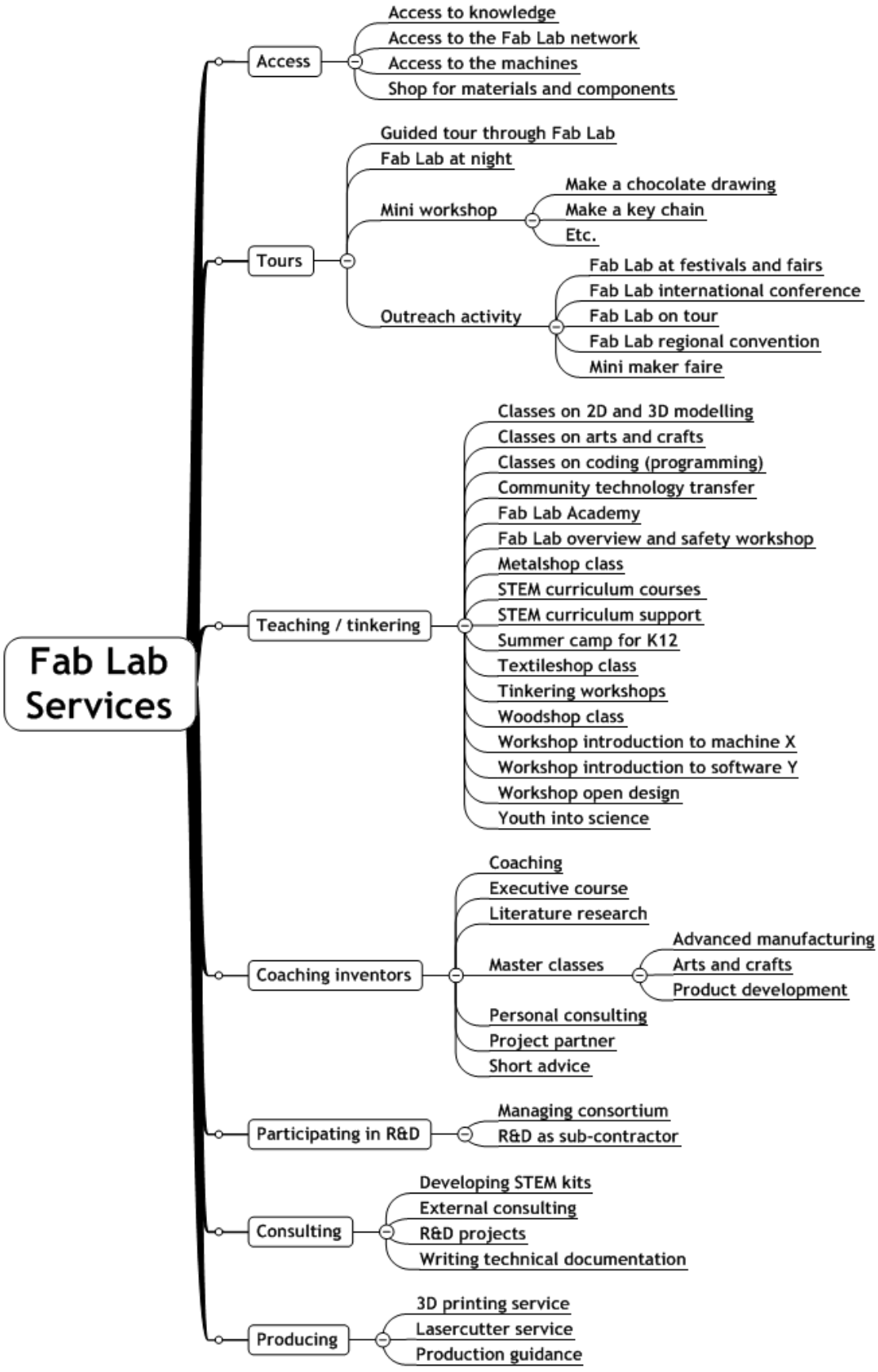
This chapter describes three changes a Fab Lab has to undergo to come to age. It has to become more and more professional in its services, its staff members and its internal organization.

4.1 Develop your services

Whatever service you are going to offer to your public, it has to be developed. The following infographic shows examples of services ordered by seven basic services. See also: Running Fab Labs by Lindi Mophuti (http://bit.ly/1wr8B1n).

When developing a service (event, activity, and project) for your Fab Lab, you can start from scratch and develop a description of your service in an ad hoc way. At least you should give it a name (e.g. the Chocolate workshop), a summary of the activity, a list of materials, info on the environment used and the role of the facilitators. Preferably, you also consider a business case for your new service: which inputs are required, which outputs have to be produced, what the outcomes for the target groups are and which medium term effects do you expect.

Instead of ad hoc, you can develop a service as a project. The "Design thinking for educators toolkit" (http://bit.ly/1xb6RK8) offers some useful guides. Included are issues like the marketing of your service: how are you going to attract visitors, as individuals, as groups, e.g. schools?



Infographic: Examples of services by Fab Labs

Whether ad hoc or via a project, it helps to start with an existing description of a service (e.g. originating from another Fab Lab) and to change it to meet your local needs. The following table lists some sources for such descriptions.

Sources for Fab Lab service descriptions	URL
Exploratorium project activity guides for tinkering sessions with children	http://tinkering.exploratorium.edu/
Fab Academy past student projects to build upon	http://fabacademy.org/archives/2014/students/index.html
Fab Share; website to share Fab Lab projects	http://fabshare.org
Fablab@school curriculum components	http://fablabatschool.org/page/fablab-activities
Fablab@school past student projects to build upon	http://fablabatschool.org/page/projects-1
Global fab awards and exhibition 2014	https://www.fab10.org/en/awards
Instructables	http://www.instructables.com
List of Fab Labs to access the websites of other Fab Labs and see their services to visitors as well as projects by visitors	https://www.fablabs.io/labs
Project ideas, tutorials, inspiration from the "Invent to Learn" book and/or website	http://bit.ly/invent-to-learn
The art of tinkering; meet 150+ makers working at the intersection of art, science and technology; Karen Wilkinson & Mike Petrich; Weldonowen, 2013	http://tinkering.exploratorium.edu/the-art-of-tinkering
Vigyan Ashram Fab Lab, Learning while Doing, projects	http://www.learningwhiledoing.in/

Table: Sources for Fab Lab service descriptions

When testing your services, fine tune them and later delivering them for real (running the activities, etc.), you may include a mini evaluation at the end of your sessions. Let the visitors write down their answers to three questions: 1. What was good? 2. What could be improved? 3. Which other comments do you have? As facilitators you can also add your own observations and record some statistics like the number of visitors. Of course, the Fab Lab team needs to review this mini evaluation and to follow-up any pending issues. If the Fab Lab defined a business case for the service, it is wise to review it regularly and to see whether the business case and/or the service itself need an update.

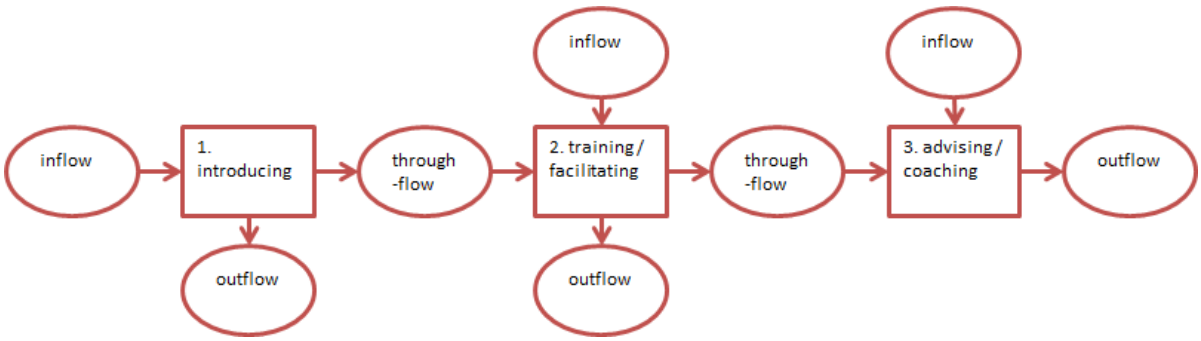
Tip: For cataloguing purposes, exchange of information and easy retrieval, it is useful to register the following metadata for each service:

- General: Name, short description / learning goal, intended audience, keywords;
- Life cycle: version, date, status, contributors;
- Format: required machines, tools, and materials, requirements for location, set-up time, duration;
- Facilitation: qualification, number;
- Rights: license type (preferred Creative Commons - Attribute), eventual costs.

4.2 Develop your staff

Many Fab Labs only can afford a limited number of staff members. They have to develop more specialisms than they learned in formal education so far. A learning organization (see before) might be the right context; personal development plans (and annual evaluations) might be the right tool and in-service training (mentoring) one of the techniques. In the following paragraphs we will give an infographic of the processes constituting service management, knowledge management, technical infrastructure management and general management and describe the required staff competencies.

Service management

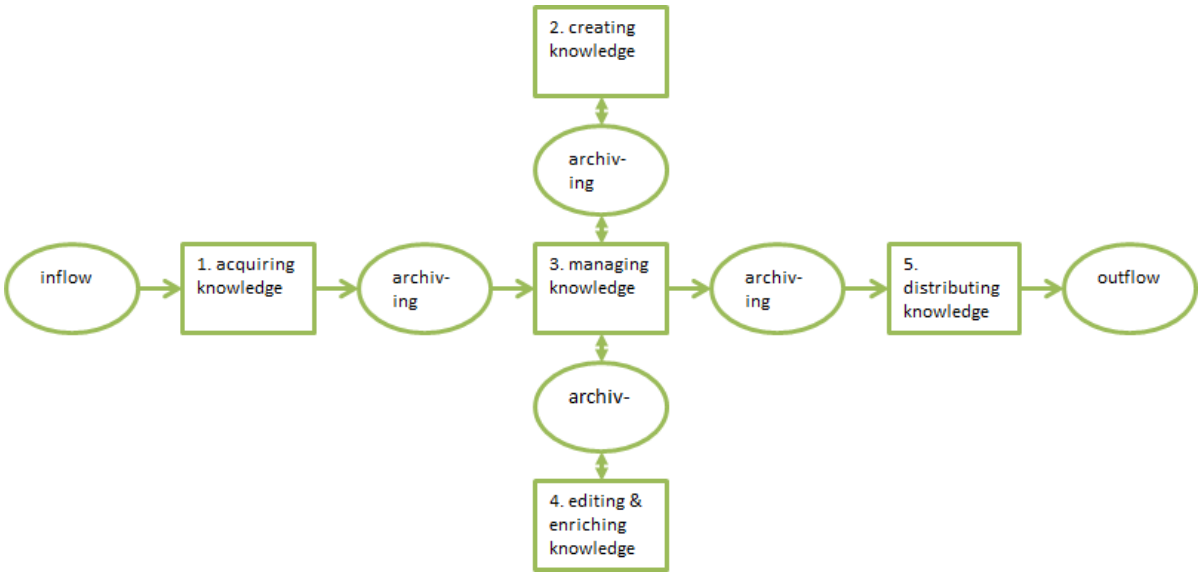


Infographic: Service management: Introducing one-time visitors, training and facilitating tinkerers, advising and coaching technopreneurs have their own inflows and outflows of people, Fab Labs also try to create a through flow from one process into the next.

Service management - to inform and arouse interest of one-time visitors, to stimulate and challenge them to return, to facilitate, educate and train recurring tinkerers, to help decide them on their next steps and to advice and counsel technopreneurs of new products and businesses, requires:

- Marketing and communication to generate an "inflow" of visitors;
- Combination of making / tinkering, pedagogy and STEM (science, technology, engineering, mathematics) to develop and facilitate tours and events;
- Fab Lab "guru" status on methods, processes, tools and materials to facilitate and train recurring visitors; the guru's background might be Fab Academy plus didactics;
- Background in management science / business administration or industrial design plus consulting skills to coach and advise initiators of new products and businesses.

Knowledge management

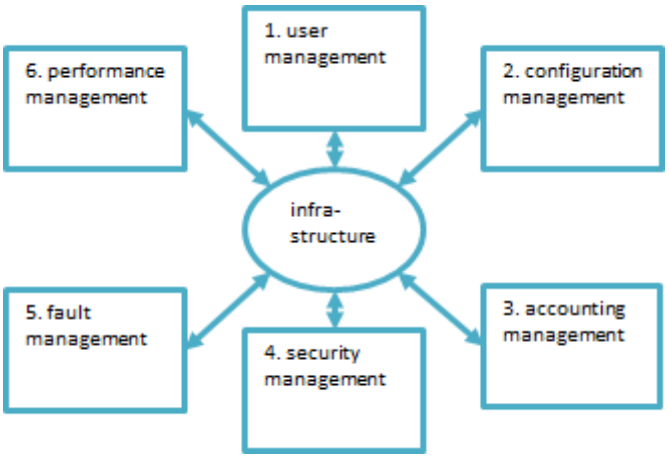


Infographic: Knowledge management: acquiring, creating, managing, editing & enriching, and distributing.

Knowledge management - to acquire and harvest knowledge, to generate new knowledge, to store and retrieve knowledge, to edit and enrich it, to disseminate it internally and externally requires:

- Editing / publishing via old and new media;
- Expertise on science and society;
- Online archiving;
- Online literature search;
- Science journalism.

Technical infrastructure management

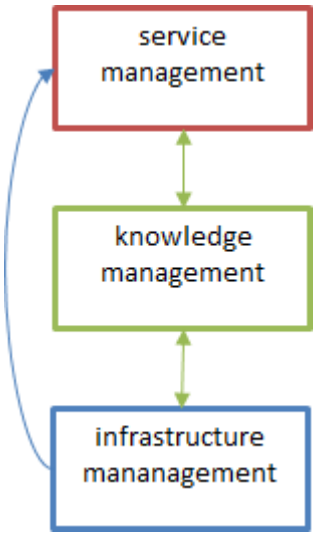


Infographic: Technical infrastructure management (derived from ISO Telecommunications Management Network - FCAPS): user management, configuration management, accounting management, security management, fault management, performance management

Technical infrastructure management - to consider and practice the management of users, configuration, accounting, security, faults and performance for machines, ict, tools, consumables, components, structural facilities and installations requires:

- Expertise which is close to ict system management; the concepts of ict system management can be applied to the management of the Fab Lab technical infrastructure as well;
- Fab Lab "guru" status on methods, processes, tools and materials, as can be acquired via the Fab Academy.

General management



Infographic: The relations between service management, knowledge management and technical infrastructure management.

General management - to keep all Fab Lab processes aligned and consistent, i.e. to keep the relations between service management, knowledge management and infrastructure management balanced. General management further implies finance including proposal writing for grants, marketing and communication (advocacy!) including acquiring new projects and initiatives, and Fab Lab human resources. This all requires:

- Management science and/or industrial design background
- Fab Academy
- Expertise in grant/proposal writing
- Deep knowledge of the community, defining new initiatives

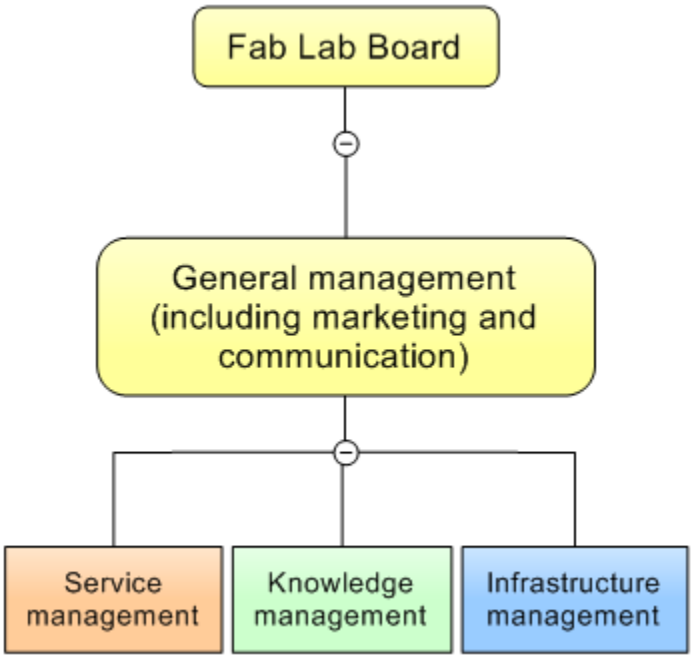
As said before, it will be an exception to find staff members who meet all requirements when they join the Fab Lab. So, be prepared that they need to develop themselves further. This will cost time and money that cannot be spent to the Fab Lab directly.

4.3 Develop your organization

Managing daily operations is no longer enough. Planning and control cycles have to be in place. Tasks like public relations and marketing have to be executed in a systematic way. The Fab Lab becomes an actor in its community and wider environment.

A Fab Lab needs at least once a year a moment to look back, to assess the actual situation and to look forward. The original business model has to be revisited. Is the Fab Lab mainly a non-profit for community development (ORG), or an educational institute (EDU) or a consulting firm on innovation (COM)? What is the actual mix between these three? Have you reasons to change this mix over the years? If so, how are you going to accomplish this? Do not forget to include your stakeholders into these considerations! Suppose you want to develop a commercial model for the Fab Lab. In that case the expertise of the stakeholders could be of great value. Their commitment might even be essential for the success of your commercialisation. And you keep them on board as friends of the Fab Lab.

Another issue for annual evaluation is the organizational structure. As long as the organization is rather small, the staff members may run the Fab Lab team wise. When the organization grows, it might be better to have a single person as its general manager and separate sub-managers, e.g. for technical infrastructure management, knowledge management and services management.



Infographic: Organisation structure for Fab Lab

The Fab Lab also needs to re-generate itself. This has to do with its material base, say the machines, but also with its processes and staff. Preferably the Fab Lab knows the motivations and ambitions of its individual staff members and can discuss and agree win-win solutions to handle them. The Fab Lab also needs to know its future needs for new staff members and their qualifications and has to scout for new candidates.

5 Fostering new businesses - Supporting the creation of new products, processes & organizations

Picture: Training course in Fab Lab Paramaribo (http://fablab.vicepresident.gov.sr)

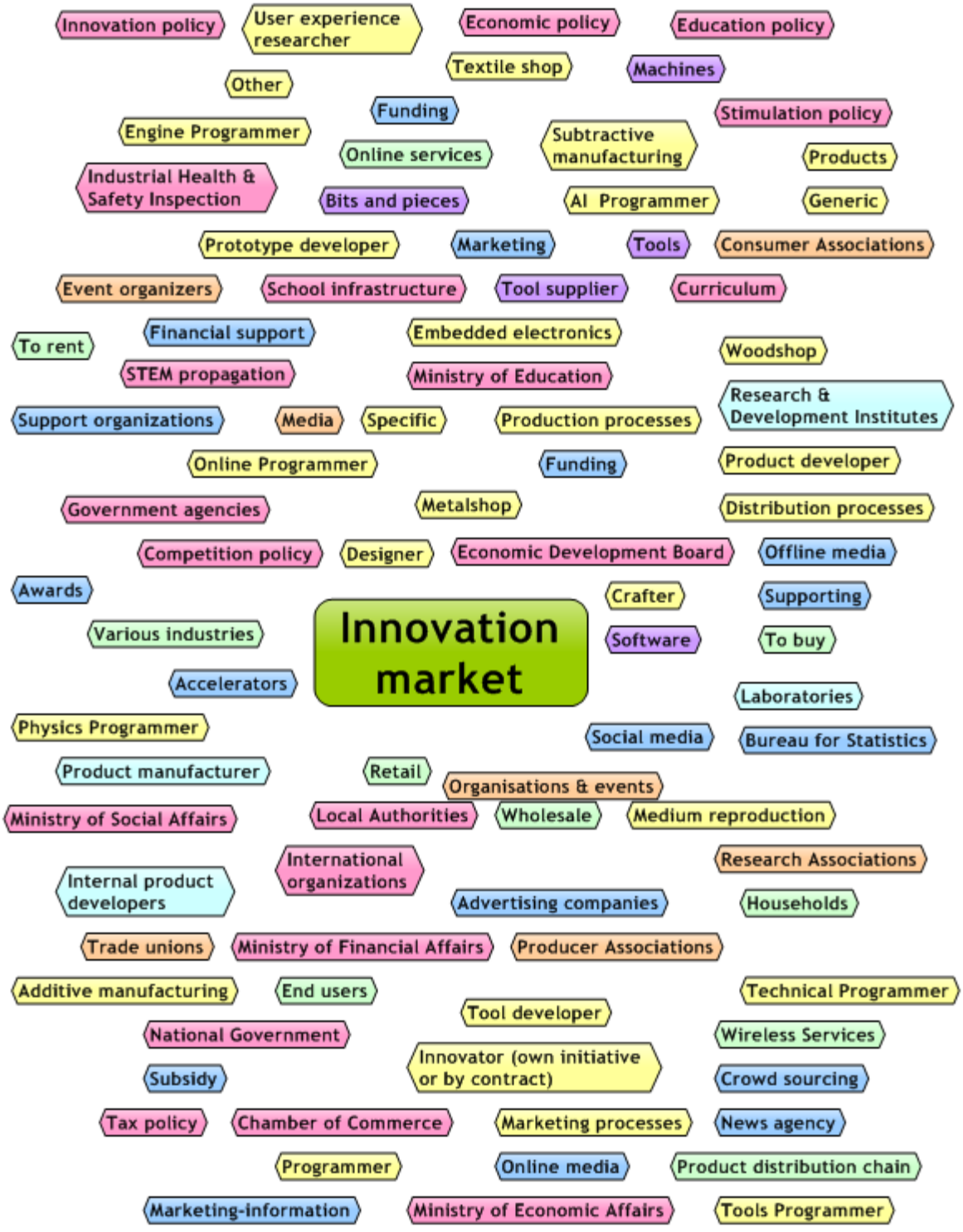
This chapter explores how the adult Fab Lab might play an important role in (triggering the) development of new products, processes and enterprises. As such, the Fab Lab is entering the "innovation market" populated by many enterprises, NGO's and government agencies. There it has to find its position. In this Fab Lab development stage it is also time to realize the power of the Fab Lab network. In many ways the Fab Lab can benefit from it, and, of course, contribute to it as well. For times to come, the Fab Lab should count its blessings. Keeping records is indispensable.

5.1 Find your position in the "innovation market"

When a technopreneur wants to develop a new product or even a new business, they have to find their way through a jungle of agencies, professional services, suppliers, competitors and potential clients. If the Fab Lab wants to offer added value to these technopreneurs it should find a clear position in this jungle including some partnerships.

Innovation market

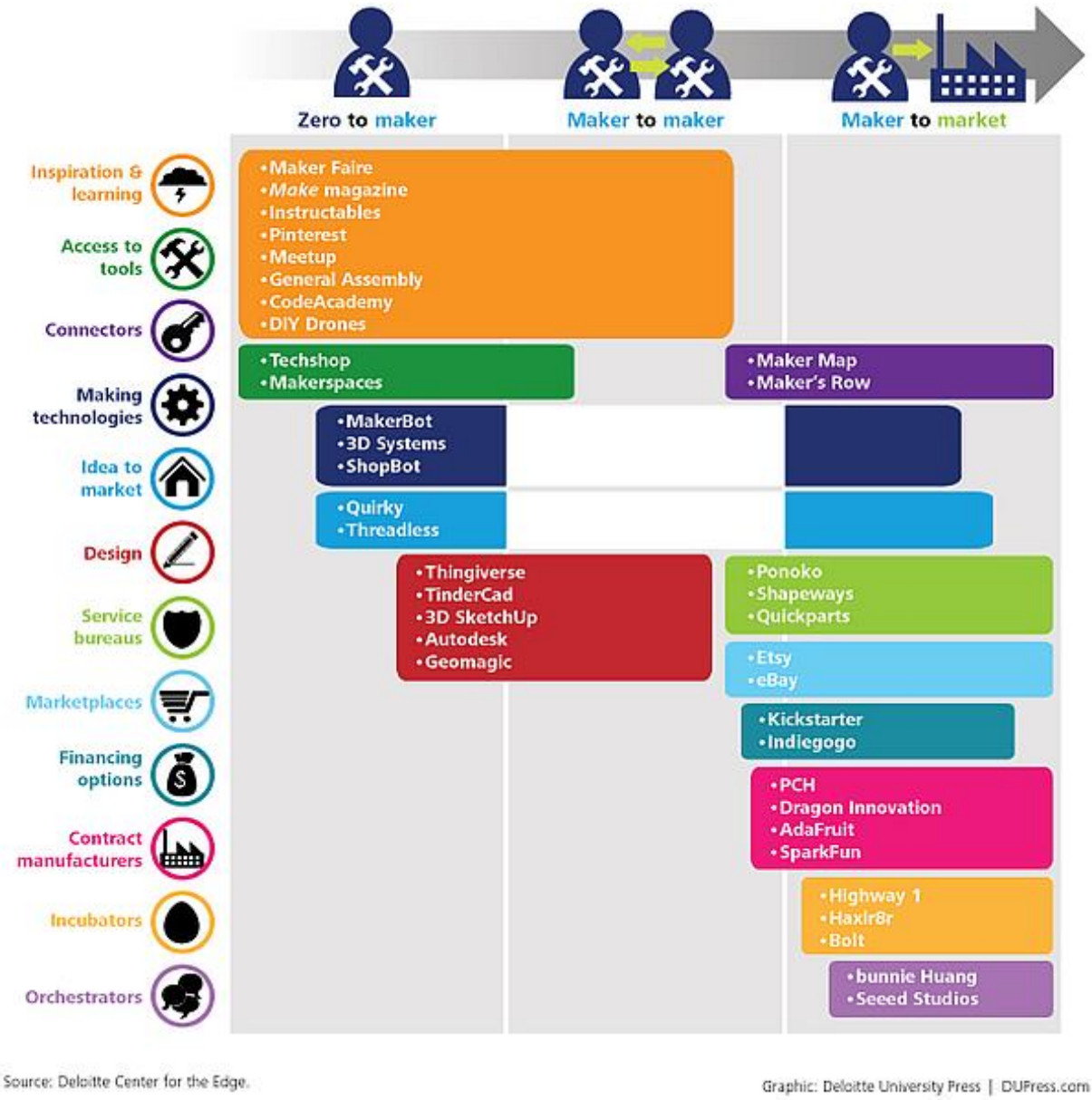
The following picture gives an impression of the innovation market. It consists of many interrelated actors. When a technopreneur is new in this field they may be overwhelmed by the complexity. Order in the apparent chaos is brought by looking for patterns, e.g. actors that form a kind of a chain. Fab Labs also need to know this market, become aware of existing patterns and find out which position and partnerships give an optimal fit.



Infographic: the innovation market

From the **perspective of the technopreneur**, it is important to find the right way through this tangle, to engage with the right partners and to receive the requested help, albeit an advise, a certain service or certain goods, conforming quality standards, at the right moment and for a fair price. How can a new Fab Lab entering this market place and find its position? For some suggestions, see "Fostering new businesses" by Victor Freundt (http://bit.ly/newbusinesses). If you need more information on a specific industry, see "The IT Professional's Guide to Researching a New Industry" by Tom Taulli (http://bit.ly/XY0PwS).

Consulting firm Deloitte tried to "untangle" part of the "jungle" which resulted in the following infographic.



Infographic: Some representative players in the maker ecosystem (Many of these entities play multiple roles in the ecosystem. The roles are evolving, and new entrants emerge daily. Source: A movement in the making; Deloitte University Press, 2013; http://bit.ly/1qaQUys

From the **point of view of the Fab Lab**, it is important to:

- Start to build (and share) your own mental model of your actual innovation marketplace. Have a clear idea about the other actors in this field, their goals, and activities. Be aware that there will be local actors as well as regional, national and international ones.
- Try to understand the dynamics of this market place. What paths did recent local innovation projects follow through this "jungle"?
- Find your own "unique selling points" and choose your partners accordingly.

Unique selling points

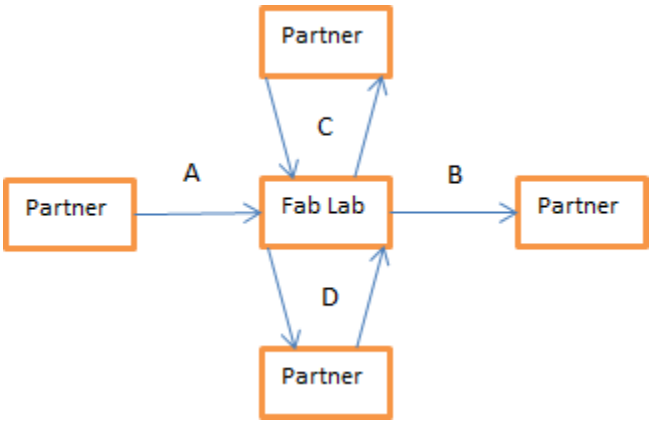
Which unique selling points does a Fab Lab have?

- Be aware of the strengths and weaknesses of your Fab Lab. Which are the competitive advantages of your Fab Lab?
    - **Collection of useful machines for prototyping?** - Could be. However, this might be a temporary advantage. Every year, these machines are becoming cheaper and simpler to use. Sooner or later technopreneurs can afford such machines themselves.
    - **Useful machines for production?** - Possibly. However, the machines (and their availability) are for prototyping or small batches. Real production work, although it could generate an interesting stream of revenues for the Fab Lab, is rather an exception than the rule. Further, you may expect more and more specialised companies to offer production capacity on comparable machines.
    - **Some genius on board?** - Nice to have. However, a very unique person may change jobs.
- What is unique about the Fab Lab? Which characteristics should be protected and developed further? In our view, Fab Labs in general are unique thanks to:
    - the **combination of machines**, tools and software
    - the **combination of knowledge** on both design and making, both the bits and atoms, both theory and practice, both the old materials, tools and processes and the new ones,
    - the **combination of people**, not only the Fab Lab staff, but also the heterogeneity of people and organizations coming together in the Fab Lab, meeting and inspiring each other and collaborating eventually,
    - the **culture of learning by making, innovating, sharing and collaborating**,
    - the **focus on open and participative design, digital manufacturing**, open source hardware and software, dedicated user interfaces, the internet of things and advanced uses of ict,
    - the **Fab Lab worldwide network, its diversity** of people from many socio-economic backgrounds, their knowledge and experience and the network as a platform for distributed research, development and: productions,
    - the **track record of creating feasible solutions** for social-economic issues e.g. derived from almost all the Millennium Development Goals 2015 and the proposed sustainable development goals for the years to come.
- Review the last bullet points and identify comparative "unique selling points" for your own Fab Lab.

Partnerships

Before you start, think about the number of partnerships you want to establish. Remember that a partnership requires time and energy to maintain. How many partnerships can you handle?

Which chains or processes could emerge? Which type of organization would be the right partner? The following infographic shows some patterns.



Infographic: Patterns of Fab Lab partnerships

The infographic above shows the following patterns:

- **[A] The Fab Lab as the next link in the innovation chain** - The partner sends some clients to the Fab Lab. The latter helps these clients further in their innovation efforts.
- **[B] The Fab Lab as the previous link in the innovation chain** - The Fab Lab sends its clients to the partner to continue their innovation process there.
- **[C] The Fab Lab as a kind of sub-contractor** - The partner asks the Fab Lab to deliver some services to partner's clients (e.g. helping to make a prototype); afterwards, they go back to the partner.
- **[D] The Fab Lab as a kind of client** - The Fab Lab asks the partner to deliver some services to the Fab Lab's clients (e.g. helping with market research); afterwards the clients return to the Fab Lab.
- **[E] (not shown) The partner and the Fab Lab form a joint venture** - The partner and the Fab Lab are collaborating in developing a common product or service, e.g. a proposal to set-up an innovation contest for young entrepreneurs. They act as a unity.

Search for the right partners. **Criteria for the selection of partners are**:

- Needless to say you should be able to **trust** each other; there should be openness on each partner's motives.
- In collaboration projects, the partner should delegate staff members with a **genuine interest** in cooperating with the Fab Lab.
- The partnership should become **structural**, not incidental. The latter is less efficient.
- The partnership should be **balanced**; avoid a giant as partner; such a partnership may leave to you too few "influence points".

When establishing a partnership it is good practice that both parties sign a **"Memorandum of Understanding"** (MOU) or even a **"framework contract"** with a description of the goal of the partnership, the give and take by both parties, the way of communicating, the way to end the partnership and all other issues parties consider as relevant. Once such an MOU or framework exists, future agreements / contracts / orders could be agreed quickly and formulated simply by referring to the MOU or the framework contract.

5.2 Learn from other Fab Labs good practices

Whatever you want to do with your Fab Lab, chances are another Fab Lab has some experience with it already. So, the worldwide Fab Lab network is an interesting source of information and collaboration.

The second column in the following table illustrates how knowledge, experience and attitudes might flow from the worldwide Fab Lab network to your Fab Lab and your staff. This global ecosystem can only sustain, however, if your Fab Lab sooner or later is going to give its inputs as well. Some suggestions are listed in the third column.

Topic	From Fab Lab network to your Fab Lab	From your Fab Lab to the Fab Lab network
Fab Labs nearby	Visit Fab Labs nearby, talk with them about their experiences, explore how you can collaborate.	Be visible to the other Fab Labs. Enter your Fab Lab, even when it is still "under development", into the list of Fab Labs on http://fablabs.io.
Web presence	Most Fab Labs have a website, many also some presence on social media, especially on Facebook. Via the list of Fab Labs (http://fablabs.io) you easily can access these websites with (usually) project descriptions, reflections on methods, tools and materials (the so-called Fab Moments), white papers, upcoming events, vision and mission and success stories, e.g. about new enterprises started. You can subscribe to many newsletters that bring you into the flow of information.	Set-up your own website and start publishing your own Fab Moments. Share your knowledge with other Fab Labs. Look for opportunities to cooperate with other Fab Labs.
Regional organizations	Regional organizations of Fab Lab could offer any help in your local language.	Host a regional Fab Lab meeting and give a presentation on the challenges and accomplishments of your Fab Lab.
Global sources of information	• Fab Academy past student projects, http://fabacademy.org/archives/2014/students/index.html • Global fab awards and exhibition, started 2014, https://www.fab10.org/en/awards • Special interest groups, e.g. on Fab Labs and education (FabEd), see the Fab Foundation, http://www.fabfoundation.org.	• Stimulate your staff and other people to attend the Fab Academy • Participate in global events, like the Fab Awards competition • Become an active member of special interest groups like FabEd

Topic	From Fab Lab network to your Fab Lab	From your Fab Lab to the Fab Lab network
Fab Nomads	Fab Nomads are members of the worldwide Fab Lab community who like to travel around and stay at other Fab Labs for one or more months. There they join the team, often as a volunteer, and do some projects. Fab Nomads might bring a lot of new knowledge and expertise to your Fab Lab. See Making, Living, Sharing, a movie by Jens Dyvik who was a Fab Nomad during 2.5 years; http://youtu.be/PNr1yBIgQCY.	Maybe you can make your Fab Lab attractive for inbound Fab Nomads by offering a place to stay and/or some allowance. Stimulate and facilitate your staff to visit other Fab Labs and maybe become Fab Nomads for some time. Contact: fabnomads@googlegroups.com
Fab Academy	A great way to acquire in depth expertise on the use and application of the Fab Lab technical infrastructure and to learn to know (virtually) Fab Lab people all over the world, is attending the annual Fab Academy. It runs from the end of January till the end of May every year. The Fab Academy consists of weekly classes via teleconferencing plus homework and guidance in selected local Fab Labs as well as a personal assignment. All together it costs about 50% of your time during four months. Nevertheless, some Fab Labs send their staff abroad to attend the Fab Lab there and to return as Fab Lab "gurus". See: http://www.fabacademy.org.	• Stimulate your staff and other people to attend the Fab Academy • Fulfil the conditions to become a Fab Academy site yourself and to run the Fab Academy from your Fab Lab.
FAB International Conference	A great way to meet people from the Fab Lab community in person is attending the annual International Fab Lab Conference. This is a full week event with plenaries, workshops, exhibitions by and for Fab Labs plus some public events like a Fab Festival and seminar. FAB9 took place in Yokohama, Japan in 2013 (http://www.fab9jp.com/). FAB10 took place in Barcelona (Spain) from 2-8 July 2014 (http://fab10.org). FAB11 will be held at MIT in Cambridge MA (USA) from 3-9 August 2015; in 2016 FAB12 will go to China (http://fabfoundation.org).	Play an active role in the community, e.g. at the annual conferences.

Table: The Fab Lab network as source of knowledge plus suggestions for the inputs from your Fab Lab

5.3 Count your blessings

No doubt that you are very enthusiastic about your Fab Lab and that everybody is welcome to visit the place and to see that you realised your ideas. The outside world, however, and especially your sponsors (!) may want more. They want to know the perceptions of visitors and staff. They want to see evidence of the outcomes you once predicted. You should count your blessings and demonstrate that you counted in the correct way. This requires keeping some records.

For many people keeping records is not a very attractive task. Nevertheless it is important to get insight in what is really going on in your Fab Lab and to use these data internally to plan and control your Fab Lab and externally to be accountable to your sponsors and to underpin your requests for future grants or budget.

Record keeping should start on the first day your Fab Lab is open. Maybe the first time you really need realistic statistics is one year later, when you have to apply for new budget. However, starting collecting data at the moment you need them is too late; reconstructing missing old data is almost impossible.

Which records should be kept? Of course your financial administration has to be up-to-date and correct. It shows you your assets and liabilities at a certain moment and your income and expenses during a year. Every booking has to be motivated by underlying documents.

The financial administration, however, is only one side of the coin. More interesting are records on the services you have delivered and the visitors you attracted. These make clear whether your Fab Lab is really meeting its targets. We recommend three "golden" rules:

- for accuracy reasons: record your data on the spot, i.e. where and when they are created,
- for efficiency reasons: avoid recording the same data twice,
- for efficiency and effectiveness reasons: use ict where adequate.

The following table lists some examples of operational data to be registered, the way the data can be used to monitor and intervene in actual processes and the use for policy making.

Not all operations will fit within a form of list and can be totalised easily. Especially the "handling" of technopreneurs will be rather custom-made. But even then, let's try:

- The Fab Lab gives advice and coaching to a technopreneur, the Fab Lab may call this a project. After 1-2 times of talking, Fab Lab and technopreneur produce an intake document.
- During the project the Fab Lab staff member writes a simple logbook (including time spent) that might be understandable for his/her colleagues.
- At the end of the project the technopreneur can give feedback; Fab Lab and technopreneur produce an exit document. This contains the lessons learned plus any issues regarding property rights and sharing future benefits (see Fab Charter).
- Again, this information might be useful for monitoring and intervening. The Fab Lab staff can ask critical questions about the progress and the time spent. This may result in changes.

Ultimately, all projects of this type can be listed with some metadata and used for future Fab Lab policy making.

Operations	**Monitoring & intervening**	**Policy making**
Service management: Training 3D design Participants enrol via online form. Participants fill attendance list every day.	Norm: 5 days, attendance should not decrease more than 10% a day. Is attendance decrease from day to day worse than the norm, then think how you can change it on the spot.	Rank the training programs in popularity (enrolments). Rank the training program in average attendance. Use these figures in planning future training programs.
Knowledge management: Newsletter Secretary enters new issue record in KM logbook	Norm: every other month, 2-4 pages, 200+ recipients, to be increased over the year with 25%) Staff reviews KM logbook. If something is wrong it will be analysed further. Actions will be planned. Staff reviews content of newsletter and picks their favourite item.	Include the number of editions and the circulation count at the end of the year in the annual report. Used to set new targets for Fab Lab Newsletter for coming year. Favourite items of this year's newsletter are copied to annual report.
Infrastructure management: uptime complex 3D printer Technical manager enters record in logbook: machine down, machine up.	Norm: 90% of opening hours Staff reviews logbook weekly and intervenes where necessary.	Statistics from month to month are collected and will be discussed with the supplier of the 3D printer.
General management: Early morning (safety) inspection	Norm: 100% OK General manager communicates any issues with related staff members.	Aggregated data are included in annual report. Free dinner party for full staff when the norm has been met.

Table: Examples of data to be collected during Fab Lab operations and to be used for monitoring & intervening and for reporting and policy making

In all examples you see that your operational data lead to aggregated data that can illustrate the successes of the Fab Lab. These are your blessings. Cherish them!

6 Surviving - Funding, business model, good practices, community building

Picture: Woelab, Lomé, Togo presents its 3D-printer based on recycled PC-chassis at FAB10 Festival and wins the first ever Fab Award (http://www.woelabo.com/)

This chapter describes the last stage in the Fab Lab life cycle: surviving. Many Fab Labs start with initial funding for 1-3 years. After that time structural funding and/or steady income streams are necessary. To organize structural funding, first prepare a multi-annual plan, and then try to organize structural funding or steady revenue streams. The chapter concludes with a wrap-up: "think globally, act locally" on your worldwide contacts and local community.

6.1 Prepare multi-annual plan

Although exact figures are missing, there exist a shared perception in the Fab Lab community that half of the Fab Labs have no structural funding, while the other half only has funding for the first 1-3 years. And even if the Fab Labs manage to survive the first three (funded) years, they still make an annual loss of about 1/10 of their turnover. The best survival chances have Fab Labs that are part of a larger organization, have structural funding, and/or have some "cash cow", like commercial production activities. Whether you want to (or have to) be self-sufficient or are looking for new sponsorships, a development plan for your Fab Lab that includes more than one year is indispensable.

Before you start, it might be wise to discuss with your team what is going on in the world of making. See the "Background" paragraph before. In which way is the world moving and what is its impact on

the maker movement itself? What will be the probable future for Fab Labs in general, what will be the desirable future, especially for your Fab Lab? The, forget the actual situation of your Fab Lab (for a moment) and try to imagine the Fab Lab your team wants to create in, say, five years from now (your midterm ambition).

Remember the mix of community (ORG), education (EDU) and business (COM) orientation we mentioned earlier. Are there reasons to change or tune this mix for your Fab Lab? And how about the services you deliver to this mix? Maybe a service you developed for EDU could be offered to ORG as well! You also can conclude you should address new target groups (e.g. health workers / hospitals) or add new services (e.g. production work)

Once, your Fab Lab has a clear and shared vision on the near future, it is time to elaborate your multi-annual plan. When you make it a rolling plan for the coming years, you can review, update and extend it annually in an efficient way. The following table might be a useful tool. Do not forget to involve your stakeholders and/or user council in this process.

[A] **Category**	**[B]** **Year 0 - actual situation**	**[C]** **Year 1 - next year**	**[D]** **Year 2**	**[E]** **Year 3-5**	**[F]** **Midterm ambition**
Target groups					
Services					
Activities					
Resources					
Revenue streams					
Costs					

Table: Tool for preparing a global multi-annual plan

The table shows a tool to develop a multi-annual plan:

- First, identify the items that are important for your team to consider, i.e. the elements of your earlier business model, and write them in column A. (We did already).
- Next, prepare a concise description of the actual situation (we call it year 0) and write it in column B.
- Then try to imagine the Fab Lab your team wants to have in, say, five years from now (your midterm ambition). Write it in column F.
- Once, column F has been filled, go through columns C, D, and E to specify changes and actions to develop your Fab Lab step-by-step from its actual situation (column B) to its desired situation (column F). Tip: Use stickers for easy changing and moving.
- Discuss the results. Do they reflect enough ambition to motivate your staff? On the contrary, are the ambitions for the subsequent years feasible? Do you have alternative revenue streams

when your most important source of income does not develop as well as expected? Change the results where appropriate until your team feels comfortable with the whole.

When it has to come to applications for grants etc. a lot has to be worked out further. Nevertheless, the global multi-annual plan will give you a consistent and shared basis to depart from.

6.2 Organize structural funding

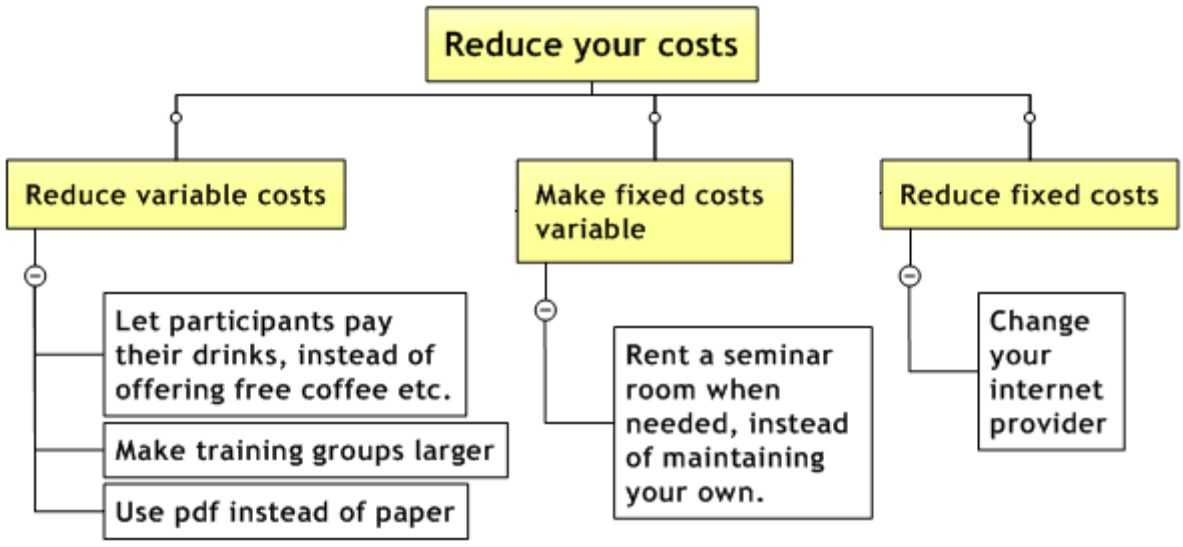
First analyze the financial situation of your Fab Lab and try to diminish expenses and increase income in various ways. Then, select an appropriate funding strategy. If that fails you need an escape.

Analyze your financial situation

Your multi-annual plan contains estimates for revenue streams (income) and expenses (costs). Part of your expenses will be fixed. You have to pay them anyway, even if the Fab Lab had no activities at all, e.g. rent, internet. Parts of your expenses are variable: the more services you deliver, the more expenses you have. The same can be said about your income. Part of your income will be fixed (an annual grant), part will be variable (tuition fees).

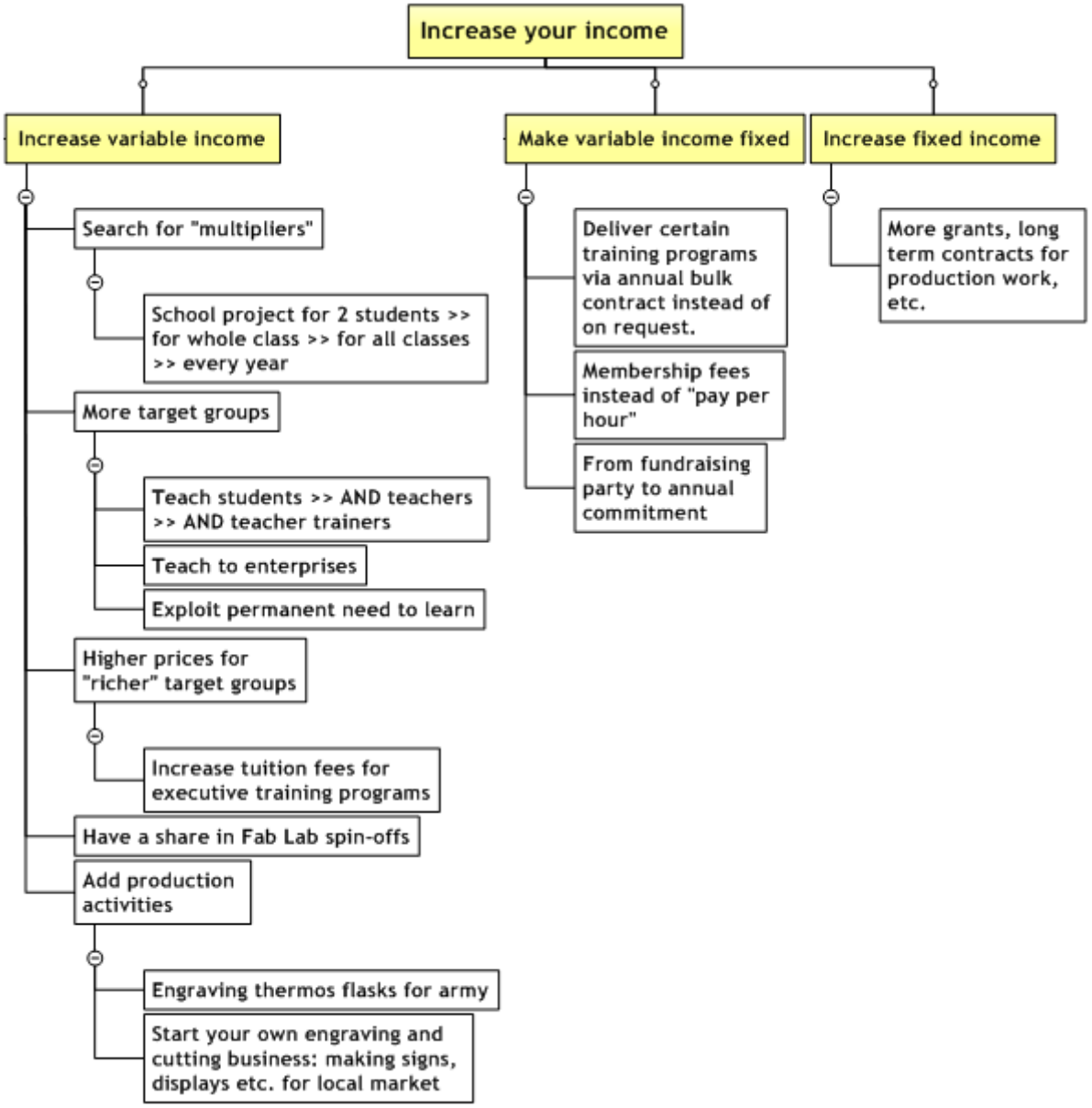
You can arrange your budget according to the concepts fixed and variable and review it critically. Can you reduce your costs and/or increase your income?

The infographic below focuses on cost reduction and gives some examples.



Infographic: Three ways to reduce Fab Lab costs plus examples

The second infographic gives some examples to generate more income.

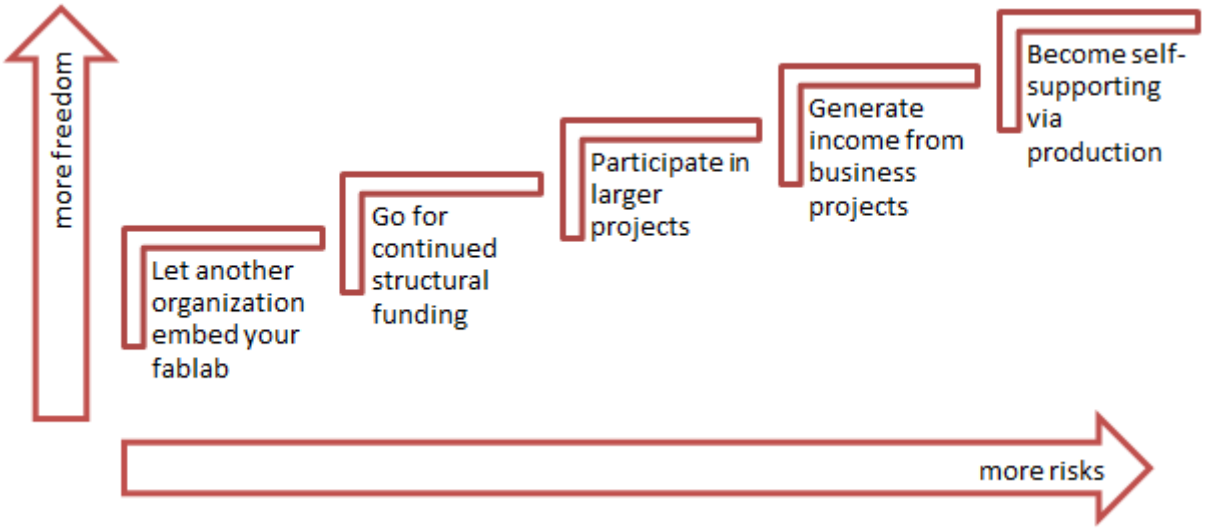


Infographic: Three ways to generate more Fab Lab income plus examples

Select a funding strategy

Even when you did a good job in reducing your Fab Lab's costs and increasing its income, it is possible that you still did not make the ends meet. More income is needed, preferably structural income.

The following infographic illustrates five strategies to consider. It is up to your Fab Lab which one(s) you will try to apply. Please, note that not only your financial viability, but also your independence is at stake. When you become self-supporting via production your are more independent than when another organization is embedding you!



Infographic: Five strategies for increasing Fab Lab income in a more structural way ordered by degree of freedom and risks

The five strategies to be considered are:

- **Let another organization embed your Fab Lab** - A creative hub of enterprises, a university or school, a business complex: they all have in common that they might want to have a Fab Lab on their site. It might be so important for them that they will pay a fixed amount of money every year or, in fact, take over the Fab Lab ownership.
- **Go for continued structural funding** - One way is to try to "harvest" resources more systematically, e.g. via local enterprises or service organizations. Another way is to identify a social issue that can be tackled by (contributions of) the Fab Lab (improvement of creativity, reduction of school dropouts, innovation of small and medium enterprises), develop a business case and request funding form local authorities or government. Keep in mind that each sponsor and fund has its own policies. Your greatest chance of success requires your application to match their policy seamlessly. Some sponsors prefer to give something visible and tangible: a new machine, a couple of laptops. Other sponsors prefer to pay for capacity building: staff training. Sometimes sponsors are interested in a single gift, e.g. the funding of a project comprising an outreach activity including services, staff, and materials. Whatever the type of funding, try to make it structural, i.e. for a range of years.
- **Participate in larger projects** - Government agencies might write tenders for projects too large for a single business partner. In that case various business partners including the Fab Lab can form a consortium. Further, universities may have resources for additional research and development projects. It might be a win-win situation to give the Fab Lab a paid role in such a project.
- **Generate income from business projects** - According to the Fab Charter "*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.*" Parties could agree a lump sum to be paid to the Fab Lab or a share in future profits. Various projects in the Fab Lab might result in new tools and high precision instruments. Hiring out to third parties, or, better, applying them to fulfil third party's needs (e.g. non-destructive testing), might generate income for the Fab Lab.
- **Become self-supporting via production** - Your Fab Lab can go into production work for big or small clients. Examples are: 1) mass customisation for a single client who returns every year, 2) producing unique products for the local market like signs and displays, 3) producing spare

parts, furniture. See "Guidebook to starting your own engraving and cutting business" by Epilog (http://bit.ly/1oskCd2).

Prepare an escape

When your efforts to get structural funding fail, what will be your escape? Well, in fact you have to cut all costs wherever possible:

- **Housing** - You may search for empty shops or offices that might be hired at a very low rate (in fact as anti-squatter policy) until a regular tenant shows up.
- **Workspace** - Collect (and repair) second hand furniture.
- **Machines** - Maintain what you have; new machines only at mini Fab Lab level or machines other Fab Labs can miss.
- **Materials and components** - Garbage collected from other workshops and enterprises.
- **Staff** - Interns and volunteers only, for continuity: a retired person with her own income.

6.3 Think globally, act locally

Some Fab Labs are built in a bus or truck and move from school to event and further and other Fab Labs fit in a suitcase and can be carried (almost) everywhere on earth. Most Fab Labs, however, are bound to a fixed physical location and work mainly for and with their direct environment, a mix of local community, local schools and local businesses. Together they form their Fab Lab community.

To make the most of your Fab Lab, it should be embedded in its local community and be part of the worldwide Fab Lab network and/or the maker movement that also comprises maker spaces, hacker spaces, repair cafes, tool libraries, maker faires etc. See the earlier section on "Learn from other Fab Labs good practices" to reflect on your position in the Fab Lab network. See the paragraph "Background" for some references about changes in the global economy and reflections on the maker movement.

The local Fab Lab community is important for the Fab Lab as it contains all local target groups. On the other side the Fab Lab is important for the community as it may have a positive impact on life and welfare there. Reasons enough for the Fab Lab to pay attention to building up and fostering "their" community. The Fab Lab's public relations activities partially are community management activities. The relation with the community sometimes is even formalised via board members, user's council, members meetings, etc. See: The Butterfly Paper No. 1 on ict related community development in Africa (http://butterflyworks.orghttp://butterflyworks.org). See also: and "The art of community; building the new age of participation" by Jono Bacon (http://bit.ly/Y6cPN4) based on his experiences with the Linux community.

It is the challenge for the Fab Lab to think globally and act locally!

7 Appendices

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7.2 Workshop details

We present some pictures from the first edition, its "raw" results and how we "cooked" them to be useful input for the second edition. We also have some pictures from the latter.

Summary

During the International Fab Lab Conference FAB10 (Barcelona, Spain, 2-8 July 2014), two editions of the Fab Lab Life Cycle Workshop were run. The workshops were structured by life cycle stages:

- **Conception** - How to start, paperwork, funding, and all issues until the lab goes live
- **Early childhood** - Teething problems, challenges during the first year
- **Coming to age** - Management issues, professional PR and advocacy, service development
- **Fostering new businesses** - Supporting the creation of new products, processes and organizations
- **Surviving** - Funding, business model, good practices, community building

The two editions of the workshop were different in length and in the origin and number of participants.

Item	Edition 1	Edition 2
Date	Wednesday, 2 July 2014, 14 h	Sunday, 6 July 2014, 11:30 h.
Location	Disseny Hub Barcelona	Green Fab Lab Valldaura
Duration	2 h.	1 h.
Participants	FAB10 participants involved in local Fab Labs	FAB10 participants from World Bank group involved in education policy making and large scale projects in developing countries
Numbers	Initially 25, ultimately 45	About 15 all the time

The workshops were developed by Pieter van der Hijden en Beno Juarez. They used the "envelope game" format from the Thiagi Group (http://www.thiagi.com/details-envelopes.html).

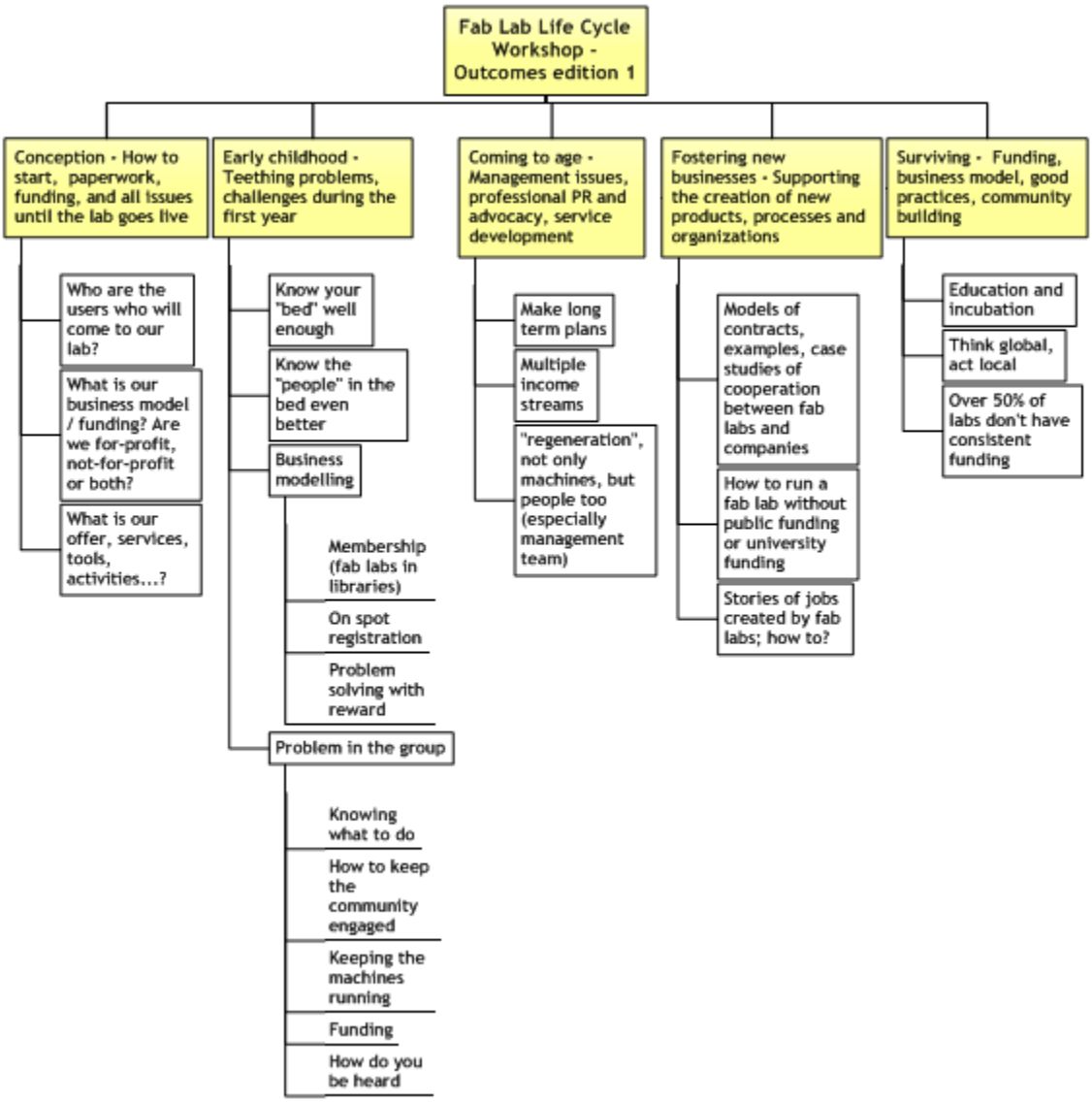
The workshops were run by one facilitator, supported by five mentors. Each mentor had a specific focus.

Role	Name	E-mail
Facilitator	Pieter van der Hijden	pvdh@sofos.nl
Mentor 1: Conception	Massimo Menichinelli	info@openp2pdesign.org
Mentor 2: Early childhood	Dirk van Vreeswijk	dirk.van.vreeswijk@coldenhove.com
Mentor 3: Coming to age	Beno Juarez	beno@fablablima.org
Mentor 4: Fostering new businesses	Enrico Bassi	enrico@enricobassi.com
Mentor 5: Surviving	Anna Waldman-Brown (1st edition), Klaas Hernamdt (2nd edition)	annawab@fabfolk.com, hernamdt@gmx.net

First edition

Picture: FAB10 Fab Lab Life Cycle Workshop (first edition) - Wrap-up

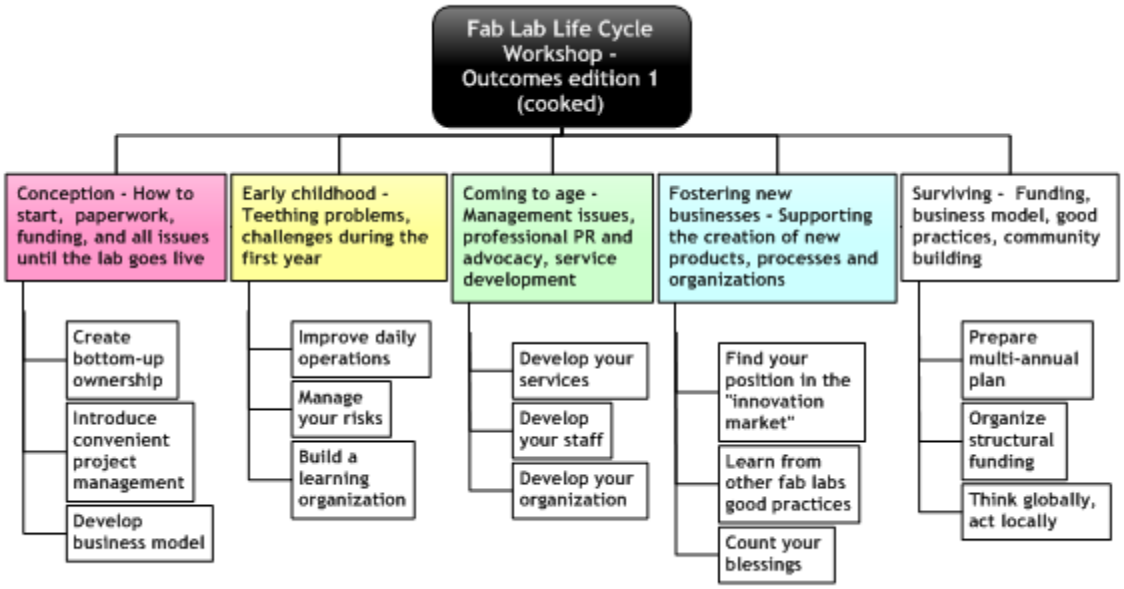
During edition 1, the groups discussed 4 out of 5 life cycle stages and peer reviewed the outcomes of the fifth stage (which was different for every group). The infographic show the "raw" outcomes as presented to the plenary wrap-up.



Infographic: Outcomes of workshop Fab Lab Life Cycle ("raw")

Second edition

After the first edition, some staff members reviewed the "raw" outcomes and their underlying notes and reframed the whole from policy making perspective. The infographic below shows the "cooked" outcomes, used as input for edition 2.



Infographic: Outcomes of workshop Fab Lab Life Cycle ("cooked")

During edition 2, the groups discussed all of 5 life cycle stages. The mentors acted as resource persons and made notes and have given their impressions during a short plenary wrap-up. This all was used as input to produce this "Fab Lab Life Cycle" report.

Picture: FAB10 Fab Lab Life Cycle Workshop (second edition) - Group work

Evaluation

At the end of each edition of the workshops, the participants were invited to fill a form and answer three questions. In short: what was good? what could be better? and other comments. Most responses were very positive. Suggestions for improvements were: more time and a more geographical diversity in the mentor's background (now most of them were from Europe). Full copies of the responses are available on request.

The participants of the second edition made a short video on their FAB10 impressions; see The Maker Movement's Impact and Potential for Developing Countries; FAB10 conference; video; World Bank, 2014; http://bit.ly/ZnXwQ7 For pictures of both editions of the workshop, see http://www.flickr.com, tags FAB10, lifecycle, workshop.