

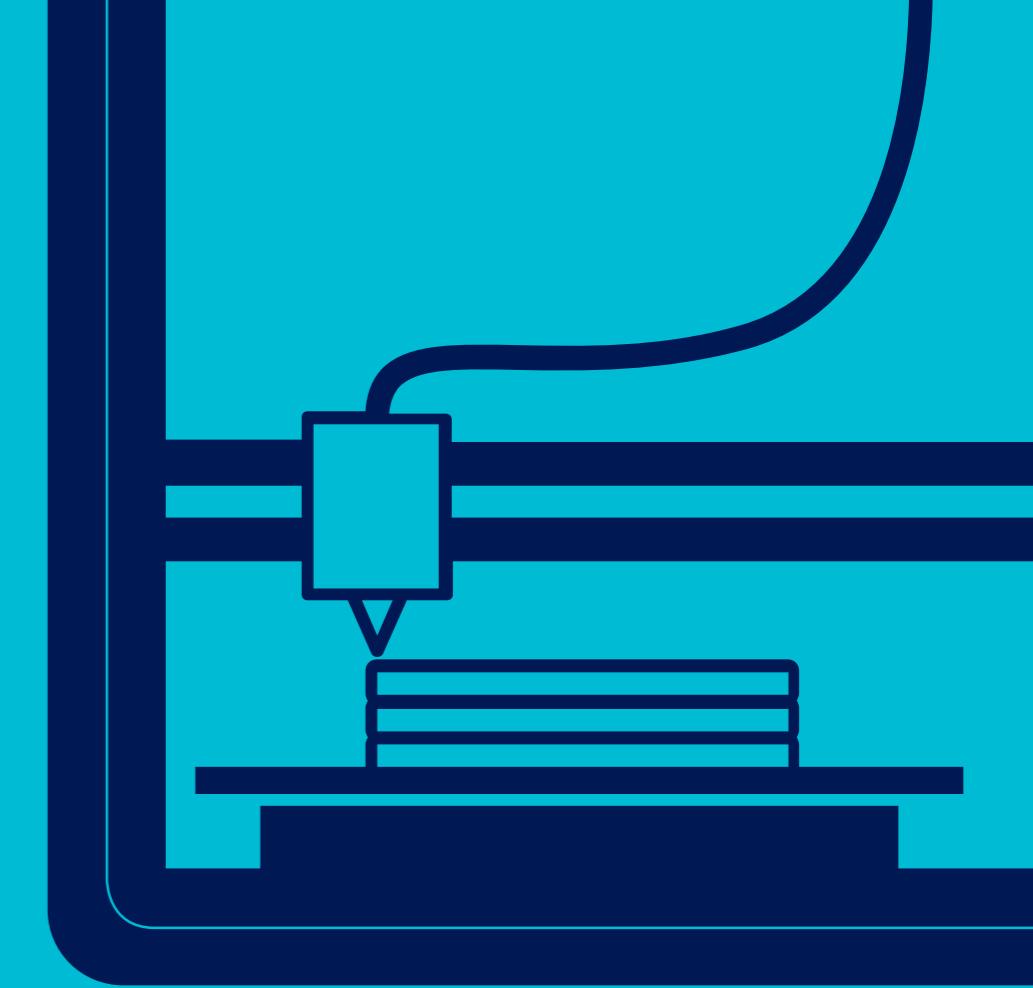
FabLab Guide

How to set up your lab
and maximise its impact

FabLab: A local fabrication laboratory which aims to democratize access to personal and collaborative invention using digital technologies to make almost anything.



University of
BRISTOL



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This guide outlines the main challenges and issues arising for anyone running, or considering setting up, a FabLab.

How much of the content is new to you will depend on the depth of your knowledge about digital fabrication, the Maker Movement and basic business fundamentals. We hope that each reader is able to take new insights from the guide and that it serves to strengthen the impact of FabLabs both locally and globally.

By Jennifer Johns, University of Bristol
in collaboration with the Fab Foundation

01 The history of FabLabs

01 The history of FabLabs

The concept of FabLab emerged from MIT's Center for Bits and Atoms.

The goal was to provide access to the tools, knowledge and the financial means to educate, innovate and invent using technology and digital fabrication to allow anyone to make (almost) anything, and thereby create opportunities to improve lives and livelihoods around the world.

The Fab Foundation was formed in 2009 to facilitate and support the growth of the international FabLab network.

Sherry Lassiter (Fab Foundation Director) observed that the number of FabLabs has been doubling every year and a half, similar to Moore's Law. This is now called the 'Lass' Law' (Gershenfeld et al. 2017: 18).

USEFUL LINKS

www.fablabs.io/labs/map



100+

Countries with a FabLab

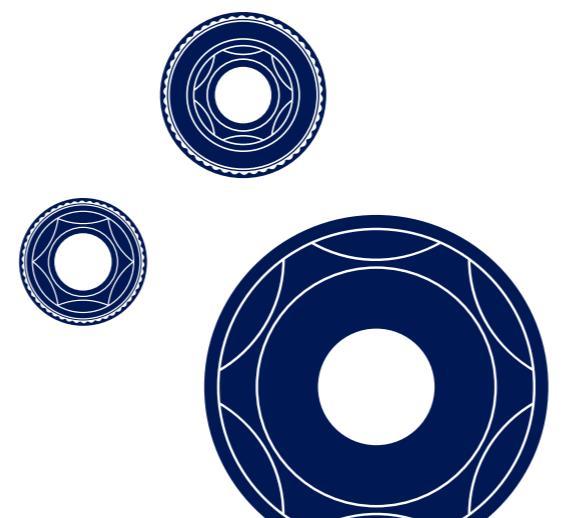


01 The history of FabLabs

The FabLab Network is an open, creative community of fabricators, artists, scientists, engineers, educators, students, amateurs, professionals, of all ages located in more than 100 countries in approximately 1,600 FabLabs.

From community based labs to advanced research centers, FabLabs share the aim of democratizing access to the tools for technical invention.

This community is simultaneously a manufacturing network, a distributed technical education campus, and a distributed research laboratory working to digitize fabrication, inventing the next generation of manufacturing and personal fabrication.



Fab Conferences



FAB01

📍 Boston, USA

FAB02

📍 Lyngen, Norway

FAB03

📍 Pretoria, South Africa

FAB04

📍 Chicago, USA

FAB05

📍 Pune, India

FAB06

📍 Amsterdam

<http://cba.mit.edu/events/10.08.FAB6/>

FAB07

📍 Lima, Peru

<http://cba.mit.edu/events/11.08.FAB7>

FAB08

📍 New Zealand

www.fab8nz.com

FAB09

📍 Japan

www.fab9jp.com

FAB10

📍 Barcelona, Spain

www.fab10.org/en/home

FAB11

📍 Boston, USA

<https://fab11.fablabbcn.org>

FAB12

📍 Shenzhen, China

<http://fab12.fabevent.org>

FAB13

📍 Santiago, Chile

<http://fab13.fabevent.org>

FAB14

📍 France

www.fab14.org

FAB15

📍 Egypt

www.fab15.fabevent.org

FAB16

📍 Montreal

www.fab16.fabevent.org

FAB17

📍 Bhutan

www.fab17.fabevent.org

01 The history of FabLabs

What is a FabLab?

Neil Gershenfeld tells us that a FabLab today fills a room, weighs about two tons, and costs about \$100,000.

That includes 3D scanning and printing, large-format and precision machining, computer-controlled lasers and knives, surface-mount electronics production, embedded programming, and computing tools for design and collaboration. With these, it's possible to locally produce and customize products that are mass-produced today, such as consumer electronics and furniture.

USEFUL LINKS

<http://news.mit.edu/2016/3-questions-neil-gershenfeld-fab-labs-0104>

BITZ unibz FabLab, Italy.



Extra resources

Gershenfeld, N. (2005) *Fab: The coming revolution on your desktop – from personal computers to personal fabrication*. New York: Basic Books.

Gershenfeld N. 2012. How to make almost anything. *Foreign Affairs* 91(6): 43-57.

Gershenfeld, N., Gershenfeld, A., Cutcher-Gershenfeld, J. 2017. *Designing Reality: How to survive and thrive in the third digital revolution*. New York: Basic Books.

02 Making motivations

02 Making motivations

Why set up a FabLab?

What motivates FabLab founders?

There are many motivations for setting up a FabLab. These include:

- formalising an existing Makerspace
- to help regenerate places, communities and neighbourhoods
- to provide services to the local community
- to educate new Makers
- to advance knowledge of digital technologies and explore new possibilities
- to support research and development and upgrade knowledge in existing disciplines
- to provide services to existing industries, especially in prototyping and innovation

FabLabs are a kind of Makerspace, but a space focused on digital fabrication, community engagement and impact.

Who or what is a Maker?

'I'm a Maker because I make things'

'I'm a tinkerer'

'A Maker is someone that makes rather than buys. Or creates rather than buys'

'I make things and I think I'm reasonably good at it'

'I'm a Maker because I teach myself how things work'

USEFUL LINKS

Make Magazine:
<https://makezine.com>

Maker Faires:
<https://makerfaire.com>

02 Making motivations

Many FabLab users would describe themselves as 'Makers'.

They participate in the 'Maker Movement' which extends the 'do it yourself' culture into creating new objects and re-purposing existing ones.

Spaces for Makers vary in how they are run and the types of equipment they have.

Some are more commercialized, aiming to help entrepreneurs make prototypes they can commercialize, others are a venue for hobbyist Makers to hang out.

Techshops used to be the most advanced in terms of tech offered and were based on a membership model. They closed down in 2017 leaving the future of community based digital fabrication in the hands of FabLabs and Makerspaces.

The story of FabLab isn't just about playing and learning. It is about the power of digital fabrication for innovation, entrepreneurship, learning for community impact and solving global challenges.

innovate

fun

play

live

learn

make

exchange • make
fail • cut • digital
friends • educate

sustain • grow
wellbeing • advance

future fork •
internet • code •
print • experience

invent • share
knowledge •
entrepreneur

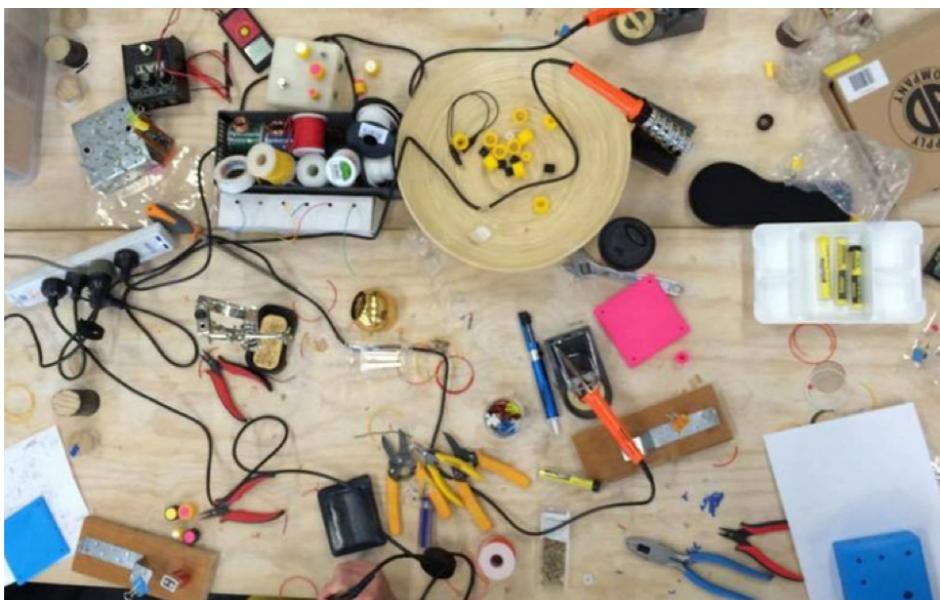
02 Making motivations

"They have the FabLab harter on the wall with what you can and cannot do. Whereas the Hackspace is very much more like the Wild West that you do whatever you want.

My girlfriend, for example really prefers the Hackspace because she just gets on and doesn't have to talk to anybody. She doesn't feel bad about not talking.

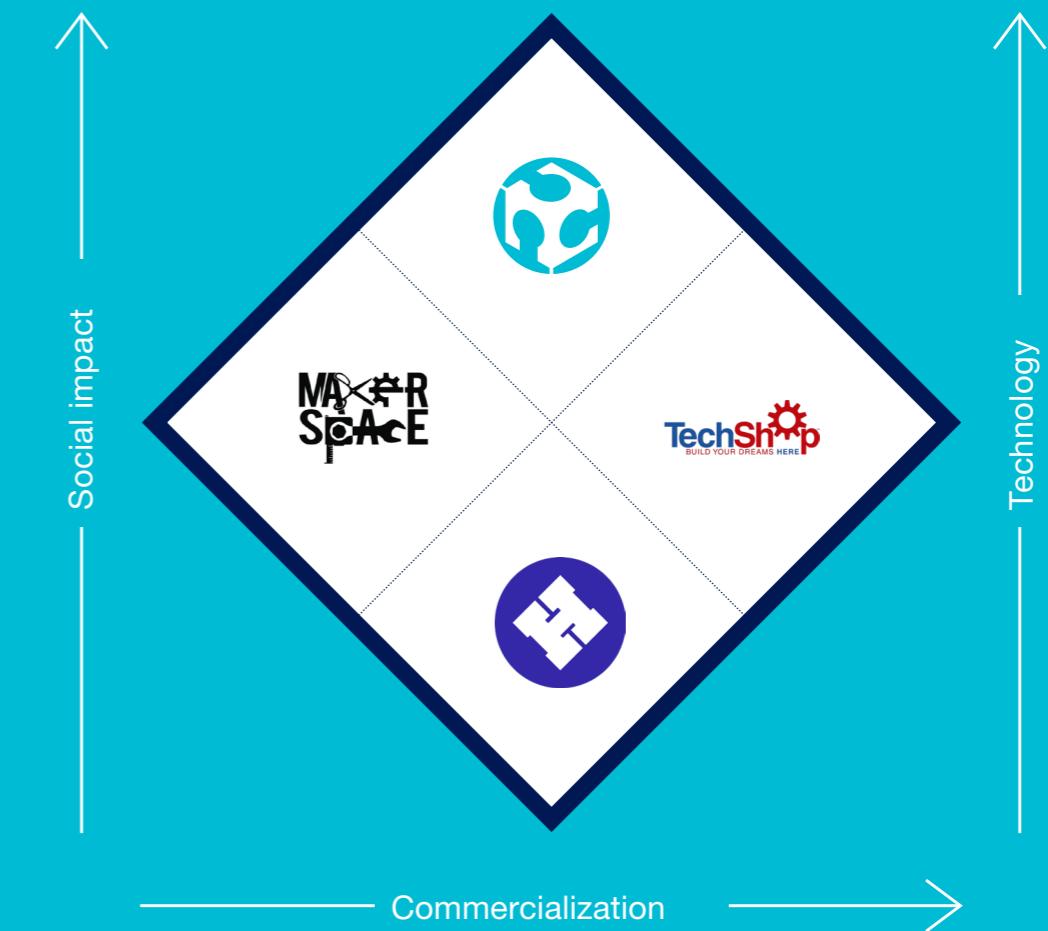
Whereas the FabLabs are more of a community whereas the Hackspace is, if you want to talk to other people you can, but if you want to ignore them and carry on making you can. It's a different culture."

Quote from a FabLab user



FabLab
Christchurch,
New Zealand.

Typology of Makerspaces

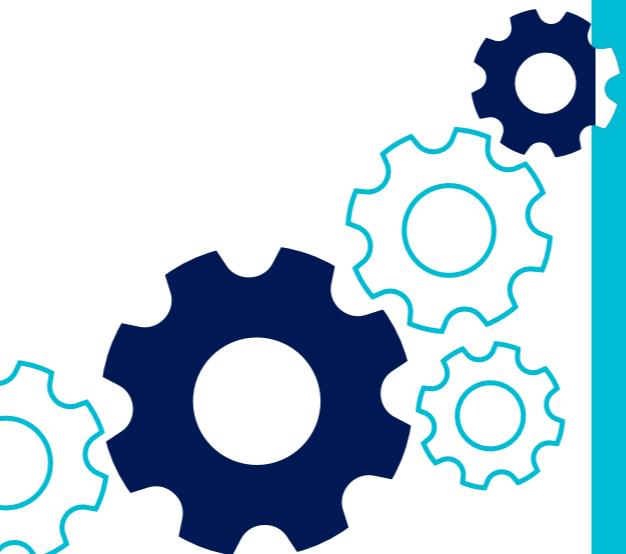


03 Fab Charter and open source philosophy

03 Fab Charter and open source philosophy

What makes FabLabs different to other Makerspaces is a set of guidelines that all labs follow.

The guidelines are designed to support managers and users and to create an atmosphere of openness.



Fab2E,
GuangDong,
China.

The Fab Charter

● What is a FabLab?

FabLabs are a global network of local labs, enabling invention by providing access to tools for digital fabrication.

● What's in a FabLab?

FabLabs share an evolving inventory of core capabilities to make (almost) anything, allowing people and projects to be shared.

● What does the FabLab network provide?

Operational, educational, technical, financial and logistical assistance beyond what's available within one lab.

● Who can use a FabLab?

FabLabs are available as a community resource, offering open access for individuals as well as scheduled access for programs.

● What are the responsibilities of users?

Safety: not hurting people or machines

Operations: assisting with cleaning, maintaining and improving the lab

Knowledge: contributing to documentation and instruction

● Who owns FabLab inventions?

Designs and processes developed in FabLabs 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 FabLab?

Commercial activities can be prototyped and incubated in a FabLab, 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.

03 Fab Charter and open source philosophy

What is 'open source' and what does it mean for FabLabs?

Originally the term 'open source' referred to a computer programme in which the source code is available for all to use, and enables modification from its original design. In the context of FabLabs, this means that much of the equipment and the designs are open source – they can be modified, thereby enhancing the potential of the technology and user engagement. Sitting alongside the Fab Charter, the open source philosophy means that when users have used free, public time in the FabLab they are strongly encouraged to make their designs available to other users so that all can learn from each other.

As FabLabs have been demonstrating for quite some time, contemporary 'open source' includes hardware as well as software. This is where the cutting edge is.

01



"Most innovation is happening in upstream, open source communities... (going) beyond software, it's the font of innovation for technology."

Tim Yeaton, Red Hat



01 Photo by Barn Images on Unsplash.

02 BITZ unibz FabLab, Italy.



03 Fab Charter and open source philosophy

WikiHouse

The WikiHouse project is an open source project designed to reinvent the way homes are made. The aim is to use digital manufacturing to make it possible for anyone to download and ‘print’ customised, low-cost, high performance houses.

☞ <https://wikihouse.cc>



☞ A-Barn in construction. Image courtesy of WikiHouseFoundation.

FabLab Beehive

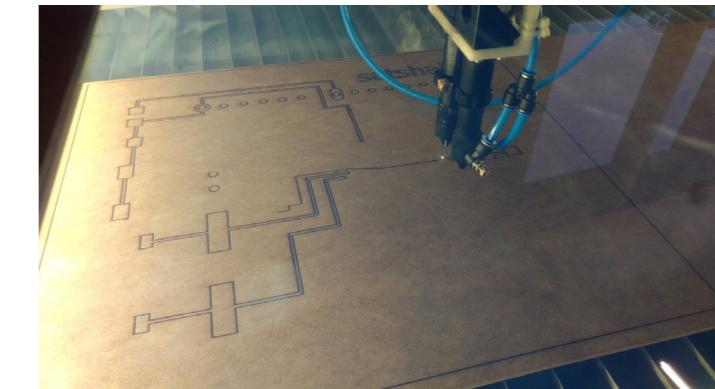
Concerned with declining bee numbers, the FabLab Barcelona at IAAC has fostered a distributed team of designers and developers to produce open source beehive designs. Either can be freely downloaded, installed to a CNC router machine and cut from a standard 4x8 sheet of material. The fabricated pieces slot together without the need for screws and glues. To date there are more than 60 hives in over 20 countries.

☞ <https://iaac.net/research-projects/self-sufficiency/open-source-beehives>

There is also a sensor kit that creates open source data regarding the healthiness of the hive, so researchers can monitor the hive. The project is about more than just the technology. It has an important role in bringing communities together around the beehives.

☞ www.osbeehives.com

☞ Example of an OSBeehive.



☞ The Open Source Dual Laser Cutter.

LaserDuo

LaserDuo is an open source laser cutter machine designed and built by Daniele Ingrassia and his team.

Developed and built in FabLab Kamp-Lintfort as a multipurpose machine, LaserDuo allows access to the laser cutting technology at lower price in comparison to similar machines available on the market.

☞ <http://laserduo.com>

04 Planning and permissions

04 Planning and permissions

Location, location, location!

It is crucial to consider exactly where the best location is for each FabLab.

In theory a FabLab can be located anywhere, but each lab needs to attract users (both the public and businesses). It may be challenging if you are some distance from urban areas, but there are examples of successful rural FabLabs.



01-02 Examples of a rural setting GreenLab, Valldaura, Spain.

03 Barcelona FabLab, Spain.

04 FabLab AST, Canada.



04 Planning and permissions

The closer a lab is to public transport and / or parking the easier it will be for users to get to the lab, and to transport materials for their projects. You may want to investigate sharing a space, for example setting up a FabLab in a public building like a library.

Do you need any permits, licenses or permissions?

Check with local and national government officials. It will help if you can get in touch with existing FabLabs in your country to ask if there are any specific rules you need to consider.



01 Suburban FabLab St Jude, Costa Rica.

02 High school FabLab Apple Valley, USA.

03 Technology Park FabLab Tehran, Iran.



Examples of different types of FabLab partnerships:

Library: Trafford FabLab (UK), FabLab Devon in Barnstaple (UK) and FryskLab, a mobile library FabLab in the Netherlands.

School: Santa Clara High School in Santa Clara, California and UI1 High School in Grindstone, Pennsylvania.

University: FabLab Nairobi, FabLab CSUB (California State University Bakersfield), FabLab UW Stout (University of Wisconsin), FabLab Aalto (University of Aalto, Finland).

There are strong corporate partnerships with Chevron, GE Foundation, Airbus and SolidWorks. These partnerships create new labs and support resources and programmes in existing labs. Other examples include Creative Lab in Guyancourt, France (with Renault) and FabLab Bristol, in the UK (with Saint-Gobain).

Think about the following factors:

01

Cost per square metre for your space. It is likely that the closer you are to the centre of urban areas, the more expensive space will be. Strike a balance between a central location and having more space in your FabLab.

02

Proximity to public transport and / or parking facilities.

03

What kind of space is going to attract local users (i.e. tidy modern office space or dirtier warehouse-type space)?

04

What facilities do you need? A toilet is essential if you expect users to stay for more than a few hours. Check what regulations you need to adhere to.

05

It is unlikely you can buy the space so you are likely to rent. Over what terms can you rent? What commitment can you make? Find out what changes you are allowed to make to the space.



05 Sources of revenue and support

05 Sources of revenue and support

Setting up a FabLab involves an investment of time and money.

It is a challenge to secure funds, organise finances, people and equipment and get up and running. But, as the growing number of FabLabs show, setting up a FabLab is possible and it can be an exciting journey!

There are a number of different routes to funding and you may find that these vary according to the country in which you are looking to set up a FabLab. One key decision relates to membership fees. Some FabLabs charge them, others don't. Membership can be charged annually, quarterly, monthly or even pay-as-you-go. There is no standard FabLab rate – each lab has to work out what suits their business model.

It is likely that your FabLab will need to use all the listed income streams to survive.

Type of funding	Advantages	Disadvantages
Public i.e. Grants	<ul style="list-style-type: none"> – Public grant money unlikely to have to be repaid. – Likely to connect to broader schemes and initiatives that can boost the FabLab. – Grants can be a driving force. They are often service or programme oriented so look for alignment between the grant organisation and a program you want to start. – Sustainability can come in the long-term if you are able to develop long-term, trust relationships with Corporate Social Responsibility departments or Foundations for which you partner on programs and services. 	<ul style="list-style-type: none"> – Difficult to be sustainable. – What happens after the grants run out? – Time consuming to be chasing grant revenue (and many will not be successful). – Dependent on funders understanding what FabLabs are and what they can offer.
Membership Fees	<ul style="list-style-type: none"> – Can bring relatively consistent income. – Ties users to the FabLab and they are more likely to attend if they are paying a fee. 	<ul style="list-style-type: none"> – FabLab may receive less users compared to free use. – Costs associated with managing the membership scheme, including substantial efforts in advertising and marketing to keep new users coming in.
Education i.e. University. Can be private or public. Can also be a lab doing professional development	<ul style="list-style-type: none"> – Consistent income and resources to invest in people and equipment. – May also come with strong existing brand and reputation. 	<ul style="list-style-type: none"> – Much lab time will be taken up with education for students. – Typically there is less public open access to the FabLab.
Private Funding i.e. Loans	<ul style="list-style-type: none"> – Working with private companies may bring other advantages such as sponsorship and / or commercial work income. – Make sure there is a clear understanding with private companies about expectations of the FabLab. – Can bring good publicity. 	<ul style="list-style-type: none"> – Risky, avoid personal investment of finances. – How to pay back loans? Is the business model secure enough?
Fees for Services	<ul style="list-style-type: none"> – Maximises existing resources (the skills and knowledge of your staff). – It increases engagement with local businesses and their staff. – Provides access to information on how Fab technologies are being used in prototyping and innovation in different industrial sectors. It is exciting! 	<ul style="list-style-type: none"> – It requires a high investment of staff time. – Many clients will want private, dedicated time in the Lab which reduces time open to the public. A balance needs to be found. – You will have to ensure confidentiality and IP protection.

05 Sources of revenue and support

Commercial revenues

Most FabLabs provide services for private companies who need digital fabrication and / or consulting on prototyping new designs and concepts. This can be an excellent source of revenue and working with businesses can be interesting and mutually beneficial.

As with membership fees, there is no set FabLab rate, but most labs publicise their rates. You need to work out what price your FabLab's services can command.

Some FabLabs conduct small scale manufacturing in off-hours for local companies. In Ghana they make dog tags on the laser cutters for the local government; in Kenya they prototype and manufacture small medical devices; in Tulsa Oklahoma (US) they help local entrepreneurs design and manufacture products related to motorcycles.

Do you incorporate the FabLab as a Limited or Inc company? Or do you set up as a charity?

There will be pros and cons of each – investigate this in your own country context.



02



Have you thought about setting up an Advisory Board?

This is a group of interested people who can help support the lab. You could include individuals from public funding bodies, local businesses and experienced Makers.



01 Work in progress at the South Australian Makers Inc.

02 Smartphone cases. Image courtesy of EOS.

05 Sources of revenue and support

Types of support: remember that there are many sources of support.



Emotional

Use your personal and social networks.



Financial

Explore all options open to you and try to have multiple funding sources.



Technological

You are part of a much bigger community. You can draw on the Fab Foundation, your regional Fab Network, and other FabLabs in your country for support. You are also part of the Maker Movement and can connect with other Makerspaces.

FabLab connect:
www.fablabconnect.com



Photos left to right by freestocks, Neil Thomas and Kyle Glenn on Unsplash.

Sustainability

A key question is around Sustainability. It is a challenge to keep FabLabs running after initial funding runs out.

You need to think about long-term sustainability from day one in planning your FabLab. Find your long-term stakeholders and partners. There are many models in both the Maker and Fab Networks.

But realise that making your own model is a highly customised process, dependent on your stakeholders and the needs and interests of your community.



06 Setting up: equipment and space

06 Setting up: equipment and space

While many people and organisations have set up FabLabs, digital technologies are still relatively new and novel.

The cheapest and fastest way to form a FabLab is to buy and assemble it yourself. This approach requires you to have some good expertise on hand to help you set up, install, debug and train staff. The Fab Foundation, and several other organisations, do offer some other ways of setting up a lab but these are more expensive.

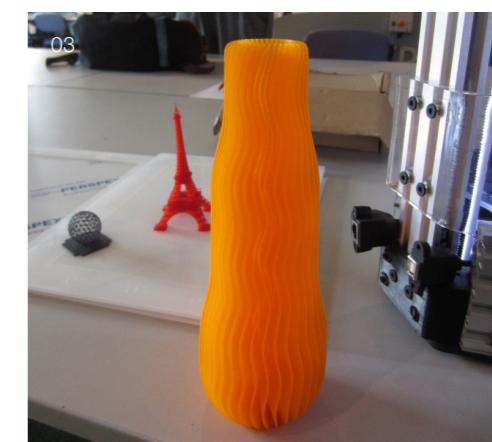
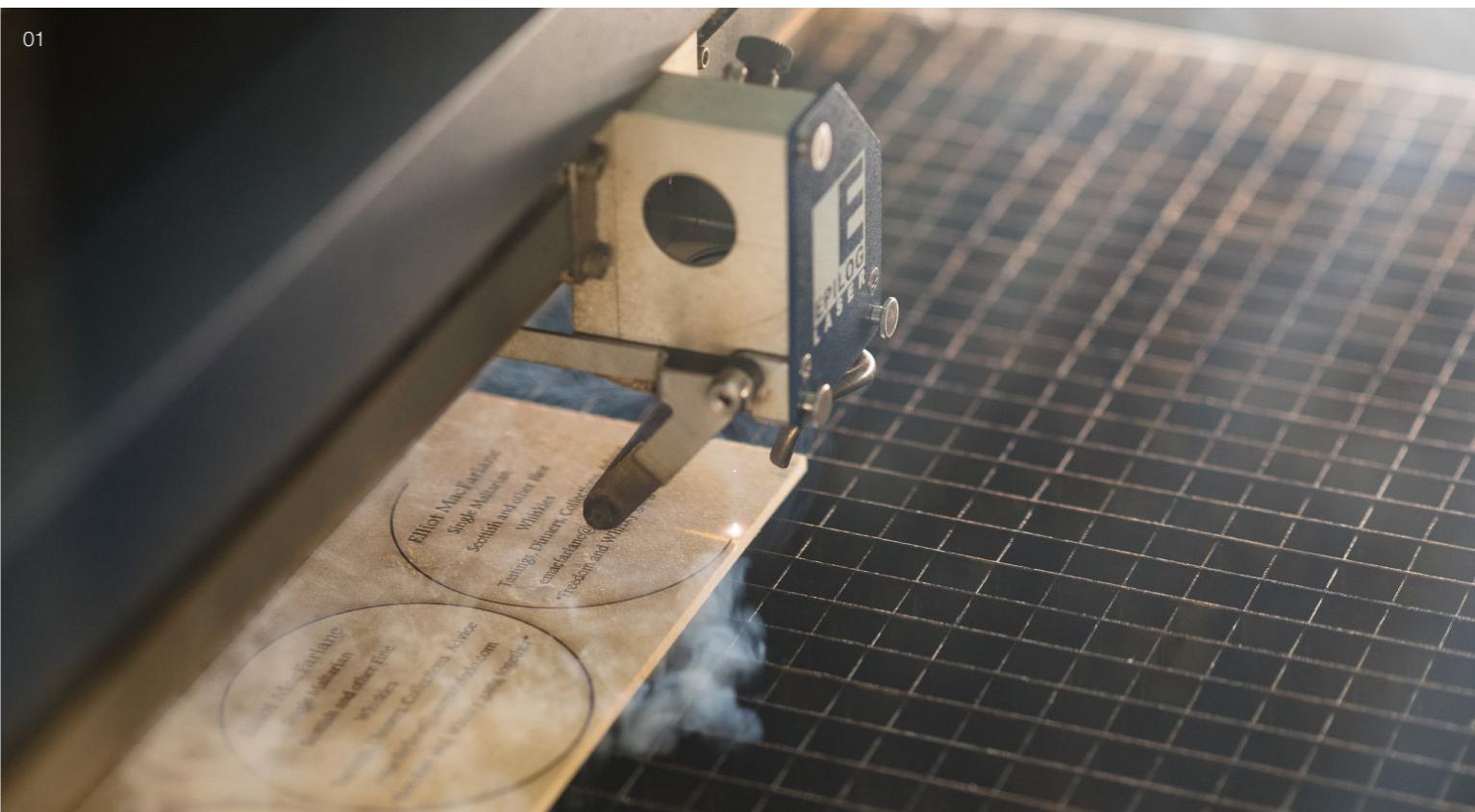
The full list of equipment, tools and consumables for a research grade FabLab is available at:

➤ <http://fab.cba.mit.edu/about/fab/inv.html>

A typical FabLab costs around \$25-65,000 in capital equipment and about \$15-40,000 in consumables. For the open source software visit

➤ <http://academy.cba.mit.edu/classes>

- 01 Epilog Laser in action at BigFabLab, USA.
- 02 CNC milling machine at MIDAS FabLab, Canada.
- 03 3D Printed object from FabLab Manchester.



06 Setting up: equipment and space

An inventory of equipment can be found at:

➤ <https://docs.google.com/spreadsheets/d/1U-jcBWOJEjBT5A0N84IUubtcHKMEMtnQPLCkZCkVsU/pub?single=true&gid=0&output=html>

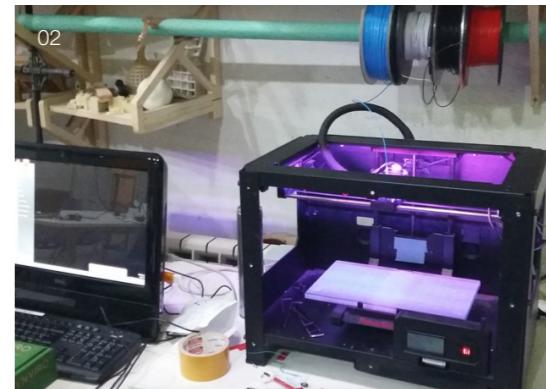
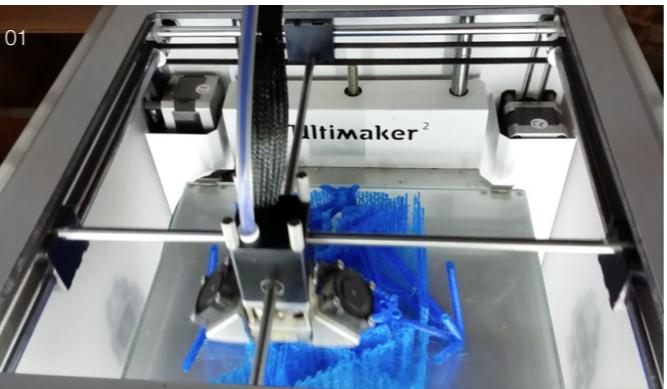
For further help contact Fab Foundation
info@fabfoundation.org.

The standardised FabLab kit is designed to make it possible and desirable for FabLab users to design and make things that can be shared globally. Users can share, designs, machine settings and tips to ensure that items can be digitally replicated anywhere in the world.

You are not limited to the standardised kit. If a FabLab wants to purchase additional equipment it is able to do so. It is also fine if a FabLab can't invest in the full set of equipment. It is advisable to try to establish working relationships with equipment manufacturers (i.e. desktop 3D printers and laser cutters) to see if they will loan items or arrange for long-term leases, which can help with a FabLab's cash flow and initial equipment investment.



- 01 Ultimaker 2 in full flow.
- 02 Makerbot 3D Printer.
- 03 Creative space in GreenLab, Spain.

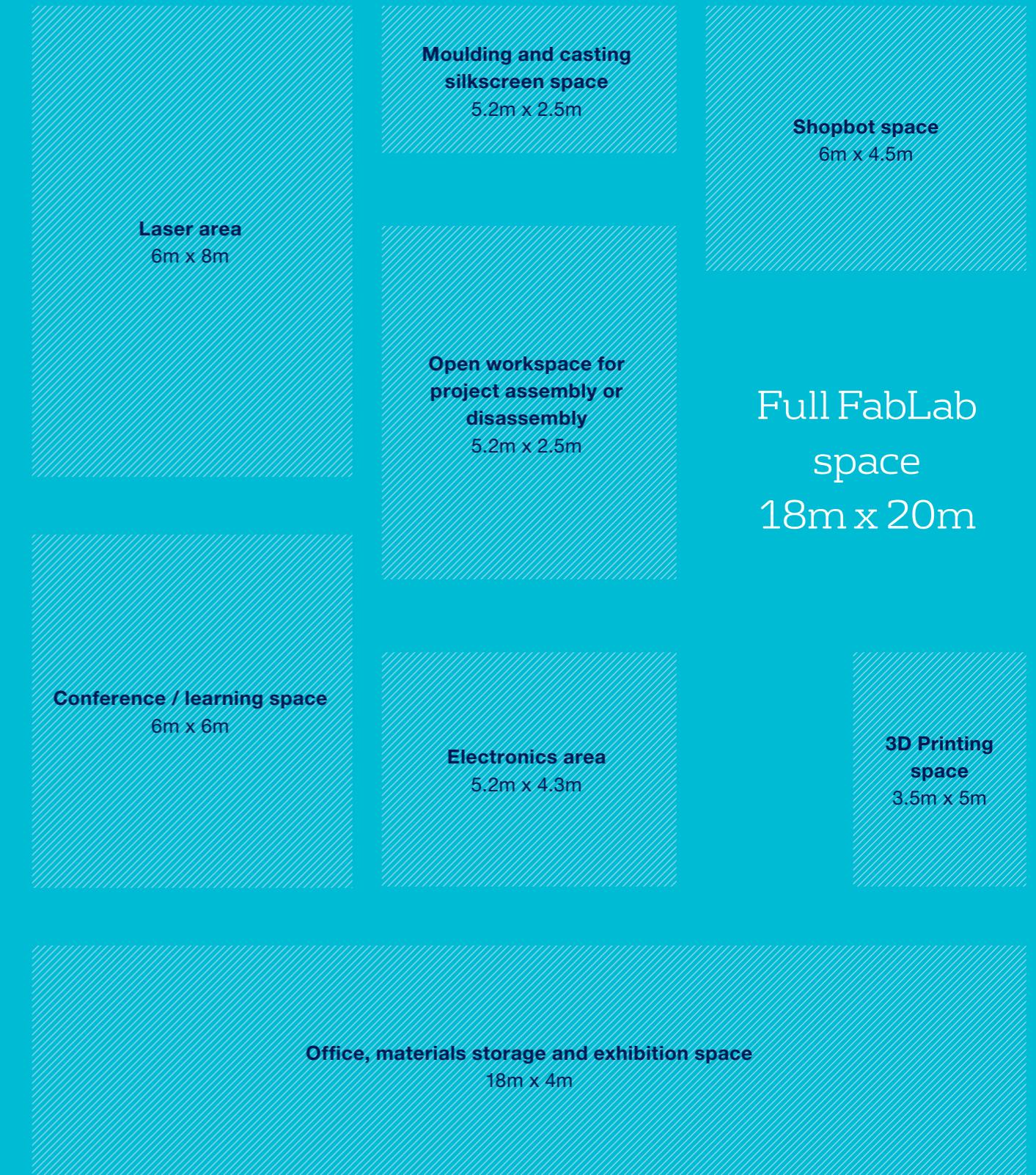


06 Setting up: equipment and space

What type of environment?

Many digital technologies are relatively clean so FabLabs don't necessarily have to be in workshops. Many FabLabs are in spaces that resemble offices. It is advisable to think about the following factors:

- 01 How much space do you need? How much can you afford? Do you include electronics components, high-precision milling machines for circuit board creation and computers for programming?
- 02 Where will you put the equipment? How do you anticipate users using the space? Does some equipment need to sit together or apart (due to noise or the generation of dust and fumes)? You don't want particles in the air around laser printers and 3D printers.
- 03 What facilities are you able to offer (coffee making for example)? Will there be space for users to talk and socialise?



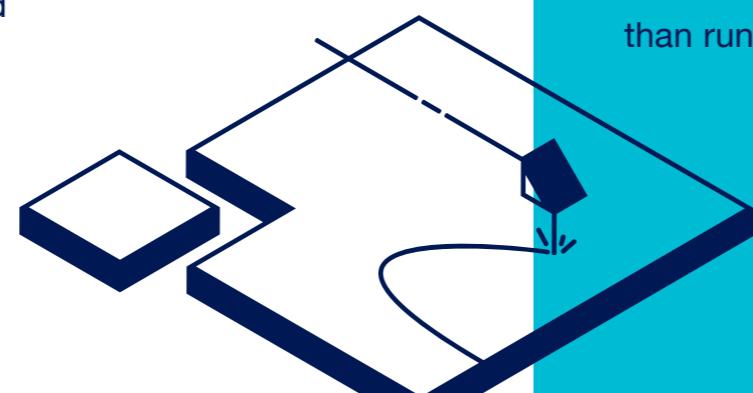
07 Staffing

Finding the right people to staff a FabLab is an important task.

There are different types of staff, hired on different contracts, who can be used to run the lab. The first position to fill is the FabLab manager, and this isn't necessarily the person / people who have initially set up the lab. Try using Maker networks to find candidates who have experience with the equipment and other Makers.

There are many functions that need to be performed including administrative support, maintenance and cleaning. If your FabLab is seeking to be more professional and impactful then you may need to think about staff to cover communications, community-building and business development.

Try to work out what each role entails, and what combination of staff suits your lab.



Manager

With stretched resources, FabLabs can be in danger of giving their managers too much to do. In an ideal situation the manager will focus on managing other staff, liaising with businesses and setting up educational courses.

It is helpful if the founders of the FabLab are able to monitor and support the finances of the FabLab to free up the manager to do their job. (The danger is that the manager ends up spending all his / her time chasing money to keep the FabLab alive rather than running the FabLab).



Intern

Interns are either working for free, or for a small salary, for a fixed period of time (between three months and a year). This is typically to enable them to train to use the equipment and to gain experience with applications of the technology.

A standard arrangement is that the intern works one third of their time helping the FabLab users and organising the lab, one third learning the machines and one third working on their own projects.



Volunteer

Many FabLabs rely on unpaid volunteers to support them. In most cases, these volunteers perform routine tasks like cleaning equipment and do so to contribute to the community.

Their contribution is ad hoc so while their combined contribution may be substantial, the FabLab cannot rely on this form of labour as it is not guaranteed. New FabLabs are unlikely to have a large pool of volunteers helping them.

Where to find people?

One place is Fab Academy. Every year the Fab Academy produces dozens of individuals trained in FabLabs using core equipment. They often have blogs and may well be looking for work in FabLabs.

➤ <http://jobs.fabeconomy.com>

Don't forget to look at international labs as well as local ones, as these individuals tend to be geographically mobile and keen for work abroad. You can look at the jobs.fabeconomy.com portal where people find and share lab managers.



🔍 An interview with Nicole, former FabLab Intern



My background

I was still an architecture student when I came to Denmark to do my internship at Fablab RUC.

I'd spent three years designing concept buildings and furniture in 2D and 3D, as architecture students do, but I had zero knowledge about manufacturing and prototyping.

My experience

Coming to FabLab for the first time, it was like Christmas on steroids: immediately I felt my creativity explode, while at the same time trying to cope with learning to use manufacturing machines correctly.

I spent every day at the lab, and almost all my weekends, prototyping, making mistakes, learning. The easiest machines for me were the lasercutter and the 3D printer.

I learnt to code electronics for my own fun projects and that was much more difficult than I thought, especially the coding, where there is a very steep learning curve. The CNC machine captivated me. I quickly learned how to use it and then experimented heavily on it, with different types of wood and different operations, like 3D milling. The CNC has been the machine that enhanced my creativity the most, to the point that I'm soon starting a furniture company.

Work after FabLab

The FabLab has been very crucial to my life since I was an intern there.

Soon after my internship, I landed a job in product design and later a lab managing job at a university where I currently work.

To this day I still use the FabLab to prototype on my own designs and try new things.

What I've learned

FabLab, and the wonderful people working there, gave me the freedom to experiment on my own and build a new diverse set of skills on my own pace.

The people you usually meet in a FabLab are inherently creative people and they are almost always open to sharing their experience and knowledge.

08 Launch and marketing

08 Launch and marketing

Once your FabLab is ready to open you'll need a plan for how you go about opening.

Is a 'soft' opening a good idea? A soft opening involves opening to a small number of selected people who can use the FabLab, test the equipment and enable staff to become familiar with running the lab. It is a 'trial run' that can last a few days or weeks. Your alternative is a 'big bang' opening in which you are open, ready for full business from day one. Either way you should think about whether you have the resources to hold an opening event in which you celebrate the FabLab opening and invite the media.

There are many ways you can publicise the opening of your FabLab, and there are tools you can use going forward to continue to boost the profile of the FabLab. You should consider traditional media.

Many governments are very interested in digital technologies, particularly in relation to Industrie 4.0 and the 'factory of the future'. Traditional media is latching onto this so may be more interested in your FabLab story. For example, the Manchester FabLab opening featured in Financial Times 22 March 2010.

Also, use social media as much as you can. Twitter, LinkedIn, Facebook, Instagram etc. are all effective ways to increase the buzz around your FabLab. Encourage users to talk about the FabLab and share photos of what they make. You can also leverage your networks, for example, draw on and / or create networks with education establishments, local firms and equipment manufacturers. They may want to support your marketing efforts.

Who is your target market?

Understand this to tailor your launch and marketing and remember it may change over time.



01 Photo by Marvin Meyer on Unsplash.

02 Article from the Financial Times regarding the opening of the Manchester FabLab.

FINANCIAL TIMES

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Fab Lab opens in Manchester

Andrew Bounds, North England correspondent MARCH 22, 2010

It is enough to hearten anyone who has ever doodled a life-changing invention on the back of a beer mat – but had no idea how to take it to the production line.

Manchester, once the cradle of the industrial revolution, will confirm its status at the forefront of UK industrial experimentation on Tuesday when the country's first Fab Lab opens there.

**THE LEADER'S GUIDE TO
NEGOTIATION**

**THE LEADER'S GUIDE TO
INFLUENCE**

**THE LEADER'S GUIDE TO
COACHING AND
MENTORING**

**THE LEADER'S GUIDE TO
PRESENTATION**

Maximising user experience: All FabLabs are free to set their own business model.

This includes opening hours and how users are encouraged to use the FabLab. There are several things to think about and decisions to make that fit your specific circumstances. Don't forget, these decisions can change as you and your users learn more about your FabLab.



Opening

Which days do you open? Do you have public open days and separate commercial days for private companies? Do you open at the weekend? Weekends are when you are likely to have the most public users visit but you need to think about who will staff the FabLab at the weekends.

What times do you open? Do you open during traditional office hours i.e. 9am to 5pm? This will be easier to staff but it means that users who work full time will only be able to come at the weekend. Do you open later in the day i.e. evening sessions to try to maximise user numbers?

Think also about initiatives that you can establish to encourage your users to work together. Some FabLabs have dedicated sessions where collaboration is the focus. Individuals aren't allowed to work on their solo projects, only on projects where users work together.



Signage and opening times for FabLab RUC, Denmark.

Not all your users will be adults. What provision will you make for children? Will you set a minimum age limit for children to use the equipment i.e. 12 years old? Children can be active and engage users and can participate in the FabLab community in meaningful ways. Family activities can help the adults too as children often readily grasp new skills and understand the potential of digital fabrication in education and work.

Remember that depending on the health and safety legislation in your country you are likely to need to conduct an induction for new users that includes safe use of the equipment.

Understand what skills your users have and where they can help each other. This may happen naturally, but good FabLab staff may be able to introduce users to each other and have them teach each other with their complementary skills.

Inter-generational learning

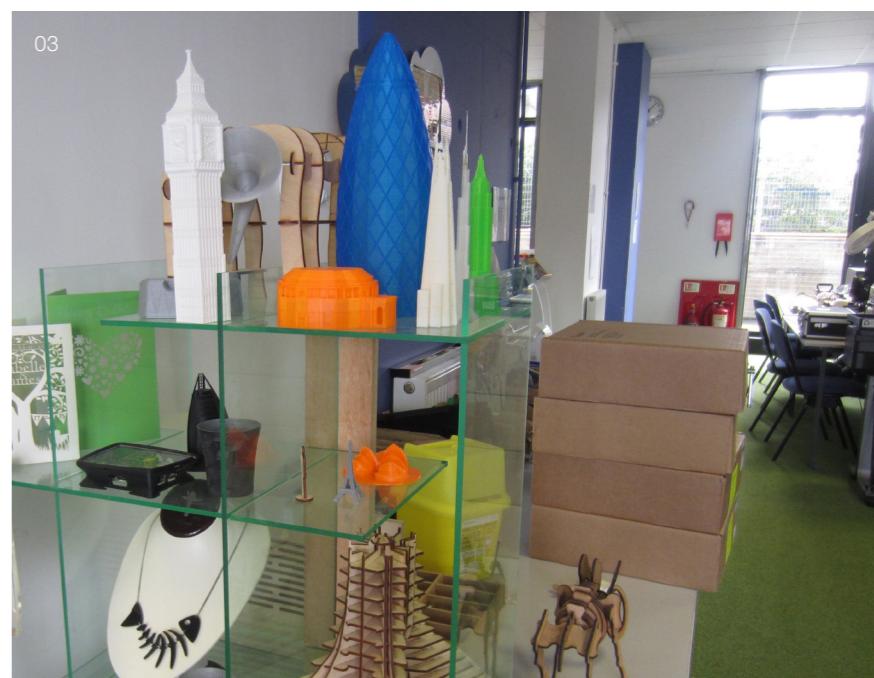
There are many ways that knowledge can be shared between generations in FabLabs. A typical example could be: Mark and Johnny both worked as engineers and are now retired. Evan is an apprentice for a large manufacturing company and he comes to the FabLab to learn about traditional engineering concepts from Mark and Johnny. Mark and Johnny are trying to understand 3D design from Evan!

Children and young adults

Younger FabLab users can gain a lot from FabLabs and contribute to the Fab community in many ways. A typical example could be: Anna started visiting her local FabLab when she was six. She is now extremely proficient with all the equipment. Anna is a regular FabLab user and even holds educational courses for other users.



- 01 Big FabLab, US.
- 02 Vigyan Ashram FabLab, India.
- 03 Series of objects created at the Manchester FabLab, UK.



🔍 An interview with Amy from Manchester FabLab



📷 Amy at Manchester Science Festival.

When did you start to visit the FabLab and why?

The first time I walked into FabLab Manchester was in 2012.

My mum and I popped in as we were walking along the canal (which went past where the Manchester FabLab was located), I'd heard of them before through events listed for the Manchester Science Festival.

What equipment did you use? What did you make?

I predominantly used the laser cutter, over the course of about three years there were probably very few Saturdays where I didn't have an hour booked on the laser.

Some weekends I'd be working on small projects which would be to explore the tool and the materials, other projects were more long-term.

The longest running project I worked on at the lab was a wedding present which was a version of *Guess Who?* but using photos

of the guests. We used the CNC to build a Raspberry Pi powered photobooth to capture a photo of all of the guests. We also used the photobooth at the Manchester Science Festival as part of the MegaPixel outreach project.

How have you contributed to the Fab community?

I've run several workshops at FabLab, some I ran on behalf of FabLab such as my six session wearable electronics course and others with organisations such as the Manchester Girl Geeks which were hosted by FabLab.

How has going to the FabLab impacted on your life?

It introduced me to a great community of people who have taught me so much about electronics and making, and encouraged me to be more engaged with the Maker community.

09 Connecting with industry

09 Connecting with industry

There are two areas in which FabLab can connect with industry.

First, through offering services for firms that want to know more about digital fabrication and how to rethink the design process (discussed in page 19, revenue and support).

Second, through connecting to the broader industry around digital fabrication technologies. 3D printing, properly known as additive manufacturing, is a rapidly expanding industry. Many of the patents held on 3D printing technologies by large firms have started to lapse, resulting in an increase in innovation opportunities. Many new firms have entered the market, producing a range of printers from large industrial printers – worth in excess of \$1million to desktop printers retailing at under \$1,000.



➤ www.fablabs.io/labs/creativelab

FabLabs connect to this story in several ways. FabLabs are potential customers for 3D printers and there are many options open to you if you are looking to add to your equipment beyond the standard kit. It is worth getting to know local representatives of the 3D printing equipment companies to see if there are ways you can help each other (and potentially get a printer on loan).

FabLabs can also be a good source of expertise. There is a shortage of people with the right skills and know how around 3D printing (see also page 43 on education).

Creative Lab in France partner with Renault and FabLab Bristol are in collaboration with manufacturer Saint-Gobain.



© Creative Lab, Guyancourt, France, in collaboration with Renault.



© FabLab Bristol, in collaboration with Saint-Gobain.

 Nifty Case Study

In 2012, Piers Ridyard needed a storage solution for his MacBook.

His 128GB MacBook Air was full after just two months and none of the existing solutions allowed him to add the storage he wanted without being a pain to carry around or voiding his warranty.

He used the Manchester FabLab to prototype his design – a storage device that uses the SD slot and is flush with the laptop – it doesn't protrude. After securing financing to make the first proper version of the MiniDrive, Piers took the idea to Kickstarter, raising enough funding to put it into production.

Piers' team went on to produce the NiftyDrive in the Far East and sell through global retailers like Apple and Amazon. Today Nifty is a large international company and remains one of the most successful and enduring FabLab success stories.



 The Nifty range, courtesy of Kickstarter.

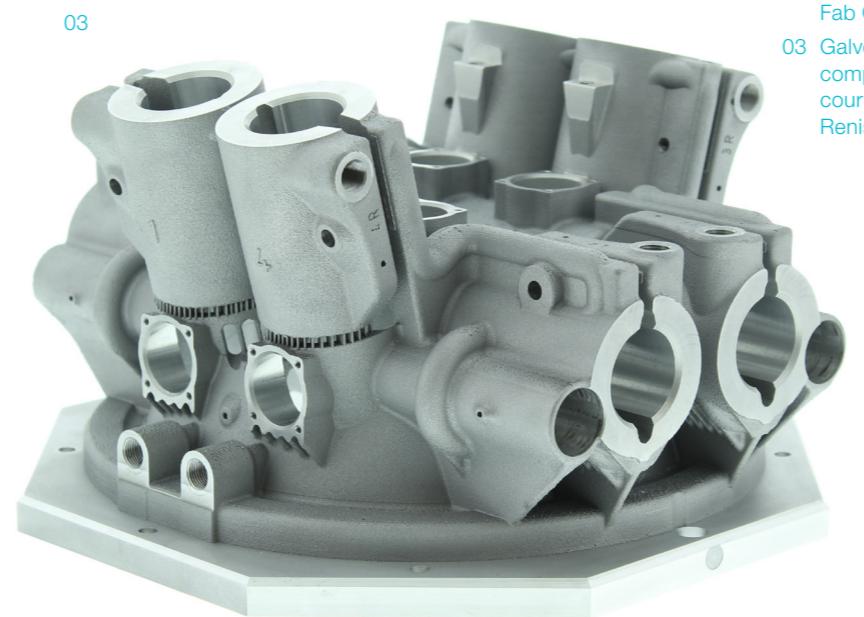
09 Connecting with industry

What does the future hold?

Much of the rhetoric around the future of additive manufacturing claims that:

- We will all have 3D printers in our homes (**very unlikely**)
- 3D printing will replace traditional technologies (**very unlikely, it will complement existing technologies**)
- Production will be relocalised nearer the consumer (**still being debated**)

FabLabs could become places where consumers can come to manufacture every day items. Or FabLabs could turn into these centres and be replaced by them. Technological change is affecting where, when and how we work, play and create. In all cases, FabLab continue to be exciting places of innovation and digital fabrication.



03



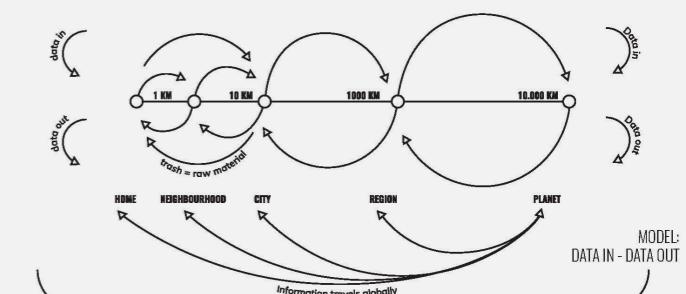
01

01 Orthosis_hand
courtesy of EOS.

02 Rescaling Global
Manufacturing
courtesy of
Fab City.

03 Galvo
component
courtesy of
Renishaw.

RESCALING GLOBAL MANUFACTURING



02

Spiral
fabrication

10 Online and offline knowledge

¹⁰ Online and offline knowledge

FabLabs have access to a wealth of knowledge and information, both inside and outside the lab.

Many users come to the FabLabs not only to use the equipment but to meet with like-minded people and exchange ideas. It is this coming together of people that make FabLabs exciting and vibrant places.

Users are also able to access many online resources to help them learn and master digital fabrication technologies and develop their own projects. Resources include Thingiverse. This is an online platform where digital designs are shared.

Your FabLab will be part of the larger global network. It will also be part of a regional network.

Barriers to knowledge sharing:

- **Language.** Much communication is in English, although online communities are collaborating to provide resources in other languages, such as Mandarin.
- **Time zones.** Your regional networks may be easier to work with as you will be on more similar time zones.
- **Distance.** Much online technology overcomes the issue of distance between FabLabs. In person, face-to-face contact can be harder. The Fab Conferences are a good way for people to meet.

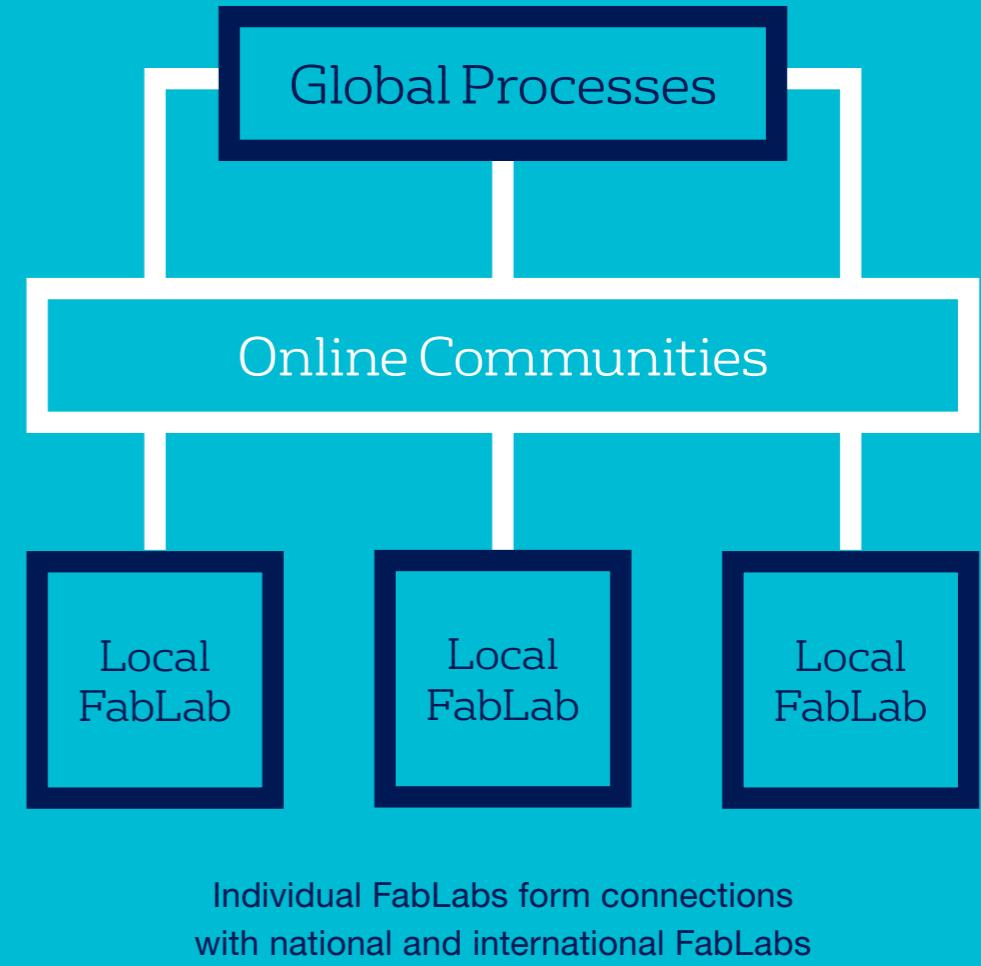


Photo by Stefan Stefancik on Unsplash.



10 Online and offline knowledge

Online	vs	Offline
Knowledge that can be shared over distances (codified)		Knowledge that can be shared face to face (tacit)
Learning by watching i.e. YouTube videos of how to use equipment		Learning by doing Sharing skills, showing each other techniques
Accessing resources like Thingiverse and FabLabs.io		Inter-generational learning and sharing Use of equipment and its maintenance
Sharing of designs		Discussion of ideas and problems
Use of forums to discuss ideas and problems		



11 Education

11 Education

One of the central aims of FabLabs is to educate.

Gershenfeld describes FabLabs as an educational outreach programme. As such, there is much enthusiasm and support for FabLabs as education centres. This is just one way in which FabLabs can have a profound impact on the communities of which they are part.

There are many courses that FabLabs can offer users. These include courses and workshops on the equipment and on using design software. Courses can be pitched at the beginner, with more advanced courses for experienced users.

Many FabLabs also try to connect with the local community by running programmes and courses in schools, for both younger and older children. Fab Academy is part of The Academy of (almost) Anything.

USEFUL LINKS

- <http://academany.org>
- www.scopesdf.org
- <https://tltl.stanford.edu/project/fablearn-labs>

“Traditional education is like mainframe computing... we are the Internet. A global distributed campus for high level education, learn top skills from global leaders, master them locally in hundreds of locations all over the world.” Gershenfeld, 2005.

The Fab Foundation also leads the SCOPES-DF (Scaling a Community of Practice for Education in STEM using Digital Fabrication). This provides online lessons for formal educators interested in using digital fabrication in the classroom. This space also allows for teachers to upload their own lessons, remix other teacher lessons and build a community of practice around digital fabrication in the classroom.

See also the work of FABLearn.



11 Education

Fab Academy instruction is based on MIT's popular rapid-prototyping course *How To Make (almost) Anything*. Both are taught by Prof. Neil Gershenfeld. The cost of the course varies locally.

Check out:

- ➊ <http://fabacademy.org/application-form/prices>
it lasts five months, conducted part time.

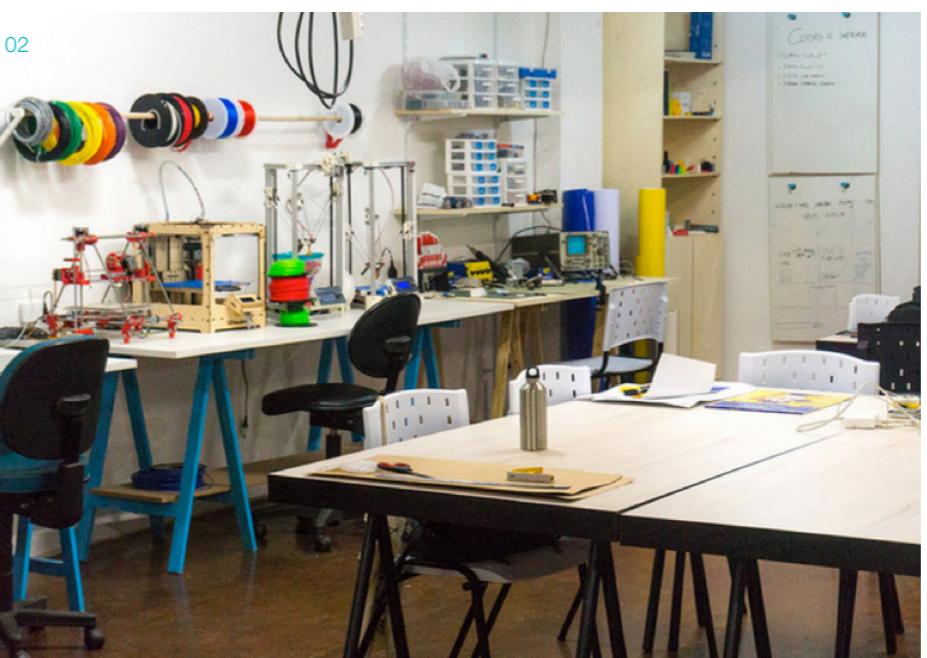
Only FabLabs that are 'nodes' can teach the Fab Academy – a list is available at:
➋ <http://fabacademy.org/2017-nodes-supernodes>
along with instructions on how to apply to be a node.

For the list of 2018 Fab Academy participants see:

- ➌ <http://fab.academy.org/2018/people.html>

Are there any local agencies / organisations that your FabLab can link with to provide services to users?

These could relate to issues such as how to commercialize a product, how to export goods, general business advice, organisations to provide services, etc.



01 Vigyan Ashram
FabLab, India.

02 Brasilia FabLab,
Sao Paulo,
Brazil.

11 Education

Fab Academy course context

01	Digital fabrication principles and practices	one week
02	Computer-aided design, manufacturing and modelling	one week
03	Computer-controlled cutting	one week
04	Electronics design and production	two weeks
05	Computer-controlled machining	one week
06	Embedded programming	one week
07	3D molding and casting	one week
08	Collaborative technical development and project management	one week
09	3D scanning and printing	one week
10	Sensors, actuators and displays	two weeks
11	Interface and application programming	one week
12	Embedded networking and communications	one week
13	Machine design	two weeks
14	Digital fabrication applications and implications	one week
15	Invention, intellectual property and business models	one week
16	Digital fabrication project development	two weeks



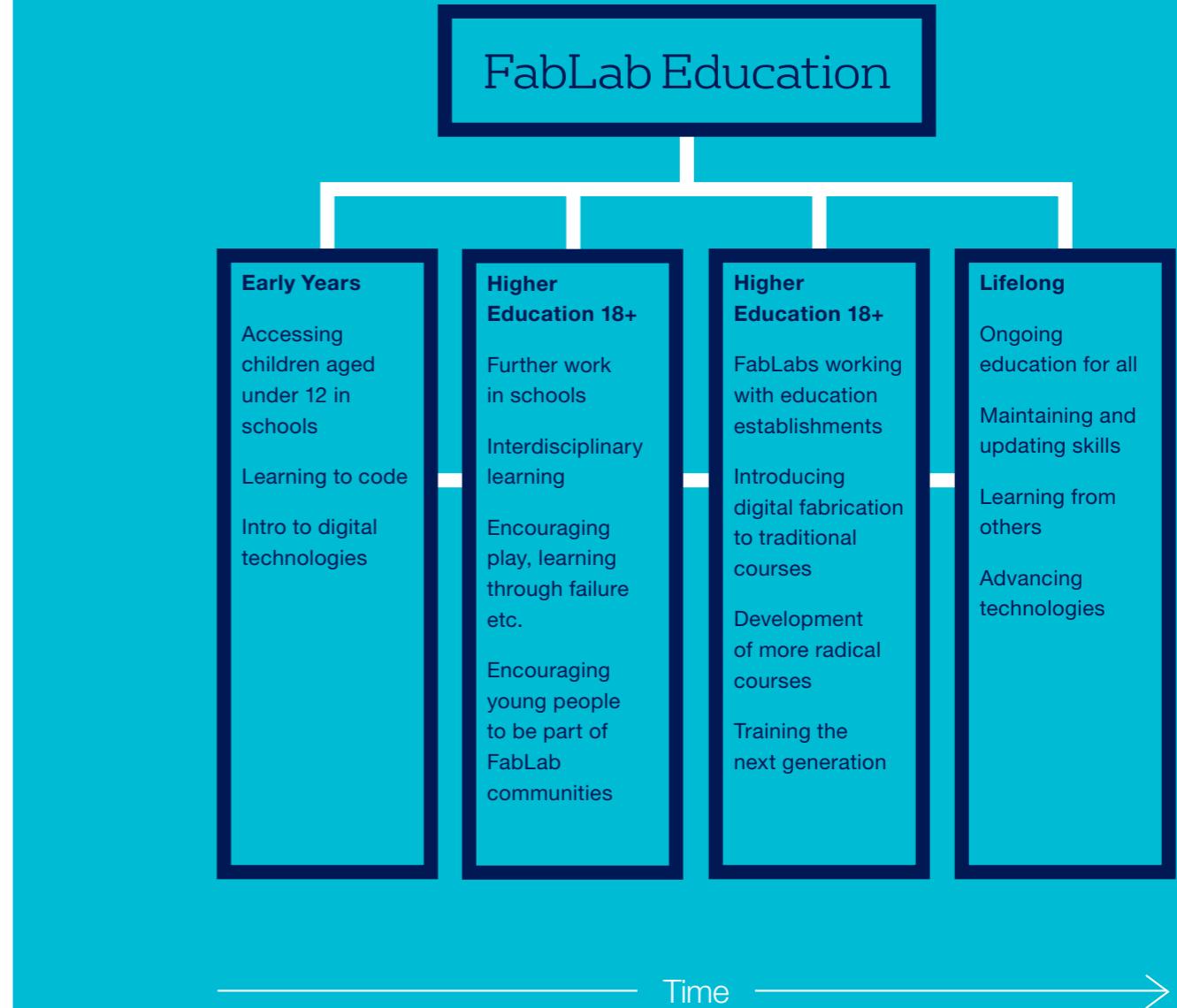
Fab City Campus photos.
© www.StefanoBorghi.com

Fab educational journey

This is one trajectory through Fab and education. But there is much work focusing on both K-12 education (first schooling through to pre-college) and lifelong learning related to learning progression.

Human skills are important – collaboration, teamwork, critical thinking, communications, empathy etc. – and learning skills (learning to learn) that will be needed to participate in 21st Century work.

These will be required to face the disruptions and challenges that technology is bringing to the future of work.



Data on Fab Academy graduations:

Fab Academy website:

⌚ <http://fabacademy.org>

Information on Fab Academy course – costs, benefits and aims. What it brings to the FabLab:

⌚ <http://fabacademy.org/annual-report-2017>

Bio Academy:

⌚ <http://bio.academany.org>

Fabricademy:

⌚ <http://textile-academy.org>



FabLab Shibuya,
Japan.

Students	Year	Registrations	Number of students	Number of sites	Graduates
How to Make Almost Anything (MIT class)	2008	?	8	?	2
Fab Academy	2009-2010	85	30	12	13
Fab Academy	2011	57	50	15	11
Fab Academy	2012	123	75	16	29
Fab Academy	2013	309	109	25	38
Fab Academy	2014	351	124	31	70
Fab Academy	2015	450	221	56	140
Fab Academy	2016	494	264	65	161
Fab Academy	2017	491	285	73	184
Fab Academy	2018	478	262	66	165 (not yet closed)

12 Social impact

12 Social impact

FabLabs are more than the sum of their parts.

They have real potential to shape the lives of individuals and to create a shift in how we produce and consume our everyday items. FabLabs can have real impact on communities. The following pages outline just a selection of the impacts that a FabLab can have.



01 Photo by Toa Heftiba on Unsplash.
02 Photo by RawPixel on Unsplash.

03 Photo by Alfonso Navarro on Unsplash.

12 Social impact

Type of impact:

Economic

Specific impacts:

- Helping to create entrepreneurs
- Supporting entrepreneurs
- Helping the unemployed
- Assisting local businesses
- Assisting multinational companies
- Informing non-governmental agencies



Examples of economic impact

- Niftydrive – additional storage for Macbooks – invented in FabLab Manchester. Now ships globally, Nifty is a multinational firm.
- Access to equipment, and support for the creative process helps budding entrepreneurs. Technology enables multiple iterations of design before approaching potential funders.
- Offering access to machines and conversations about digital technologies can help reskill, or upskill those seeking employment.
- Local businesses may use the lab for help designing new products. They may also use the FabLab as a source of new staff.
- Similarly, multinational companies may seek resources from FabLabs – for example, IKEA @ FabLab Barcelona, Sony @ FabLab Shibuya (Tokyo). This includes education and staff.
- Policy makers are increasingly engaging with FabLabs – example, FabLab Valldaura and World Bank and the National Governors Association in the USA.

[12 Social impact](#)

Type of impact:

Social

Specific impacts:

- Community
- Social capital formation
- Inter-generational learning
- Sharing
- Wellbeing



Examples of social impact

- FabLabs create communities. Users engage with each other and can form firm friendships. Users can support each other with experimentation and idea development, and in practical use of the equipment.
- FabLabs also impact on the communities in which they are based. They provide a space for people to come together and the items made in FabLabs are sold elsewhere or gifted to friends and family.
- Users increase their social, and often professional networks through using the FabLab.
- FabLabs are spaces of learning with and from each other. Inter-generational learning is a particular characteristic. Families can come to FabLabs together.
- FabLabs can be spaces of sharing.
- FabLab can be much more than tech spaces, they can feel like places of wellbeing too.

¹² Social impact

Type of impact:

Environmental

Specific impacts:

- Minimising impact of FabLab
- Sustainability
- Food security
- Recycling old material
- Retro-engineering
- Shifts in global production (relocalisation)



Examples of environmental impact

- Think carefully about location choice to minimise the carbon footprint of users travelling to the FabLab.
- FabLab operators should also think about how environmentally friendly their building is, and make every effort to minimise the impact of the lab. The ethos of FabLabs should be to maximise sustainability.
- Food security is a huge global issue. FabLabs, such as GreenLab London, Valldaura and Aquaponics are engaging in this through the GreenLabs initiative.
- Recycling of materials is important, both in terms of the materials used in labs, but also how we design particular products to be recycled and / or to minimise material usage.
- Retro-engineering of complex and expensive designs so they are available as open source designs is a great way of helping those in less advanced parts of the world.
- By producing items in FabLabs rather than purchasing and shipping internationally, users are reducing their carbon footprint and creating a culture in which people think to make what they need rather than purchasing. The same applies to fixing or repurposing items rather than disposing of them and purchasing new.

13 Global connections and Fab City

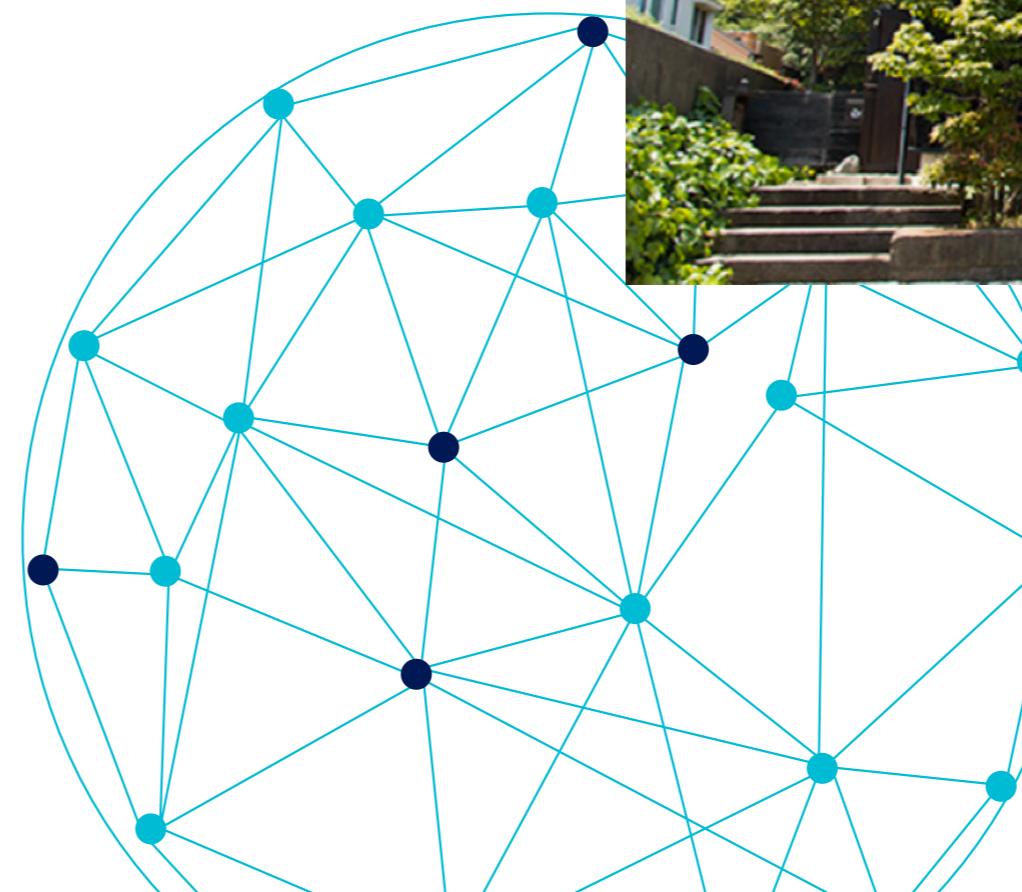
13 Global connections and Fab City

Individual FabLabs can become connected to each other through different pathways.

A global mindset gives opportunities to share designs, experiences and to participate in bigger projects. The Fab network and Fab Conferences are ways of doing this. There are also other initiatives, such as Fab City in which FabLabs can participate in designing sustainable practices in design, manufacture and living.

The global nature of the Fab community makes it easier for stories and ideas to spread globally, through the Fab network, the Maker community and social media.

➤ www.fablabs.io



📷 FabLab Kamakura, Japan.

13 Global connections and Fab City

Global example: Obama's Grandma Slippers

The story of Obama's Grandma Slippers is now legendary. It illustrates how knowledge is shared across national boundaries and how the sharing of designs can enable others to create their own variations. Jens Dyvik of Fellesverkstedet FabLab, Norway toured the world's FabLabs.

This included FabLab Kamakura in Japan where he learned how to make a particular type of slipper. Later, while in ARO FabLab in Kenya, he requested the digital files from Kamakura to which an engraved image of Obama was added. The slippers were presented to Obama's grandmother near the FabLab in Kenya. Subsequently, at a White House Maker Faire, members of the Oslo FabLab presented Obama with slippers engraved with an image of his grandmother when she received her slippers.

Watch the video:
<https://youtu.be/zgcxH8Qliac>

Global example: swustainable agriculture

The Vigyan Ashram FabLab is located in rural India. The lab provides solutions for local farmers in agriculture, creating aquaponic farm solutions for better and more crops. Aquaponics is a system of aquaculture in which the waste produced by farmed fish or other aquatic creatures supplies the nutrients for plants grown hydroponically, which in turn purify the water. Technology is also being developed for soil testing, drying foods and incubating eggs.

The lab has many international connections and participates in Fab Academy. This year Vigyan Ashram FabLab joined Fabricademy.

- ➊ <https://textile-academy.org>
- ➋ <http://vigyanashram.com>



01 Obama's Grandma Slippers.
Source: <https://makezine.com/2014/06/24/pancakebot-delivers-obama-grandma-slippers>

02 Vigyan Ashram FabLab, India.

13 Global connections and Fab City

Global example: Fab City

Fab City has been initiated by the Institute for Advanced Architecture of Catalonia, MIT Center for Bits and Atoms and the Fab Foundation. Its operation is adjacent to the 1500+ strong FabLab network, using it as a global infrastructure and knowledge source to challenge cities to produce everything they consume by 2054. Cities are encouraged to join the growing network of Fab City locations, once a year at the Fab City Summit.

The Fab City initiative is a collective of citizens, researchers, policy makers, teachers, developers and entrepreneurs working on bringing back production to cities.

In 2016 the Made Again Challenge, a project initiated by SPACE10 – IKEA's 'external future-living lab' – and the Fab City Research Laboratory created the first and largest Fab City prototype. It was a one square kilometre testbed in Poblenou, Barcelona.

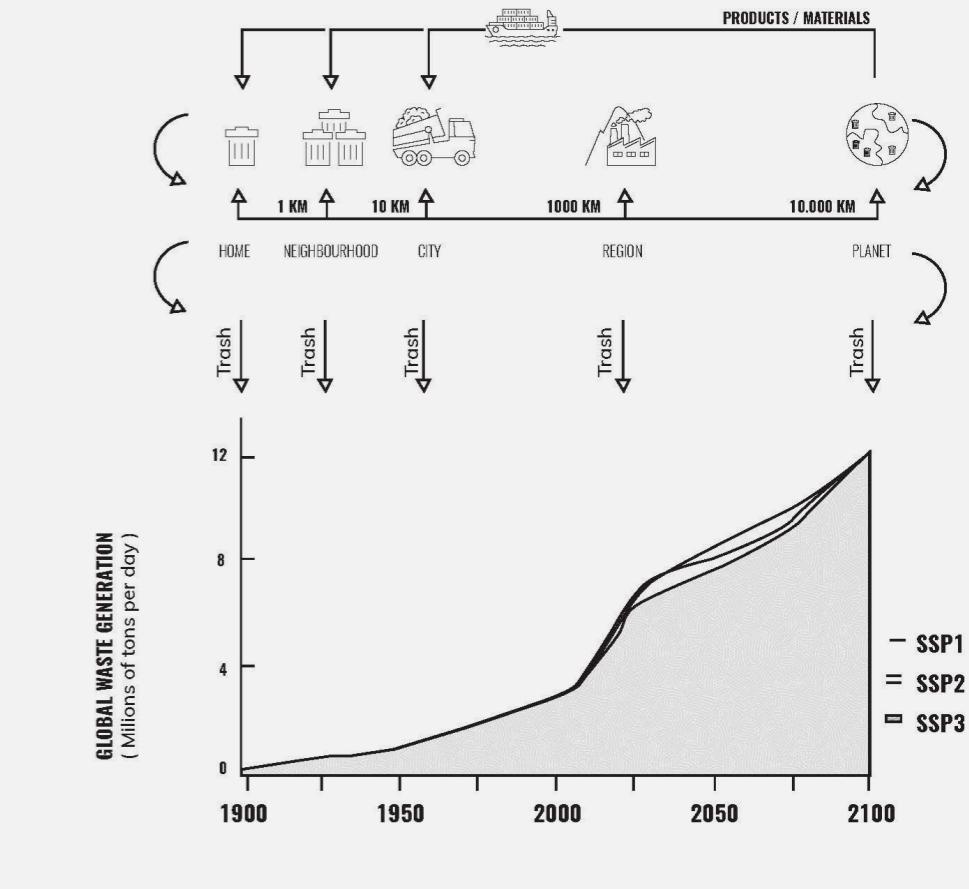
Over the course of five days, local workshops, research centres, design agencies and local producers in the neighbourhood were connected into an ecosystem. Biologists, tech professionals, local Makers, craftsmen, IKEA designers, and other trailblazers gathered in Barcelona for the project and collected wasted products from the streets of Poblenou in order to repurpose materials that were heading to landfill.

Watch the video:

- ⌚ www.youtube.com/watch?v=roOaf8bXoRE&feature=youtu.be

- ⌚ <https://blog.fab.city/made-again-documentary-the-silicon-valley-of-sustainability-in-barcelona-d23ac4ab422c>

THE CITY: A LINEAR TRASH MACHINE



⌚ The city: a linear trash machine, courtesy of Fab City.

The Fab City manifesto covers ten points that advocate an ecological, inclusive, and participatory approach that places people at the centre. It is aiming for locally productive growth alongside increased economic growth and employment. It also values the open source philosophy and experimental innovation.

- ⌚ <https://fab.city/documents/whitepaper.pdf>

13 Global connections and Fab City

Green Lab, London, UK

The Green Lab based in Bermondsey, London was established in 2014 operating in a 350sq.m that used to be an industrial school kitchen and canteen. The lab has been self funded.

The Green Lab describes it's working group as 'agricultural mavericks'. It is an open innovation lab and ecosystem for individuals and organisations to design sustainable solutions to complex urban food, water and waste challenges. It aims to nurture ideas that make our food systems more productive and resilient. Like FabLabs, the Green Lab encourages creativity, collaboration, play and experimentation. The lab houses food entrepreneurs and thinkers who want to build human-scale systems, focusing on insects, hydroponics, algae and fungi.

The Green Lab works with entrepreneurs, businesses and community groups. They focus on sustainable circular solutions, connecting food production and waste; reducing food mileage and carbon footprints through urban production; and a concentration on bold, radical and progressive thinking.

The lab is listed on the fablabs.io network:

☞ www.fablabs.io/labs/greenlab

The Green Lab website can be found here:

☞ www.greenlab.org

The Green Lab is connected through the FabLab Network to Valldaura and Green Lab Bolivia and as seeking to form mutually beneficial project collaborations with the wider green labs in the network.



☞ Green Lab, London, UK.

Acknowledgements

The author, Jennifer Johns, would like to thank the University of Bristol for their support and Sherry Lassiter, Tomas Diez and Luciana Asinari for their contributions. Thanks also to the whole FabLab community for their openness and inspirational activities.

FabLab Guide



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