

# FABSHIP

## Fablab + Earthship

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Connected Offgrid makerspaces

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# Concept

The "Fabship" project aims to participate in the advent of a new model of production, a distributed and sustainable model. It is based on two existing movements: the worldwide network of fablabs, networked manufacturing workshops, and the Earthships movement, totally autonomous buildings. The idea is to offer communities that want to radically reduce their ecological footprint<sup>1</sup> an energy autonomous production unit, which we call a "fabship", that allows us to make, invent and repair the objects that surround us in a radically sustainable way. The limits are clear and tangible: they are imposed by local natural phenomena. The goal is to empower communities by making them more innovative and autonomous. The FabShip project intends to redefine what we really need and to find a balance between production capacity and environmental preservation. How much energy, for example, does it take to locally manufacture the structure of an electric motor? Every autonomous community should be able to answer that by experience.

The project aims to answer the following questions:

- How much, at what rate, and for how long can we manufacture the objects that surround us using only local resources and renewable energy?
- For a given (limited) amount of energy, if we can't produce all the objects around us, which ones will be considered essential?
- Will natural phenomena dictate what we do or will they guide us to change the way we do it?
- Will we at least manage to produce, maintain and repair the objects that constitute the systems that allow us to be autonomous?
- How fast can we transfer knowledge in a distributed network of production sites so that a new paradigm can change the culture?
- What teaching and sharing models as well as structures need to be put in place to bring out and accelerate the diffusion of innovations and their improvements?
- What business models can emerge in a context of autonomous manufacturing?

The idea is not to limit but to channel the use of modern manufacturing towards the needs of communities that want to be more resilient.

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1. See <https://data.footprintnetwork.org>

# Earthships

**Off-grid buildings autonomous in water,  
electricity, heating (passive) and sewage treatment.**



Earthship Biotecture, led by architect Michael Reynolds, has been a pioneering eco-building company for 50 years. It builds self-sufficient homes from natural and recycled materials. Based in Taos, New Mexico, the company works all over the world, sometimes through humanitarian projects, and opens its construction sites to students who want to learn the techniques of self-sufficient construction.

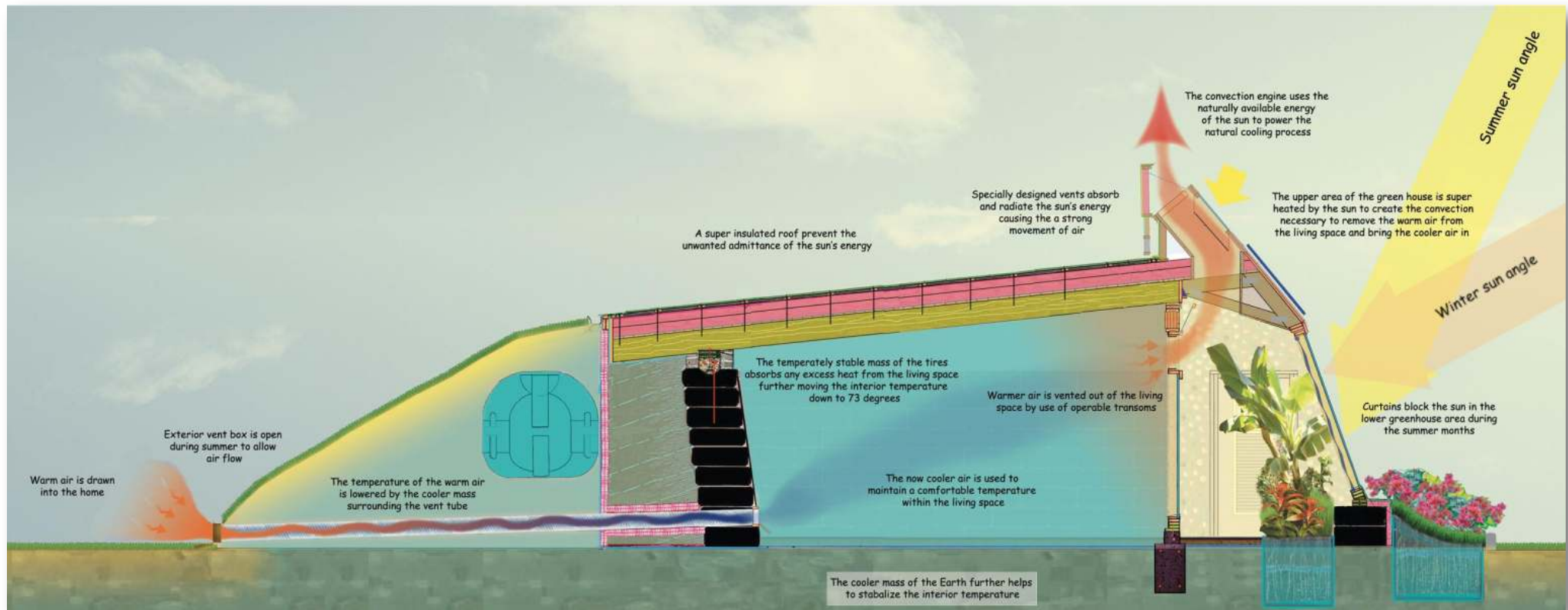
The image above shows a school built as a training site in Uruguay in 2016.



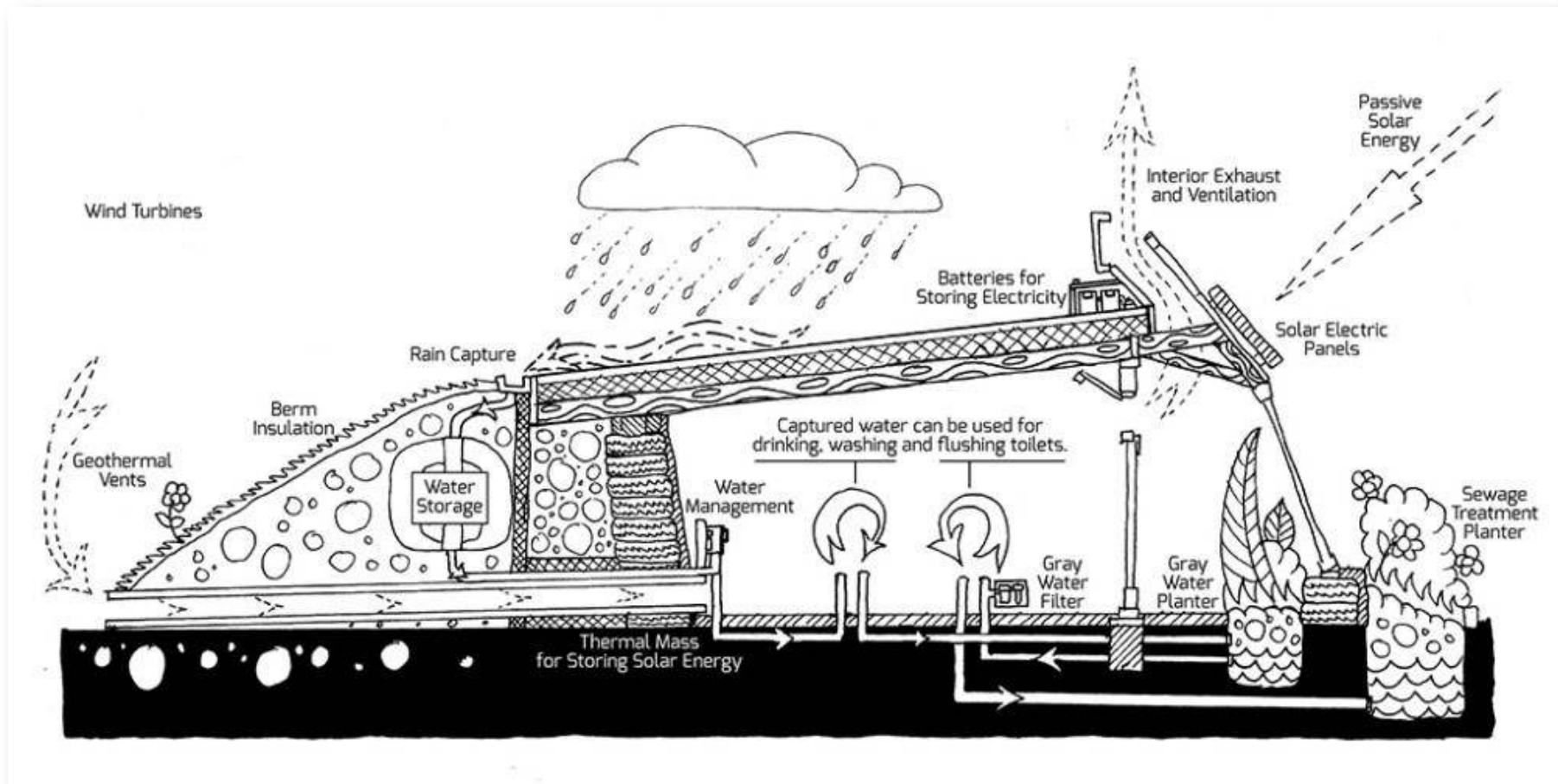


Earthships are today proven models for autonomous and ecological living. They meet six basic human needs: thermally comfortable housing, renewable energy (solar/wind), local wastewater treatment, use of recycled materials, water recovery and food production. These self-sufficient houses have already been built in different climates around the world and have proven themselves.

The image above shows a school built as a training site in Argentina in 2018.



We see here the section of an Earthship. We can observe the bioclimatic design: The greenhouse is on the south (right) in the northern hemisphere, it is a thermal buffer space, it grows plants, the hot air rises and escapes through the vents which creates a depression in the house that sucks air through the cooling tubes that are on the north. Thus, we have a natural ventilation phenomenon. The different angles are designed so that in summer, only the greenhouse is sunny, the rest is not. In winter, the sun penetrates to the bottom of the living rooms and heats the thermal mass made of compacted earth. The entire building is covered with external insulation.



On this section drawing, we can see how the rainwater harvesting system and storage work. The tank is below frost line buried in the north berm. The water is brought into the house and filtered in two qualities: running water and drinking water. sinks, showers and appliances produce grey water that goes through an indoor phytodepuration system, which is located in the greenhouse. At the end of the phytodepuration, the water filtered by the plants is collected and pressurized to be used for flushing the toilet (if there is no dry toilet). The phytodepuration produces food. Black water produced by the toilets is finally brought outside in a second filtering phytodepuration. After that it can finally return to the environment without danger.





Another example of Earthship, in France, carried out as a training construction site (Earthship Academy) during the summer of 2017.





View from the roof





Interior views





Here we see the French construction site in 2017. This is the first week. We can see the students, some members of the professional team and we can also see tires! Indeed, the earth is compacted in lost forms made of re-used tires. Tires, once buried, don't off-gas or release any chemicals and are recovered instead of becoming waste, which is difficult to recycle today. If you want, you can use other mass material such as stone, concrete or cob, ... but it will be less ecological and economical.





A group photo with everyone (students + volunteers + professionals) after one month of work: the Earthship is fully enclosed with systems working. Only finish work is still required, usually the client/owner takes care of that. This is the usual formula when Earthship Biotecture travels to build. We can also see in this photo a solar thermal panel, in the center, which provides year-round hot water, and photovoltaic solar panels which provide electrical power.





Group photo of the students, volunteers and professionals of the earthship-school in Argentina (2018).





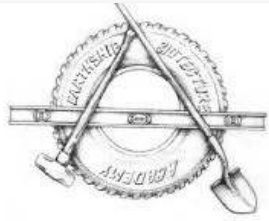
Japan...





Earthships are built all over the world. Sometimes for humanitarian projects in disaster areas.





## A GLOBAL ACADEMY



Most of the projects are hosting an autonomous construction training program called the Earthship Academy.





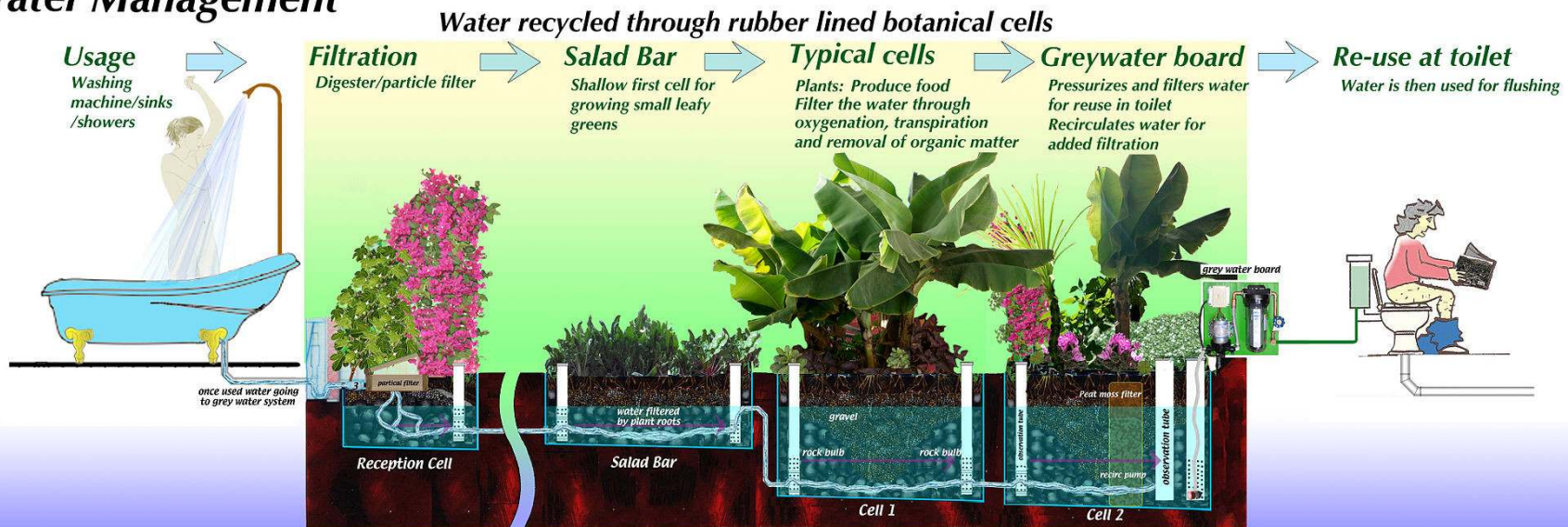
Here we see the rainwater harvesting system at the edge of the roof and the pre-filtration system just upstream of the underground tanks. We can also see a tube in the gutters: in winter, a heat transfer fluid (glycol) melts snow and ice, the main source of water in very cold desert regions in winter (This Earthship is located in the desert of New Mexico).



This is the water organization module. The water from the tanks goes through a succession of filters and a pump in order to be consumable and pressurized.



## Water Management



We see here a schematic section of what is called the botanical cell. It is in fact the phyto-depuration mentioned above and which is in the greenhouse.





**Pompe de recirculation**



**Pompe et filtre d'eau grise**

We see on the left a recirculation pump so that the water does not remain stagnant in the phytodepuration and, on the right, a pump with its filter which conveys the water that gets to the exit of the phytodepuration towards the flushing toilets. All these pumps are powered by the sun...

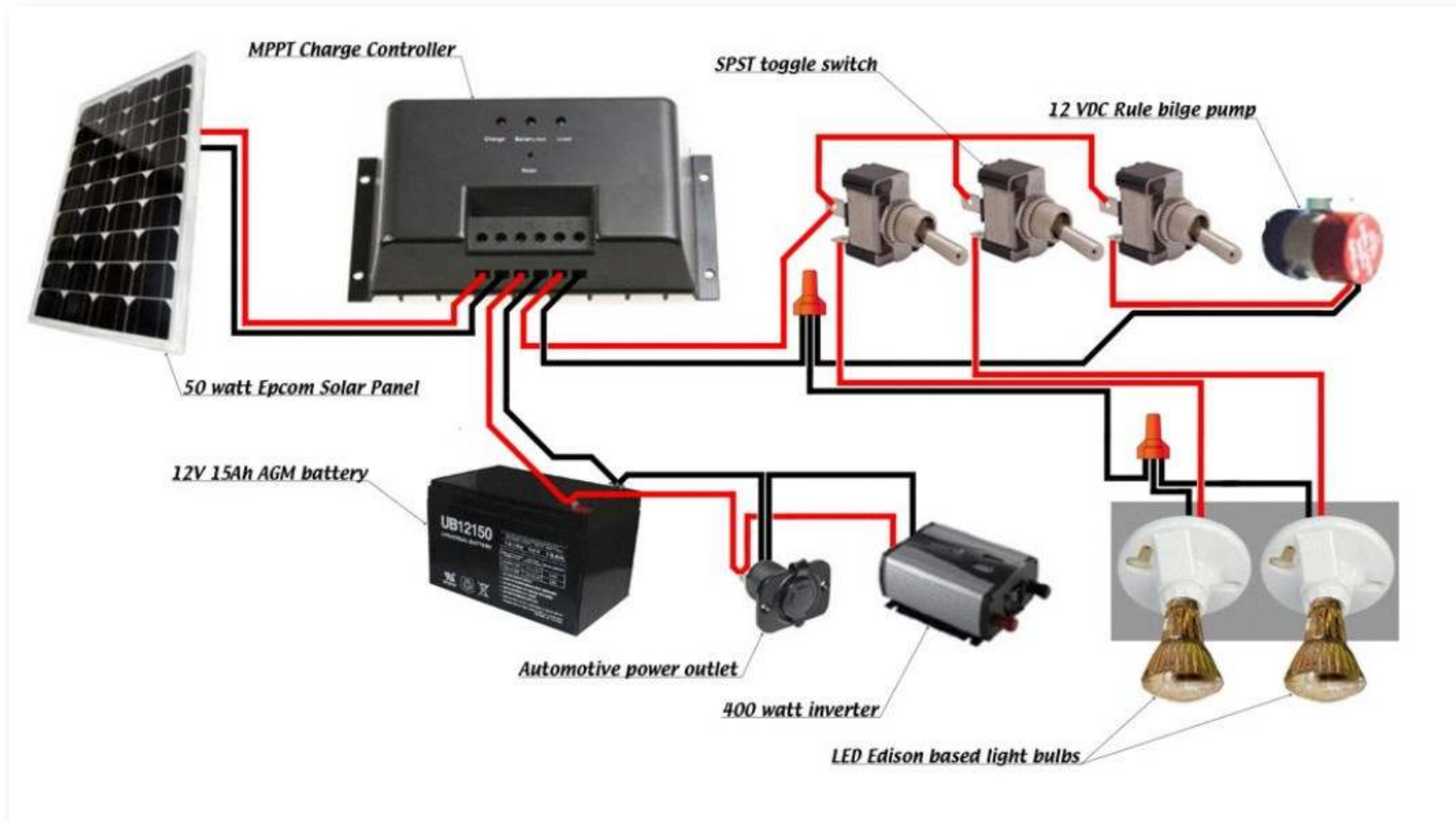


On this picture, we can see the power organization module. It is a set of power electronics components (inverter, charge controller, switch gear, etc.).





Lead-acid batteries. It is a proven technology, affordable and 98% recyclable. For buildings, we prefer them to lithium batteries.

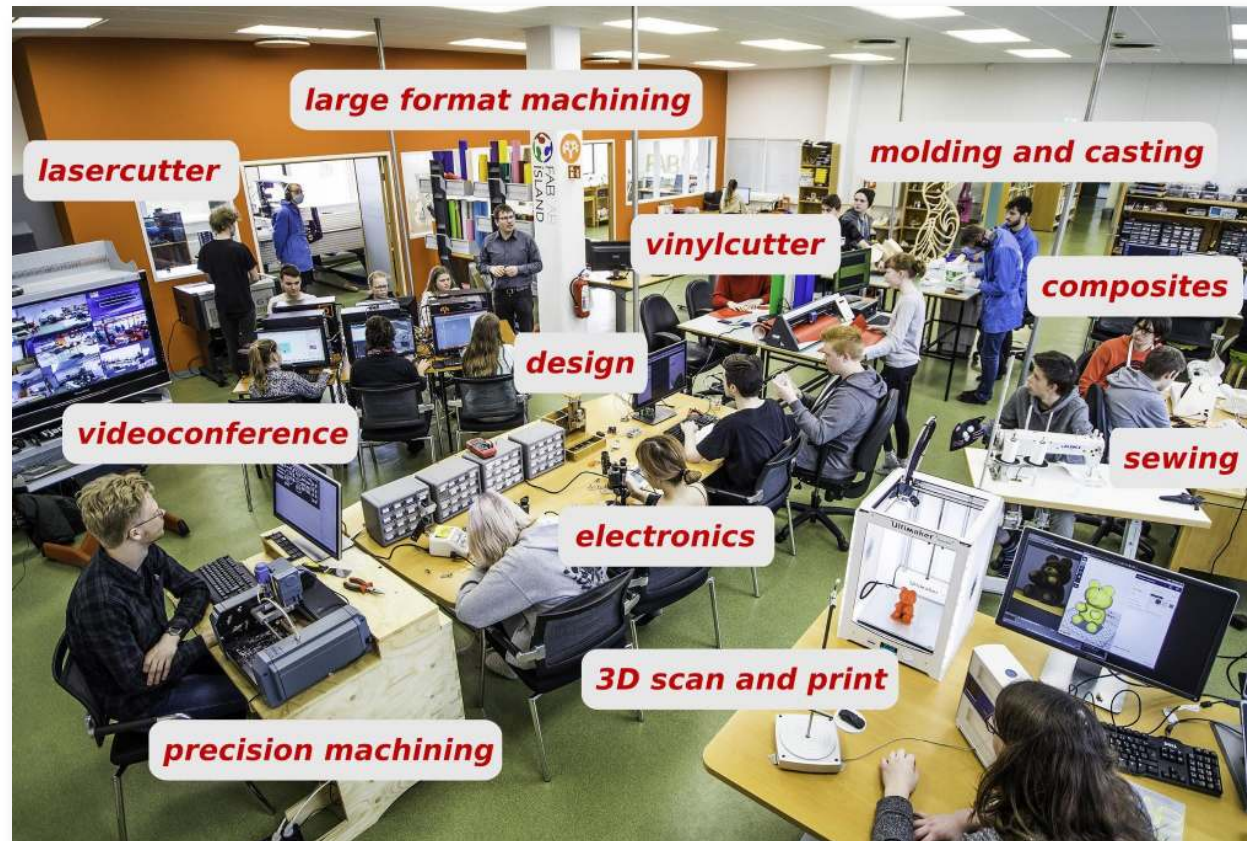


There are several models of Earthship, including one called "simple survival". The simple survival has all the features of a high end earthship (Global Model) but is a fraction of the price of the latter thanks to simplified systems, small capacity and easy to repair. The diagram above represents the electrical system that equips the simple survival type.



# Fablabs

**Local, social, distributed and community driven manufacturing places.**



FabLabs are digital workshops for innovation and invention, fostering local entrepreneurship through a set of rapid prototyping machines, tools, and software that allow users to design, invent, and develop (almost) anything. Fablabs grew out of MIT's Center for Bits and Atoms (CBA), led by Professor Neil Gershenfeld, MIT's research spin-off on the links between manufacturing and computing. They have become influential platforms for learning, invention, and collaboration. As a FabLab, you are connected to a global community of students, educators, policy makers, and innovators: an international network of knowledge and practices that spans 30 countries and 24 time zones. Since all FabLabs use common tools and processes, the result is a distributed platform for digital fabrication that is effective worldwide and based on open source technology. They also participate in the advent of a more sustainable manufacturing model, democratizing productive power, towards a more circular and responsible economic model.

The image above shows the famous fablab in Reykjavík, Iceland: <https://www.fablab.is>





A fablab is a workshop, in the conventional sense of the word, in which conventional tools can be used: hammers, screwdrivers, saws, etc...



Laser cutting



CNC milling



Vinyl cutter



3D Scanner



3D printing



Digital sewing /  
embroidery  
machine



CNC milling



Electronics

We can also find in Fablabs a specific set of digital tools: laser cutter, small digital milling machine, 3D scanner, 3D printer, digital embroidery machine, large digital milling machine, tools for electronics, etc.

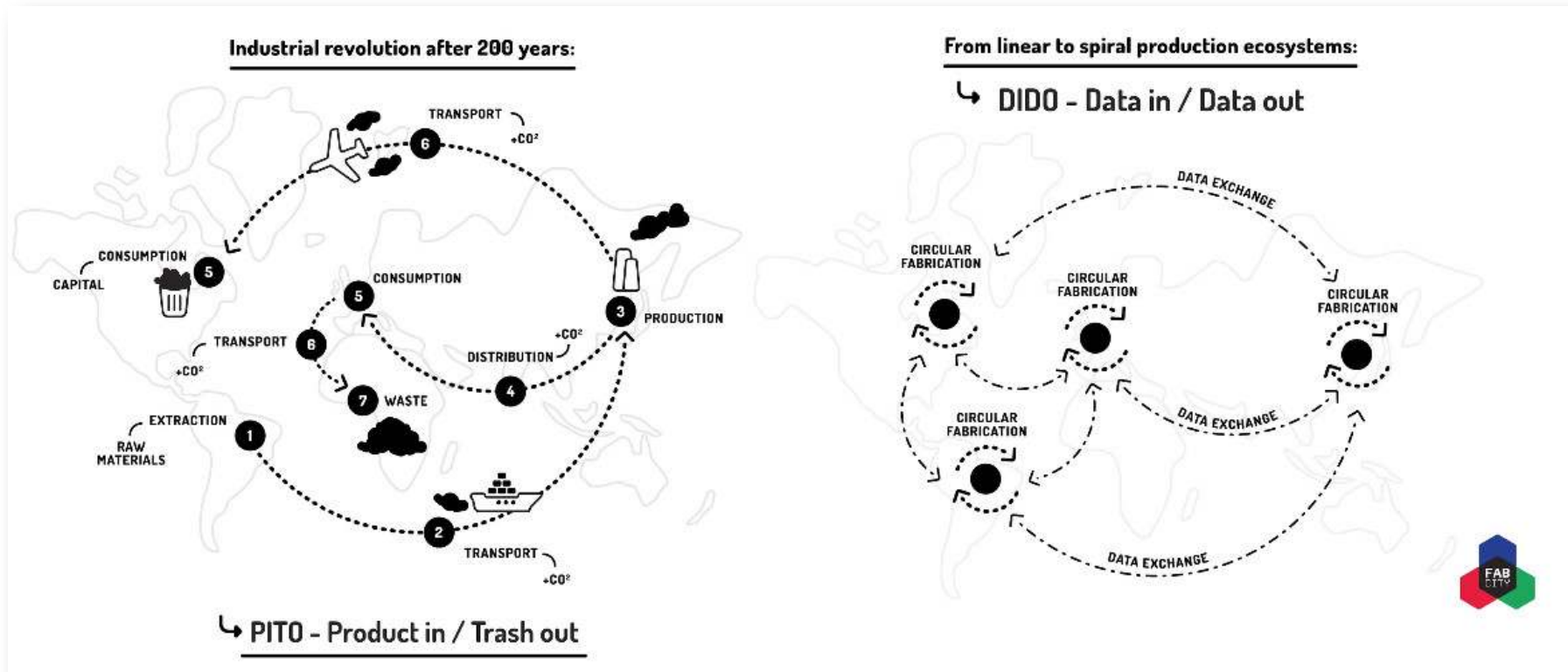




This set of tools, whose list is public<sup>1</sup> allows to turn the traditional workshop into a micro factory capable of producing almost anything, on a small scale. The picture above shows the LFO fablab in Marseille, France : <http://lfofablab.org>

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1. List available at : [this address](#)



This diagram, borrowed from the FabCity initiative founded by Tomas Diez, explains the difference between two production models. On the left we have the traditional model which consists in extracting materials, transporting them far away to transform them into objects, transporting these objects far away again so that we can consume them and finally throwing them away which implies transporting them far away again so that we don't see them anymore... On the right a local production and recycling model based on data exchange. The idea is that the "atoms" remain local and that only the data used for the local manufacturing and recycling travel.

1. See <https://fab.city/>





In the next pages we'll find some examples of emblematic projects of the Fablab movement. Here we can see textile creations by Anastasia Pistofidou<sup>1</sup> at the Fablab in Barcelona.


1. Anastasia pistofidou, co-founder of [FabTextiles](#) and [Fabricademy](#).

*The*  
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Colorado Top Bar Source File Pack

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Healthy



Dormant




Missing Queen



Swarming



Collapsing



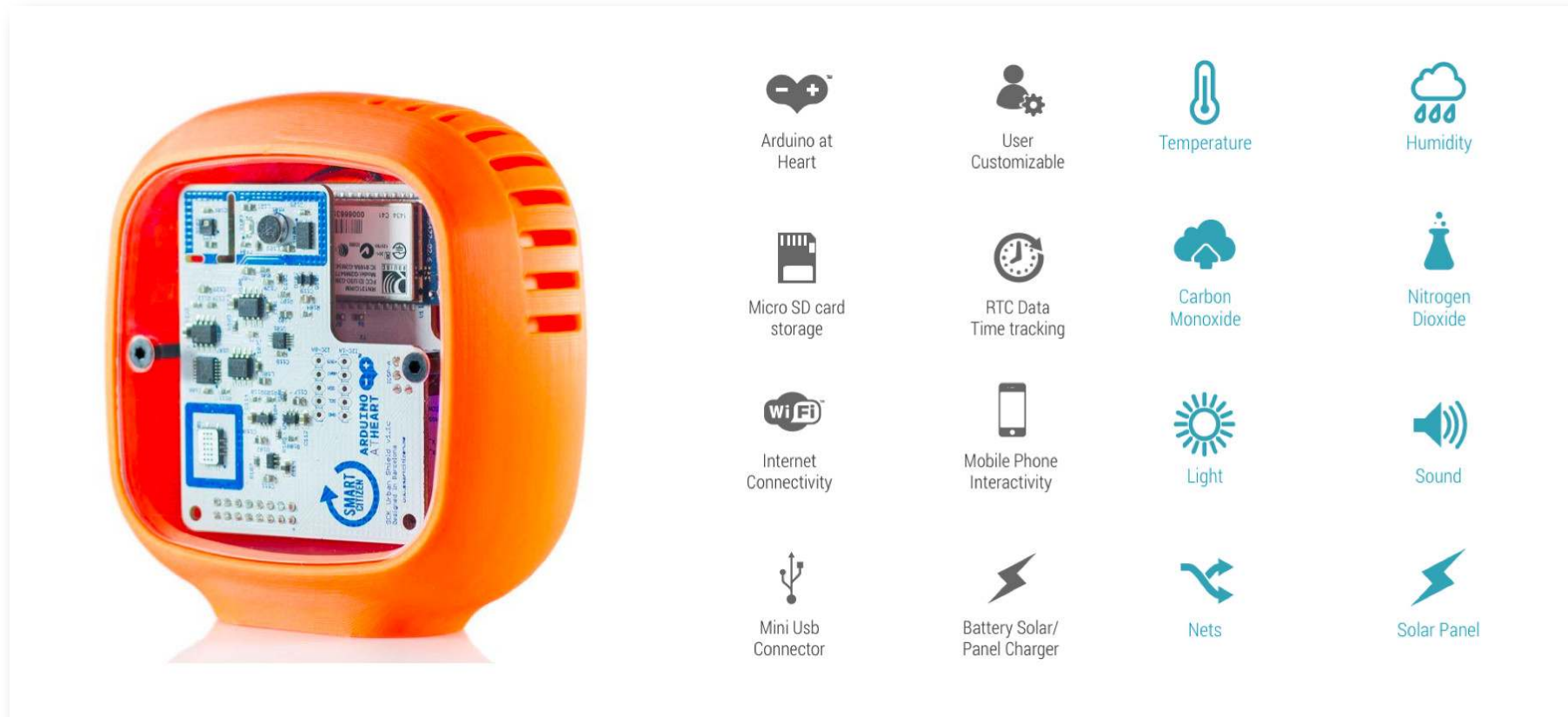
Collapsed

Here is the Open Source Beehive project. Download the files and build the hive with a digital milling machine. The same goes for the electronic module to be placed in the hive to monitor its health.

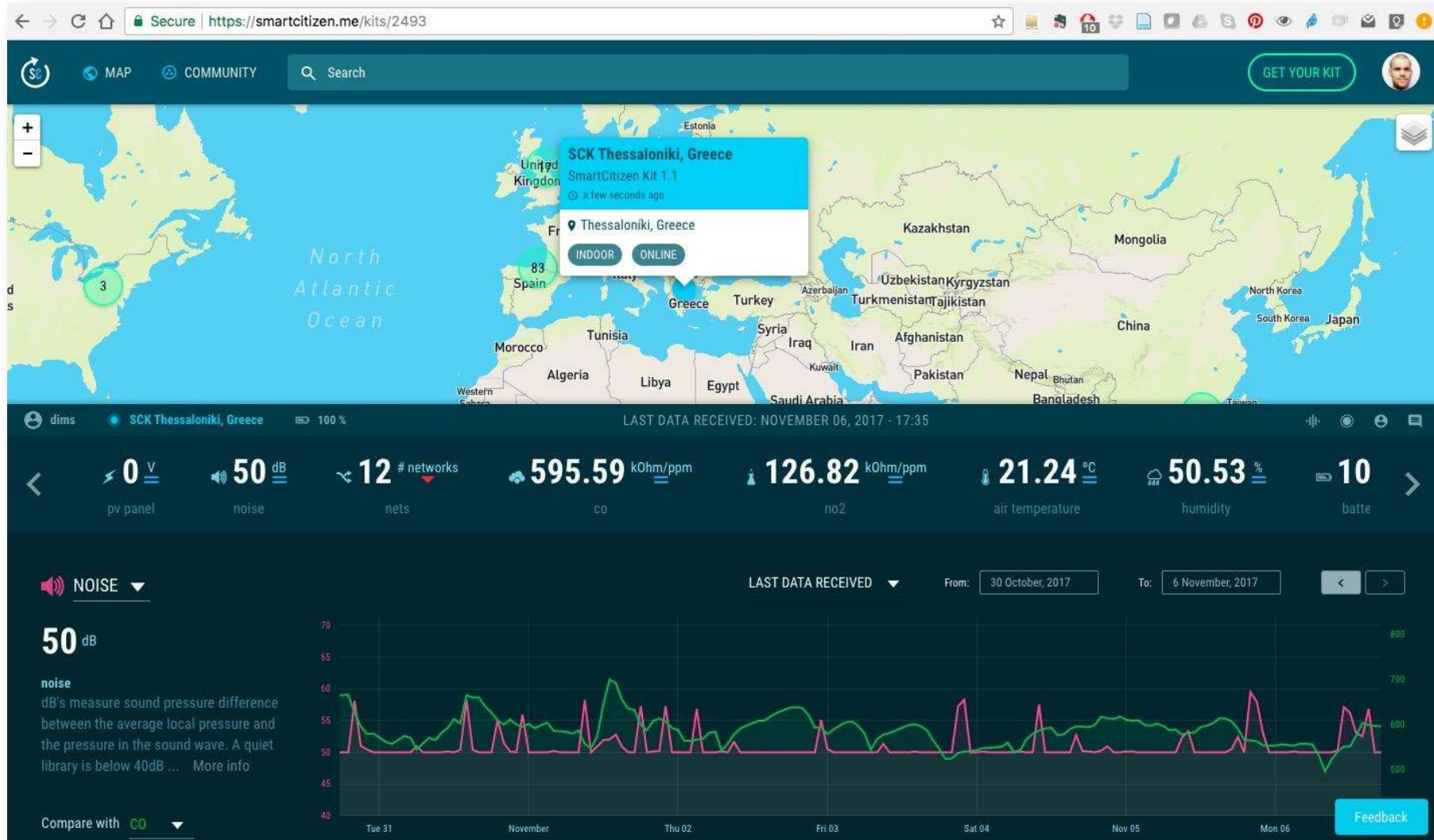
[contents](#)

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Here we have the "Smart Citizen Kit" project. It is a kit that anyone can make in a Fablab, it is open source and open hardware. It is then placed wherever you want and it allows you to measure humidity, temperature, pollution, brightness etc.



The data collected from the Smart Citizen Kit doesn't go on a platform owned by a multinational company, it goes on a free and open source platform so that you and your community can track data acquired by the kits. It becomes easier for citizens to do citizen science with big data since there are now thousands of smart citizen kits around the world.





The making of these objects are opportunities to run some workshops where young and old meet, exchange, learn and gain in autonomy. A Fablab strengthens the social fabric.



Here a plastic recycling project: Precious Plastics<sup>1</sup>. Make your own machines to reuse plastic and make new objects, plans are available online and open source.

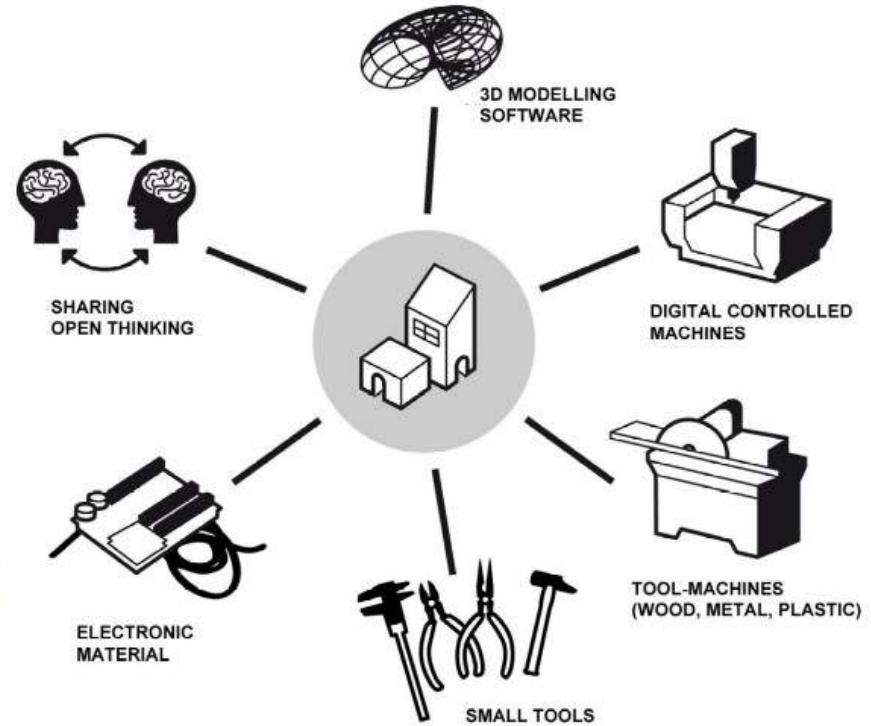
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1. <https://preciousplastic.com>





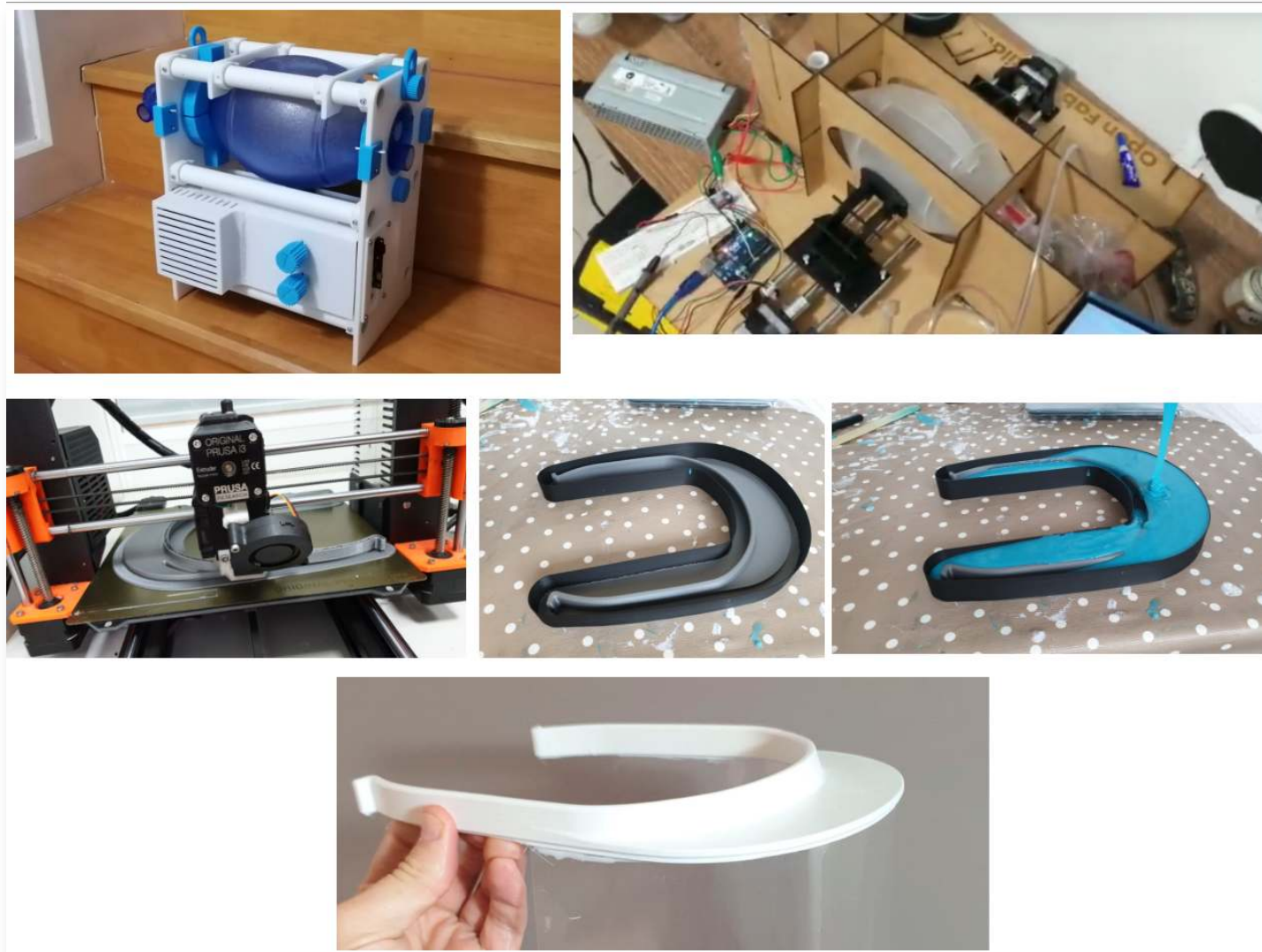
Fablabs map.



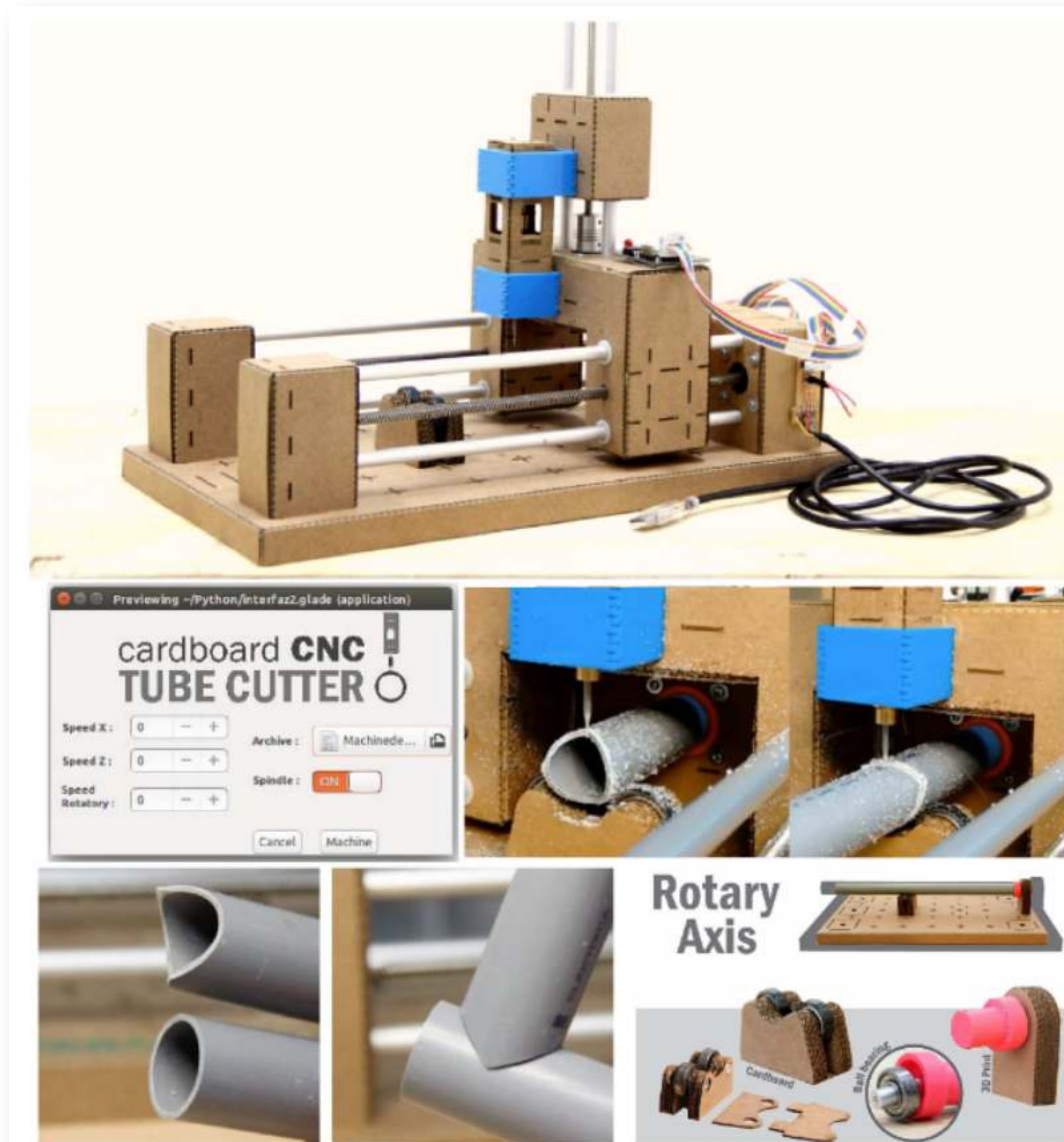
The Fabfoundation coordinates the Fablab movement, including the fabAcademy, the school for learning how to use, manage, and to some extent, create a Fablab. Every Wednesday, Professor Neil Gershenfield gives a live lecture from MIT on a particular fabrication topic. The course is interactive, you can ask questions, it is open source and available online. The course is not free if you want to use a Fablab to do all the assignments and receive your diploma.







Fablabs have shone during the coronavirus pandemic. Thanks to a global collaboration and exchanges of file describing the objects, via open source, respirators and visor holders were already designed and available for manufacturing within a few weeks. A great demonstration of resilience.



This example shows that with very little material (here, mainly recyclable cardboard) we can quickly build a machine that meets a specific need.



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FABEX

Academy

Training courses have emerged within the network of fablabs, each with its own specificities. Here is an example with the Fabricademy that deals with anything textile.

Week 8

# Textile Scaffold

Composites  
Crystallization  
Solidification  
Fabric formwork  
Concrete casting  
Technical Textiles  
CNC milling

Anastasia Pistofidou

Fabricademy | textile & technology acad

*Communauté mondiale des fablabs en réunion.  
Anastasia y présente le programme de formation distribué : Fabricademy (fabricademy.org) qu'elle a co-fondé. Chaque fablab peut, localement, relayer cette formation globale en fabrication digitale appliquée au domaine du textile. Chaque fablab fait ainsi partie d'un réseau mondial de concepteurs et de fabricateurs.*

Like the Fabacademy, the Fabricademy offers interactive online courses and global coordination around the topic of digital fabrication and textiles within the world of Fablabs. Here, Anastasia is leading an online session. Each fablab can, locally, relay this global curriculum in applied digital manufacturing.



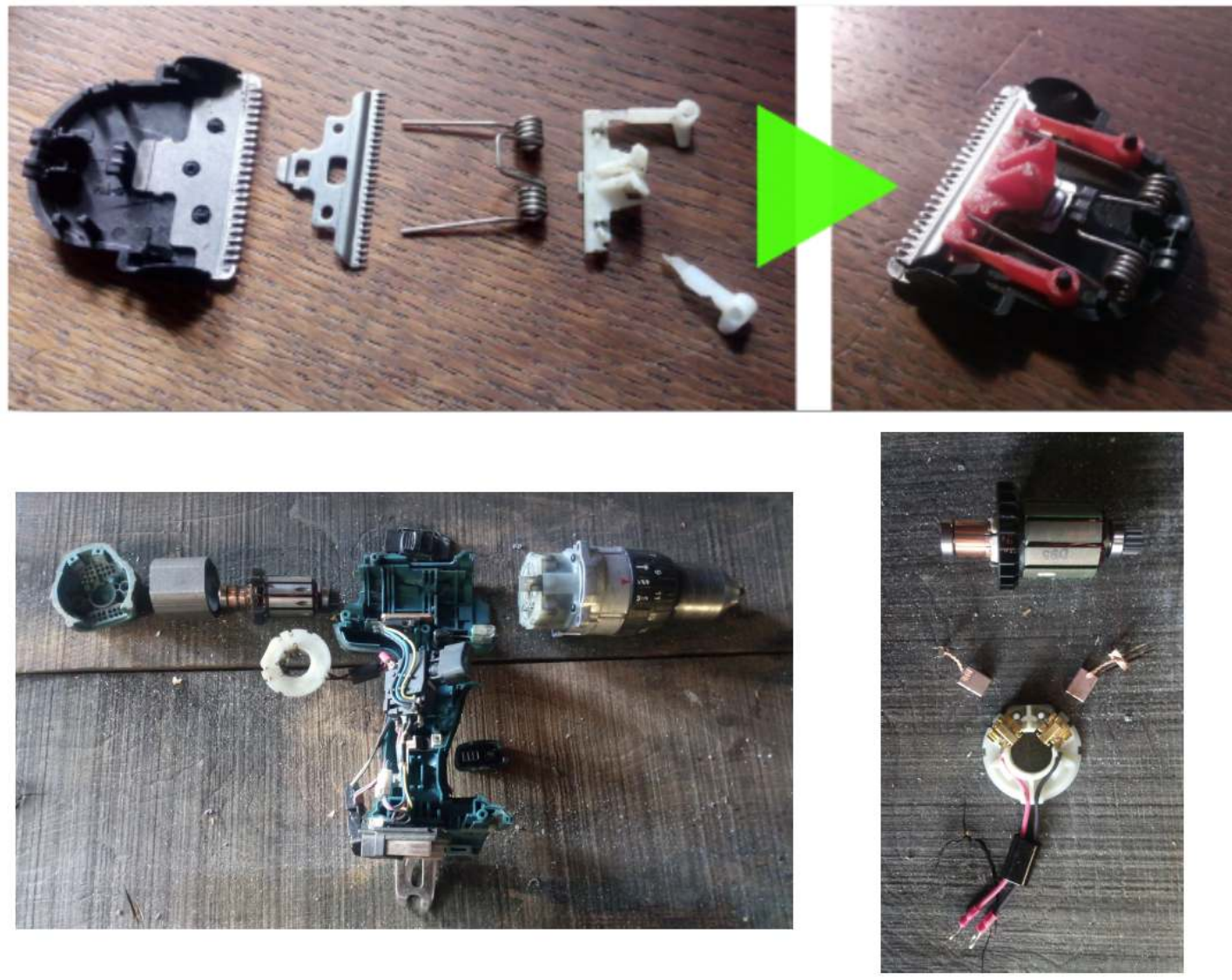


Throughout the end of the course, each student must complete a final project, putting into practice what he or she has learned during the course. The image above shows an example of a student's achievement.



Fablabs are also usually equipped with basic equipment for simple biological manipulations. This picture shows the production of pigments based on chromatogenic bacteria culture (not dangerous ones!)





Obviously, Fablabs are not only workshops to create new objects, repairing also represents a large part of the activities that are carried out there. Once a part has been modeled, it can be shared and lead to multiple repairs or even improvements of parts suffering from programmed obsolescence.

The question that arises is the following : given the energy context and the scarcity of resources, how can we set limits to this omnipotence so as not to destroy our environment and remain focused on the essential ?



This image represents the extreme gadgetization of the world with this device which benefit/cost ratio in energy versus resources is close to zero.



# FABSHIP

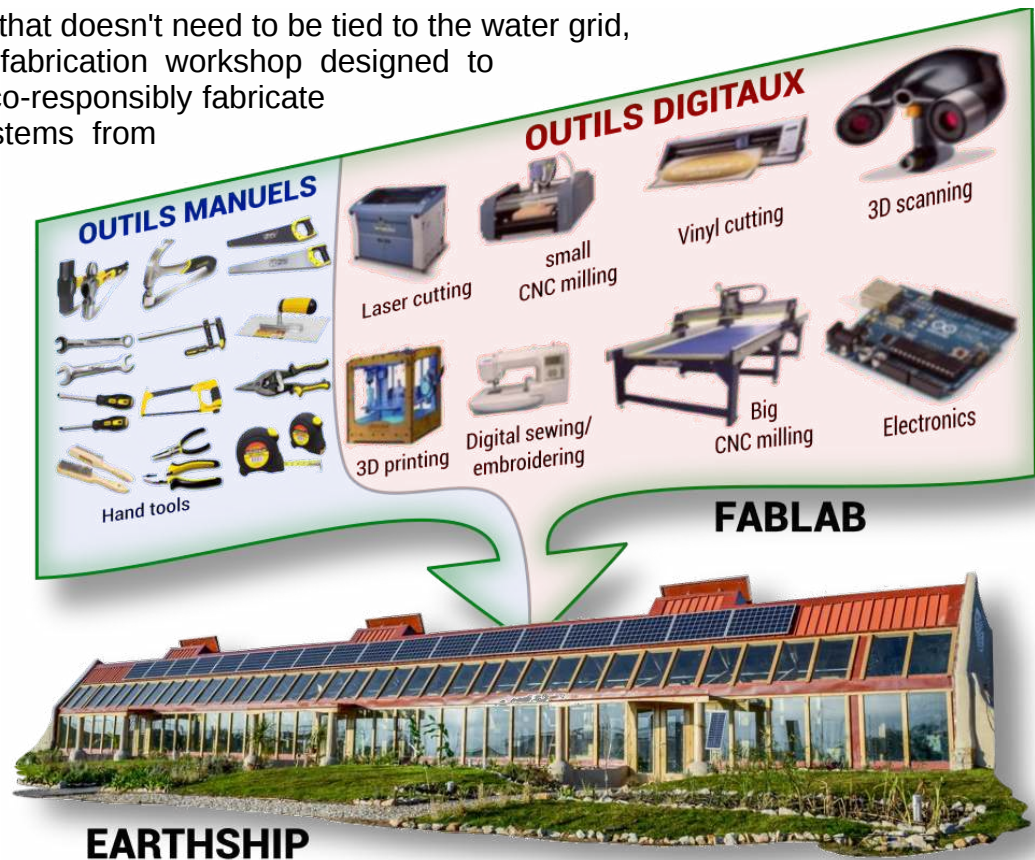
Shared off-grid manufacturing workshop

A FabShip is a FabLab in an Earthship, i.e. a fablab that doesn't need to be tied to the water grid, electricity, heating and sanitation. It is a shared fabrication workshop designed to increase resilience by allowing any community to eco-responsibly fabricate and repair their objects, tools and autonomy systems from renewable energy.

By combining digital manufacturing technologies and low-techs, Fabships encourage innovation with an environmental awareness and propose alternatives to the current predominant production model. Directly connected to local renewable resources, they empower citizens by giving them agency with emerging technological tools.

We can find in a Fabship the **conventional hand tools** : hammers, screwdrivers, saws, drills, etc., and also a **specific set of digital tools** : laser cutter, digital milling machine, 3D scanner, 3D printer, digital embroidery machine, tools for electronics, etc.. The tools are shared within a community of users. A Fabship is a **true micro factory** capable of doing « (almost) anything »<sup>1</sup>, at small scale. The fact that the workshop is autonomous allows us to always have as a constraint the amount of energy (and water) used in the workshop. Thus, the ecological criterion will be unavoidably respected, which necessarily leads to more environmentally conscious designs and repairs.

Fabships aim to bring these two movements together under one roof. They aim to quantify the societal and environmental impact that the pooling of means of production and innovation in a network of interconnected communities can have in a society in ecological deficit<sup>2</sup>.



1. "How to make (almost) everything", title of MIT's course ([MAS.863](#)), where the fablab movement originated from, taught by Professor Neil Gershenfeld.  
 2. See the notion of ecological deficit <https://data.footprintnetwork.org>





Being able to locally manufacture and repair the self-sufficiency systems we mentioned earlier is particularly interesting from a resilience perspective. It also creates jobs and connections.

Moreover, as open source<sup>1</sup> designs, these systems have a phenomenal potential for ingenuity since they are the result of a worldwide collaboration of enthusiasts. This document, for example, was only made with free and open source tools (software), the results of a massive collaboration of passionate and committed citizens: Linux, Gimp, Inkscape and others. Of course, these examples are software, but the era of open source hardware has already begun.

1. Explanations on Wikipedia : [https://fr.wikipedia.org/wiki/Open\\_source](https://fr.wikipedia.org/wiki/Open_source)

# ~400k€

The budget for a fully equipped 250 m<sup>2</sup> Fabship (100k€ worth of equipment) is about 400 k€.

It can be reduced if the construction is done as a autonomous construction training program (Academy) and if the chosen machines are of smaller capacity.

Ideally, a Fabship is located in the heart of an ecovillage.



# Conclusion

Fabships are Fablabs installed in Earthships, that means they are passive and energy self-sufficient fabrication workshops. The goal is to allow any Fabship-equipped community to strengthen its resilience and develop its autonomy. If a Fablab allows users to make almost anything, a Fabship, because of its limited energy, helps users to prioritize what to make first, i.e. what matters in an energy stressed context. A fabship allows local, citizen and distributed manufacturing without costing the planet. It is about collaborative eco-manufacturing. The Fabship project is totally in line with the philosophy of "Think Global, Act Local". By combining digital manufacturing technologies and low-techs, Fabships encourage eco-responsible innovation and propose an alternative to the current concerning production model. In a similar way and by sharing their knowledge openly, the FabLabs and Earthships movements address locally the technological and human challenges facing humanity today. They empower citizens to become more environmentally conscious and technologically savvy.

We have found land to build a first prototype in an off-grid community in the center-south of France. This prototype means to prove and enhance the concept of sustainable self sufficient rural fablabs, so that it can be replicated in any community that wants to design globally how to build locally the world they dream to leave in with what the Earth and the Sun have to offer.

We offer consultancy on how to build and set-up your off-grid fablab.

We also welcome your feedback and support. We are looking for financial support to launch the first Fabship and the alternative business model that this project proposes.

Thank you for your attention.

# Contact

To get in touch, please email us at : [info@fabship.cc](mailto:info@fabship.cc)



