ISSN 2398-3132

PROCEEDINGS OF DRS

DRS2016

27–30 JUNE 2016

VOLUME 3

50th Anniversary Conference
Brighton, UK

Design + Research + Society
Future-Focused Thinking

EDITED BY:
PETER LLOYD
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Proceedings of DRS 2016

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50th Anniversary International Conference
Brighton, UK, 27–30 June 2016

Volume 3

Editors
Peter Lloyd and Erik Bohemia

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Proceedings of DRS
2016 International Conference
28–30 June 2016, Brighton, UK
www.drs2016.org
Volumes 3 of 10

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Proceedings of DRS 2016 International Conference: Future–Focused Thinking

ISSN 2398-3132

Published by the Design Research Society
Loughborough University, London
3 Lesney Avenue, The Broadcast Centre, Here East
London, E15 2GZ
United Kingdom

Design Research Society Secretariat
email: admin@designresearchsociety.org
website: www.designresearchsociety.org

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Skilling and learning through digital Do-It-Yourself: the role of (Co-)Design

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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. Its investigation represents an opportunity for better understanding the dynamics underpinning the acquisition of competences for the next century citizens through making. The objective of this paper is presenting our preliminary reflections on the factors characterising the current trend of digital DIY, envisaged as a phenomenon of social innovation empowering people by developing skills through making collaboratively. We introduce a model representing the dynamics (over the three levels of social innovation, social practice and creative process) and factors (i.e. technology, motivation and collaboration) for learning and skilling in this context. The concluding section describes future developments based on co-design for the delivery of tools enabling designers and key players in four main areas of intervention in which the model can be transferred.

Keywords: Digital Do-It-Yourself (DIY); Making and makers; Learning; Competences and skills; Co-Design Tools

1. Skilling through digital DIY and the role of Design

The modern concept of competence comprises not only relevant knowledge and skills, but also a range of personal qualities and the ability to perform adequately and flexibly in well-known and unknown situations. This set is often called 21st century competences which are considered of fundamental importance for people to face the complexity of contemporary age. Creativity and the ability to produce ideas, knowledge and innovations is a key player. It represents the intangible substrate for innovation (Kozbelt et al. 2010), however its management requires the development of specific techniques and educational programmes. Since the last decades of the 20th century, research in learning processes have suggested the importance of making and doing as a means to foster the acquisition of skills, especially the

creative ones. Therefore, observing and understanding the dynamics of making-based activities could shed more light on how creativity unfolds and skills are acquired.

The current trend of self-production (i.e. Do-It-Yourself or DIY) (Anderson, 2012) is emblematic of the contemporary attitude to making and its investigation may represent an opportunity for a better understanding of the dynamics underpinning the acquisition of the 21st century competences. The spreading of digital fabrication technologies and infrastructures are sustaining a self-production trend re-emerged over the last decade (Atkinson, 2006) thus leading to what has been called 'the new DIY age' (Hoftijzer, 2009) or also a new industrial revolution (Anderson, 2012) and even a paradigm shift (Fox, 2010). Collaborative self-production is one of the ongoing social innovation phenomena in which people reinvent their ways of living, especially thanks to ubiquitous 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) (Manzini, 2015).

Digital fabrication-based DIY – or simply digital DIY – is here envisaged as a creative practice through which people may increase their self-confidence and empowerment by developing new skills and knowledge. Rooted in design and construction, these digital making activities often emphasize the development of 21st century skills, such as problem-solving, critical thinking, and collaboration.

1.1 Why design?

Given the skilling potential of the making trend especially in terms of creativity, major implications for professional designers are expected. Design literature has suggested since a long time that everybody is a designer (Simon, 1969; Cross, 2011), and more recently that "in a world in rapid and profound transformation, we are all designers" (Manzini, 2015:1). These theories refer to the ability and need for untrained people to create what they need even without the support of professional designers. The role of design in the era when everybody does design is therefore questioned and needs to be reshaped.

The Industrial Designer Society of America (IDSA),[1] discussed the implications of DIY for designers at the 2010 conference named 'DIY Design: threat or opportunity?' and acknowledged that, although DIY is not a totally new phenomenon, the implications of this shift for the design professions are potentially massive. The DIY resurgence is making consumers question the need for mass production, and by extension, the need for designers.

Atkinson (2006:1) concluded that

> "[n]o accounts have really developed the key issue of how DIY acts as the antithesis of the prescribed design of the mass marketplace [considering that] DIY as a design activity has not been the focus of a great deal of attention."

However, Manzini (2006) stresses that

[1] http://www.idsa.org/

> "if it is true that we live in a society where 'everybody designs', designers should accept that they can no longer aspire to a monopoly on design and, at the same time, they have to be able to recognise what could be their new, and (…) important, specific role."

Past research suggested possible roles of designers for the contemporary DIYers (Salvia, 2016). In this paper we propose 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 EU funded project 'Digital Do-It-Yourself (DiDIY)' aims at developing a human-centric and multi-perspective approach to the scientific study of current self-production trend enabled by digital fabrication technology, 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.[2]

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

1.2 Objective and structure of the paper

The objective of this paper is presenting our preliminary reflections on the factors characterising the current trend of digital DIY, envisaged as a significant phenomenon of social innovation which may foster skilling processes with ultimate effects on people empowerment through the act of making collaboratively.

To this purpose, section 2 introduces the (mainly constructionism-based) theories of learning through making; section 3 describes the current trend of digital DIY and highlights main debated topics in literature; section 4 presents our research area and summarises the research activities that will be carried out.

2. Making as a learning opportunity

The intellectual capital of citizens is envisaged as the driving force for the 21st century (Sahin, 2009), during which a global paradigm shift affects frames of reference about the ways of living, working, and socialising.

Advanced economies, innovative industries and firms and high-growth jobs require more skilled and empowered workers with the ability to respond flexibly to complex problems, communicate effectively, manage information, work in teams and produce new knowledge. In the United States, for instance, companies have made significant organizational and

[2] http://www.didiy.eu/

behavioural shifts, providing higher levels of responsibility to workers for increasing productivity and innovation (The Partnership for 21st Century Skills, 2008).

The acquisition of different forms of knowledge and skills is needed for people to thrive as tomorrow's leaders, workers, and citizens in a constantly changing world and never-ending learning process. To cope with the demands of this century, people need to know more than core subjects and to develop such skills as thinking critically, applying knowledge to new situations, analysing information, comprehending new ideas, communicating, collaborating, solving problems, making decisions (Sahin, 2009).

The Partnership for 21st Century Skills (2008) identify three broad categories of these learning – mainly cognitive – skills, which include:

- Information, i.e. technical skills enabling the confronting of the technology and media-driven environment;
- Learning and innovation, i.e. skills focusing on creativity, critical thinking, communication and collaboration;
- Life and career, i.e. skills that give people the ability to navigate the complex life and work environments in the globally competitive information age.

The 21st century skills require the development of an *ad-hoc* education system that prepares students, workers and citizens adequately. We envisage that significant benefits may be gained if the development of this system is based on *Constructionism*, a theory developed in the 1980s by Seymour Papert, one of the founders of MIT Media Lab. This theory bases learning on creativity, tinkering, exploring, building, and presentation (Papert, 1980), thus covering a significant number of the 21st century skills. Learners apply concepts, skills and strategies to solve real-world problems that are relevant and personally meaningful. In this process, they engage with problem-solving, decision-making, and collaboration (Bers et al, 2002).

Built upon Piaget's *Constructivism* theory (Piaget, 1970) according to which learners' knowledge is the result of the construction of ideas and their relations yet within the mind of the learner, Papert's theory involves learners in the construction of physical artefacts and in their sharing with others. In other words, Constructionism emphasises the benefits of making *external* artefacts as a powerful means to achieve Piaget's *internal* (reads 'in the mind') construction of understanding.

Making encourages a deep engagement with content, critical thinking, problem solving and collaboration while sparking curiosity (Peppler and Bender, 2013). As a consequence, it is agreed that making fosters lifelong learning by encouraging learning by doing (Peppler and Bender, 2013). The potential of making as a way for more effective learning has been increasingly sustained over the last decade and has inspired several other Constructionism-based theories – which we will further explore – such as *Authorship learning* for which collaboration if fundamental (Donaldson, 2014).

The current challenge is to encompass learning at all ages in both formal and informal situations with a practice that involves a wide variety of the digital tools that form the landscape of students' future learning and working environment (Donaldson, 2014).

Current socio-technical trend of self-production and making facilitated by digital media represents an opportunity for the engagement of a wider audience in the development of the 21st century skills. A number of researchers and educational leaders see in the digital DIY the potential to engage young people in personally compelling, creative investigations of the material and social world (Vossoughi and Bevans, 2014). Furthermore this will democratize tasks and skills previously available only to experts (Blikstein, 2013), expanding participation in STEM fields.

The next section describes the self-production trend and highlights the benefits that this phenomenon may bring about in the acquisition of skills.

3. The creative practice of digital DIY for social innovation

DIY generally refers to the activity carried on by untrained people for the realisation (designing and making) of a product, instead of having it done by a specialist (Kuznetsov and Paulos 2010). The outcome of this activity is eventually used or consumed by the creator or people with personal connections (e.g. relatives or friends), without the generation of direct profits (i.e. sales). Over the last decade engaged individuals described as 'makers' (Anderson 2012), 'craft consumers' (Campbell 2005), 'lead users' (Von Hippel 2005), 'professional amateurs' (Leadbeater and Miller 2004) and 'prosumers' have been united by the will and ability to create artefacts that they desire and may be supported by innovative technologies (e.g. Atkinson et al. 2008), networks (e.g. Leadbeater 2008) and companies with new business models (e.g. Franke, Von Hippel, and Schreier 2006).

The contemporary making attitude is considered creative, innovative, inventive, collaborative, resourceful and empowering. Makers and digital DIYers play with technology to learn about it, to figure out how things are made, how to fix them, or how to use them in a whole new way. They are non-linear thinkers, curious inventors and problem-solvers. According to Thomas Kalil, deputy director of the White House's Office of Science and Technology Policy, the maker movement really

> "begins with the Makers themselves — who find making, tinkering, inventing, problem solving, discovering and sharing intrinsically rewarding." (in Dougherty, 2010)

The socio-technical change taking place has dramatically contributed to reshape (at least some streams of) DIY towards a phenomenon of social innovation, moving from a more traditional individualistic practice to a collaborative one for positive impact on society.

We believe that the exploration of the making-based digital DIY phenomenon may generate beneficial insights for the facilitation of the 21st century skills development. However, these opportunities are still debated in literature and the main elements of this social practice are reported in the following section.

3.1 The social practice of digital DIY and the (de-)skilling debate

Digital DIY may be described as a 'practice' from sociology perspective, as it emerges from, constitutes, and makes sense of

> "forms of bodily activity, forms of mental activity, things and their use, background knowledge in the form of understanding, know-how, states of emotion, and motivational knowledge" (Reckwitz, 2002:249).

As a practice, digital DIY evolves over the time because of the active integration of both existing and new elements in practices (Shove and Pantzar, 2005), including:

- Materials, i.e. tangible resources, such as tools, parts and materials;
- Meanings, i.e. motivations, such as personal satisfaction, self-development and monetary saving;
- Competences, i.e. capabilities and skills, such as manual dexterity, technical knowledge and creativity.

Literature on digital DIY is still emerging and has been mainly focused on the first two elements above, i.e. materials and meanings. Research focused on the material set namely addresses the technological development of automated machines for digital fabrication, comparison of these machine performances and outputs, and the places where such practice takes place amongst others (Hielscher and Smith 2014).

Research focused on the motivational component (i.e. meanings) mainly refers to attitudes and aims of the digital DIY communities which include the will to make and innovate, supporting the *glocal* community through sharing and expressing a political statement.

Lastly, research on competences regards the skills involved in this practice, typically the technical ones such as coding, making virtual models, interacting with digital fabrication technologies (e.g. 3D printers and laser cutters).

However, making is creating and as so it requires adequate skills for the development of creativity. The creative elements of all DIY enhance people's notion of themselves as an agent of design rather than merely a passive consumer (Atkinson, 2006). It is plausible that the level of attitude, experience and skills in delivering creative ideas and managing the creative process affects the way in which the digital DIY practice is carried out and the output is generated. However, little research addressed creative process in (especially digital) DIY and further research could explore if digital DIYers approach the creative process differently from trained designers, how the creative process may change when addressed collaboratively, or the difficulties encountered by digital DIYers when developing the creative process. Such research questions could enable the identification of potential areas of intervention for designers aiming at supporting them.

Further research is needed to shed light on the technical, cognitive and social skills mainly involved in this practice, which may help to address more debated questions such as how the materials set influences the acquisition of new skills. In fact, the spreading of digital

fabrication raises arguments on its potentially skilling or even deskilling effect (Hielscher and 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, 2011:34)

The main argument on the deskilling effect refers to the highly digital nature of the creative process through such machines as 3D printers, CNC mills and laser cutters. The digital DIYer is supposed to develop a virtual model of the object to be made and eventually the machines will produce this as a whole or as components to be assembled. Focusing on the virtual representation of the object undermines the ability for the practitioner to experience material 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 is the development of a creative process which is led by a virtual idea 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 characteristics.

As a response to such arguments, Ree (2011) has claimed that although such 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).

Furthermore, digital fabrication technologies need to be set according to the materials used. Therefore, the fruition of such machines requires knowledge of material physical qualities which possibly were not so fundamental for non-digital DIYers, such as melting temperature for plastics to be 3D printed.

Digital fabrication technologies could represent 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 (2008:80) inferred from a study about craft consumption, 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."

Although we are aware that the debate could benefit from an even wider framework including political context and power relations (Soderberg, 2013), drawing on the arguments above we envisage the potential for digital DIY practice to foster the development of creative skills; the involved material set (e.g. technologies) opens up the range of artefacts that can be made thus stimulating the creativity of people. 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.

3.2 Digital DIY as a phenomenon of social innovation

The reconfiguration of the elements of the digital DIY practice mentioned above (i.e. materials, meanings and competences) triggers the evolution of the practice and the recruitment of more practitioners over time. The establishment of the Internet, web 2.0 and social media has contributed to the spreading of groups who collaborate on a wider – sometimes even global – scale, for common purposes. This is an example of commons-based peer production, whereby

> "large groups of individuals…co-operate effectively to provide information, knowledge or cultural goods without relying on either market pricing or managerial hierarchies to co-ordinate their common enterprise" (Benkler and Nissenbaum, 2006:394).

It has led to several phenomena, initiatives and communities (e.g. open source, peer-to-peer, etc.) emerging with the aim of contributing to a more community-oriented society. Peer production has been envisaged as

> "an opportunity for more people to engage in practices that permit them to exhibit and experience virtuous behavior" (Benkler and Nissenbaum, 2006:394).

This is in our view the most significant element of social innovation in digital DIY, i.e. the opportunity for people to acquire competences and trigger virtuous behaviours through and with others, in a collaborative way and often for the benefit of the local or global community.

Likewise, places play a key role. FabLabs and Hackerspaces, for instance, are distributed systems of fabrication, i.e.

> "sociotechnical systems that are scattered in many different but connected, relatively autonomous parts, which are mutually linked within wider networks." (Manzini, 2015:17)

This is enabling the coalescing of committed individuals who support each other in 'communities of practice' (Lave and Wenger, 1991) or even 'creative communities', i.e. groups of people who cooperatively invent, enhance and manage innovative solutions for new ways of living (Manzini, in Bœuf et al. 2006). Although the distribution of fabrication systems may be the result of the need to make products as local as possible, thus lightening the whole system, other fundamental reasons regard the quest for autonomy, self-sufficiency and ultimately for resilience (Manzini, 2015).

Making oriented activities, such as digital DIY, are opportunities for individual and social empowerment, as they provide opportunity for

> "giving people independence and self-reliance, freedom from professional help, encouraging the wider dissemination and adoption of modernist design principles, providing an opportunity to create more personal meaning in their own environments or self-identity" (Atkinson, 2006:5-6).

This effect is closely related to its connecting nature (Gauntlett, 2011). Watson and Shove (2008:74) infer that different approaches to DIY converge in its fundamental role of

> "mediating and maintaining relationships between people, whether it is in family relations within the household, construction and maintenance of self-identity and self-esteem, or broader constructions of space and identity".

The digitalization of the making based practice is a contemporary form social innovation, which

> "meet social needs and create new social relationships or collaborations. […] innovations that are both good for society and enhance society's capacity to act." (Murray et al. 2010:3)

It can be inferred that such benefits are dramatically sustained by a socio-technical system based on the importance of sharing, collaborating and supporting each other. Making creates a supportive community of learners that can leverage the interests and skills of each member of the group towards shared goals. Therefore, digital DIY can potentially sustain the development of the 21st century skills.

Inter-disciplinary attitude is also a potential benefit of making as an educative and collaborative practice. Disciplinary boundaries are considered *inauthentic to makerspace practice according to* Sheridan et al. (2014:526-7) and the

> "blending of traditional and digital tools, arts and engineering can create a learning environment with multiple entry points that foster innovative combinations, juxtapositions and uses of disciplinary content and skill."

This element characterises the contemporary evolution of DIY and therefore individualistic-(although digital-) oriented activities are out of scope for this study.

Observing the development of digital DIY activities may be informative about the dynamics of acquisition of new skills through collaborative tasks.

4. Hypotheses and future developments

The analysis of the current scenario of digital DIY as a social innovation phenomenon will enable us to define a model through which it will be possible to identify the crucial dynamics and factors for learning and skilling. Eventually the model could be used for enabling the replication and adaptation of such dynamics into a different environment, such as school and work.

The model takes into account the interplay of digital DIY main expressions enacting on different levels also addressed above, which include:

1. Digital DIY as a phenomenon of social innovation for the fundamental role of collaboration and sharing;
2. Digital DIY as a practice carried out by the individual connecting materials, meanings and competences;
3. Digital DIY as a creative process, developed through cognitive tasks.

On the basis of preliminary reflections on literature review, we propose that three are the main factors which influence such learning and skilling process across the three levels above:

- Technology;
- Motivation;
- Collaboration.

The evolution toward digital technology (from Materials component) facilitates both the connection of people and the accessibility to tools with appreciable results in a relatively short-term substantially. On the one hand, it is radically easier to interact with other people across geographical boundaries for collaborating and sharing knowledge. On the other hand, rapid manufacturing technology allows the creation of products even at earlier stages of the acquisition of the required technical skills, in contrast with the generally lengthy skilling process in manual crafting.

The motivational aspects of DIY practices widely intended (from Meaning component) are believed here to be crucial for sustaining the practice over time. The practitioner is supposed to persevere (or being strongly motivated) in overcoming the difficulties related to self-organization and the use of spare time on the one hand, and on the other social interactions when collaborating and participating (either for the rewarding sensation of being with the others or for social impact).

Collaboration, both with peers (i.e. other digital DIYers) and with facilitators (who are acknowledged as so by the digital DIYers) is here believed to be possibly the most significant elements characterising the latter evolution of conventional DIY towards the digital one. Collaborating is an opportunity to acquire knowledge and develop skills through other peers, to strengthen social bonds and to make an impact on a wider level than the individual one, which are less likely to happen in conventional individualistic DIY.

Our future research steps aim at the identification of the dynamics interlinking the factors and the levels above, with direct observations and interviews amongst others in the places where digital DIY is carried out, in order to deliver the model described above. Eventually, we aim at interpreting and translating the model for (some of) the areas of the DiDIY project (i.e. organization and work, education and research, creative societies, and legal rights and obligations), which may benefit from the potential skilling processes of the digital DIY practice.

Investigating the complexity of Digital DIY calls for a transdisciplinary research methodology able to enhance people needs and visions. A bottom-up approach where people are directly involved in the research and production of knowledge seems necessary to achieve a complete understanding of digital DIY.

To this purpose, we believe that the involvement of practitioners in the investigation and creation of enabling solutions is crucial. Therefore, we aim at contributing by developing design- (and in particular codesign-) driven tools facilitating the analysis of the learning process and the identification of the skilling dynamics and generate models for including

such dynamics in working and educational environments which may benefit from the skilling process enabled by digital DIY practice.

Co-design is a research approach which involves 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. The close relationship with the final user of the co-designed solution makes this approach a powerful means for accessing and making explicit people's (also tacit) needs, desires and aspirations for the construction of new possible futures.

In this perspective, people are considered all the way as co-design researchers and companions. The division between expert designers and laypeople becomes blurred and so do the borders between research and practice. In order to do so, Scheldeman (2012) suggests that the designers should allow for "meaningful relation… design should not prescribe or predict, but enable."

Enabling may result a challenging task for professional designers and this calls for suitable toolboxes and modes of experimentation, which may not still exist. In our case, we planned to make use of human-centred co-design workshops for the purposes mentioned above. Two series of four workshops each, one per thematic area of the DiDIY project, will be held in two different European countries (one in Northern Europe and the other in Southern Europe).

The first set of workshops will be explorative, aiming at exploring and understanding the skilling dynamics in the selected area on investigation, while the second set of generative workshops will aim at delivering solutions for implementing the skilling processes. For instance, a teaching module for primary school or a toolkit for professionals.

Acknowledgements: This paper presents reflections from the research tasks carried out by the authors for the DiDIY Project proposal, which addresses the call ICT 31-2014 Human-centric Digital Age of the Leadership in enabling and industrial technologies, Information and Communication Technologies Horizon 2020 work programme. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 644344. The views expressed in this paper do not necessarily reflect the views of the EC.

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