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Digitally making as an opportunity for skilling and empowerment

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Abstract

The current trend of digitally enabled self-production (i.e. digital DIY) is emblematic of the contemporary attitude to making and crafting. Although digital DIY has been seen as an opportunity for social and technological innovation, a major debate is taking place in research literature about its potential skilling or deskilling effect on practitioners.

For instance, on the one hand, focusing on the digital representation undermines the ability to experience materials qualities and manufacturability. The ultimate effect is the development of a creative process, which is led by a virtual idea disconnected from the material world. On the other hand, the machine itself is a manifestation of knowledge, skills and labour involved in its design, manufacture and maintenance.

The objective of this paper is to further unpack this debate and presenting our reflections from an ongoing research project on the potential of digital DIY as a skilling process through making collaboratively. We introduce a research model representing the dynamics enacting over three interdependent levels (i.e. social innovation, social practice and creative process) in which three factors of technology (e.g. digital fabrication), motivation (e.g. commitment) and collaboration (e.g. with peers) are envisaged as crucial for learning and skilling.

Keywords

Digital Do-It-yourself (DIY), making, skills, design.

1. Introduction: The digital self-production trend

The current trend of self-production (i.e. Do-It-Yourself or DIY) is emblematic of the contemporary widespread interest to crafting and making, applied to a wide range of products, from knitwear and clothing (e.g. wearables), to furniture and electronic devices (e.g. Arduino), and even houses and more complex infrastructure items (e.g. solar panels). This contemporary DIY appears to embed a potential of technological and social innovation by many so that the envisaged impact is the initiation of "the new DIY age" (Hoftijzer 2009), a new industrial revolution (Anderson 2012) and even a "paradigm shift" (Fox 2013). The collaborative nature characterises the contemporary evolution of self-production moving away from the more individualistic conventional DIY of the past century. This collaborative evolution has been enabled especially by digital technologies connecting people on a global scale (e.g. Internet 2.0) and bringing production closer to consumption (e.g. digital fabrication and distributed systems), thus making this an ongoing social innovation phenomenon in which people reinvent their ways of living (Manzini 2015).

A recent research project by Nesta mapped major European organizations and activities for 'digital social innovation', intended as: "a type of social and collaborative innovation in which innovators, users and communities collaborate using digital technologies to co-create knowledge and solutions for a wide range of social needs and at a scale that was unimaginable before the rise of the Internet." (Bria 2014, p.i) They consider social innovation "in relation to the initiatives that are based on 'meaningful discontinuities' in the way involved participants behave and interact collaboratively leveraging the power of collective intelligence through open digital technologies." (Bria 2014, p.5)

The potential of social innovation embedded in the new DIY age is related – at least in part – to these interactions between makers who will support each other for the accomplishment of goals, also known as 'commons-based peer production' (Benkler & Nissenbaum 2006). In the realm of crafting and making, significant outcomes of the digital DIY trend include platforms not only for designing (and sometimes producing) collaboratively parts and products but also for sharing knowledge and competences typically related to the use of digital fabrication technologies and infrastructures (e.g. 3D printers and laser cutters).

The debate: skilling or deskilling?

The current self-production trend represents therefore an opportunity for fostering social innovation especially by sharing and developing a new set of digitally-based skills. Furthermore, crafting and making involve the development of cognitive and manual skills, including creativity and the ability to produce ideas, problem-solving, critical thinking, and collaboration, which are considered key players for the next century citizens, students and workers (The European Parliament and the Council of the European Union 2006; Partnership for 21st Century Skills 2008).

However, the overall effect of the digital evolution of this making practice on individual skills and empowerment is still debated. In fact, the spreading of digital fabrication raises arguments on its potentially skilling or even deskilling effect on people (Hielscher & Smith 2014). "On the one hand, these technologies are said to encourage passive consumers to engage in creative making process in their spare time without having to pick up years of craft learning – reskilling, whilst on the other, they are said to automate making processes previously requiring craft skill – deskilling." (Ree 2011, p.34)

Further research is needed to shed light on the technical, cognitive and social skills mainly involved in this practice, which may contribute to fundamental questions such as how the digital-fabrication technology influences the acquisition of new skills. This debate is quite well-known in the STS field, with the emblematic Braverman's theory of deskilling through technology advances and automation. More recently, Söderberg (2013) reconsiders this theory, in particular in relation to capitalistic system, in which automation could represent a means to weaken unions and workers' strength. The argument is based on the dispute around such deskilling theory and related works in STS field. This is then related to the contemporary debate about the deskilling risk of 3D printers through the case of the RepRap and its comparison with the history of CNC machines.

This topic in literature has been more oriented to consider the effects on organization of labour and ultimately on workers' empowerment but the arguments on the consequences of automation may be relevant for a better understanding of the effects of digital means of production on skills development.

The history of major technological upheavals is characterised by different response to technology, as summarised by Dellot (2015) (see figure below), ranging from the Luddite proposal of machine destruction to safeguard workers to the intention of owning the means of production as a means of emancipation for the hacker movement. However, these movements somehow failed in their actions for different reasons, such as the absorption of the hacker movement in the consumption realm (Dellot 2015). The awareness of these past failures could be the starting point for planning interventions in the current maker movement in order to catalyse its potential, especially in terms of skilling and self-reliance in this paper, thus avoiding to miss another opportunity for positive societal change. In fact, according to a recent investigation carried out by RSA (Dellot 2015) participating to makerspaces increases the potential for people to generate three main benefits, which are fulfilment, learning, and enterprise.

Phase	Response	Driver	Leaders	Faults
Luddite movement	Destroy the tech	Introduction of first automated machines	Workers	Relied on violence and failed to recognise benefits of new tech
Arts and crafts movement	Ignore the tech	Onset of mass production	Intellectuals	Became distracted by nostalgia and lacked broad-based appeal
Hacker movement	Own the tech	Introduction of computing and the internet	Techno-enthusiasts	Lost its emphasis on making and championed consumption over production
Maker movement	Embrace the tech	Technological ubiquity	Leaderless	?

Figure 1. Four movements championing making. Source: Dellot, 2015.

The debate is relevant for design research as well. Making is creating and as so it requires adequate skills for the development of creativity. The creative elements in DIY enhance people's notion of themselves as agents of design rather than merely passive consumers (Atkinson, 2006). It is plausible that the level of attitude, experience and skills in delivery creative ideas and managing the creative process affect the way in which the digital DIY practice is carried out and the output is generated. From a design research perspective, it will be relevant to understand how the creative process may change when addressed collaboratively, or the difficulties encountered by digital DIYers when developing the creative process in order to identify potential areas of intervention for designers aiming at supporting them.

Objective of the paper

This paper draws on arguments from the debate on the skilling and deskilling potential of digital making, based on the preliminary reflections of the authors in an ongoing research project about design interventions fostering the acquisition and development of skills through digital DIY practice.

The debate is possibly nurtured by the challenges involved in the definition and measurement of skills, which vary according to discipline and purpose. For instance, Attewell (1990) groups these approaches in four sociological notions of skill (positivistivic, ethnomethodological, Weberian, and Marxist) and points out the criticism towards the attempts of quantifying variations of skills – over time or across people – as they risk to be too simplistic unreliable.

Delving into the discussion of definition is out of scope for this paper and, at least provisionally, we consider skill as the cognitive, physical and social ability of doing something, independently from the level of proficiency. However, unpacking definition and – whenever possible also measurement – of skills is already planned for the

next steps of our research, with a focus on the key competences (The European Parliament and the Council of the European Union 2006).

In the next two sections of this paper, the arguments found in literature on the two extremes of skilling and deskilling potential in digital DIY is addressed with regard to two main groups of skills, which are cognitive and body, and social skills respectively. It is here anticipated that at this stage of the research, a higher potential for skilling, rather than risk for deskilling, results from literature. The paper concludes with the proposal of a model for mapping the dynamics of skills development.

2. Debate on cognitive and body skills development

Technological advances reshape the way people think, speak and perceive reality, thus implying transformations on culture and society. The use and development of digital devices requires the acquisition on at least fundamental knowledge in informatics and electronics. This also implies sometimes a more unstructured approach to tasks and daily life. The use of digital media has cognitive implication on the human brain and according to some theories this undermines the ability of reading deeply, the semantic comprehension of a piece of text or the deep emotional involvement, thus provoking a form of apathy (Cortoni 2015). On the other hand, digital media may foster the development of problem solving and information analysis skills. Furthermore, implications on the development of a creative process through a more 'agile thinking' enabled by the use of digital media are expected.

The main typologies of cognitive skills involved in this process of digitally enabled transformation identified in literature regard the balance between virtual and material worlds and the awareness and appropriation, summarised below.

Virtual representation vs material experience

One of the main arguments on the deskilling effect of digital DIY refers to the fundamentally virtual nature of the practice through production machines such as 3D printers, CNC mills and laser cutters. The digital DIYer is often involved in the use or development of a virtual object and eventually automated machines will produce this or its components to be assembled.

Focusing on the virtual representation of the object undermines the ability for the practitioner to experience materials qualities (e.g. hardness) and manufacturability (e.g. lathing, melting), and to learn through hand making, thus flattening the three-dimensional knowledge of hand making to the bi-dimensional realm. The ultimate effect could be the development of a creative process, which is led by a virtual representation of reality disconnected from the material world. The potential consequences of such deskilling effect include inefficient and ineffective ways of producing due to a lack of knowledge of materials features.

Digital DIYers risk to overly on technology thus undermining the exploratory manual approach, which may turn out useful when attempting to repair or restore. Less repairing ability (maybe also due to lower manual skills in repairing machineries) and as a consequence disempowerment.

As a response to such arguments, Ree (2011) has claimed that although digital tools turn much of the in-situ effort of materialisation over to a machine, the machine itself is a manifestation of knowledge, skills and labour involved in its design, manufacture and maintenance. Moreover, he has tried to argue that there is an element of improvisation and experimentation within the digital fabrication making process. Once the object is created it can be held and studied and therefore altered (often there is the need to finish off the digitally fabricated objects through handwork) (Ree 2011).

Boza (2006) summarises the reflections from a hybrid making-based experience with students, in which manual tasks where integrated with CNC operations. The final goal is demonstrating the complementarity of these two different ways of working, especially when the innovation brought by technology may risk to obscure the quality of hand-crafting. The author refers to the work by Pye, in 1968, who called handcrafting as the "workmanship of risk" and machines as "workmanship of certainty", the reason is self-explicatory.

Students were asked to create plywood panels, perforated with CNC milling machines and adjusted with manual tasks (such as preparing, sanding, carving). The author concludes pointing out that "for the student the result was a comprehensive understanding of their design proposal, of the materials employed, and of the methodologies/techniques necessary for the two to coalesce into one". The final reflection is that "while craft relies on a predefined yet intuitive process technology can become the catalyst for humanizing opportunities to occur rather than an end to the means" (Boza 2006, p.7).

Furthermore, digital fabrication technologies need to be set according to the materials used. Therefore, the use of such machines will require knowledge on material qualities which possibly were not so fundamental for non-digital DIYers. For instance, melting point – particularly relevant for plastics to be 3D printed – can be considered of secondary importance for common people, moving the level of knowledge from more a macro to micro level, from properties enacting on a more visible level to the ones determining micro-level properties.

Awareness, appropriation and learning

The digital DIY is subject to the risk of overemphasising the role of technology over human abilities, focusing on what technology can do and neglecting the potential for human involvement. For instance, many things can be made more easily or efficiently by hand rather than by machine.

Dellot (2015, p.14) believes that "[t]he maker movement helps people gain mastery over technology in two senses […] it is concerned with enabling people to use technology to produce something useful [...] This is important for self-reliance. But the movement is also about helping people to understand technology, by which we mean becoming aware of how it works and what it is capable of. Through novel acts of making we come to understand the workings of tools and the make-up of objects. This gives us a sense of agency but also a greater awareness of technology's externalities, for example on sustainability and matters of privacy."

This awareness allows for the transfer of competences from one field to another, typically with notions of informatics and electronics, which may be useful also for increasing the confidence in maintenance and repair of technologic devices.

According to Ackermann (2013, p.4), contemporary DIYers "make do with what they have (bricolage) in order to make theirs what they care for (appropriation)!" as a reaction to increased level of commodification. The author defines 'appropriation' as "the process by which a person or group becomes acquainted with, and gains interest in, things by making them their own", typically through a mere process of adoption of a given technology, reinterpretation of an artefact to fit individual needs or pushing its design capabilities.

Making also fosters knowledge acquisition and learning. In her book chapter, Schrlhowe (in Walter-Herrmann & Büching 2013) aims at highlighting the opportunity provided by FabLabs as learning environments, on the constructionism oriented basis that making is an effective means for constructing knowledge. This hypothesis is based on five factors identified in FabLabs, which are:

1. combining physical activity and abstract thinking, which is typical when using the fabrication technologies available in FabLabs
2. revealing the model behind the scene, i.e. an environment which displays how things are made thus facilitating the opportunity for better understanding production and customisation processes
3. initiating processes of reinventing and refining ideas and products, fostered by the plethora of tools available in FabLabs and namely through a trial and error approach which could encourage imagination and reinventing.
4. relating to post-modern society's conditions, closely related to the acquisition of key competences
5. social and community learning, embedded in a participatory culture.

As pointed out by Cortoni (2015) on the use of digital media from an educational perspective, the possibility to acquire or lose cognitive skills depends on frequency and intensity of their use and, referring to the work by Rheingold, the consolidation of possibly fleeting input from digital media can be regulated, taught and practiced.

3. Debate on social skills development

Literature on digital making tends to converge towards the positive impact of this practice in fostering social relationship. The digital making trend is fundamentally a phenomenon of social innovation (Manzini 2015) gathering people with different levels of skills and interest around a common project. Digital DIYers collaborate thanks to the development of tools and platforms, which facilitate dialogue and participatory work. The Web 2.0, wiki platforms, makerspaces, hackerspaces allow both digital and physical interaction between people committed to develop a project collaboratively. As pointed out by Dellot (2015, see figure 1) this is a leaderless movement in which participants are equally invited to join and contribute according to their possibilities and interest. The result is a resilient network of knowledge and competence, or also of 'Collective intelligence' which Nesta defines as: "[a] kind of ability to solve problems in distributed fashion so that the entire system is self-maintaining in the face of often unpredictable problems." (Bria 2014, p.14)

The collaborative approach in digital making requires – or at least encourages – the ability of working in teams, dialoguing for reciprocal understanding. According to Mellis (2014, p.28) "DIY electronic devices let individuals express many different skills and interests. These can complement each other, allowing for various forms of collaboration between people with different kinds or levels of expertise and interest in the process. Furthermore, these involvements offer different possible outcomes, whether production of useful devices, learning about technology, or social activities."

In the discussion of their analysis of the literature on the social nature of makerspaces, Hielscher and Smith (2014) also consider creativity as an opportunity for empowerment and democratised innovation. For them, open questions in this area include how material capabilities and skills are linked to the wider social and political ambitions, which level of skills are needed to be part of such a revolution, how far this making process can be framed as a political or social activism form.

Digital making is not necessarily an inclusive practice as yet. Although the movement and the trend encourages wide participation, members of makerspaces for instance – in which collaborative digitally enabled production takes place – are remarkably unbalanced in terms of age and gender (Hielscher & Smith 2014). Possibly, such a practice or place is not so appealing for everyone yet, especially older and female people. Considerable efforts are still required to make the movement an actually inclusive one, thus maximising the opportunity of developing collaborative skills with a wider variety of people and contexts.

4. Conclusions and future developments

These preliminary reflections on digital making sustain the hypothesis that the balance between the skilling and deskilling is not fixed but margins for developing cognitive, body and social abilities are evident if properly fostered. Digital fabrication technologies may be seen as an appealing opportunity of being involved in creative processes for less engaged DIYers who are let down by the often long lapses of time required to acquire manual skills of the traditional non-digital DIY. As Watson and Shove inferred from a study about craft consumption (2008, p.80), such machines are "not instruments of de-skilling and dumbing down but as agents that rearrange the distribution of competence within the entire network of entities that must be integrated to accomplish the job in hand. By implication, efforts to understand the dynamics of what people do – for example how the boundary shifts between situations in which people employ a professional or in which they do the work themselves – should therefore focus on the co-evolution of these hybrid entities rather than on the human or non-human elements alone."

Although we are aware that the debate could benefit from an even wider framework including political context and power relations (Söderberg 2013), drawing on the arguments above we envisage the potential for digital DIY practice to foster the development of creative skills, as the material set (e.g. technologies) opens up the range of things still to be made thus stimulating the creativity of people, which may be amplified through a collaborative approach. Tools fostering creativity during the creative process may limit the deskilling chances for digital DIYers, namely supporting with the identification of the most effective material to be used.

The EU funded project 'Digital Do-It-Yourself (DiDIY)' (http://www.didiy.eu/) aims at developing a human-centric and multi-perspective approach to the scientific study of current self-production trend enabled by digital

fabrication, in order to better understand its impacts on all areas of society and to support both education and policy making on Digital DIY, through models and guidelines driven by social and cultural strategies.

In particular, we – as partners of the DiDIY project – are going to explore the dynamics facilitating the acquisition of skills and 21st competences in this practice. As design researchers, we aim at contributing by developing (co)design-driven tools facilitating the identification of the skilling dynamics in place where digital DIY practice takes place and explore models for including them in working and educational environments.

Understanding the dynamics for the acquisition and development of the above skills is our core intent. We hypothesise that skilling processes in digital DIY take place through the interplay of main factors enacting on different levels, which include digital DIY as a:

1. phenomenon of social innovation in which collaboration and sharing take place
2. practice carried out by the individual using tangible means, attributing meanings and enacting competences
3. creative process, developed through cognitive tasks.

Three are the factors, which we believe influence the skilling process across the three levels above, i.e.:

a. digital technology, both facilitating collaboration and access to tools
b. motivation, as commitment to participate and self-organization
c. collaboration, both with peers and with facilitators.

The resulting model will be verified through fieldwork activities over the following months, namely through direct observations and interviews in the places where digital DIY is carried out. The verification of such dynamics involving often-tacit skills appear challenging. To this purpose, we anticipate the potential of using tools eliciting the manifestation of skills borrowed from design thinking and co-design. These design approaches aim at investigating and clarifying processed of ideas generation and even facilitating them. Their tools enact on a deeper level, eliciting what people know, feel and dream (Sanders 2002).

Eventually, the model could be reinterpreted and adapted to identify similar skilling dynamics in different practices.

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