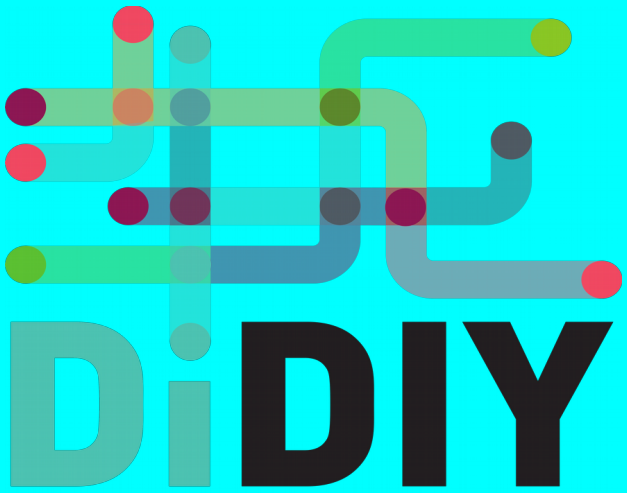

DiDIY

DIGITAL DO IT YOURSELF

Knowledge Framework

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Executive summary

Digital Do It Yourself (DiDIY) is a new human-centric, socio-technological phenomenon, enabled and rapidly evolving thanks to the widespread social availability of affordable technological tools that support, often through open online communities, the low cost prototyping and manufacturing of physical artefacts from digital specifications. This is leading to new scenarios in the roles and relations among individuals, organizations, and society, in which opportunities and threats emerge accordingly.

The DiDIY Research Project (www.didiy.eu), which addressed the Horizon 2020 call for a "Human-centric Digital Age", studied how DiDIY is:

- reshaping organization, work, education, research, and creative design;
- impacting on creative society;
- influencing legal systems;
- changing ethics.

This Knowledge Framework (KF) is one of the fundamental outcomes of the Project, as it provides a conceptual and lexical ground to interpret the DiDIY phenomenon.

DiDIY is interpreted according to (a) the fundamental dimensions in which human beings can be involved in it (DiDIY as cognitive process, individual practice, and group processes and the wider societal context) and (b) the components of such involvement (DiDIY as an activity and a mindset).

This general interpretation, presented in **Section 1** together with the basic methodological hypotheses, grounds a rich conceptual structure. **Section 2** introduces the conditions considered as necessarily characterising DiDIY; then in **Section 3** several interpretations of what DiDIY may be are presented; finally, **Section 4** assumes the focus of the four core aspect identified of DiDIY (corresponding to the Project' Work Packages) and proposes some related interpretations.

In order to make it more explicitly and effectively understandable, this complex structure is systematically introduced through the metaphor of a building, whose structural elements (pillars, storeys, and walls) represent the several mutually interacting dimensions of the phenomenon. In synthesis, the KF includes **contents** on DiDIY organised in a **conceptual structure**, presented by means of a **metaphor**, as follows:

Structure	Metaphor	Contents
the necessary conditions specifying what DiDIY is (***Section 2***)	**Pillars**: the yes/no conditions of existence of the phenomenon: they are central to the building, that cannot stand without them	DiDIY as: – a specific kind of DIY – a specific kind of activity enabled by digital tools
the interpretations of what DiDIY may be, common to multiple aspects of the phenomenon and admitting a range of options (from narrow to broad interpretations) (***Section 3***)	**Load-bearing Walls**: the more/less interpretations common to two or more aspects: they carry the weight of the building and are common to all Storeys	DiDIY and the role of: – individuals – communities – technology – design – ethics
the aspects of the way DiDIY can affect the society and the related interpretations, admitting a range of options (from narrow to broad interpretations) (***Section 4***)	**Storeys** and **Internal Walls**: what is specific to each aspect and the related interpretations: each aspect corresponds to a Storey, that includes some Internal Walls	DiDIY in: – organisation and work – education and research – creative society – laws, rights, and responsibilities

The building of DiDIY is under rapid and largely undirected construction. By identifying and studying those which appear today its main structural elements we hope to provide some guidelines useful to understand it and help it to develop according to a socially rational plan, as an element of the city that may become our society of knowledge.

1. Introduction

This Knowledge Framework (KF), on the phenomenon that we have proposed to call "Digital Do It Yourself" (DiDIY), is aimed at providing a conceptual and lexical basis to interpret the DiDIY phenomenon. Multiple information and data gathering methods were exploited to this goal. A set of hypotheses and research questions on DiDIY were formulated and at least preliminarily answered, to better understand and ultimately to characterise what DiDIY is, so as to provide a conceptually and methodologically grounded support to policy makers, teachers, entrepreneurs and managers, etc interested in DiDIY and its possible roles in improving schools, companies, organisations, and society.

Under the assumption that DiDIY is an ongoing phenomenon requiring the adoption of a diachronic perspective, from January 2015 to June 2017 the partners of the DiDIY research Project (www.didiy.eu) analysed and explored it, reporting the outcomes in the Project deliverables, all freely accessible from www.didiy.eu/project/results.

Companion readings of this KF are in particular the

"Foundational interpretation of DiDIY" (www.didiy.eu/public/deliverables/didiy-d2.2.pdf) and the Vocabulary of DiDIY (www.didiy.eu/public/didiy-vocabulary).

1.1 DiDIY: a human-centric phenomenon

Consider the following exemplary situations.

- I 3D scan an existing broken part, correct its failure in a 3D design software system, 3D print it, and make it "smart" through sensors and actuators connected to an Arduino board (www.arduino.cc).
- I regularly visit Instructables (www.instructables.com) because I like to learn about new "making" projects but also because I like to answer questions posed by others and to support other makers. I share my own projects, I adapt projects created by others, and I inspire people with my techniques and ideas, at Ravelry (www.ravelry.com).
- I have an idea for a new product based on a technology that I can not develop on my own. I enter in the community of "experts", ask for help and I work to implement the software component. In the process myself and other contributors have shared iteratively the design files and software code under free licenses through an online platform so the result is available for all for replication and further development.
- Using designs downloaded from the Web, I build hardware

tools that, connected to a personal computer, can be driven by it to cut, drill, etc wood, metal, plastic and set up with them a community lab where everybody can book those tools for as many hours as needed, to build or repair furniture, car parts, toys, appliances, etc.

- I am a teacher and, together with some colleagues, I make a web platform where we collect some tools for a new educational approach. It is a dynamic platform where other teachers, and people, can download materials and upload new tools and experiences.
- A group of educators using Raspberry Pi (www.raspberrypi.org) discuss in an online forum the pros/cons of using it in K12 classes, and they come up quickly to a complete requirement analysis. Based on this analysis, a new version of RP is developed.
- I am a member of a local makerspace and really enjoy socialising and learning new skills through creative making. I find that this community making resource helps me to get together with my community.

Despite their differences, these situations share the feature that many people today can afford to use (and sometimes to buy, and

usually to learn how to use) digital tools to do something by themselves, sometimes alone and more often in social, traditional or online, contexts. While the Do It Yourself (DIY) phenomenon is surely not new (its origin could be traced back to the beginning of the organisation of work), the widespread availability, versatility, and flexibility of digital tools are generating something new, with the potentiality of a game changer. We have proposed to call this phenomenon **Digital Do It Yourself** (DiDIY).

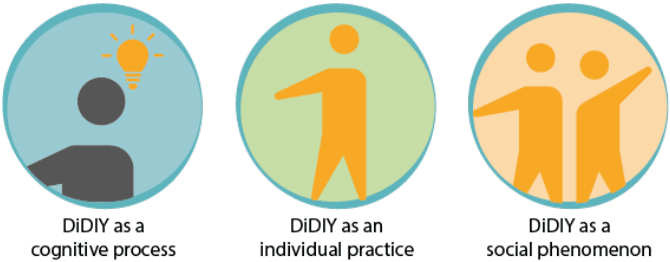
The dimensions of involvement of human beings in DiDIY

By focusing on the human-centric nature of the phenomenon, multiple facets of the human beings involved in DiDIY have to be taken into account. DiDIY operates on, and in the interactions between, a number of levels of human activity. From the inner, less visible, cognitive and tacit processes that concern individuals to the outer, more evident and articulated interactions with other people and between groups of people. DiDIY outcomes are the result of the interplay of:

- **cognitive processes**: DiDIY is a process intended to generate an outcome through multiple steps from idea generation to

product realization; this involves such cognitive attitudes as creativity, critical thinking, and problem solving;

- **individual practices**: DiDIY is a practice, requiring forms of bodily activity, things and tools, states of emotion and motivational knowledge; this involves intrapersonal attitudes such as intrinsic motivation, self-development and self-management;
- **social dynamics**: DiDIY is a phenomenon resulting from the interaction between people at different levels of skills and commitment, sharing resources and collaborating on projects, and encouraging a sense of creative agency and participation in the world; this involves interpersonal attitudes such as communicating and collaborating, emotional literacy, peer support, adaptability and flexibility, community engagement, and system thinking.



The three dimension of involvement of human beings in DiDIY.

In parallel to these dimensions, the "yourself" in DiDIY is originally an individual, but the widespread availability of networked digital information processors and the interest to share knowledge have created new options of DiDIY, in which the yourself can be a group, a class, a community of practice, a team in a company, a company, an industrial cluster, the society as such. This could be more accurately described as **Do It Together** (DIT) or **Do It With Others** (DIWO), as it typically involves building on ideas and projects developed by groups of people. The collaboration is set up not only in face-to-face situations but also through:

- **transmission networks** (from the Internet to the Internet of Things), that enable
- **communication and design networks** (sharing digitally coded information on texts, music, images and videos, geolocalisation of objects, shapes of objects, etc), that enable
- **collaboration networks** (thus intended as social, technologically-enabled systems).

Such networks are thus the effective enablers that make DiDIY not only a cognitive process or an individual practice but also an important social phenomenon.

The components of involvement of human beings in DiDIY

Given the human-centric nature of the phenomenon, individual motivations and abilities strongly influence the way each DiDIYer operates in different contexts: practice could at times range from simply replicating (e.g., 3D printing, etc) or customising a ready-made product to striving to create something entirely new. Hence DiDIY is neither a purely technological phenomenon nor a purely psychological or sociological one, even though it includes both technological,

psychological, and sociological components. A fundamental tension is present in (DIY and) DiDIY, as something that someone:

- **does**: an activity to create, modify or maintain objects or services; in this sense, (DIY and) DiDIY can be studied, understood, and promoted in terms of tools, products, structure of collaborations, etc; this is the object-related component of the phenomenon;
- **has**: a mindset, and then a producing and consuming culture; in this sense, (DIY and) DiDIY can be studied, understood, and promoted in terms of motivations, competences, social contexts, etc; this is the subject-related side of the phenomenon.

Both components focus on DiDIY as a human-centric phenomenon where:

- the component of DiDIY **as an activity** is the condition that allows us to consider as a DiDIY practitioner also an individual who engages in DiDIY for necessity rather than for personal interests, i.e., a reluctant DiDIYer; this guarantees that the phenomenon can be analysed in terms of social, economic, and technological conditions, dynamics, and consequences;

- the component of DiDIY **as a mindset** is the condition that allows us to consider as a DiDIY practitioner also an individual who is drawn to DiDIY in virtue of their interests, but whose personal circumstances do not contingently allow them to engage in that kind of activity, i.e., an inactive DiDIYer; this guarantees that the phenomenon can be analysed in terms of motivations, competences, and skills.

The co-presence of **object-related** and **subject-related** components is a basic reason for the complexity of the phenomenon, particularly in the longitudinal perspective of a person. Indeed DiDIY usually:

- **originates as an activity** – for example, someone has to fix something and they decide to do it themselves, even though they never did anything like that before, because they suppose that what has to be done is not that lengthy and hard — and later on this
- **turns into a mindset** – they discover that doing this themselves has been effective, rewarding, etc, and then begin doing other things themselves, thus further developing their skills and attitudes.

Sometimes the same happens in education: students start from

an assigned activity, which for them at the beginning is just a task to be completed, and progressively some of them develop a mindset transferring the concept to other learning activities.

There are several ways to engage in DiDIY, and varying degrees of involvement may be appropriate in different contexts. Any practitioner may operate at different times (adapted from Sanders 2006) as a:

- **doer**, who operates to accomplish something through productive activity with minimal amount of interest and skills (doers are then reluctant DiDIYers);
- **adapter**, who operates to make something one's own by changing it in some way, with the interest to personalise the object so that it better fits their personality or contextual constraints;
- **maker**, who aims at creating something that did not exist before, with a genuine interest in the practice as well as the experience;
- **creator**, who operates to express themselves or to innovate, fuelled by passion and guided by a high level of experience, and relying on the use of raw materials and the absence of predetermined patterns.

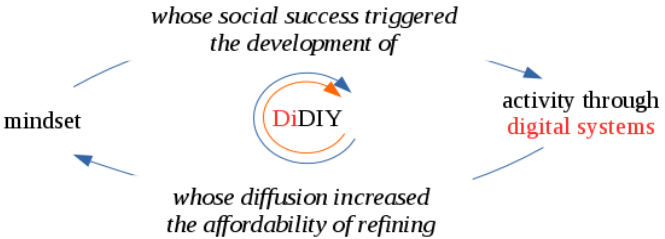
Ways of creativity as means to interpret the engagement of DiDIYers in the practice (adapted from Sanders 2006).

	Motivations	**Requirements**
Doer	To get something done / to be productive	Minimal interest Minimal domain experience
Adapter	To make something on my own	Some interest Some domain expertise
Maker	To make something with my own hands	Genuine interest Domain experience
Creator	To express my creativity	Passion Domain expertise

Although with different levels of interest and commitment to the practice, people in this relatively wide range of involvement degree will contribute to the establishment and development of DiDIY in time and space. Therefore, even apparently less significant activities carried out by doers foster the spreading of

the DiDIY phenomenon.

This mutual relation of the two components – sometimes DiDIY-as-activity develops DiDIY-as-mindset, and sometimes DiDIY-as-mindset develops DiDIY-as-activity – can then activate a positive (self-reinforcing) feedback process, thus progressively transforming DiDIY into a socio-technical phenomenon.



The two components of DiDIY – a mindset and an activity – in a self-reinforcing loop.

1.2 Methodological assumptions

DiDIY is proving to be a complex, multifarious, dynamic, and still evolving phenomenon, and at least at the moment a definitive criterion can hardly be given to establish what DiDIY is and what it is not, and more concretely, in front of a given candidate situation, whether it is a case of DiDIY or not. Nevertheless, the concept is not empty, nor just subjective or contextual. This KF provides a well-grounded and at the same time flexible foundation to the several perspectives developed by the four Project core Work Packages:

- DiDIY reshaping organisation and work, and
- education and research;
- DiDIY impacting on creative society, and
- on laws, rights and responsibilities

and aims at making them convergent toward a consistent and encompassing interpretation of the phenomenon.

Acknowledging the observed spatial (synchronic, cross-sectional) and temporal (diachronic, longitudinal) complexity of the phenomenon under consideration (DiDIY is not identical in different geographic areas and social contexts and is changing

over time), in structuring the KF **openness is preferred to specificity**.

The KF is indeed expected to be:

- **encompassing**, so as to allow the consideration, comparison and – where considered appropriate – integration of multiple interpretations;
- **adaptive**, so as to allow the modification of its structural elements and of its contents in case new perspectives emerge or the phenomenon itself changes.

As a consequence, no clear-cut criteria are proposed here to decide whether something is a case of DiDIY or not. Nevertheless, the KF provides an interpretation of what DiDIY is in terms of (at least loosely intended) necessary conditions for DiDIY, which of course are not claimed to be also sufficient. Instead of sufficient conditions, the KF proposes then several interpretations of what DiDIY *may be*, each of them presented as a potentially continuum of options:

- **from a narrower view**, assumed as identifying non controversial, canonical cases of DiDIY,
- **to a broader view**, enabling us to include in the analysis also

borderline cases that might be accepted as DiDIY only by someone in some contexts.

The conceptual structure upon which the KF is built aims thus at providing a characterisation of the DiDIY phenomenon, that allows us to study it and to better understand it, rather than providing its mere definition. To this end, a structure is defined to set boundaries and to highlight declinations. This structure enables the integration and interpretation of data and information deriving from DiDIY experiences (practices, activities, projects, experiments, etc) and research (methods, approaches, case studies, etc), and can drive the development of a roadmap and guidelines intended to support phenomena resulting at the core of our model and to drive the peripheral ones – yet innovative – towards the core.

1.3 A metaphor: DiDIY as a building

The previously mentioned observed complexity of DiDIY implies that an interpretative framework on DiDIY which can be sufficiently analytical must be multidimensional, and therefore complex in turn. In order to make this KF more effectively understandable, we present here DiDIY by means of a metaphor, as a multiple Storey (i.e., aspects of interpretation) building whose structural elements are:

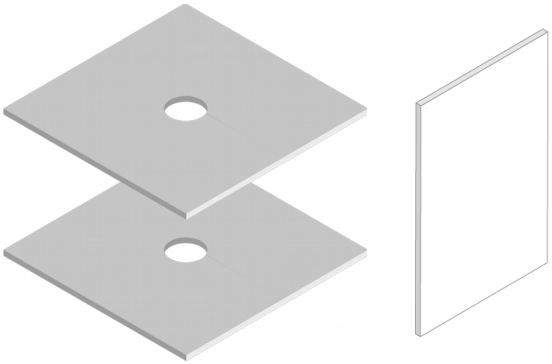
- **Pillars**, i.e., the necessary conditions specifying what DiDIY is and without which the whole building would collapse and disappear;

Representation of the Pillars 1 and 2.

- **Load-bearing Walls**, i.e., the interpretations of what DiDIY may be, common to multiple aspects of the phenomenon and admitting a range of options: the building has Load-bearing Walls that carry the weight of the building and are common to all Storeys;

Representation of the Load-bearing Walls.

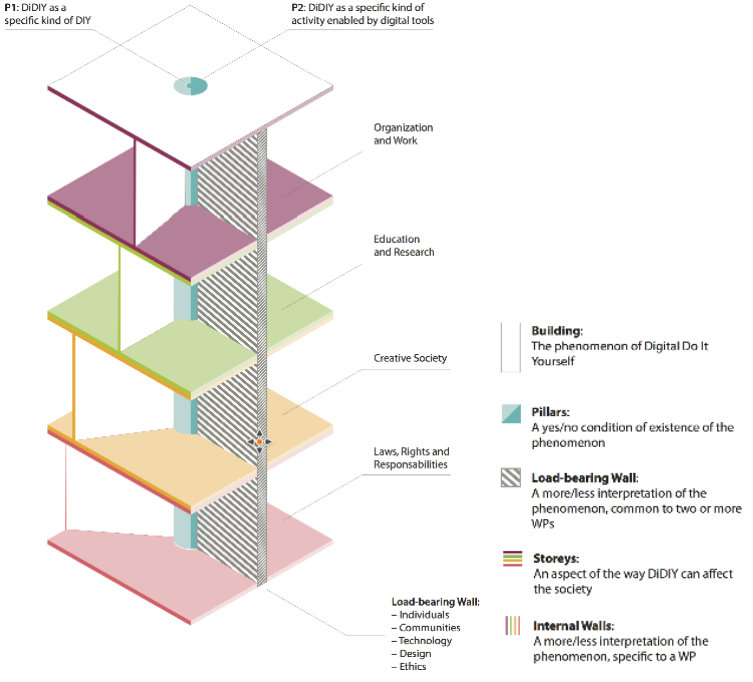
- **Storeys and Internal Walls**, i.e., the aspects of the way DiDIY that can affect the society and the related interpretations, admitting a range of options: each Work Package of the Project corresponds to a Storey, that includes some Internal Walls, i.e., specific interpretations of what DiDIY may be.



Representation of general Storey and Internal Wall.

Synthesis of the metaphoric elements
used to present the KF structure and their interpretation.

Element of the metaphor	**Interpretation in the phenomenon**
Building	The phenomenon of Digital Do It Yourself
Pillar	A yes/no condition of existence of the phenomenon
Load-bearing Wall	A more/less interpretation of the phenomenon, common to two or more aspects
Storey	An aspect of the way DiDIY can affect the society
Internal Wall	A more/less interpretation of the phenomenon, specific to an aspect



DiDIY as a building.

Such a building is under rapid and largely undirected construction. By identifying and studying those which appear today its main structural elements we hope to provide some guidelines useful to understand it and help it to develop according to a socially rational plan, as an element of the city that may become our society of knowledge.

Pillars

Each Pillar provides a fundamental shared interpretation of what DiDIY is – a condition claimed to necessarily characterise DiDIY. The Pillars are intended to be the fundamental features of DiDIY, and as such they are common to all aspects of the phenomenon and independent of any aspect-related specificity. The two Pillars that have been identified are presented and commented in the KF.

Load-bearing and Internal Walls

Each Load-bearing or Internal Wall provides an interpretation of what DiDIY may be, thus enriching the information on DiDIY according to specific features. Each Wall admits a multiplicity of options, thus explicitly acknowledging that DiDIY is currently a

fuzzy (more-or-less) rather than a crisp (yes-or-no) phenomenon. To make this clearer, all Walls are introduced with the same formal structure:

"in a narrower view DiDIY…, while in a broader view…"

where there is a tension between the narrower and the broader view, based on the provisional hypothesis that the narrower view **is non-controversially acknowledged as DiDIY** (and maybe even "stereotypically DiDIY"), whereas the broader view **might be accepted as DiDIY** only by someone in some contexts (possibly, also depending on market conditions, legislation, etc).

From the narrower to the broader view there is then a potentially continuum of options, that attempt:

- to contribute to a **shared core interpretation** of DiDIY ("when we talk and research about DiDIY we plausibly intend at least…"), in reference to the narrower view for each Wall and thus by complementing the specifications provided by the Pillars, and
- to obtain a **flexible concept system**, that admits and allows us to study multiple positions ("when we talk and research about DiDIY we might also intend…"), in reference to the broader view for each Wall.

In this context the distinction between Load-bearing and Internal Walls relates to the their generality in the structure and therefore to their degree of influence in the phenomenon:

- each Load-bearing Wall represents an interpretation that is **common to multiple aspects** identified as relevant of the phenomenon;
- each Internal Wall represents instead an interpretation that is **specific to one of such aspects**.

Storeys

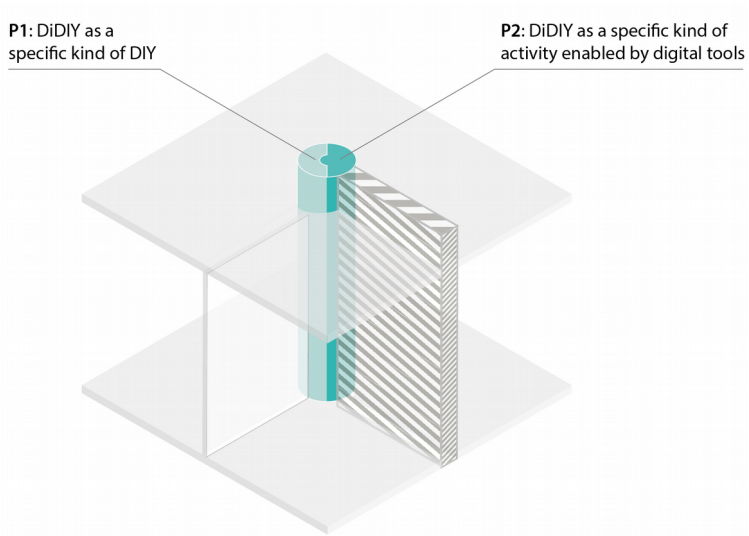
Each Storey of the building represents an aspect of the way DiDIY can affect the society, as interpreted in the perspective provided by one of the core Work Packages of the Project, i.e.,

- **organisation and work**, as reshaped by DiDIY;
- **education and research**, as reshaped by DiDIY;
- **creative society**, as impacted by DiDIY;
- **laws, rights, and responsibilities**, as impacted by DiDIY.

1.4 In synthesis

As also highlighted by the metaphor of DiDIY of a building under construction, with its several structural elements, we are proposing here a structure aimed at providing a context in which multiple perspectives on the phenomenon can be hosted. DiDIY emerges as a human-centred, socio-technical phenomenon, whose features can have significant mutual correlations worth specific explorations and analyses.

2. Pillars



A more detailed representation of how Pillars are shown within the building.

P1. DiDIY as a specific kind of DIY

DIY is a phenomenon that started well before DiDIY, so that the hypothesis that DiDIY is a specific kind of DIY (i.e., every case of DiDIY is also a case of DIY, but there are cases of DIY that are not cases of DiDIY) implies that:

- everything that generally characterizes DIY also applies to DiDIY, so that the existing studies on DIY are useful also to understand DiDIY, but at the same time;
- not everything that specifically characterizes DiDIY also applies to DIY, so that new studies on DiDIY are useful to better understand it.

In synthesis, DIY is a production and consumption process, with a strong social connotation, where people's creativity and self-improvement through the development of new skills and knowledge are key elements, that can be understood (Watson, Shove 2008) through the interpretation of the practice in terms of:

- **materials**, i.e., tangible resources required to accomplish the process;
- **competences**, i.e., capabilities and skills required or involved in

the accomplishment of the process, typically to use the materials components mentioned above;

- **meanings**, i.e., individual and possibly collective motivations for accomplishing DIY.

Addressing how these elements and their complex mutual relationships apply to DiDIY is fundamental to achieve a specific characterisation of it.

Section 4, on "DIY", of "Foundational interpretation of DiDIY" (www.didiy.eu/public/deliverables/didiy-d2.2.pdf) introduces and explores DIY as the context of DiDIY.

P2. DiDIY as a specific kind of activity enabled by digital tools

Digital tools spread in our society well before their actual use in DiDIY, so that the hypothesis that DiDIY is a specific kind of activity enabled by digital tools (i.e., every case of DiDIY is also a case of use of digital tools, but there are cases of use of digital tools that are not cases of DiDIY) implies that:

- everything that generally characterizes the use of digital tools also applies to DiDIY, so that the existing studies on this use are useful also to understand DiDIY, but at the same time;
- not everything that specifically characterizes DiDIY also applies to the use of digital tools, so that new studies on DiDIY are useful to better understand it.

In synthesis, digital tools provide us with flexible and efficient options to operate on information, and can be understood in terms of:

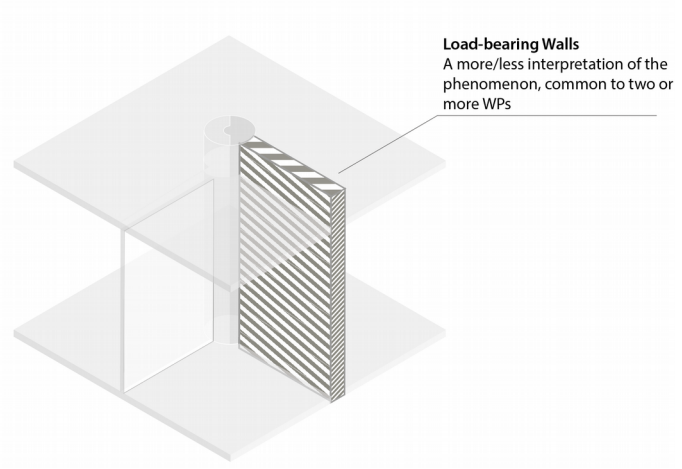
- **software**, for operating in virtual worlds and then opening new opportunities for creative people;
- **internet**, for efficiently transmitting information and then

opening new opportunities for open communication and collaboration;

- **physical computing**, for interacting with physical objects through information and then opening new opportunities for the scenario that we have called "Atoms-Bits Convergence", the new ABC.

Section 3, "On digital", of "Foundational interpretation of DiDIY" (www.didiy.eu/public/deliverables/didiy-d2.2.pdf) introduces and explores the use of digital tools in DiDIY.

3. Load-bearing Walls



A more detailed representation of how the Load-bearing Walls are shown within the building.

3.1 DiDIY and the role of individuals

LW1. DiDIY and individual motivations

In a narrower view DiDIY involves individuals who operate on the basis of ethical principles, while *in a broader view* it includes all people who choose to engage in the practice of DiDIY independently of their individual motivations.

The possible motivations that move an individual toward DiDIY are many and different, and may be related to ethical principles (e.g., concern for the environment), but also to a desire to save money, develop new skills, acquire social reputation, generate profits, etc.

Some research questions

Q: What are the specific motivations driving DiDIYers – either casual or regular practitioners –, and what are the most important forces behind the spread of DiDIY, both today and for the foreseeable future?

> A: Motivation is a factor that appears to be necessary to

activate the interest in a project or a community. While motivations can be of various nature, such as personal interest, economic need, local necessity, etc, two main motivations have been identified: one is linked to the recognition by a community, and one is linked to the acquisition of new skills.

Motivational aspects are believed to be crucial also for sustaining the DiDIY practice over time, when the practitioner is supposed to persevere in overcoming the difficulties related to self-organization, use of spare time, and social interactions in collaborations: here are important in particular the rewarding sensation of being with the others and the interest of generating a positive social impact.

The collaboration, both with peers – i.e., other DiDIYers – and facilitators – acknowledged as such by the DiDIYers –, is believed to be possibly the most significant element characterising the evolution of traditional DIY toward the digital one. In this perspective the sharing of knowledge, experiences, spaces, and projects is a critical enabler to create and keep alive a community which shares the same ethics and system ecology.

Q: Is there any significant correlation between the specific motivations driving DiDIYers and the way they operate (e.g., their collaboration attitude, the tools they use, etc)?

A: In the multiple cases that a complex phenomenon like DiDIY presents, some basic correlation between motivations driving DiDIYers and their way to operate can be identified in the following scenarios:

- *operating with mindset and sharing/collaborating*: it is the ideal condition in which all the main factors are in positive relation with each other;
- *operating with mindset but not sharing/collaborating*: driven mostly by profit and/or personal interests;
- *operating without mindset but sharing/collaborating*: driven mostly by profit interests or visibility;
- *operating without mindset and not sharing/collaborating*: driven mostly by profit interests.

LW2. DiDIY and the relations between producers and consumers

In a narrower view DiDIY involves individuals who are both producers and users/consumers of the produced items, while *in a broader view* it relates also to cases in which these two roles remain separate, such as hobbyists occasionally selling 3D printed items to others.

As both an activity and a mindset, DiDIY further blurs the distinction between producers and consumers that is already a characteristic of DIY, leading to the concept of "prosumer" (Toffler 1980): a person who combines the roles of producer and consumer with regard to one and the same product.

Some research questions

Q: What are the main conditions that enable prosumers to create value for the context (group, company, society) in which they operate?

> A: Together with preliminary conditions about, e.g., some minimal competences of the prosumers, at least two general conditions have been identified:

- *permission*: can they access the knowledge under appropriate conditions, i.e., are the designs, software, and contents under free licenses?
- *replicability*: is the documentation – including designs and software – of quality sufficient to enable replication and adaptation to personal needs?

Q: What is the likely impact of DiDIY on producers (e.g., retailers) and on modes of consumption? To what extent will prosumers and hobbyist producers take over the roles played by commercial producers, and how will the latter have to evolve to adapt to this new state of affairs?

A: To such a general and complex question only some preliminary answers can be given.

- *Increase of services*: in general a shift from products to services is transforming the economy. Instead of buying a mass consumption good, producers are likely to offer custom-made and personalisation services. Production itself is becoming a service, in the form of offering the machinery and specialised digital fabrication services, training, and

personalisation.

- *(Re-)Localisation*: instead of shipping components and finished products around the globe, data can be sent around to produce locally while sharing designs and data through the internet. Before the key logistics flows in modern cities was: consumer products in – trash out. This is expected to move towards: data in – data out, while having a dynamic local circular economy increasingly relying on "open source" principles of sharing designs, software and data (the so called "open source circular economy").

LW3. DiDIY and critical thinking

In a narrower view DiDIY is a means for fostering critical thinking, while *in a broader view* it is done by individuals in situations that might be just unrelated to a critical approach to making.

Critical thinking allows people to make effective analyses, inferences, evaluations, reasoned decisions and to take purposeful action. This attitude is important for students to deeply understand academic content and for workers to think

about how to continuously improve products, processes, or services.

Some research questions

Q: Which are the dynamics triggering critical thinking in DiDIY?

> A: Making encourages a deep engagement with content, critical thinking, problem solving, and collaboration (Peppler, Bender 2013), while considering the impact of the creations on society, ecology, and the environment (Schön et al. 2014). This aspect was found in the current literature but, because of its complexity, it has not been specifically investigated in the research.

Q: How critical thinking can be fostered in DiDIY and transferred from here to other domains and practices?

> A: We found that DiDIY initiatives and projects have relevance and potential to integrate knowledge and practice, across a broad spectrum of social impact issues, from fostering creativity and community engagement to promoting entrepreneurship. Many makers in our workshops told us that

through their making practice they had developed an awareness and concern for the sustainable use, and re-use, of materials and many were critically aware of, and keen to engage with, issues around consumerism and waste. The potential for DiDIY communities to encourage and develop critical thinking through collaborative making, problem solving and peer-to-peer experiential learning, across making practices, was apparent.

3.2 DiDIY and the role of communities

LW4. DiDIY and collaboration

In a narrower view DiDIY is about activities carried out collaboration (the plural form of "you", also known as "Do It With Others", DIWO, or "Do It Together", DIT) and transdisciplinarity, while *in a broader view* it is about activities carried out by one person (the "yourself" as an individual).

By taking a helicopter view, one can find almost always some form of collaboration, as even the individual maker builds on previous knowledge produced by others. The individual can be seen as standing on the shoulders of giants: building on collective works produced and shared within (online) communities, typically by many others.

Some research questions

Q: Is the ability to manage collaboration a strategic dimension of DiDIY? And in particular how do DiDIY collective actions influence the sense of ownership, personal involvement, motivation, and satisfaction?

A: In DiDIY communities have a fundamental role to keep the motivation to participate high and to build up and strengthen relationships. This is typically obtained through "activators" (be them persons, institutions, ...) who construct, support, and reinforce the relations within the community. Examples are Fab Labs and community managers. Moreover, digital and physical hubs are effective means to connect, facilitate, and feed existing networks of communities and individuals.

See also the research questions in LW1 to understand how DiDIY collective actions influence the sense of ownership, personal involvement, motivation, and satisfaction.

Q: How do co-design tools influence the way people construct new meanings on DiDIY?

A: Involving people using a co-design approach gives the opportunity to:

- have meaningful conversations with people and collect their ideas;
- elicit people's creativity thought collaborative activities and specific materials;

- be in empathy with people and understand their needs and desires;
- actively involve people in research activities and knowledge creation;
- accustom people to use sketches and prototypes as ways to express and better define their thoughts;
- promote a design approach to everyday challenges;
- enhance people's visions on possible futures.

This in turn allows to:

- work collaboratively to identify priorities;
- draw on evidence to decide which challenges to focus on;
- pursue promising ideas as projects;
- work with people to ensure that solutions address real needs and deliver real benefits.

Co-design tools lead people to apply a strategic design approach to the use of digital tools of production and sharing, which become a means to activate new opportunities, ideas, and meanings.

Q: Might co-design be both a valuable research approach used to investigate DiDIY and a valuable method to be used by non-designers in DiDIY activities independently? And would implementing co-design in collective DiDIY activities increment creativity and therefore innovation?

> A: DiDIY is a complex phenomenon in which people are directly involved in the research and production of knowledge, and therefore co-design methods and approach appear ideal for both investigating and creating knowledge. Co-design involves and enables non-trained designers in activities, or collaborations, for the development of solutions that aim at improving their lives with the support of professional designers or, as in this case, with design researchers. DiDIY has strong sharing and collaborative dimensions itself, and therefore it seems adequate to consider co-design not only as a research approach, but also as a possible mindset to DiDIY practices. The choice to use co-design is dictated by the desire to engage people and draw input from their experience. The comparison of results from multiple workshops that involved people from different backgrounds and cultures, seems to indicate the effectiveness

and the relevance of co-design as a process of experimentation in the context of DiDIY. Indeed, these workshops, conducted in a similar way with different groups of people, brought similar results, as a proof that can be considered to be of scientific importance.

LW5. DiDIY and open communities and releases

In a narrower view DiDIY is about openly sharing knowledge in communities and openly released outcomes, while *in a broader view* it is also of individuals operating alone and about outcomes that are maintained proprietary.

The legal rights under which the digital files are shared determine the affordances that users in these communities have, and thus their possibilities to use, reuse, share, adapt and become economically sustainable. Liberal licensing schemes like free and open licensing are typical in online design sharing platforms, as they convey the maximum freedom or rights to their peers (for an overview of online design sharing platforms in the context of DiDIY, see wiki.freeknowledge.eu/index.php/Design_Sharing_Platforms).

Some research questions

Q: What are the main (cultural, psychological, etc) factors hindering from openly sharing DiDIY-related knowledge in communities?

A: There are several different factors that may stop people from openly sharing their designs and knowledge, including:

- *sheer habit*: they are not used to doing this and it does not occur to them;
- *social embarrassment*: they are afraid that their ideas or designs will look poor in comparison to others' contributions, or that someone else will have already thought of it;
- *a fear someone will steal "their" idea*: they want to assert authorship and control over the design or idea for personal or commercial purposes;
- *they do not want to be bothered*: it takes effort to document and upload the creation and they prefer to spend their time otherwise;
- *they do not feel they will benefit from doing so*: others will benefit but not them;

- *they fear they might be liable if the design is defective*: or other less well defined legal fears.

Q: What motivations do participants have to openly share knowledge in communities and what incentives could be helpful to facilitate the change from knowledge hoarding towards openly sharing? In other words, how can the attitude to open sharing be promoted?

A: A combination of solutions, each addressing different aspects of the above problems, can be adopted to promote open sharing, including:

- make it fun, so when one contributes something she/he gets positive feedback and comments;
- encourage a supportive culture, where people are not made to feel small, but where the norm is to help others and give positive comments. Any Trolls need to be noticed and ejected or persuaded away. Try and ensure that reputation comes from being supportive and not competing in other ways;
- make it as easy as possible to contribute, without there

being a lot of requirements to comply (e.g., compulsory fields to fill in). Once people start contributing they can then be encouraged to improve the standard of their documentation, etc. Develop tools to help automatically document as people create;

- give basic advice about safe sharing of plans and designs so people feel confident to do so. Ensure there are helpful FAQs and guides if people want them;
- ensure that people can find others like themselves so they can form supportive sub-groups with like people (e.g., those with the same aims, or gender, or culture, etc).

LW6. DiDIY and free or open access policies

In a narrower view DiDIY is associated with opening the source of personal projects with a specific and specified use and redistribution license and enabling collaboration through communities offering distributed revision control, while *in a broader view* it is associated with the informal sharing of a project, or just its outcomes, to an online community or social network, leaving the access policy just undefined.

The effectiveness of DiDIY through transmission → communication → collaboration networks has been emphasized and accelerated by the availability of free or open access policies:

- *at the transmission level*, the protocols of the TCP/IP stack, that constitute the technical foundation of the internet, are freely licensed and open by design;
- *at the communication and design level*, both digital, machine-ready designs and the documentation needed to learn how to produce, modify, and use them can be freely shared, sometimes in open formats, that can be processed with free of charge, low-cost software of third parties, accessible to everybody with a computer, not just with expensive applications by the inventor and sole "controller" of the file format;
- *at the collaboration level*, projects can be developed, shared and reused quickly, without paying royalties and/or going through complicated, expensive legal/bureaucratic procedures, or generally asking for permission, and at global scale in the logic of open collaboration and innovation (open source communities, IPR management via Creative Commons

licensing (creativecommons.org), etc).

Some research questions

Q: What are the main opportunities and the main threats in DiDIY when performed according to free or open access policies?

> A: To such a general and complex question only some preliminary answers can be given.
>
> *Opportunities*:
>
> - increase of access to knowledge and reduction of dependency on large patent and IPR portfolios;
> - increased chance of synergies between different DiDIYers due to open discovery and access, particularly if there are effective tools to aid this discovery;
> - showing that open sharing can work and still provide people with income, reputation, etc.
>
> *Threats*:
>
> - the owners of large patent and IPR portfolios are not interested in giving up their power;

- a DiDIY "tragedy of the commons": DIY repositories get filled up with 'junk' designs of low quality so it is hard to find useful information there;
- DiDIYers find it hard to generate a sufficient income this way and suppose that if they had IPR it would be different (regardless of whether it actually would have been).

3.3 DiDIY and the role of technology

LW7. DiDIY and outcomes

In a narrower view DiDIY is aimed at producing physical artefacts, while *in a broader view* it is also aimed at creating intangibles and performing services.

This has fundamentally to do with the role of the digital in DIY, as the means to integrate physical and informational components ("atoms" and "bits") of entities, a situation that we have proposed to call "Atoms-Bits Convergence" (ABC). While there is not a principled necessity that ABC is the only significant component of DiDIY, ABC has several important consequences, in particular by making it possible:

- to transfer, store, and process manufacturing instructions without any practical degradation in the final product, thus in many cases guaranteeing the complete replicability of the results even if multiple individuals are involved in the process of design and manufacturing, as in the case of objects produced by 3D printers from 3D CAD data files;
- to create distributed processing and control systems, in which

the components can automatically acquire information from their physical environment and exploit it to contextually operate in order to modify the environment, as in the case of "smart objects", possibly as parts of Internet of Things systems;

- to produce objects even if the producers are unable to operate functionally equivalent non-digital tools, due to distance (the tools are somewhere else), lack of manual skills (the designer can make a 3D drawing on a computer but might be unable to use a chisel, maybe because of a physical disability), etc.

Some research questions

Q: What are the roles of digital tools in DiDIY, and how can they be exploited to make DiDIY more effective or efficient?

> A: The roles played by digital tools vary broadly from a domain application to another. We can ascribe this to the immaturity of the phenomenon, that does has not yet spread in multiple work contexts and in any case not for a sufficient amount of time. With respect to the threefold classification provided above (digital tools to manage instructions, to create control systems, to produce objects) we found a few but

significant evidences. In the manufacturing companies, we noted that the use of digital technologies for DiDIY purposes is mainly constrained within the borders of the R&D function. On the contrary, no empirical evidence was found about the use of digital technologies to enable monitoring and control of the operations. This result is coherent with the typical attention dedicated to creativity and DIY within R&D departments, nevertheless it shows that the impact of DiDIY on manufacturing processes is still quite limited. As an another example, within the health sector, and specifically within the orthopaedic diagnostic process, we studied the use of technology both as a way to store information (the first role in the list) and as a tool to create artefacts that enable simulating, and training through simulation, the interaction (the surgical operation) with the real object corresponding to the 3D printed one.

LW8. DiDIY and state-of-the-art technologies

In a narrower view DiDIY is associated with state-of-the-art technological tools, while *in a broader view* it is performed also with traditional, well-established tools.

This aims at exploring whether there is some significant reasons for assuming that DiDIY is related to innovative tools or they are only attractors. An example somewhere in the middle is that of BetterPress Lab, a group of Italian female makers based in Rome (www.betterpresslab.com). They use traditional typography, employing old movable type to create old looking or vintage posters. In many cases they use a 3D scanners and printers to re-create movable types of some letters that had been lost or broken over the years.

Some research questions

Q: What are the tools currently and mostly used by DiDIYers? Which ones do they consider innovative or state-of-the-art technologies?

> A: DiDIYers could nowadays use different tools according to the type of application they intend to create. Tools may not necessarily be computer based all round. In fact, it is typical in Fab Labs that makers use drilling machines, laser cutters, etc, that do not necessarily come with integrated IT boards. DiDIYers may use IT tools too. This is the case of prototyping boards (e.g., Arduino (www.arduino.cc), Raspberry PI

(www.raspberrypi.org), etc) and 3D printers/3D scanners to enable new types of application. Tools that are considered innovative or state-of-the-art are those who enact the Atoms-Bits Convergence (ABC) all along the creation of new applications. According to a broader definition of ABC, or beyond its definition, we shall consider as potential tools enabling DiDIY any digital tool that allows an individual in an organization to achieve a superior competence and autonomy in carrying out their job. In this broader sense they include:

- data visualisation software that enables managers to synthesize complex phenomena in few charts;
- social networking tools that allow network marketers to create and develop a network of collaborators to support sales activities in a B2C market;
- production plant software dashboards that allow workers in a plant to gain control of large part of a production process instead on focusing on a single specific task.

Q: What is the actual role that DiDIYers attribute to state-of-the-art technological tools? Is the being state-of-the-art a

significant reason for making DiDIY attractive or is it just an extrinsic element?

A: While state-of-the-art technological tools are not necessary to DiDIY, they seem to have multiple roles which result in them either being associated with DIY activity or to enable/promote it, including:

- people who like making things like playing with new tools;
- a new tool opens up a wealth of new creative possibilities that may not have previously been explored and it is fun doing this;
- some new tools allow to leverage the expertise of others (e.g., 3D printing something designed by others) and then to avoid having to go through a professional;
- some tools just allow amateurs to create in a way that was hard previously, so one can design on a computer, taking all the time one needs getting a design right, before sending it to a computer-controlled lathe, which otherwise would have required hours of skill development.

DiDIYers find in digital technologies a great potential to generate DiDIY initiatives. Nevertheless, DiDIY is a mindset

and, as such, even when triggered by technology, is not strictly dependent on state-of-the-art technologies. The findings of this Project show that DiDIY can be boosted/facilitated easily with the usage of the above-mentioned tools. But its potential lies in the mindset of DiDIYers: the crucial passage to DiDIY enactment is to facilitate the aggregation of people that share a common mindset of innovation, collaboration, group working.
DiDIY is, eventually, based on infrastructure too: this means to connect people physically and digitally, therefore fostering a collective intelligence of the group of DiDIYers. This is, probably, one of the most prominent stream of future researches.

Q: How do the current technologies change the way (Di)DIY is carried out with respect to the past (e.g., required skills, possibility for collaboration and sharing)?

A: Tools that allow the easy sharing of designs or expertise facilitate mutual support and hence "turbocharge" the DIY movement, allowing a disparate community to come together electronically, even if sparse. Moreover, the availability of

tools that ease capturing designs (from atoms to bits) or physically expressing designs (from bit to atoms) produces as an effect that

- more designs can be shared, some made by craftsmen, some "uploaded" from the physical world and that
- these designs are more useful since they can be "downloaded" back to the physical world without requiring a high level of skill.

Current technologies, in the light of DiDIY, call for the generation of new, both hard and soft, skills. Amongst the hard skills, and depending on the application domain, people develop basic technical skills in the areas of software development, management of 3D printing devices, development of sensors-based automated systems. On the soft side, people develop skills such as creativity, complex problem solving, negotiation, critical thinking.

The potential of DiDIY is to foster new kind of applications where people having different skillset and mindset could work together. Therefore, it is crucial to facilitate the building of ecosystems, both physical (i.e., Fab Labs) and digital (i.e., online communities), where people can share both knowledge

and artefacts and tools for DiDIY.

LW9. DiDIY and cheap resources

In a narrower view DiDIY involves only the use of affordable tools and materials in principle available to every individual maker, while *in a broader view* it can also involve more hi-tech and expensive methods of making things, also in collaboration with commercial services.

The software and hardware tools exploited in DiDIY are often very cheap, and sometimes also free and open-source (as illustrated for example by modelling software like Blender (www.blender.org), or hardware like the RepRap 3D printer (reprap.org)), thus in principle widely affordable. On the other hand, thanks to online 3D printing services like Sculpteo (www.sculpteo.com), people are now gaining access to hi-tech manufacturing methods like CLIP (Continuous Liquid Interface Production) 3D printing with which to turn their digital designs into reality.

Some research questions

Q: To what extent can DiDIY help democratize access, thanks to significantly lowered costs, to products and modes of manufacturing that would otherwise have been reserved to the wealthy?

> A: Relating to products, DiDIY has the potential to bring down costs for users, particularly in relation to items the price of which is usually increased by the factoring in of significant labour costs. Relating to modes of manufacturing, the availability of DiDIY tools for the home, in Fab Labs and via commercial services such as Shapeways (www.shapeways.com), Scuplteo (www.sculpteo.com), or open-access factories in countries like China, similarly makes digitally precise manufacturing (and in the case of open-access factories, even mass manufacturing) available to people other than commercial companies and the wealthy.

3.4 DiDIY and the role of design

LW10. DiDIY and co-design process

In a narrower view DiDIY involves individuals who are co-creators of what they produce, from idea generation to final outcome implementation, while *in a broader view* it includes also those who are simply users of the outcomes of creative process, made by professional possibly with other co-creators.

What essentially characterizes co-design is the involvement of non-designers in collaborative activities: collaboration is then a key element of the process and knowledge is produced and shared as a collective action. Making is at the heart of co-design as it is of other design disciplines: "one key ingredient of the designerly ways of doing research is that they involve creative acts of making. These acts of making are not just a performative act of reproduction, but a creative act which involves construction and transformation of meaning" (Sanders, Stappers 2014). As Sanders and Stappers state, "methods and tools for making give people – designers and non-designers – the ability to make 'things' that describe future objects, concerns or

opportunities".

Hence, two dimensions embedded in co-design enable DiDIY:

- the social and rational idea of democracy setting the conditions for proper and legitimate people participation, and
- the importance of eliciting participants' tacit knowledge. hence not just their formal and explicit competencies, but those practical and diverse skills that are fundamental to collective making.

In this view collaboration through co-design might be seen as a collaborative process to implement the practices of DiDIY.

In the narrow view, laypeople can be involved in the creative process as co-creators of what they need, using their creativity and being involved in the whole creative process, from idea generation to final outcome implementation. However, not everyone is interested or available for such a full commitment. Hence, in the broad view DiDIYers can be participant or simply users of the outcomes of creative process, made by professional possibly with other co-creators.

Some research questions

Q: How can DiDIYers be involved and encouraged to participate in co-design processes? Which are the motivations or dynamics that can work as levers for such engagement?

> A: In order to answer this question the research identified a design- and creativity-based model able to generate innovation in the Project areas, through the exploration of DiDIY as a mindset and a social practice. Enabling non-designers may result a challenging task for professional designers and this calls for suitable toolboxes and modes of experimentation. As a result of several human centred co-design workshops, a "Co-design DiDIY Toolkit" and the related guidelines have been developed with specific techniques and tools that can be used to unlock people's creativity while helping them to work collaboratively. The toolkit and the guidelines focus on the importance of creativity in achieving innovation, identifying a design and creativity based model able to generate innovation in the macro-areas of Education, Work, Creative, and Legal.

Q: How can design contribute to the work and creativity of DiDIYers? Can professional designers develop tools enabling DiDIYers in the optimization of their practice?

A: Designers can contribute to the development of DiDIYers' creativity. In fact, in a world where everyone does design, professional designer have to find a new role to play. Designers can support digital DIYers either as collaborators or facilitators according to the creativity level. The idea is that professional designers may contribute by facilitating the creative process of making, especially within the digital social innovation phenomenon frame, as a means to foster people empowerment. The Co-design DiDIY Toolkit and the related guidelines developed in the Project contribute to this task by developing an ad hoc design process and related (co)design-driven tools specific for DiDIY, that can help non-designer to create innovative digital solution in their professional field.

The underlying principle is that people are the experts: they are the ones who know best what the right solutions are. The toolkit does not offer solutions, but creative techniques, methods, tips, and worksheets to guide non-designer through a process that gives a voice to communities and allows their

desires to guide the creation and implementation of solutions.

3.5 DiDIY and the role of ethics

LW11. DiDIY and ethical values practised

In a narrower view DiDIY is based on a set of ethical values and convictions that tend to prevail among practitioners of DiDIY and to govern their activities, while *in a broader view* it simply refers to a new approach to making things.

Some research questions

Q: Which are the core ethical values behind typical DiDIY practices? How are these values conflicting or in sync with mainstream values? How do they relate to legal systems?

> A: When observing the core values behind the characteristics of DiDIY we can extract the following:
>
> - the value of sharing and helping others (*solidarity*);
> - the reputation economy (*trust*, *transparency*, *demonstration of skills*);
> - equal rights of access and participation (*equity*);
> - participants not needing to obtain permission (*free-as-in-*

freedom, autonomy).

These values may not be necessarily shared by all, but they can be seen as present in most if not all of the DiDIY communities. It is somewhat tricky to characterise the exact nature of the relation between these core values and those of "mainstream society". It is often said that we live in an individualistic world largely oriented towards passive consumption. To the extent that this is the case, the values at the root of DiDIY clearly challenge those of the mainstream. On the other hand, there is undeniably a growing trend in contemporary society towards greater sharing of information, and the expectation that it should be freely available, and DiDIY is fully in line with those recent social developments. The emphasis placed by DiDIYers on the freedom to distribute information for others to use – often a practical need, a pre-requirement for DiDIY to happen – presents a challenge to existing legal frameworks, such as intellectual property laws, as discussed further in the next section.

LW12. DiDIY and Intellectual Property Rights

In a narrower view DiDIY is about sharing designs, instructions, and documentation under non-exclusive conditions, while *in a broader view* it can also include exclusively controlled forms of knowledge.

DiDIY may be specifically about sharing designs, instructions and documentation under non-exclusive conditions, even though the current Intellectual Property Rights (IPR) legislation tends to restrict this kind of sharing by default (e.g., copyright is granted as all rights reserved by default). In this sense, the IPR system is the first one being challenged by DiDIY practices, and not necessarily by infringing exclusive rights in patents or copyright, but by questioning the foundation of IPR itself. IPR is based on the hypothesis that creators and inventors need to have exclusive control over their works. The open sharing under free licenses of software, hardware design, documentation and instructions has shown that exclusive control over a developer's work is not a necessary condition for such works to be created (and in abundance). In the broad view, however, DiDIY can also include exclusively controlled forms of knowledge, including the use of patented tools and designs or documentation that can be

used for only certain practices of DiDIY.

Some research questions

Q: If digital innovation is shown to work without exclusive IP rights, including in the context of DiDIY (e.g., open source modelling software or 3D printers like the RepRap (reprap.org)), should non-exclusive sharing practices be strengthened in our legal systems?

> A: We arrived at a positive answer to this question. Though none of us went so far as to advocate the complete abolition of IPRs like copyright, we found it desirable to strengthen existing exemptions of DiDIY activities for private, non-commercial use, in the context of IPR law. We also concluded that reforms to patent law might be worth discussing in some legal contexts, though this issue is undeniably of great complexity.

Q: What main legal obstacles currently exist towards the practice of DiDIY and what changes could be proposed?

> A: We identified two main areas that present obstacles to the

widespread diffusion of DiDIY. The first is the current legislation on patents and designs. Exclusively protected works could pose undesired obstacles, especially for non-commercial personal use, which is the core of DiDIY. While exceptions for non-commercial, personal use are present in copyright, design right and patent right systems, in order to avoid legal uncertainties these should be strengthened. For spare parts the exceptions, including for commercial use, should be revised to foster a thriving circular and repair economy in relation with DiDIY practices. The second area is that of responsibility. Our social and legal system is catered for a mass production and consumption system that keeps manufacturers or sellers responsible ("liable") for faults in their products through consumer protection and other laws. In DiDIY contexts practitioners can be held liable in case of negligence, as they have a so called "duty of care". Above all education in a caring culture, a culture of responsibility, is required here to signal dangerous practices and situations and collectively develop practices to avoid them.

LW13. DiDIY and sustainability

In a narrower view DiDIY has the goal of promoting the long-term sustainability of making practices, while *in a broader view* it simply describes a new set of methods for designing and manufacturing things in a DIY spirit.

DiDIY has complex relations with sustainability (see, e.g., the considerations of Rifkin (2013 and 2014)): it is typically based on small-scale technologies, with limited efficiency and low repeatability, and occasionally relies on materials that are not optimal from an environmental point of view (e.g., non-recyclable plastics). But on the other hand, it may help save items otherwise discarded (thereby countering planned obsolescence), reduce waste and the purchase of new items, and develop new skills.

Some research questions

Q: How can DiDIY help contribute to more sustainable practices when it comes to design, production, and consumption? In this context, what is the role of DiDIY manufacturing as contrasted with other forms of DiDIY, as related, e.g., to the Internet of Things?

A: First, DiDIY can be seen in the context of mass customisation, or personal fabrication, where in the case of DiDIY designs are shared and adapted to the personal needs of an end user, and often produced locally. In that sense it fits the vision of the Fab City (fab.city) of Data In – Data Out instead of the old paradigm of Products In – Trash Out.

Second, DiDIY can be seen in the context of the ever increasing share of the service economy, where the sale of finished products is – at least partially already – giving way to the production of kits for self-assembly and services like training and support for people to make their own product according to their demand and wishes. It should be noted here that the legal systems of the past were designed for mass produced and sold products and not so for maker services, with the consequence that product liability can be challenging for selling a unique product, since certifying a product is costly, but providing services around it is less burdensome in this perspective.

Third, from the consumption perspective DiDIY can fit neatly the increasing number of collaborative consumption platforms, local buying groups and consumption cooperatives.

Consumers united can self-organise the design and production of custom-made products in small or medium sized batches, thereby taking away the middlemen and cutting out a large portion of product price and, above all, only acquiring products aligned with real needs.

Fourth, in relation to the Internet of Things, we observe the emergence of community telecom networks, such as Guifi.net in Catalonia in the 2000's (guifi.net) running a bottom-up, self-organised internet network (now >35.000 nodes) or The Things Network (www.thethingsnetwork.org), using the Long Range IoT radio protocol to run an open stack network infrastructure started in Amsterdam by ten peers in 2015, now replicated in over 400 cities around the world. What these experiences show is that it is not only possible to run low-cost networks by and for the citizens, but they are able to provide higher protection of personal data and privacy, encourage digital social innovation and are generally an ideal breeding ground for DiDIY activities.

LW14. DiDIY and social risk

In a narrower view DiDIY offers new ways for people to make the things they need for everyday life and to exercise their creativity in a socially conscious, responsible way, while *in a broader view* it can also include the creation of dangerous materials such as weapons and viruses that would present real risks for society.

DiDIY has short, medium, and long term risks for society. The experience that the flow of digital information is difficult or even impossible to control suggests that the control of physical systems generated through digitally driven DIY will be equally difficult. Control of intellectual property rights (design, copyright, trademark, patents, etc) and dangerous materials (weapons, some of which might be undetectable by current security systems; and chemicals, drugs, microbes, viruses, nanoscale materials, etc) will thus be a challenge or – in the former case at least – perhaps needs to be given up.

Some research questions

Q: Assuming it is desirable to exercise some control over the circulation of DiDIY weapons, should this be done by regulating

the possession of digital blueprints for their manufacture? Or should we rather focus on alternative solutions, such as controlling some of their components, such as gun powder? Would self-registration (as is being introduced in the area of DiDIY Drones) be a reasonably effective measure?

> A: No consensus was reached among the Project partners on the issue whether the idea of regulating the very possession of digital blueprints for DiDIY guns was worth considering, or not. Some of us argued for a negative answer, on the grounds that such regulation would be unenforceable. Others, while conceding that the distribution of such blueprints could never be brought under full control, suggested that this fact does not automatically show such a proposal to be utterly worthless. An analogy was drawn with the fight against the online distribution of child pornography and "revenge porn", where some effect, even though far from perfect, is usually judged to be better than no effect at all. There was greater consensus, however, on the legitimacy of trying to control access to components like gun powder, and on the need to avoid over-reacting to the threat of DiDIY weapons (even though what counts as an over-reaction might remain a topic

of debate) and to focus on solutions that do not unduly infringe on citizens' privacy rights. Indeed, there have so far been no reported cases of violent crime perpetrated with the help of such weapons. In the United States, in particular, the vast majority of guns used in recent mass shootings were actually (guns manufactured industrially, and) obtained legally and with a federal background check. As for the idea of a mandatory registration scheme for DiDIY guns, none of us were opposed to it, although we did not all agree about its likely effectiveness.

Q: Can the spread of "distributed manufacturing" as a correlate of DiDIY contribute to negative social developments like technological unemployment, for example by rendering some links in the supply chain superfluous, and should we take regulatory steps to counter this, and if so, which ones? Will the net social impact of DiDIY be overall positive?

A: It is not impossible that the spread of DiDIY could result in some degree of job loss, though this is difficult to estimate, and we did not find any studies focused on this specific issue, as contrasted for example with the consequences of industrial

automation. Nonetheless, the idea of introducing special regulations to counteract such a hypothetical effect seems inappropriate at the moment. For one thing, any negative impact of DiDIY in this context would likely be less significant than that of automation, and might end up being compensated by the parallel, DiDIY-induced creation of new jobs. For another thing, the potential social benefits of DiDIY are more tangible than its speculative harms for employment, so that the establishment of restrictive regulation could, based on current evidence, mostly be expected to unnecessarily stifle innovation.

LW15. DiDIY, ethical responsibility, and duties of care

In a narrower view DiDIY solicits makers to assume a responsibility about the duties of care that they have towards the consumers of their products, while *in a broader view* it only requires us to ask how society should regulate the practices of the maker community, in terms of what it should permit/forbid.

It is generally taken for granted that commercial manufacturers have certain duties of care towards those who consume their

products, duties that can for example provide the basis for a negligence lawsuit in cases where a defective product results in injury to the consumer. However, there is less consensus regarding the extent to which hobbyists who engage in DIY practices are ethically responsible for the harm that the products they create might cause, and have an obligation to do their best to prevent harm to those who might use these products. The advent of DiDIY highlights the need for more careful reflection on such issues.

Some research questions

Q: Does DiDIY change the nature of the duties and responsibilities that makers have when creating new products, and if so, how exactly? Do we need new mechanisms (e.g., regulatory) to ensure that these duties are fulfilled, or can relatively simple technological solutions (e.g., software that scans and automatically corrects the flaws in a digital design) offer sufficient guarantees in this context?

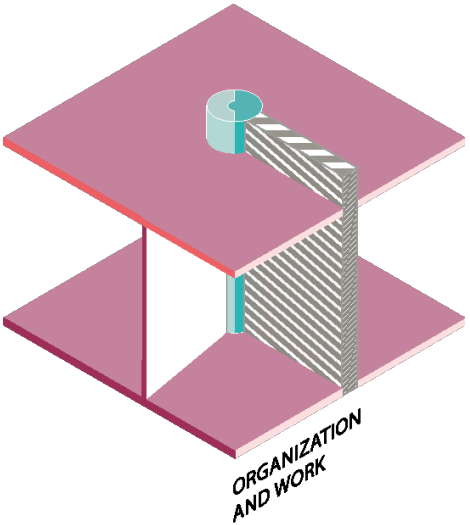
> A: Makers have long had a duty of care towards the people that purchased and/or used their creations. The advent of DiDIY does not change this. However, the rise in the digital

age of the internet, of CAD systems, and of DiDIY tools has greatly facilitated the dissemination of DiDIY products, and thereby the potential impact that makers can have on other people. This means that the fulfilment of their duty of care has become a matter of much greater significance.

When it comes to helping ensure that this duty is fulfilled, we found the imposition of heavy regulation on the activities of makers, such as "strict liability", to be undesirable and a likely threat to the innovation and creativity that DiDIY can help foster. Technological solutions that would, for example, allow to automatically detect and remove defective designs distributed online are a very promising tool that could come close to solving the problem of quality control. Until such solutions can actually be implemented, however, an idea we found particularly appealing was that of instituting a clearinghouse guaranteeing – through proper testing – the safety of the CAD files it made available online for purchase, and ideally having liability insurance. A recent initiative called Fab Market (market.fablabs.io) is an interesting step in this direction.

4. Storeys and Internal Walls

4.1 DiDIY in organisation and work



DiDIY as a building: the Storey of Organization and Work.

IW1. DiDIY and organisation...

In a narrower view DiDIY is related to individuals, while *in a broader view* the "self" in "yourself" is also an organisational entity of any size, with strong organisational ties (e.g., a firm, a formal network of enterprises) or weaker organisational ties (e.g., a community of practitioners, a cluster).

Makers' communities (as a type of communities of DiDIYers) are typically organised around voluntary contribution to a commons-based digital resource or set of resources, that can be distributed and reused by anyone free of charge, and generally under free or open licenses (this is called Commons-based Peer Production (CBPP), a term first introduced by Harvard Law School professor Yochai Benkler (Benkler 2002) and greatly expanded in 2006, in his book Wealth of Networks).

Some research questions

Q: How will the work of a workman in a manufacturing firm be reshaped due to the influence of DiDIY? How will it change in relation with the evolution of other organisational roles in their firm?

A: In order to answer to this question we focused on the characteristics, both individual and environmental, of a maker, which has been subject of research in the recent past. We explored how such a profile can have an impact, within the setting of a structured organization, instead of the traditional context of the makers community. Following this approach, we found that the spread of DiDIY can lead to reshape both activities and competences of workers of different kinds. We found emblematic evidence of this in some case studies. A production plant where production is supported by PLM and Radio Frequency Identification (RFId) devices and sensors to track work-in-progress. Workers have access to a software dashboard showing operational data collected thanks to such hardware infrastructure. This richness of data can be directed towards the automation of activities, but also the allocation of tasks to workers, following a schedule defined by managers. In this case, however, real time information on the production process is made available to the workers, who can then take tactic decisions about which are the most critical activities to be prioritized, which would need to be re-worked, how to distribute jobs among other workers in their team. This requires a certain degree of

discretionality and the access to a broader knowledge (related to workers' competences, workstation saturation, etc) than the one related to highly specific operational tasks. To fully exploit this approach, workers need not only operation competences to exert their role, but also tactical skills in the area of planning, traditionally pertaining to manager.

Q: How will the work of a knowledge worker be reshaped due to the influence of DiDIY? How will it change in relation with the evolution of other organisational roles in their firm?

A: This question has been taken into account in the context of the transformation of the role of the CIO (see the following question).

Q: How will the work of the Chief Information Officer (CIO) be reshaped due to the influence of DiDIY? How will it change in relation, in particular, with the related evolution of other CxO roles? And more generally: which organisational roles are most likely to disappear, and which will be most likely created, due to the influence of DiDIY?

A: The role of CIOs, together with the whole set of line managers, is facing a relevant transformation because of DiDIY. Managers of a variety of organizational units are using digital systems and tools to innovate. Marketing with social media and the related analytics, as well as Operations with IoT and analytics, and R&D with 3D printing are some of the business areas where this is happening. The ease of access of these technologies is putting the managers with a DiDIY mindset in the condition of requiring only marginally the expertise of the IT manager to be able to design the innovation (being it a new channel of advertising, a new monitoring system of an assembly line, or a new product), to release a prototype, and even (in some cases) to implement it. In these cases, CIOs (and the IT department) have the role of carrying out the operational tasks required to execute the innovation plan. Depending on how much this approach is taken to the extreme, the CIO role becomes non relevant or even unnecessary when execution is outsourced to IT vendors. On the contrary, where CIOs and IT managers are keeping the pace of emerging digital technologies and dedicate interests and efforts to explore applications in their organizational context (in other words, where CIOs are

DiDIYers and have the power to exert their DiDIY attitude), they play the role of innovation champions, leading the so-called process of digital transformation of the organization.

Q: Do DiDIYers cluster? What are the factors enabling single DiDIYers get together and create teams to design and develop innovative digital products (e.g., robots)?

A: On the one hand DiDIYers can be seen as individuals, drawing upon knowledge shared over the internet, learning and creating their own, individual projects. On the other they often group together around a shared project, with people with different expertise and backgrounds. In that sense hackerspaces, Fab Labs and makerspaces but also specialised meetups around Arduino (www.arduino.cc), 3D Printing, etc, are typical contexts where people get together to share their experiences and group around projects of shared interest. Open spaces, open platforms, and shareable projects are enablers of these collaborative endeavours. For people to participate, the "rules of engagement" need to be set out clearly, like the licenses used for a project people collaborate on, or the conditions of access of a makerspace.

Q: How do collaborative innovation networks among DiDIYers foster cluster initiatives? How can DiDIY-related entrepreneurial ecosystems transform in cluster initiatives?

> A: Cluster initiatives, i.e., effective platforms to improve the cluster-specific business environment and thus the networking among business, institutional, and research-oriented actors, can influence the dynamic development of clusters and their competitiveness (Porter, Ketels 2009; Ketels 2011). The development of a strong entrepreneurial ecosystem is subject to the presence of high quality cluster initiatives. There are no relevant studies in literature that could help understanding the rising phenomenon of clusters initiatives resulting from the interaction between DiDIYers inside collaborative innovation networks. The entrepreneurial dimension of the DiDIY phenomenon has been recognized regarding its impact on the formation and competitiveness of smart manufacturing clusters (Porter, Heppelmann 2014). Smart, connected products are changing how value is created for customers, how companies compete, and the boundaries of competition itself. These shifts will affect virtually every

industry, directly or indirectly. However smart, connected products will have even a broader impact than this. They will affect the overall economy, giving rise to the next era of IT-driven productivity growth for companies, their customers, and the global economy at a time when the impact of earlier waves of IT has largely played itself out and productivity growth has slowed down (Porter, Heppelmann 2014).

Q: What are the factors enabling small or medium-sized enterprises to evolve from single-player subcontractors into components of a DiDIY-like cluster, competing with large companies?

A: To answer to this question, we observed firms at their business models level, with the aim to find common factors that will support the hypothesis of evolution of single-player subcontractors into components of a DiDIY-like cluster. A cluster of firms can be abstracted as a configuration of business models (Zott, Amit 2010; Zott, Amit, Massa 2011), where two main types can be recognized: business models of the firms affiliated to the clusters, and business models of the organization in charge of formally managing the clusters (the

"cluster head") (Tsvetkova et al. 2014). The business models of the affiliated firms can vary significantly. Such diversity allows highlighting three main factors influencing:

- *IS/IT alignment at firm level*: firms have different information needs and IT infrastructures;
- *strength of network ties*: firms have different types and topologies of networks of social relationships due to different clients and channels);
- *willingness to collaborate*: this incorporates different organizational cultures and different attitudes towards competitive vs. collaborative behaviours, within the firm and with its partners.

IW2. DiDIY and work

In a narrower view DiDIY is related to activities carried out by individuals, while *in a broader view* we can assume that the "self" in "yourself" is also an organisational entity of any size, thus DiDIY is related to activities in organizations with strong ties (e.g. a firm, a formal network of enterprises) or weaker ties (e.g., a community of practitioners, a cluster).

Some research questions

Q: How will the activities performed in an R&D department be influenced by the advent of DiDIYers among the R&D employees and among the firm customers?

> A: Activities carried out within R&D departments naturally call for innovation and creativity of their employees. DiDIY is intertwined with creativity – as reported all along the Project deliverables – and it impacts at the R&D level too. Employees would find new innovative ways, for example, to design products given the opportunity to access online shared database storing files that can easily printed using 3D printers. This opportunity, to rapidly prototype objects is believed to dramatically impact on the R&D supply chain in terms of bridging the gap between customers' ideas and pre-series products. Being able to produce customized products in a mass production and over a short period of time is way more disruptive than ever.

Q: What are the properties of a co-working space that lead to superior performances of accelerated start-ups due to the

interaction among DiDIYers and eventually the development of a community of DiDIYers?

> A: We identified in the reviewed literature a set of characteristics of maker spaces, that we propose to generalize as characteristics of any organizational environment where it is wanted to leverage the DiDIY mindset of the workers:
>
> - quality and availability of affordable digital tools;
> - connected facilities and online social networks enabling knowledge sharing;
> - gamification, that seems to foster user participation in an (online or in presence) innovation community, motivating people through the use of game elements and dynamics in nongame contexts;
> - openness, enabled by the presence of digital systems and tools for information sharing.

Q: How will the activities of a retailer be influenced by the advent of DiDIYers among its customers?

> A: We explored how DiDIY is affecting shoppers behaviour

and, as a consequence, the way retailers work. Several retailers are implementing in-store technology to improve the shopping experience, one notable example being the presence of beacons, aimed at integrating the digital and the off-line channel and push customized offers to the shopper while she browses through the shelves of a store. Another important trend is the in-store use of augmented reality (e.g., augmented reality 3D mirrors for cosmetics retailers; simulation software to virtually install the furniture in any given room). Such technical innovations imply physical modification of the stores and demand the need of different layout and display placement, that must be able to integrate innovations without an invasive approach. On the workforce side, these digital innovations involve the role of the shop assistants that can interact with the consumer via devices like smartphones and tablets directly in the shopping point, and provide a more customized and engaging shopping experience.

Q: How will the activities in the supply chain within the manufacturing industry be influenced by the diffusion of DiDIY practices among the firms in the supply chain and among final

customers?

A: DiDIY impacts at different level of a supply chain:

- *in the upstream processes*, by facilitating the birth of new models for idea generation thanks to faster ways to find and collect ideas and transform them into physical objects;
- *in the manufacturing process*, by leveraging the state-of-the-art digital technologies to have benefits under the business performances, in terms of quality, cost and time optimization;
- *in the downstream processes*, thanks to the possibility to find new ways to execute distributive logistics activities.

In general terms, DiDIY may produce effects on the optimization of a supply chain from both a process perspective, thus aiming at speeding up the throughput time, and a human perspective, especially calling for new skills necessaries to manage innovative applications.

Q: How Digital DIY can contribute (by shrinking, growing jobs, or changing job profiles) to the evolution of the workforce?

A: During the years of the Project we have not found a

definitive answer to this question. DiDIY, as reported in the answers above, and proved in a collection of several, though isolated, cases, is indeed a phenomenon affecting the way organizations work and is transforming the workforce, but it is not possible yet to reach a general conclusion on this matter. Rather, we can provide a conceptual framework where DiDIY is presented as an alternative to the traditional uses of digital technology. Automation, Virtualisation, Self-Service are typical ways of finalizing the adoption of digital tools: they rely on the principle of subtracting task from workers (or entire portions of the organization) and putting computing devices in their place. DiDIY is based on the principle of adding extra-capacities to workers, allowing them to fully exploit their not replicable capabilities such as creativity, insight and entrepreneurial attitude.

IW3. DiDIY and business models

In a narrower view DiDIY is about activities satisfying personal needs, while *in a broader view* it may also include activities with a business aim, both in a profit or a no-profit context.

While DiDIY typically focuses on creating solutions to solve one's personal or collective problem, it does not exclude the making of products and then selling them. When a business builds certain tools appropriate for their business activity by themselves, this activity can be considered DiDIY. The existence of a business aim, or an economical impact, does not exclude it from DIY.

Typically the sharing of knowledge of DiDIY takes place in online communities where people participate with a large variety of motivations. Peers produce collectively digital resources that some use to solve their personal needs, while others offer professional services "on top" of the digital common. We can take as relevant examples:

- the Free Software community, where a large part of developers make a living with services related to their contributions to the common resource;
- the Open Hardware communities, where artists, researchers, entrepreneurs, activists, hackers and makers of all sorts come together and contribute to shared projects as they see fit.

If this model might be generalized, we could argue that DiDIY thrives particularly well when people have full rights to engage

in any kind of activity related to the digital resources shared.

Some business models that can be observed include:

- *sell products as kits*: users buy a kit and self-assemble it instead of making all individual components themselves – the original developers tend to make a margin on the sales;
- *sell finished products*: even though you can make it yourself, some people prefer to buy a finished product – the original developers tend to make a margin on the sales;
- *platform model*: people can replicate freely the hardware and/or software but connect to an online platform (e.g., gitHub (github.com), particle.io (www.particle.io));
- *services*: provide value added services while keeping the designs under free/open licenses.

Some research questions

Q: In what conditions past experiences and cases of DiDIY attempted or proved to generate a business impact?

> A: Free Software and Open Source Software development (as in GNU/Linux, Apache (apache.org), and many others) has shown that DiDIY can work. It is still not clear, however, and

there are no well established experiences yet, if and how these models are transferable to non purely software products.

Q: Can DiDIY be a resilient business opportunity? What are the barriers to overcome?

A: It is a major problem that DiDIY does not seem to have resilient business models yet, but only either (a) amateur ones, where income generation is not critical or central, or (b) precarious, indirect ones that involve selling associated training and/or consultancy. Certainly this is the perception of many. As documented elsewhere, DiDIY style practices are difficult to fit into an established and centrally controlled work environment. The existing systems of data, organisation, finance, liability, and habit work against any such introduction.

Q: What is the role of knowledge sharing among peers in the building of a successful business model?

A: This is a vital condition. In situations where "vertical"

specialised development pays off, individual firms benefit more by owning such developmental paths: there may not be others out there that could help, and maybe others would steal the potential income. In "horizontal" situations, where there is more value in sharing ideas and where having many minds thinking creatively about the same problems is helpful, a DiDIY way of working might be more productive. The transition from a "vertical" to a "horizontal" system, but also vice versa, is hard since lots of changes have to happen together for it to occur, and probably needs some catalyst to happen (or you start afresh with a new system).

Q: What business models do people and organisations pursue to dedicate their time and resources to DiDIY?

A: People and companies gain value from developing a quality, peer-reviewed product, in a way difficult within a single firm, and then income from selling associated services (consultancy, customisation, etc). It should be noted however that most successful Open Source Hardware projects do sell products based on their freely licensed designs. This may not be a core DiDIY practice, but certainly is a major revenue

strategy for projects developed with the DiDIY mindset.

IW4. DiDIY and professionalism

In a narrower view DiDIY is related to activities performed by non-professionals, while *in a broader view* it is also for professionals who maintain their DiDIY mindset.

Artisans, and the typically micro or small sized organisations they set up, are often solely focused on products sold to a local market, and operate with a Do It Yourself attitude privileging creativity and proactivity. Digital innovation appear to bring new opportunities for this category of individuals, who appear to own the characteristics of the digital artisans envisioned by Barbrook almost two decades ago (Barbrook 1997).

Some research questions

Q: What are the differences, if any, in DiDIY if carried out by an amateur or a professional?

A: If performed by a professional, in the context of commercial transactions, there must be a consumer-producer relationship, and thus consumer protection legislation applies.

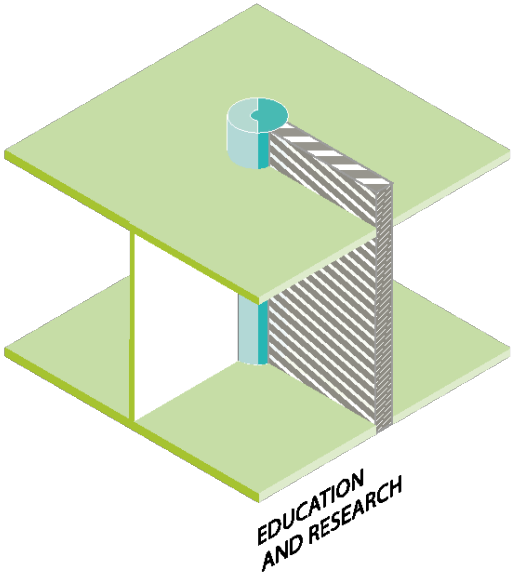
If performed by amateurs, there is not necessarily such relation and the receiver of the products is not necessarily paying for a finished product nor expecting professional quality, warranty and related legal protections.

Q: Under what conditions is a professional activity appropriately considered DiDIY if performed with the mindset of the DiDIYer?

A: We introduced a reference definition of a DiDIY worker. A DiDIYer, i.e., certain organizational roles (or, at a higher level of aggregation: certain organizational units, certain enterprises),

- carries out their own certain activities, activities previously carried out by experts (or specialized companies) – this aspect deals with the traditional notion of Do It Yourself
- by exploiting certain digital technologies
- and possibly exploiting the knowledge sharing within a certain community (of individuals, of organizational entities) – these aspects deal with the innovative notion of Do It Together, where "together" refers to a community the DiDIYer belongs to.

4.2 DiDIY in education and research



DiDIY as a building: the Storey of Education and Research.

IW5. DiDIY and education

In a narrower view DiDIY is related to a new generation of students already immersed in new technologies as "producers" of knowledge and/or information, while *in a broader view* it refers to the adoption of new pedagogical approaches for the benefit of general/adult learners in acquiring new skills, abilities, and ways of thinking.

As the segment of society which usually adapts first to the "new" is the young, we see youth much more involved in exchanging information and knowledge over the web than ever before. Today, students are growing and learning in informal environments, making education less institutionalized and more personalized. Like, all citizens, students too are moving from mere "consumers" to "producers" of knowledge and information.

Educational institutions are now competing with a more fluid concept of learning, that takes place also outside the class and in recreational spaces. Extra-curricular activities such as RoboCup Jr (rcj.robocup.org) and First Lego League (www.firstlegoleague.org) involve schools' teams in project-oriented education initiatives, providing scaffolded learning environment where students can develop sophisticated solutions

to a given challenge.

DiDIY in education is currently being used in many different ways, from holistic experiences to more specialized ones. In the educational setting, where the pedagogical goals are predominant, DiDIY enables students to create and at the same time demonstrate what they have learnt to do, providing direct evidence of the outcomes of the learning process. The opportunity to talk about that object, to communicate about it, to tell a story about it is a way to learn, while at the same time we teach others. The creation of physical outputs reinforce the students' interests in engaging in such activities.

Some research questions

Q: Thanks to the widespread and affordable access to the internet and the growth of the free software and open source and open hardware movements, pupils work on common projects and share working spaces with their colleagues-friends. Does this lead to new ideas or to conformism? Besides, they also share the same working spaces with teachers, thus making it harder to predetermine the flow of communication. How is communication and sharing reshaping student-teacher and learning/teaching

flows?

> A: Besides some limited personal reports of interviewed stakeholders, which seem to point to a scenario leading to an improvement of creativity, this research question remains open. In order to fully understand the effect of this new cultural and technological conditions, specific research involving data collection on the field would be required. By comparing learning strategies and outcomes in different class settings, with or without the implementation of DiDIY-related activities, it would be possible to study if and how the widespread and affordable access to the internet and the growth of the free software and open source and open hardware is shaping the working flow of teachers and students.

Q: How sharing and learning happens is influenced by cultural models. A possible critique to DiDIY is about the individualism of the model, perhaps implicitly based on western cultural assumptions. Does DiDIY-related activities in school reinforce transversal competence such as cooperation and communication among peers, or does it emphasize individualism? How can the

roles of individuals be shaped in DiDIY-related learning processes?

> A: DiDIY-related activities, if and when carried out both in traditional school setting and outside the classroom, are in general specifically used as a pedagogical approach to reinforce transversal competences, rather than to deliver technical competences to pupils. In this sense, individualism seem to be partially discouraged when engaging in the DiDIY-related learning process.

Q: How can DiDIY be exploited to ease/emphasize the transition from a teacher/curriculum-centred school to a student/experimentation-centred education ("flipped learning")? Is DiDIY also transforming the role of teachers accordingly? How? What new competences are expected from them? (these questions need to take into account that DiDIY educational activities are also related to environments different from schools – such as labs, museums, robotics academies, etc – and educators that are not teachers). Is this transition always a desirable outcome?

A: DiDIY-related activities are generally used as a tool to personalize and/or customize the learning experience of pupils, reinforcing motivation by putting the learner at the centre of the process. In order to be effective, however, teachers and educators need to feel comfortable with the potentialities and limitation of the new technological tools. In this sense, they are required to acquire not only some basic skills but also, and more importantly, a new proactive attitude toward technology.

Q: It has been argued that schools as institutions could have greatly benefited from the computer age, but they have been somehow reluctant to do so (S. Papert). Will DiDIY have better chances to allow for major changes within the educational system, also taking into account the concurrent existence of multiple forms of DiDIY aimed at substituting schools, such as MOOCs?

A: In the limited time frame of the Project, we were able to observe a general positive attitude toward of the educational system towards these new technologies, but wider longitudinal data would be required to evaluate the long-term

effect of DiDIY on education.

Q: How is gender of individuals related to the attitude toward DiDIY? (this question is particularly important also considering that DiDIY is used in many countries as a special tool to attract more students and make them study more Science, Technology, Engineering, and Mathematics (STEM) subjects) Considering that STEM courses have a very low percentage of female attendance, one possible areas of interest could be that of evaluating if and how DiDIY may attract more women to STEM classes.

A: From the report of experiences collected during the Project, the key element affecting the participation of girls and women to STEM subjects seem to be more related to the presence of female role-models rather than to the activity in itself. This is an important subject, that would require further investigation.

Q: At present DiDIY in education is mainly used in close relationship with STEM subjects, and if other subjects are

involved they have an ancillary role. Is there a main role for DiDIY in other subjects, such as humanities, arts, etc, so to move from STEM to STEAM (Science, Technology, Engineering, Arts, and Mathematics)?

> A: Although the need for a closer collaboration of integrate arts and humanities with STEM subjects seem desirable, practical examples of successful activities in school projects are few. Beside dedicated school- or class-projects limited to a single subject and/or topic (an art project using 3D printers, a social studies workshops using Arduino (www.arduino.cc), etc), DiDIY-related activities in educational systems still fail to recognise the transversal potentialities of a structured discussion at the class level on topics such as the ethical, cultural, historical, and moral implications of the use of new technologies. In this sense, DiDIY-related activities provide a unique opportunity for teachers, educators, and pupils to tackle and reflect upon some non-trivial questions. Both STEM and humanities could mutually benefit from a closer collaboration, bringing overarching moral, social, and ethical issues to the attention of young and older students.

IW6. DiDIY and research

In a narrower view DiDIY is related to individuals who, outside traditional research environments, engage in research activities by virtue of the widespread availability of affordable new technologies and open access knowledge, while *in a broader view* it refers to the reshaping of the concept of scientific research itself as free from traditional institutional constraints.

DiDIY research laboratories are emerging as an alternative to academic research. The DiDIY revolution has increasingly made available (and affordable) tools and knowledge to a wider audience, enabling citizens to participate to research activities that would otherwise been out of their reach. Research outside universities is typically carried out in two different settings:

- *industry-based laboratories*: the size of these facilities might differ significantly, from big enterprises to small start-ups. Research is typically well focused on a particular issue. Gaining an economic revenue is a key aspect of this activity;
- *open labs*: typically organized by associations of citizens. Open-source principles and knowledge sharing are usually encouraged. Self-reward and the sense of belonging to a community are the key reasons for people to participate;

- *private labs*: set up and run by private citizens, often in their own homes.

Without the need of formal qualification or strict procedures, this closer contact between citizen and research might create fertile ground to innovation. By changing the idea of who can do science and what science is, this new research setting have the potential to improve the long lasting difficult relationship between scientists and society. The levels of engagement can differ substantially, from a better information about science, to the participation by observing, gathering or processing data. However, several limitations apply, among which the reliability of data gathered by non-trained researchers, the understanding of the limitations and the ethical implications of the scientific research.

Some research questions

Q: The many uses of DiDIY in education and research have one element in common: creativity has a crucial role, and is often relieved from the burden of the actual "making" of the outputs ("if you can imagine it, you can create it"). Thus, students and researchers really have the opportunity to work on their ideas,

shaping them mostly in a non-physical environment, and even the last part of the process may not require them to have particular dexterity. How do teachers, students, and researchers use this unique feature of DiDIY?

> A: Like in the case of educational settings, the activity performed in this Project was able to answer only partially to this question. Besides some limited personal reports leading to the idea of an improvement in creativity, the effect of this new technological and cultural conditions can be only tested by collecting data in controlled environments.

Q: How is the age of individuals related to their possible attitude toward DiDIY? Is the fact that at the moment DiDIY is exploited in learning and research mainly by young people contingent to the current "DiDIY culture"? May DiDIY effectively exploited as a driver in learning also of adults, and in the case how?

> A: This research question remains open, as the data collected are not sufficient to discriminate the relationship between age of participants and the DiDIY culture. This being said, age appears a driving factors in the acquisition of new (digital)

skills. In this sense, future research should account for the differences (in terms, for example, of cognitive flexibility and motivation) between younger and older people in the attitude toward new technologies.

Q: How can DiDIY help special groups of individuals (e.g., disabled, second generation immigrants, specially gifted) getting more (or less) involved in research activities?

A: This research questions remains open, as the data collected were not representative of special groups. Despite the fact that the notion of "inclusiveness" seems to be well integrated in all the school setting surveyed in the project, the information gathered seems to point to the presence of some considerable barriers to starting DIY activities, leading to an incomplete access to DiDIY tools which might impede some groups from being involved.

Q: Is, and in the case how, DiDIY affecting the research careers of young researchers?

A: This research questions remains open, as the data

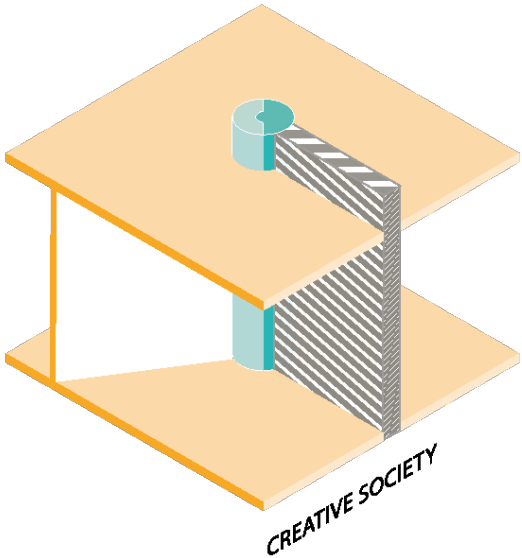
collected were not representative of young researchers.

Q: How is DiDIY contributing to the so-called cultural phenomenon of "citizen science"? Is the democratisation of science a desirable outcome?

A: Several examples of current national and international events concerning the relationship between science, as communicated by researchers and media, and citizens seem to underline a still widespread insufficient scientific knowledge by the society as a whole. The widespread availability of low-cost sophisticated technological tools can help increase the awareness of the whole society about the potentialities and, even more importantly, the limitations of science and technology. Despite the concept is not new, the term "citizen science" has gained a lot of attention in the cultural, social, and political life. Some areas of science (in particular, biology and ecology) have benefited from the widespread availability of DiDIY tools more than others. However, further research would be desirable to understand the impact of DiDIY in this field, also in terms of positive (e.g., increase of scientific awareness, knowledge acquisition, useful

contribution to scientific research) and negative outcomes (e.g., data accuracy).

4.3 DiDIY in creative society



DiDIY as a building: the Storey of Creative Society.

IW7. DiDIY and creativity

In a narrower view DiDIY fosters creativity as people make things using state-of-the-art digitally-controlled technologies, while *in a broader view* it is also about the ways in which creativity can be fostered much more widely, as people connect using digital tools and systems (such as the internet) to develop various digital or non-digital kinds of creative practice.

Within this research, the term "creativity" is intended to encompass a range of creative interactions. It includes the creativity of individuals who are making objects using DiDIY technologies; the creativity that results from the social interaction of individuals coming together and exchanging ideas and working on DiDIY projects; and creativity in the wider community, for example, the creative impact on society that results from how DiDIY projects are manifested in the wider world.

The level of "creative engagement" itself may be subjective to the participants. It may encompass a wide range of activity from simple engagement in a making activity to complex original design and construction of original objects or projects. Similarly, creative groups, and creative society impacts, are likely to

operate at a range of scales.

As a mindset DiDIY may also be seen as a creative continuum, in particular small creative projects and activities may lead to a self-reinforcing DiDIY mindset and lead to more complex creative activities. There are creative implications for this progressive engagement, for example, the exchange of creative ideas and inspiration via online communities enables widespread dissemination of designs. Collaborative engagement opens the way to potentially enabling creative solutions to local, social and environmental problems.

Free and open access is concerned with the protocols allowing or restricting the use and modification of designs and as such has implications for both the creators of designs and those wishing to use them, moderating the shared use of creative capital. DiDIY enables the shared production of creative content and therefore greater opportunities for co-design and the creation of collaborative value chains. It may also lead to the need for a new class of creative professionals mediating DiDIY.

Research, in context, will be carried out to establish how creativity is sparked, fostered and sustained within DiDIY activities and how this impacts on wider creative society. The

extent of creativity needs to be studied in the context of the specific creative engagement and its perception by the participants involved.

DiDIY is an emergent phenomenon and our research is aimed at exploring DiDIY in relation to creativity, through case studies of emergent and current practice and hands-on workshops.

Some research questions

Q: What is the impact of DiDIY on the creative agency of individuals? Can DiDIY influence, alter or empower the dynamics of an individual maker's relationship to digital technologies?

> A: Empowering individuals to actively engage with how things are made, and to recognise that they can make things themselves, are key motivations within DiDIY projects. Empowering people to be creative with technology is often a central part of their vision. Within DiDIY we found a strong ethos of creative problem solving, and a spirit of collaboration, cross-fertilisation, and knowledge exchange, that enable makers to progress their DiDIY skills within making communities, online and offline, tackling more

ambitious projects. Makers told us that learning new skills improved their confidence, enabled self-expression and helped make them feel more socially connected, for example, building teamwork and friendships through their making activities. Many makers told us they got a deep sense of satisfaction and enjoyment from making. Makers were excited by the potential of digital networks for creative inspiration and sharing, and online platforms were greatly valued as a source of knowledge and support. Makers readily integrate digital tools into their creative practice and value the opportunity to forge collaborative partnerships and work in new ways. DiDIY encourages makers to be curious about technology by affordably providing the opportunities, tools, support, and knowledge to enable them to undertake technology projects. For example makerspaces and workshops enable collective access to DiDIY tools and technologies that may not be affordable for individuals. At the same time projects and platforms making use of DiDIY technologies, alongside local makerspace facilities, are creating new possibilities for making, and for citizen engagement, through online and networked information systems and platforms such as the Smart Citizen project (smartcitizen.me). These

kinds of initiatives have opened up new opportunities to engage with technology-based citizen projects on a personal and collective level.

Q: Does DiDIY foster a spirit of self-motivated creativity and entrepreneurialism that could lead to significant social change?

A: The ease of access to different kind of resources allows the individual to develop both specific technological competencies and soft/life skills that enable people to follow their own interests and to experiment new attitudes and abilities. In the DIDIY practice people create what they need even without the support of professional designers and they often build up valuable projects that have the potentiality to be developed and lead to entrepreneurial activities. The individuals also, through the practice of DiDIY, have the possibility of accessing personal resources to experiment their capacities in order to reinvent themselves in professional life and in daily practice.

Q: Do ABC technologies such as 3D printing offer a significant

alternative to previous ways of making things, and what difference do they make to social attitudes to material production and consumption?

> A: Digital manufacturing technologies such as CNC milling and 3D printing have the potential to promote flexible, local manufacturing, in which bespoke products are made using locally sourced and recyclable materials, within small-scale local manufacturing facilities based on globally sourced information, knowledge, designs, and data. This vision of a circular economy is promoted, for example, in initiatives such as the Fab City project (fab.city). This is aimed at harnessing DiDIY technologies, facilities and communities within Fab Labs, to work towards environmentally sustainable cities in the future. More generally, making is always concerned with materiality and many makers told us they had integrated environmental aspects such as reuse, upcycling, and recycling of materials into their creative practice. A culture of making leads individuals to reflect more carefully on their environmental impact, and encourages them to develop innovative and more sustainable solutions to everyday problems. DiDIY technologies such as 3D printing enable the

creation of bespoke items and spare parts. Making projects, such as Fixperts (fixperts.org), make use of these capabilities to encourage a culture of repair and fixing.

Q: What is the impact of DiDIY on creative society?

A: DiDIY fosters creativity in individuals through the promotion and provision of new ways to make, new ways to connect with other makers, and new ways to learn skills and share projects, both online and offline. Our research showed how the internet and online communities play a central role in promoting knowledge, projects and skills, boosting creativity and creating a dynamic in which sharing and creativity reinforce each other. As more people get involved in DiDIY initiatives, more projects are begun and then shared, and more people become inspired to get involved themselves, providing impetus for creative society to flourish. Good creative platforms, online or offline, provide the collaborative support and help that people need to progress in knowledge and ability with the technologies, and in confidence and skills and to stay engaged. We found that many new types of engagement with making are taking place in this way,

enabled by creative platforms, for example, in a diverse range of makerspaces and collaborative work spaces, providing opportunities for individuals and communities. Our research gives in-depth examples of these kinds of initiatives and shows how DiDIY is a strongly emerging phenomenon with increasing relevance to wider society. For example, we present results from workshops with makers in libraries where we found strong interest in makerspaces being hosted in civic settings, such as schools and libraries.

Q: Can DiDIY enable communities, online or offline, to meet the challenge of social, environmental and economic issues? What is the potential for DiDIY to provide the creative resources for communities to tackle problems locally?

A: One fundamental factor of DiDIY is the possibility of easily accessing technology, knowledge and skills, both online and offline. Accessibility is understood both as the physical possibility of reaching points of access to technology but also as the possibility to translate the technical languages to develop empathy and make contents easier to consult for a vast public of peers, men and women, of different ages.

> Accessibility is also translated into a simplification of the normative languages which regulate the use of the shared ideas of the community. The easy access to technologies allows individuals and organizations to draw on skills, and consequently fosters their growth and development. These practices and technologies have many potentialities for changing the world on a personal and community level. Indeed collaborative engagement opens the way to potentially enabling creative solutions to local, social, and environmental problems.

Q: What are the relationships between digital cultures, offline making, and digital making?

> A: DiDIY is a community-based phenomenon. Geographical communities and communities of interest, both online and offline, are key to how DIDIY is experienced and practised by makers. Communities provide a sense of identity, often sharing the same values and passions, and thriving through active support, feedback and knowledge exchange. Offline shared facilities provide access to technologies but more importantly also provide the social bonds and social capital,

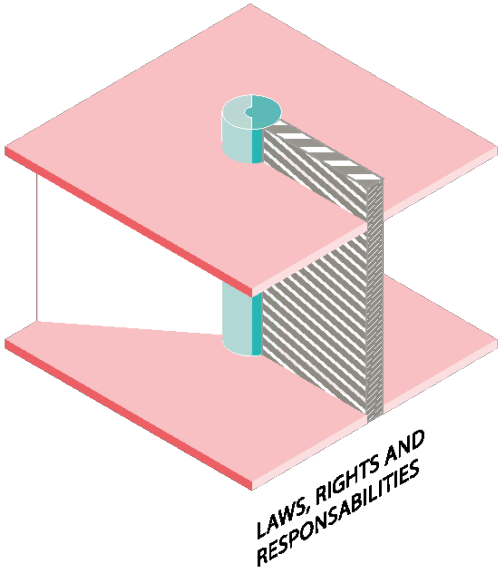
encouraged through voluntary participation and face-to-face contact, which makers told us was a valuable way to learn. Makerspaces are usually membership-based and, as grassroots organisations, depend on active participation. We found that this culture of community was strongly expressed within both online and offline platforms for making and creativity. Makers were keen to use online sources of inspiration, help and knowledge but valued face-to-face interaction and most often followed a process of hands-on creative problem solving, working through iterations of design and making, building confidence through small steps and making use of many diverse sources of help, from peer-to-peer learning to technicians and experts.

Q: Does the DiDIY ethos inspire people to bring about changes in their local culture?

A: Digital technology is a means that allows breaking down frontiers and spreading ideas and projects to the different local communities around the world to solve their local needs, readapting the solutions according to their culture and geographical area of reference. An interrelation exists

between local demands, resources, actions and flows of global skills.

4.4 DiDIY in laws, rights and responsibilities



DiDIY as a building: the Storey of Law, Rights, and Responsibilities.

IW8. DiDIY and its socio-legal challenges as a different production system

In a narrower view DiDIY is an activity for hobbyists or amateurs making unique or customised things themselves within the existing system dominated by mass production, while *in a broader view* DiDIY is part of a larger shift towards collaborative commons and open source sharing of knowledge that is facilitated by new business models focused on specialised, value added services.

The laws, rights and responsibilities that dictate economic and social behaviour have been shaped primarily during the early industrial revolutions, when large, centralised infrastructures for mass production needed exclusive control over intellectual property. This narrow view holds that DiDIY practices have little impact on the production system and the laws that were designed for it, maybe because its rise can be stopped or reoriented by regulation or because it is thought that the economic impact of DiDIY is limited. In the broad view, however, DiDIY may be considered as part of a larger shift towards collaborative commons and open source sharing of knowledge that is facilitated by new business models focused on

specialised, value added services. In this sense it can be appreciated that the phenomenon of DiDIY implies a change in both the number of people engaged in the production process of physical objects ("production by the masses") as well as in the scale of this production (scale of one or few units).

The emerging phenomenon of DiDIY and the rise of openly shared hardware designs (so called "Open Source Hardware") questions this model of exclusive control over intellectual works. Moreover the engagement of non-professional designers and makers in the production of physical objects raises questions of responsibility and liability, when third parties get injured by these objects.

The possibility of DiDIY becoming a mindset is interesting in relation to its potential social and ethical implications. If widespread enough, it could mark a shift in social practices and expectations that made it more difficult to implement certain types of regulation. As an analogy, one can think of the way in which a number of people have been conditioned to expect music to be available online for free: this new mindset seems to have made online music providers more cautious about trying to abolish free streaming services (funded by ads) in favour of a

subscription-only system or other paid services. Another dimension in which DiDIY becoming a mindset is interesting is the "repair" culture, (e.g., www.didiy.eu/resources/rusz-refurbishment-repair-services).

Some research questions

Q: What laws may hinder the adoption of DiDIY and what challenges pose DiDIY practices to current legislation?

> A: Design rights and in particular patents provide risks to DiDIY practices in that it is infamously hard to know whether one is infringing a patent until a legal takedown request is communicated to the design sharing platform or designer. Anti-circumvention legislation such as the US Digital Millennium Copyright Act makes it illegal to bypass Digital Restriction Management (or "Digital Rights Management", DRM) technologies, thereby hindering end users to repair or modify the products that they legally acquired.
>
> Hence DiDIY challenges the very foundation of copyright, design and patent right legislation in that these are based on the hypothesis that state granted monopoly rights are needed to encourage the creation of ideas and inventions. The

existence of thriving ecosystems around Free Software, Open Source Hardware, etc shows that this hypothesis is no longer valid as such.

Q: What exemptions in IPR legislation exist to allow and encourage the use of DiDIY practices for (self) repair? Which legal measures can be taken to strengthen these rights vs. the exclusive protections held my IPR owners? What can be done to protect commercial repair services based on small scale DiDIY activities, even of exclusively protected parts?

A: Exemptions exist to allow the use of patented, copyright protected or design right protected designs for non-commercial, personal use. Other exemptions exist to allow interoperability and the creation of spare parts. However courts have often sided with spare parts and industrial manufacturers by not applying these exemptions.

Existing exemptions should be strengthened to allow an independent repair economy, fostering local economy and longer product lifetimes. Also measures against planned obsolescence, or the requirement to publish designs of spare

parts for local self-production, would be helpful. In order to assure high levels of quality, critical spare parts could be tested by local certification centres, based on open source testing methodologies and public support.

Q: How do DiDIY practices affect the control of dangerous weapons and pathogens?

A: As indicated in LW14, the social diffusion of DiDIY presents a challenge for the control of dangerous weapons and pathogens, insofar as it puts such devices into the hands of people who would previously have lacked the equipment and/or technical know-how to make them, and can now do so away from control. We have also mentioned the need to avoid over-reacting to the threat presented by DiDIY in this context: for example, it should not be used to justify unacceptable infringements on the privacy of citizens via increased government surveillance. This would not be a proportional response to harms that are still speculative at this point. Still, this does not mean that no action should be taken in the face of those concerns. Besides the measures we have already outlined in LW14 in relation to gun control, an education and

outreach strategy of the kind we have seen from the government in countries like the United States might be the best approach in the current circumstances, as it would at least reduce the risk of involuntary creation of dangerous pathogens by DIY biologists using DiDIY tools.

Q: How can the practice of DiDIY in the field of Unmanned Aerial Vehicles (UAVs) – commonly known as "drones" – be regulated?

A: To some extent, the legal and ethical issues raised by DiDIY drones overlap with those relevant to non-DiDIY drones. These challenges can partly be addressed by having a mandatory registration scheme requiring DiDIY drones, just like civilian drones of other types, to carry a clearly visible identification number. Beyond that, our remarks on EU legislation and product liability (see the answer to IW11) apply in the context of DiDIY drones as well. If there were evidence that DIY (including DiDIY) drones present greater risks to people (other than the user) than non-DIY drones, there would be a case for introducing new, more stringent regulations on the former. However, at the present time, such

evidence is lacking.

(A longer list of issues and challenges under research in this area can be found at the page www.didiy.eu/didiy-rights-and-obligations-legal).

IW9. DiDIY and the relation with Free Knowledge & Open Source Hardware

In a narrower view DiDIY knowledge is shared freely within communities, while *in a broader view* DiDIY projects may come also with non-free conditions.

One of the foundational principles of DiDIY is the sharing of knowledge. Where DIY is something that one theoretically can do completely alone and keep private, in the case of DiDIY there is practically always a form of knowledge sharing (imagine that someone buys a household 3D printer or an electronics product that helps them set up a little sensor network for themselves: even if they are proprietary systems, in some way some shared knowledge is involved).

In the narrow view knowledge is shared freely within DiDIY

communities. Most typically this occurs through online knowledge sharing platforms that are open for participation and share knowledge about techniques, solutions and projects providing certain rights to other users. Very typical are projects classified as Free Knowledge, Free Software, Open Source Software, Open Source Hardware and Free Cultural Works. These are different terms for expressions of knowledge ("works") that are shared with the following four freedoms:

- the freedom to use for any purpose;
- the freedom to study and adapt to one's needs;
- the freedom to copy and share with one's neighbour;
- the freedom to distribute modified versions.

In the broad view, DiDIY knowledge sharing at least requires access to the ideas and the possibility to adapt these to one's needs. DiDIY projects may come with non-free conditions. One restriction that may apply is the non-commercial one (e.g., under the CC BY-NC license (creativecommons.org/licenses/by-nc/2.0)), which limits the use or sharing of the works for non-commercial contexts. DIY typically is done for solving a person's or group's problems and not directly commercial exchange (though selling of the results may occur). Another restriction

that sometimes is used is a non-derivative restriction (e.g., CC BY-ND (creativecommons.org/licenses/by-nd/2.0)), which restricts users from distributing modified versions. Now when one or more of such restrictions apply, these works can not be considered "free" (as in freedom) nor "open source" and (thus) they would not be part of the collection of free knowledge. That said, the use of free licenses – that guarantees the mentioned four freedoms – is often a considerable advantage for communities to become sustainable and very common under practitioners of DiDIY. This relates also to the sustainability and business models.

Some research questions

Q: What legal limitations and solutions exist for protecting the sharing of Open Source Hardware?

> A: Copyright law is the most important legal basis for sharing creative works. While this law grants the author of the work exclusive rights of use, reproduction, and distribution, the practice of so called Copyleft licenses uses that precise exclusive control (since the 1980's) to flip the rights ("all rights reversed"): the author grants the work under the four

freedoms to any user for any purpose (www.gnu.org/philosophy/free-sw.html). This establishes a basis of equal rights, encouraging collaborative peer production.

Hardware design files can easily be protected under copyright law, considering that this law protects "pictorial, graphic and sculptural works", which include "two-dimensional and three-dimensional works of fine, graphic, and applied art, photographs, prints and art reproductions, maps, globes, charts, diagrams, models, and technical drawings, including architectural plans". When the design files needed for digital fabrication are considered under copyright protection, the copyright holder will have the exclusive right over the reproduction of the work, and any derivatives made of it. It is these rights that the author or copyright holder can then license to others. This should be a sufficiently strong basis for the open source licences. Typically licenses provide also disclaimers of warranties and fitness for a particular purpose, thereby enabling people to share their designs without fear of unnecessary liability.

IW10. DiDIY and the openness of the Internet of Things

In a narrower view DiDIY communication and knowledge sharing through the internet occurs mostly using open standards, thus allowing vendor-independent tools to be interoperable, while *in a broader view* also proprietary protocols are used.

The entire stack of TCP/IP protocols, on which the Internet is based, is free and open, and so are most application protocols on top of TCP/IP, such as HTTP that is the core component of the web. However many proprietary protocols are also being used, in particular in the emerging Internet of Things (IoT) domain. Will the application protocols of IoT be eventually free and open?

The best assumption / forecast / hope we can say on this, at this point in time, is that IoT is likely to have an evolution similar to the original one: a first stage of lots of competing non-interoperating protocols (regardless of their IPR status, i.e., whether they are patented / copyrighted or not), followed by extinction of most of them, and survival of one or a very few ones, maybe just for protectionism reasons (think power plugs in different countries) but with almost full interoperability.

Open standards have a strong advantage to maximise the

possibility for collaboration between competitors and implementation in a rapidly changing IT environment. Because of the social importance of the network effect, legislators may want to design policies to avoid vendor lockin and assure specifications are defined as open standards.

Some research questions

Q: Given the importance of open standards for vendor-independent interoperability, what legislative efforts and policy recommendations should be made in this field?

> A: Policy recommendations include the mandatory use of open standards for any products or services part of public procurement, public investments, or support measures. Open standards with at least one Free Software implementation are a prerequisite for establishing vendor neutrality.
>
> In the field of the Internet of Things and telecom networks in general, policy measures should be taken to guarantee a decentralised telecom infrastructure. Concrete measures include:
>
> • lifting unnecessary regulatory and financial burdens;

- getting rid of third-party liability when sharing internet access;
- expanding the spectrum commons (making available unlicensed radio magnetic spectrum dedicated to public or community networks);
- updating open-access rules in telecom infrastructures;
- protecting free software and user freedom in radio equipment;
- abrogating blanket data retention obligations;
- bringing direct and targeted public support;
- opening the policy-making process to community networks

(a formal letter by a broad alliance of community networks was presented to the European Commission, EU member states delegations, as well as members of the European Parliament, on 16 March 2017: www.laquadrature.net/en/netcommons-open-letter-EU-policy-makers-on-community-networks).

Q: What effect is the emergence of IoT, i.e., sensor and actuator networks, having on the privacy and anonymity of its users?

A: IoT is increasingly becoming a monitoring system of the whereabouts of citizens in public spaces but also in the most intimate of their lives. It may capture a lot of information about people's identity, tastes, intention, behaviour. Then, all these pieces of information are filtered through Big Data analytics, drawing a revealing portrait of single persons habits, personalities, and choices. For the protection of privacy and anonymity, users of such applications should not only be made fully aware of what information is disclosed and to whom, but they should be given the option to opt out and require strong encryption. In this sense government strategies to mandate tech companies to install backdoors for mass surveillance not only harm civil liberties but can be perceived as a serious threat to the adoption of such technologies. On the other hand, bottom-up community networks can in such context be seen as – at least potentially – providing stronger guarantees to protect these basic civil rights.

IW11. DiDIY, quality control, and product liability

In a narrower view DiDIY is about hobbyists creating new things

using digital technologies, while *in a broader view* it can also involve business entities (e.g., 3D printing services), provided that such entities are not in control of the entire process of creation of the relevant artefacts.

New rules regarding quality control and product liability might need to be introduced to protect users and consumers of DiDIY products for two main reasons:

- non-professional makers, unlike businesses, are typically not covered by existing liability laws, warranty and insurance;
- small-scale production lacks the scale to afford professional testing and product certification.

Some research questions

Q: How does the phenomenon of DiDIY affect the notion of duty of care and product liability? Who bears the consequences of the damages caused?

> A: As mentioned in LW15, the phenomenon of DiDIY increases the social relevance of the duty of care that makers have long had towards those who purchase and/or use their products. Moreover, most forms of DiDIY present a challenge

to current regulations on product liability, to the extent that they do not count as commercial enterprises, but rather involve hobbyists who might at most be occasional sellers, on account of which they are not subject to strict liability laws of European countries in cases where a defective product results in harm to the user, laws that protect the victim by placing the burden of proof on the defendant in a lawsuit. In such cases, the victim will usually not be able to claim compensation from the designer/maker of the product unless they can show that the latter was guilty of negligence, i.e., breached their duty of care.

Q: Is current European legislation on product liability and consumer protection adequate to deal with the challenges raised by DiDIY? If not, what legislative changes are required to meet those challenges?

A: In light of the risks described in the answer to the previous question, some changes to existing legislation might be worth considering. Yet we concluded that any such changes should, for the time being, at most remain modest in nature. Policies that might prove desirable, assuming they were not

implemented by major file-sharing platforms like Thingiverse (www.thingiverse.com) out of their own initiative, would include requiring such platforms to remove uploaded designs that had been reported as unsafe, and to ban those who repeatedly uploaded such files; or, once the technology became available, to mandate the use of software that would automatically detect and remove unsafe files from those platforms. By contrast, we would not recommend extending strict liability laws (of the kind formulated in the EU's Product Liability Directive) to hobbyist sellers of DiDIY products. Indeed, by forcing such sellers to face potential liability costs that they might not be in a position to absorb, such a stringent legal move would rapidly lead them to end their DiDIY activities, together with any benefits these might have brought to users. It seems difficult to justify that type of outcome based on the current evidence of risks associated with DiDIY products.

Q: How can small scale production be facilitated in testing and product certification?

A: Investigating all possible ways of supporting the activities

of local Fab Labs can help promote testing and product certification in the context of small scale production. A recent illustration of this is Fab Market (market.fablabs.io), a new online shop for locally made products that invites anyone who so wishes to submit a design to them. If someone's creation is approved, that person will then be invited to their local Fab Lab (provided that it is part of the FabShop Network associated with Fab Market) for prototyping and testing. If such a system were to be adopted more widely, it would seem important that the Fab Labs in charge of product testing should collectively agree upon an adequate set of standards to guarantee safety.

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The DiDIY Project

The **DiDIY Project**, active from January 2015 to June 2017, was carried out through a multidisciplinary team (www.didiy.eu/project/people), by an international consortium of seven partner institutions (www.didiy.eu/project/partners):

LIUC – Università Cattaneo (IT, www.liuc.it), a university established in 1991 by the Industrial Association of the Province of Varese

University of Westminster – Communication and Media Research Institute (UK, www.westminster.ac.uk/camri), a world-leading centre for media and communications research

Ab.Acus srl (IT, www.ab-acus.eu), a company whose mission is to design and develop technologically advanced products and services

Manchester Metropolitan University (UK, www.mmu.ac.uk), the largest campus-based undergraduate university in the UK, with an emphasis on vocational education and employability

Free Knowledge Institute (NL, freeknowledge.eu) a hub that, since 2007, has coordinated several international projects in the

areas of Free Software, Open Standards, Open Educational Resources, Access to Knowledge

Amerikaniko Kollegio Anatolia (GR, www.act.edu), a non-profit educational institution with a comprehensive undergraduate curriculum in Business, Business Computing, International Relations and English

Politecnico di Milano – Dipartimento di Design (IT, www.dipartimentodesign.polimi.it), a scientific-technological university funded in 1863, which trains engineers, architects and industrial designers.

The goal of the Project was to produce well-grounded models and guidelines to support both education and policy making on DiDIY, intended as an ongoing phenomenon that, while surely enabled by technology, should be driven and shaped by social and cultural strategies, not technology.

You are welcome to join the public DiDIY blog (www.didiy.eu/blog) and to browse the documents presenting the results of the research activities (www.didiy.eu/project/results).

For any other information, or to know more about the DiDIY Project, please fill the form at www.didiy.eu/contact.

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Disclaimer: The views expressed in this document do not necessarily reflect the views of the EC.

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