Liuc Papers

Pubblicazione periodica dell'Università Carlo Cattaneo - LIUC

Numero 297, giugno 2016

Serie

Digital Do It Yourself 1

Marco Fioretti, Wouter Tebbens

Digital DIY for self-sustainability of rural areas

Serie: Digital Do It Yourself

Liuc Papers

ISSN:1722-4667
ISBN: 978-88-941811-1-1

Direttore Responsabile: Piero Cavaleri
Direzione, redazione, amministrazione: Università Carlo Cattaneo - LIUC
C.so Matteotti, 22 - 21053 Castellanza (Va) - Italia
tel. 0331-5721 - fax. 0331-572320

Registro stampa Tribunale di Busto Arsizio n. 11/93 del 11.06.93

Comunicazioni di carattere organizzativo vanno indirizzate a:
Piero Cavaleri, *LIUC Papers*, Università Carlo Cattaneo, Biblioteca «Mario Rostoni»
Corso Matteotti 22, 21053 Castellanza (VA), Tel. 0331-572.267 # E-mail pcavaler@liuc.it

DIGITAL DIY FOR SELF-SUSTAINABILITY OF RURAL AREAS *

*Marco Fioretti, Wouter Tebbens***

1. Introduction

Digital Do-It-Yourself techniques, from 3D printing to micro-sensors, allow people to fabricate and reproduce complex objects, from drones to milking machines, with reduced costs and skills. Digital DIY can contribute to feasible, practical solutions for economic and social sustainability of rural areas.

Digital DIY can help making agriculture and farming economically and environmentally sustainable, thanks to machinery and crop/livestock monitoring systems that greatly reduce both the costs of equipment, and the time and skills required to build and manage them.

Digital DIY can also be applied to provide crucial services for rural areas, from Internet access to telemedicine. At both levels, Digital DIY solutions can be reused, and completely adapted to the actual local needs of each community, at the smallest possible costs.

In this paper we first define Digital DIY, Free Software and Open Source Hardware, and mention some of their applications in agriculture and rural contexts. Next, we consider how Digital DIY can enable people to build civic and social services bottom-up, also in rural areas, and the main challenges to reach those goals. In the conclusions we argue that solutions based on Open Source Hardware and Digital DIY can and should be applied in rural areas, thus contributing to a sustainable society, from an environmental, social and economic point of view.

2. Definitions[1]

- **Digital Do-It-Yourself:** a new socio-technological phenomenon which stems from the widespread availability of digital devices that support ABC, that is the convergence of physical ("atoms") and informational ("bits") components, as well as the growing accessibility of related knowledge and data through open online communities. The

** Free Knowledge Institute (http://freeknowledge.eu)

term "Digital Do-It-Yourself" is abbreviated here as "DiDIY", which is also the name of the H2020 research project (www.didiy.eu) in whose context this paper was written.

- **Fab Lab (fabrication laboratory):** a small-scale workshop offering (personal) digital fabrication tools and services.
- **Maker culture:** a technology-based extension of DIY culture, using digital technologies to create new devices, often by cookbook-style reuse of reference designs

3. DiDIY and its applications in rural contexts

DiDIY is heavily based on Free/Open Source Software and Open Hardware. A detailed description of those terms, inner workings, communities and practices is outside the scope of this paper. Here, it suffices to say that they refer to software and hardware designs that (while **still** copyrighted!):

1. is legally usable without paying any license
2. comes with full source code and design files, released under licenses that explicitly allow, and encourage, their reuse, modification, and redistribution by anyone, under the same conditions (the "Free" in "Free Software" refers to the freedom to use and modify it in this way, regardless of whether and how much the developers are paid for each copy of their software)

Free Sofware and Open Hardware are mostly developed by communities of both professionals and hobbyists that cooperate through the Internet. They put the maximum emphasis on the freedom of all developers and end users to study, adapt, reuse and share all knowledge necessary to replicate the project. It is exactly because of this freedom that DiDIY is a very powerful tool and mindset, even in agriculture: "if a `[farming]` tool does 80 percent of what you want to do, you can search the Internet and find the stuff that does the last 20 percent."[2]

Most Open Hardware projects that are relevant in rural contexts are based on some combination of the Arduino microcontroller[3] and the many sensors and other accessories already available for it in online marketplaces. Other relevant technologies are DIY numerical controllled cutting and milling machines like DIYLILCNC[4], or OpenBuilds[5], and 3D printing.

In practice, farmers and rural communities in general can benefit of DiDIY in (at least) four main areas:

- building and maintenance of farming machines and other tools, or of their **spare parts**

- (remote) automatic monitoring of land, livestock and equipment
- automation and remote control of several farming operations
- sharing of raw data and knowledge for better management of operation and decision-making, both for single farmers and at community level.

Water is so essential in all forms of farming that as a first example of DiDIY in agriculture and rural communities it seems proper to mention the "Water Treatment Tower" at Instructables.com[6]. The following paragraphs of this chapter briefly mentions some other applications of DiDIY in agriculture.

3.1 Environment monitoring

Besides water, many physical components of a (farming) ecosystem can be effectively monitored with DiDIY tools and techniques.

Commercial sensors may be easy to use but often rather expensive and, more important, much less configurable than needed.

Using, instead, the right combinations of Arduino, Arduino sensors and relatively simple software, every farmer may build at very low cost (tens of Euros) custom monitors of any combination of temperature, humidity, pressure, motion and other physical parameters.

The practical applications, already used in the field and with open designs available online (see the "Online Resources" section) go from weather stations to real-time monitors of all sorts of "systems", from simple ones, like one field or barn, to relatively complex (micro) ecosystems like beehives or fish tanks. The Open Source Beehives project, for example, tries to prevent bee population decline by "bringing [Open Source, DIY] sensor monitoring into beekeeping"[7].

DiDIY with Open Hardware is also already popular in Aquaponics systems, in which "water from fish ponds is automatically analysed and used to irrigate vegetabls in exactly the right moments and amounts"[8]. The "Smart Aquaponics" project uses [Open Hardwar] sensors to "autonomously mimic the earths water cycle and model nitrogen cycles, oxygen cycles etc. to grow healthy organic produce for feeding new and existing colonies"[9].

3.2 Farming automation

Monitoring is, of course, only a prerequisite to action that makes sure a “system” remains in the desired state, or evolves towards it. The same communities and suppliers that support Arduino and similar microcontrollers also offer accessories to make them *control* an environment, that is relays, actuators, motors and software to operate them. Applications already working in the field include:

- distribution of configurable amounts of fodder and water to farm animals
- automatic opening and closing of the doors of chicken coops
- small, highly automatised greenhouses like Greenduino, Hortduino[10] or Horto Domi
- Milking machines[11]
- An automated CNC for precision agriculture is being developed by the FarmBot community[12]. Complete working versions are about to be offered through the kickstarter crowdfunding platform as we write this article[13].

3.3 Machinery

The possibilities of DiDIY are not limited to "light" equipment like the one described in the previous section, or of their *spare parts*. Projects like the "Global Village Construction Set"[14] are one of the first to develop open designs of tractors or harrows. The Global Village Construction Set (GVCS) is a modular, DIY, low-cost, high-performance platform that allows for the easy fabrication of the 50 different Industrial Machines that it takes to build a small, sustainable civilization with modern comforts[15]The current prototypes are not as powerful, nor are they “smart”, that is equipped with sophisticated software, as the commercial, state-of-the-art products from companies like, e.g., John Deere. At the same time, DiDIY machines like those are adequate to the actual needs of small farmers and can be entirely built locally, at fraction of the costs. Above all,such machines:

- can be fully customised, that is optimised for the actual needs and constraints (climate, nature of terrain, etc) of **each** user, without “intellectual property” restrictions of any sort
- leave their owners full "Right to Repair", meaning that they can be entirely **serviced** by independent experts, without the costs and restrictions embedded in commercial products

3.4 Energy production

While DiDIY can enable distributed design and manufacturing of tractors, it can't power them. At the same time, DiDIY solutions that let barns, greenhouses, irrigation systems and the like work off-the-grid are already available. When commercial power generators are not accessible, or do not match farmers needs, they may try (or co-develop) DiDIY solutions. Examples, at various stages of development, of what is possible in this area go from solar concentrators from GoSol[16] or Zenman Energy[17], to the Vertical Wind Turbine called

SolarFlower[18], or DIY communities to build your own gasifier kit[19] or community designed micro-hydroelectric plants by Global Anchor[20].

3.5 Drones

Small drones for civilian purposes, and especially DIY, Open Hardware ones[21] have become very popular in the last few years, to the point that several states have started regulating their use. Their potential in rural areas, however, is still largely untapped. DIY drones services that may already be used in **every** rural community include, but are not limited to:

- close, visual inspection of remote fences, orchards etc..
- tracking and rescue of cattle, if equipped with (DIY) radiocollars
- delivery of medicines and other small parcels to farmers in remote areas

3.6 Housing

Experiments and projects of DiDIY housing go from experiments with 3D printing of custom made concrete walls or whole small houses, to less glamorous "Earth Brick Presses"[22]. A very popular project in this space, and an interesting one for its ease of use, is the WikiHouse[23]: an Open Source house construction set, of which everybody can download the design files, cut the corresponding parts with a CNC router and assemble them with very simple tools and procedures.

3.7 Furniture

For furniture various open projects exist, that enable you to make your own furniture. SketchChair[24] offers a software tool that allows you to sketch and virtually try the chairs you design before sending them to a CNC mill. You are encouraged to share your designs with the community allowing others to continue and personalise the design. Furniture design studio AtFab offers their designs[25] under free licenses to the OpenDesk[26] community. These more professionally looking designs can be downloaded freely for CNC milling them yourself or you can hire a local maker to make it for you.

Also 3D Printing furniture can be an interesting option, as shown by the Dutch Bits and Parts design studio who published their Puzzle Chair[27] under the Creative Commons Attribute NonCommercial NoDerivatives license. It takes some 30 hours printing the parts for this chair at an Ultimaker 3D printer.

A restaurant in Barcelona called Leka has worked together with the nearby FabLab to remake the restaurant almost 100% by DiDIY activities[28]. The furniture they built is published

on their site under open licenses, as well as the personnel dresses they wear, designed together with the nearby design school BAU[29]. To complete their aim for openness, they have published some of their recipes as “open food” as well[30].

3.8 Mapping

OpenStreetMap is a digital map of the whole world, similar to Google Maps, but developed like Wikipedia: everybody can improve the map, create their own versions and legally reuse and redistribute them, even for commercial purposes. From a farming/rural community point of view, OpenStreetMap is relevant because:

- it lets the member of each community map their own land, in their own language, as **they** want and need it, adding, naming and updating features at will
- the results are usable for anything from land monitoring to tourist guides and forestry management
- even people without smartphones, computers or computer skills can contribute data to OpenStreetMap

The latter activity is possible thanks to the Walkin Papers/Field Papers services[31] that let everybody print maps, draw on them and (have others) scan them back, so that somebody else can quickly include all the hand-drawn details into the digital version of OpenStreetMap.

3.9 Connectivity

Internet connectivity, which in rural areas is still far from granted, is a necessary prerequisite to participate into DiDIY, or at least enjoy its results by downloading design files or instruction manuals.

Luckily, when a whole community supports it, DiDIY can also solve this problem, by providing the tools to build community-owned and operated local access networs, even in rugged areas that would never be a priority for commercial access providers. In Europe we have several thriving communities that do just that. Guifi.net is a community built telecommunications network which was born in Catalonia/Spain; it is open, free and neutral because is built through a peer-to-peer agreement where everyone can join the network by providing his connection, and therefore, extending the network and gaining connectivity to all. The radio link and Internet access points in the village of Verrua Savoia, in Northern Italy, were built by a local non-profit association also "with parts scavenged from computers"[32]. Still in Italy, Ninux is a wireless network community with the goal to create and expand a free, open and experimental computer network[33], based on a pico peering agreement, which shares the network with all contributors.

Freifunk[34] (German for: "Free radio") is a non-commercial open Grassroots initiative to support free radio networks in the German region. Freifunk is part of the international movement for open wireless radio networks. The main goals of freifunk are to build a network that is decentralized, owned by those who run it and to support local communication. The initiative is based on the Picopeering Agreement. In this agreement participants agree upon a network that is free from discrimination, in the sense of net neutrality.

3.10 Data networks for the Internet of Things

For connecting remote sensors and actuators to the Internet a variety of radio technologies exist. However mobile and WiFi are not always adequate for their high energy consumption and thus short battery lifetime. Bluetooth maybe battery friendly but is – like WiFi – only applicable for short range applications. New radio technologies have emerged that combine low power with wide areas – the so called Low Power Wide Area Networks (LPWAN).

One of the options is LoRaWAN (Long Range Wide Area Network) that is the only radio technology of this kind that is developed by an open consortium of manufacturers, network operators and other interested parties. Its standards and protocols are published in a non-exclusive manner as an open standard.

This technology allows you to set up your own network, where one antenna can reach to five or ten kilometers, especially in rural areas. A community called The Things Network[35] helps people to set up LoRa infrastructure and assures its access as free of charge. Given that up to 10.000 sensors can connect to one antenna at the same time, and the antennas now being so cheap as 200 euro, the abundance is so much that sharing the network as a commons[36] is a very attractive. So much so that around the world many local Things Network communities are popping up.

3.11 Traceability and quality control

Many rural areas produce unique varieties of high quality foods, beverages, textiles and other raw materials. The low volumes of these goods, however, mean that the complex quality control procedures adopted by big companies may be not accessible to their producers.

DiDIY and Internet cooperation, however, may also lower the costs and complexity of systems that certify origins, quality and supply chains of unique products from rural areas. Two examples from Italy of such services are a 3D printer modified to 3D-print bar codes on hand-made pasta from organic wheat (seen by the author at Maker Faire Rome, 2015) and, even if it is not Open Source, the I-Olive system[37]. Its iPAD application allows its users to file digitally

signed, non-editable quality reports of extra-virgin olive oil samples that they get with unique codes, but without knowing their producers. This gives, even to small farmers from many different areas, **one common, low cost but highly reliable process** to certify their oil and its distribution.

3.12 Online resources and communities

Many more working applications of DiDIY in agriculture and rural sustainability than those mentioned in this paper can be found in online portals and magazines like Instructables.com, Appropedia.org, Farmhack.org and modernfarmer.com. Farmhack.org is particularly relevant here, as it was specifically designed to "bring together farmers and engineers", because "as simple as Arduino can be, many farmers simply don't have the time to learn the techniques and would rather consult with a professional"[38].

It is also worth noting that the same portals provide very practical and cost-effective solutions **also** to many "low-tech" farming needs. Solutions, that is, in which the only "Digital DIY" component is the ability of the Internet to connect people with similar problems, and empower them to co-create and share solutions. In other words, DiDIY in agriculture can, and it already is taking, many forms that are useful even for farmers who may have no actual needs for microelectronics and other high-tech products.

4. DiDIY advantages

The examples in the previous chapter suggest that DiDIY-based equipment and procedures answer to the actual problems and needs of each single farmer, or rural community, better than many commercial products, or proprietary or centralised solutions that have been developed with public funding. The main reasons are that DiDIY-based solutions:

- are easier to deploy, much more customisable and also more economically sustainable with bottom-up initiatives and programs
- empower the user, approriating the technologies she needs;
- empowers the community, encouraging to share one's experience and solutions with others, thereby allowing all to stand on the shoulders of giants (of collective wisdom and shared knowledge);
- in most cases, do not require special government permissions nor corporate licenses or contracts;
- can create local service jobs, not exposed to delocalisation

Other advantages of DiDIY are described in the next paragraphs.

4.1 Make farming more reliable, less stressful

A large scale adoption of DiDIY in farming may have an important *social* effect. If solutions like the ones mentioned in Chapter 3 became commonplace, they may contribute to make farming less physically demanding and less time consuming. Even better, they would make farming less stressful and risky, by reducing human error where feasible, and providing more data for better decisions. This is equivalent to say that DiDIY can make farming, and living in rural areas in general, more "bearable" than it has traditionally been. These benefits would apply both to native residents, and to people who may not otherwise leave the "comfort" of city life (including, in both cases, senior citizens). Appropriate DiDIY solutions hardly make their end users rich, but often leave them with more leisure time and spare money than they would have had without DiDIY.

In the long/medium term, all this may make a meaningful impact, considering the aging and depopulation problems that afflict many rural areas these days, in Europe and elsewhere.

4.2 Real ownership of the most appropriate equipment

Commercial, proprietary tractors and other state of the art farming machines are black boxes, whose maintenance and diagnostic tools also vary, in incompatible ways, from manufacturer to manufacturer. In the most extrem cases, even if a farmer managed to get the right software, without a factory password, tht is without the permission of the manufacturer, no maintenance would be possible[39]. By definition, no restrictions like these are possible with Open Hardware. In general, DiDIY contributes to bring back real ownership of one's equipment, including the possibility to improve and repair it, in rural areas, right in the activities, like agriculture, where it matters most.

4.3 Loss of isolation, without loss of identity

As we have mentioned in section 3.8, DiDIY empowers rural communities to design, deploy and operate their *own* local connectivity services, even at relatively high speeds. Of course, if real broadband connections between them and the rest Internet are unavailable, such networks will **not** give their owners the same access to digital services enjoyed in most urban areas. At first sight, this may make such projects look pointless, but there are at least two considerations that are worth doing. First of all, an high speed connection to the Internet is great, but is not a *mandatory* prerequisite for many non real-time but *essential* services, from email to e.g. downloading DiDIY files or manuals for later usage. In the second place, what is actually needed in many cases would only be high speed connectivity *within the community itself*. Such

connecivity could still support, just to give a few examples, *local* telemedicine, video streaming of Community Councils or Uber-like sharing of transportation, tools and other resources.

In other words, DiDIY networks like the ones previously mentioned may very well be enough to give a rural community all the digital, broadband-only services it needs *for itself*. This would not only improve (public) services and local quality of life. It would also diminish the isolation from the outside world that historically afflicts rural communities, but in a way that doesn't force them to give up their identity and traditions, by using the same, one-size-fits-all services born and designed for very different cultural contexts.

At the same time, by making residents accustomed to using digital services, such networks may eventually bring the local demand for broadband connections *to the Internet* to levels high enough to attract for-profit providers.

4.4 Small communities, Big (community-owned!) Data and Commons

In traditional agriculture, many collective and individual decisions are based on combination of local tradition, personal experience and small amounts of **isolated** field data (that is: not collected and correlated in any systematic way).

Soil nature and microclimate, however, can vary even inside the same field. Systematic collection and analyses of great amounts of data can increase the yield of fields, and reduce the risks of certain decisions.

The availability of low cost, fully customizable DIY sensors and Free Software empowers even small farms and communities of farmers, to do just that, that is to *collectively* gather, share (even if only *among themselves*) and analyse agriculture-related data.

In general, in addition to all its other possibilities, DiDIY (re)introduces in farming and rural communities levels and forms of cooperation and sharing that would not be possible otherwise. Services and organisations like OpenWeatherMap.org and HabitatMap.org, that share meteorological or ecosystems data, are built just out of that concept[40].

This is equivalent to say that DiDIY is an enabler, and a supporter in the management, of both material Commons (fields, pastures, springs..) and immaterial ones, from the data about those resources to maps, local folklore and mutual support services. In this context, an interesting experiment to observe may be the one born in Italy and called “Rural Iperconnections”[41].

4.5 DiDIY for whole rural “systems”

If the goal is to make a rural community really resilient and self-sustainable, it is not enough to provide it with the technology and knowledge for more efficient farming. All its components

must contribute to that goal. One such component is housing: there are plenty of abandoned homes and buildings, in rural areas all over Europe, that may theoretically provide low cost social housing. Those homes and buildings, however, raise the following questions: could they all be enough comfortable, energy-efficient and safe by contemporary standards and expectations? Quite often, "remodeling" those buildings may make less sense than building *whole new houses and infrastructures from scratch, with state-of-the-art technology*. In both cases, however, the traditional, market-based answers may be expensive enough to leave no intermediate solution between abandonment and gentrification. When that happens, DiDIY styles alternatives like WikiHouse may offer valid alternatives.

Going further, we may say that in order to develop, or preserve, a whole rural area as a self-sustainable place in which it is worth living, that area needs solutions that are[42]:

- (self) organised, bottom-up
- taking their history and unique characteristics into account
- designed with a *process* which is friendly to all the levels and sides of human life
- managed with cheap, not invasive interventions that match the real needs and features of each place

The points above are a practical synthesis of the goals of International Society of Biourbanism (ISB)[43]. But all the approaches that, like the ISB one, aim to rebuild complete common spaces from the bottom, can benefit of DiDIY tools, mindset and communities, in ways and areas that go beyond farming.. One integrated proposal of this kind is the one called Progetto Leo[44], by ISB, M. Fioretti and others.

5. Obstacles and Risks

5.1 Education and Cultural Divides

In many cases, writing the software for an Arduino-based sensor system "only" involves a copy and paste job of someone else's work, after reading documentation that is only available in English. In order to merely *use* an Arduino-based system, one must "only" be able to use documentation and user interfaces in English, or ask the right questions in, often, English-only online forums.

In practices, such activities are still beyond the skills of much of the general population, even in cities. This is the biggest obstacle to the widespread adoption of DiDIY, and in rural areas is a much bigger problem than elsewhere. In those contexts, even the design and service jobs created by DiDIY may only go to outsiders, or be used only as a way to acquire enough skills to *leave* the community as soon as possible. It is fair to assume that solutions like MOOCs

(Massive Open Online Courses) and self-education can hardly play any meaningful role in rural communitiess. The very model of MOOC, that is *one* program for tens of thousands of learners, is a bad match for the needs of many **small** communities, each with at least some needs different from all the others. Even worst is the fact that people unable, so to speak, to teach themselves to learn online, that is those most likely to fail in any MOOC, or in self-education, are exactly those "from traditionally underprivileged backgrounds - poor and underdeveloped areas"[45].

5.2 Other risks

Some DiDIY-related risks have nothing specific to rural areas. On the ecological front, there is the risk that DiDIY activities - without proper education - may increase non-recyclable waste of microelectronic/plastic objects. Regulation-wise, existing product liability regulations are not adequate, in several cases, to deal with DiDIY products. There are lots of legal challenges[46] due to our current legal system being designed for a traditional world of mass production for consumption by the masses. Mass production may change into mass personalisation and production by the masses. The challenges include the way we as society deal with rights and responsibilities. For example product liability only applies when (finished) goods are bought in the market. Digital DIY is typically outside of the market which makes that often nobody can be held liable when products break and may cause injuries. Didiyers and prosumers should therefore be aware of the risks of dealing with certain materials. Legislation and insurance offerings should be adapted to these new realities.

An issue more tied to rural communities is access to *adequate* financing. DiDIY needs much less money than highly automatized factory farms, high-tech tractors and similar products, but may require financing services (microcredit? Maybe) of a nature quite different from those available to most EU farmers these days. Good lessons on this side may come from Africa where "in countries like Kenya, less than 10% of farmers have access to formal credit, with women faring far worse than men. Better access to credit, especially for smallholder farmers, could bring about a revolution in African agriculture"[47].

6. Conclusions

Many of the digital technologies now fashionable in cities may bring even more benefits in rural areas. In the same areas, however, the current centralised, market-focused applications of those technologies may be much less feasible and sustainable than the DiDIY-based ones.

We say "DiDIY-based" because the purpose of this paper is not to promote any *specific* product or technology, as much as the general approach, mindsets, knowledge bases and community structures that constitute the foundations of DiDIY.

It is on those foundations that each rural community may build its **own** personalised solutions to solve its **own** actual problems, with the smallest possible effort and expenses. We suggest that DiDIY may play a role in *all* sorts of actions that are needed to make a rural community self-sustainable and resilient, even indirectly. Digital DIY with open technologies may not increase a community's GDP, but it can help it to become more resilient and connected with the outside world, but on its **own** terms, without losing its identity by assimilation or depopulation.

In synthesis, DiDIY goes beyond the limits of free markets, without excluding them altogether; it brings in some benefits of globalisation, without some of its disadvantages; and favours "rural sustainability without the need for permission". In a more transformational way we can see DiDIY as part of the bigger commons movement[48], where knowledge is shared globally and production takes place in a more locally oriented manufacturing processes.

In order for this to happen, it is necessary to tackle the problems outlined in Chapter 5, especially those related to cultural divides.

As far as documentation and user interface go, the answer is easy to find: it only takes one translator, once, to make some manual or user interface available to all the speakers of some language. Free Software and Open Hardware mean that any Public Administration, University or NGO surely can, both technically and legally, translate that material (or pay professionals to do it), in any language or dialect, including ones that would never interest commercial suppliers.

When it comes to design and building DiDIY products, it is not necessary for every farmer to become a "didiy-er", in order to personally benefit from DIDIY. As long, of course, as every single rural *community*, or network of such neighboring communities, has enough skills and material resources to provide such services to their members. (e.g. local rural fablab, skilled *local residents* manning it etc). One way to favour such developments is to include, in the programs of Agriculture and Zootechnic schools and universities, specific education about DiDIY. Education, that is, that goes beyond mere technical training on Arduino or similar products, to present the *high level* advantages of DiDIY, as outlined in this paper, and their best applications in the surrounding communities. Another action is to assist rural communities (as in the already mentioned "Project Leo" proposal) in developing their **own** versions of Fab Labs that offer "DiDIY services" to all their members.

Notes

[1] a more complete definition of the same terms is in the DiDIY Knowledge Framework, www.didiy.eu/sites/didiy.eu/files/didiy-public/public/deliverables/didiy-d2.3-1.0-pub.pdf, and in section 1.2 of "Current DiDIY Support and awareness in Europe", www.didiy.eu/sites/didiy.eu/files/didiy-public/public/deliverables/didiy-d8.4-1.0-pub.pdf

[2] "Farm geeks learning to love the circuit board", 2013 http://modernfarmer.com/2013/05/farm-geeks-learning-to-love-the-circuit-board/

[3] http://arduino.cc

[4] http://diylilcnc.org

[5] www.openbuilds.com

[6] www.instructables.com/id/DIY-Water-Treatment-Tower

[7] www.opensourcebeehives.net

[8] "From water sensors to weather stations, DIY farm hacking takes off", 2013 http://modernfarmer.com/2013/05/farm-geeks-learning-to-love-the-circuit-board)

[9] https://hackaday.io/project/1877-smart-aquaponics

[10] http://www.hortduino.com/

[11] Such a system is described in detail at https://nicegear.co.nz/blog/building-100-arduino-vacuum-pressure-gauges/ and https://nicegear.co.nz/blog/milking-cows-with-arduino-part-1/

[12] http://wiki.farmbot.cc/

[13] http://farmbot.io/

[14] http://opensourceecology.org/gvcs

[15] http://opensourceecology.org/gvcs/

[16] GoSol guides to build your own very low-cost solar concentrator can be found online: http://www.gosol.org/ Unfortunately there is no license information available that would encourage modifications and improvements.

[17] www.zenmanenergy.org

[18] http://solarflower.org/

[19] www.build-a-gasifier.com/gasifier-kits

[20] www.globalanchor.org/docs/GA_nutshell_RevB.pdf

[21] Two of the more active projects are www.dronecode.org and www.open-drone.org, and one of the biggest online community forums on DIY drones: http://diydrones.com/ set up by Chris Anderson, former chief editor of Wired and now running his open source drone company 3D Robotics, 3drobotics.com/

[22] http://opensourceecology.org/wiki/CEB_Press/it

[23] www.wikihouse.cc

[24] http://sketchchair.cc/

[25] http://atfab.co/cnc-furniture/

[26] https://www.opendesk.cc/

[27] http://www.bitsandparts.org/

[28] http://www.restauranteleka.com/open-source

[29] http://www.restauranteleka.com/open-cloth/chaqueta-cocinero

[30] http://www.restauranteleka.com/open-source/pagina-2

[31] http://walkingpapers.org

[32] "A village has what all of Italy wants: the Internet", 2014, www.nytimes.com/2014/12/03/world/europe/a-village-has-what-all-of-italy-wants-the-internet-.html

[33] http://wiki.ninux.org/FrontPage

[34] http://freifunk.net/

[35] http://thethingsnetwork.org

[36] See analysis here: http://freeknowledge.eu/blogs/things-network-4x-commons-internet-of-things and a panel discussion in the Barcelona FabLab: http://freeknowledge.eu/blogs/now-lora-building-smart-city-bottom-up

[37] http://iolive.it

[38] "Farm Geeks learning to love the circuit board", 2013, http://modernfarmer.com/2013/05/farm-geeks-learning-to-love-the-circuit-board/

[39] "New High Tech Farm Equipment a Nightmare for Farmers", 2015, www.wired.com/2015/02/new-high-tech-farm-equipment-nightmare-farmers

[40] For more on these topics, in precision agriculture but also in other fields, see www.nesta.org.uk/news/precision-agriculture and http://modernfarmer.com/2014/03/betting-big-precision-ag/

[41] www.ruralhub.it/tag/iperconnessioni-rurali

[42] Synthesized by ""Digital innovation or Biourbanism? Both, of course!", 2014 http://stop.zona-m.net/2014/09/digital-innovation-or-biourbanism-both-of-course

[43] www.biourbanism.org/biourbanism-definition

[44] http://progettoleo.tumblr.com (In Italian)

[45] For more on this problem, see e.g. "Will MOOCs be Flukes?", 2014, www.newyorker.com/science/maria-konnikova/moocs-failure-solutions) and "Bringing the Rural Poor Into the Digital Economy, 2014, www.psmag.com/books-and-culture/bringing-the-rural-poor-into-the-digital-economy

[46] This issue is discused at length in the preliminary report of the DiDIY project on "Current DiDIY support and Awareness in Europe, 2015, www.didiy.eu/sites/didiy.eu/files/didiy-public/public/deliverables/didiy-d8.4-1.0-pub.pdf

[47] "Better access to credit, especially for smallholder farmers, could bring about a revolution in African agriculture", 2014, www.fin4ag.org/en/article/2014-07-16/better-access-to-credit-especially-for-smallholder-farmers-could-bring-about-a-revolution-in-african-agriculture.html

[48] Commons transition: http://wiki.commonstransition.org/

Abstract

Digital Do-It-Yourself techniques, from 3D printing to micro-sensors, allow people to construct and reproduce complex objects, from drones to milking machines, with reduced costs and skills. Digital DIY can contribute to feasible, practical solutions for economic and social sustainability of rural areas. Digital DIY can help making agriculture and farming economically and environmentally sustainable, thanks to machinery and crop/livestock monitoring systems that greatly reduce both the costs of equipment, and the time and skills required to build and manage them. Digital DIY can also be applied to provide crucial services for rural areas, from Internet connectivity to telemedicine. At both levels, Digital DIY solutions can be reused, and completely adapted to the actual local needs of each community, at the smallest possible costs. In this paper we will first define Digital DIY, Open Source Hardware and their impacts and challenges in agriculture. Next, we will look into how Digital DIY enables people to build civic and social services bottom-up, also in rural areas. We argue that solutions based on Open Source Hardware and Digital DIY can and should be applied in rural areas, thus contributing to a sustainable society, from an environmental, social and economic point of view.

Biographical sketches

Marco Fioretti

Marco Fioretti holds a Degree in Electronics Engineering at the University La Sapienza of Rome, Italy and almost fifteen years of experience as designer of digital integrated circuits and telecom system designer, in Italy and Silicon Valley. Fioretti is a long time freelance contributor for several international magazines covering Linux, Free Software and Open Standards. He has participated to several projects in these fields, from RULE (Run Up to date Linux Everywhere) to the OpenDocument Fellowship and the Digital Standards Organisation, and published several essays about Open Data and Open Digital Standards. After several years collaborating as tutor of the Free Technology Academy, in 2013 Fioretti joined the Board of the Free Knowledge Institute.

Wouter Tebbens

Wouter Tebbens is co-founder and serves currently as president of the Free Knowledge Institute. Between 2006 and 2008 he was coordinator of the European Commission's FP6-funded SELF Project. From 2008 onwards he led the Free Technology Academy. He achieved a Master of Science in Production and Operations Management at the University of Twente (Netherlands). He has worked in various functions in Europe, Argentina and Spain. In 2002 he founded the company xlocal.com offering services based on free software to SME companies. Between 2004 and 2007 he presided the working group on Free/Libre/Open Source Software at Internet Society Netherlands.