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Approaching maker´s phenomenon

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Abstract. The rising of maker's movement in recent years has been spoiled by the popularization of open source technologies like 3d printing and many others. The expiration of a set of patents have made possible the emergence of several and different communities that play and tinker with technology. At the same time, these new socio-technology based collectivities have its origins in other pre-existing ones such as "Do It Yourself" and "Hackers". Our goal in this paper is to perform a comprehensive analysis of all these trends reviewing the existing literature and identifying the main features, values and aspirations.
Moreover, we argue some policy recommendations in order to maximize the impact of these spaces into the urban sphere trying to boost its potential in education and social innovation.

Keywords: makers, DIY, hackers, P2P, P2P production, prosumers, open innovation, social innovation, makerspaces, hackerspaces.

1 Introduction

In recent years, because of the potential created by new technologies in the field of digital design and the realm of digital production [1], the new possibilities of personalized fabrication for citizenship have constantly increased [2]. In addition to this, the advent of collaborative spaces in both the physical and virtual worlds has led to an explosion in knowledge and innovation expressed through very wide-ranging initiatives such as MakerBot [2], RepRap [3], Maker Faire [4], Thingiverse [5] and Rally Fighter [6] among others. All of these projects use the new potential allowed by personalized fabrication along with a peer-based production basis. Throughout these dynamics, new interesting opportunities are currently being created [7] for today's economic development [8].

With the objective of broadening our knowledge about the aforementioned initiatives and identifying common features of these spaces and movements, as well as ascertaining how much capacity for innovation they possess, we decided to discuss their role in the development of the long-desired transition towards the society of innovation [9]. To do so, we focused our research on the characterization, analysis and definition of the main characteristics and values of these new movements.

2 DIY, Hackers and Makers

Although "Do It Yourself" (hereinafter referred to as DIY) has become a mature movement considering it began in the roaring 1920's with pirate radio broadcasting [10], it has remained more or less present since the 1970's [11] and it was popularized in the 1980's and 1990's [12] with many authors even identifying a "third wave" [13]. We must not set aside another type of technical and social movements which have arisen in recent eras establishing a new and wide-ranging paradigm of innovation based on collaboration and cooperation [14], crowdsourcing or collective action [15, 16] and production amongst peers [17]. These paradigms are distant from the classical linear model of innovation [18] and have a "bottom-up" approach. These sorts of self-empowering philosophies have also gained momentum in recent years due to the new possibilities spawned by personal fabrication [19] and other types of open technologies conceptualized as "open hardware."

It can be complicated to define a movement like DIY [12] and certainly one definition may not encompass all three areas into which that movement is normally divided (art, design and crafts). But after having reviewed the bibliography we have decided upon the following definition:

"We define DIY as any creation, modification or repair of objects without the aid of paid professionals." [11]

From this definition, we can infer that altruistic, amateur facet of producing artifacts and diverse technologies are stressed. Following the appearance of DIY, other new movements have come about and known in the digital realm as "Hackers" [20] and later as "Makers" [21] when they transcended to the physical plane. In our opinion, both terms share the non-professional, open character of creating, modifying and repairing digital or physical objects. But these movements differ mainly from the original DIY in terms of the collaborative nature of their production amongst peers, the use of open-source technologies and their access to knowledge through the Internet.

We would like to offer both definitions of the concepts which we have mentioned in order to illustrate these similarities and differences. As for the first definition, we base ours on the one stated by Pekka Himanen in his book "The Hacker Ethic" (2002) and what he proposes to be the "jargon file."

"The hackers 'jargon file' compiled collectively on the Net, defines them as people who 'program enthusiastically' and who believe that 'information-sharing is a powerful positive good, and that it is an ethical duty of hackers to share their expertise by writing free software and facilitating access to information and to computing resources wherever possible." [20]

For the second definition, we would like to highlight the work of Silvia Lindtner who has explored intensively the maker´s movement in China. She enounces this new group of DIY enthusiasts as follows;

"By makers, I refer to those who think of themselves as working in the domains of making, hacking, tinkering, repair work, open source hardware, manufacturing, and do it yourself (DIY) production." [22]

Also, it is usual to find references to "maker cultures" in the literature and this is why we would like to pay attention to the definition that again Silvia made in a prior paper;

"*Today, we find ourselves in the middle of a new hacker culture (or 'maker culture') that both harkens back to this model of technology production as individual empowerment and departs from it in significant ways. This contemporary maker culture is concerned not only with open Internet technology and digital things, but also with physical things such as hardware designs, sensors, and networking devices that bridge the digital and physical worlds. While the earlier movement was concerned with the workings of software code and the workings of the Internet, this contemporary maker movement is concerned with hardware designs and the workings of the Internet of Things."* [23]

It seems clear that this new wave of DIY is shaped by the popularization of different open source technologies but it is also important to acknowledge that this new interest in physical objects is bridging the digital and physical universes. This materialization of digital artifacts is the quintessence of maker´s phenomenon. After transcending digital communities and specific events, co-creation spaces have become common. "Hackerspaces," "Fab Labs" or "Media Labs" are some of the names of these new collaborative spaces that allows manufacturing digital goods in a collaborative manner [24]. With more than 2044 Hackerspaces distributed around the planet[1] and approximately 355 planned to be open, the phenomenon is present in many urban environments but not only [25, 26]. Alongside this expansion, an increasingly common celebration of events dedicated to the hacker and maker culture have popped up in a wide range of cities, including Maker Faires, Hackathons, Open Hardware Summits and other similar events.

These spaces have a diverse stuff such as 3D printers, digital design instruments, electronic kits, soldering equipment, laser cutters and a long list of tools. This machinery allows users to experiment and learn with other users through informal and practical learning, developing at the same time self-managed projects. Moreover, digital platforms where you can find free code design like Thingiverse[2], makes possible to modify, customize and produce technological objects. Given the plethora of projects and the ground-breaking nature of many of them it is not surprising that many media and authors have labeled the potential spawned of this new paradigm as a "Third Industrial Revolution" [21, 27, 28], a "democratization of manufacturing" [19] or a way of promoting "grassroots innovation and entrepreneurship" [29].

Despite these disruptive ideas and probably techno-optimistic views [30], the convergence of movements such as commons-based peer-production and digital fabrication is also seen as an opportunity to connect people with the activity of manufacturing goods and products once again. Also, it can be seen as part of a commitment to a more sustainable form of production and consumerism [31] and longer-lasting in terms of the durability of its products [21]. Last, contributing to the

[1] Data retrieved from: http://hackerspaces.org/wiki/List_of_Hacker_Spaces (consulted on 05/24/16)

[2] For further information, see: http://www.thingiverse.com/ (consulted on 05/24/16). This platform have a strong influence of The Whole Earth Catalog (http://www.wholeearth.com/index.php) which was a groundbreaking publication leaded by Stewart Brand.

social good and corporate citizenship through making is another of the highest aspirations [32].

3 Understanding maker culture

We understand "making" as a social construction of technology (SCOT) [33, 34], a network of relationships [35] where users matters [36] rather than as a technological paradigm (TTP) [37]. Technology is not the main driver of user´s engagement. The creations that arise in these communities are the result of interactions amongst the different social groups that meet up in these spaces [33, 34, 38]. That is why it is so important to understand the learning and working dynamics that occur on maker collectivities. Here, we propose three features that try to explain the different motivations and aspirations of maker culture.

3.1 Commons-based peer production

The physical materialization of a large number of digital technologies present on the Internet and the Web [29] has unlocked new possibilities for social production processes. That is why this transition from the virtual realm to the real world has also enabled to transfer the modes of digital production to the physical environment too [2]. Thus, cooperative and collaborative work is usually present in these spaces.

Commons-based peer production [17] is the work dynamics that has arisen due to the boom of "Web 2.0" and its collaborative applications [39]. This working basis has made possible to develop outstanding collaborative projects such as Linux, Wikipedia and many others but what´s more important; it has opened unique and exceptional possibilities for co-creation [2]. Therefore, it is not surprising that these spaces promote collaboration and empowerment for their members across its different activities, aiming to connect people in the local community. In other words, they apply the logic of "the platform" as a system for innovation like collaboration happens in the digital space.

Makerspaces are rapidly growing at urban areas but they are also starting to appear in rural regions. The case of Calafou [25] is one of the best examples that we can mention. The potential of initiatives like Farmbot [26] leads us to think that this phenomenon could also be very relevant for revitalizing rural ecosystems and nurturing its social capital.

3.2 Open source technologies

The use of non-proprietary technologies is something that clearly defines movements like hackers or makers. Both groups have used and promoted "open-source software" and "open hardware" in order to use technology as an instrument for meeting community's needs. Technology is envisioned as an element of empowerment and not as an objective itself [40]. Some of the open technologies which have allowed new possibilities to DIY movements include CNC (Computerized Numerical Control)

drills, 3D scanners, laser cutters, printed circuits, software controllers and of course, 3D printers, as well as many others.

These technologies have been introduced into the public domain because the patents have expired and it has been possible to transfer manufacturing "from factory to desk" [29]. The popularization of this type of technologies has also led to a "democratization of innovation" as has been pointed out by some authors on similar phenomena [41, 42]. In our opinion, this has led to the crystallization of a new paradigm of collective innovation with fewer entry barriers and in a much more amateur basis.

3.3 Informal learning

In the last part of this section we would like to pay attention to the learning dynamics that can be found in this type of spaces. Although they offer internal and external training in diverse formats, this is something that is delivered in an informal way. The idea of a community of practice [43] seems to be present at every time and takes place both in the physical spaces and in the digital platforms that are used by this type of spaces.

Many of the activities are associated with the use of new open technologies, such as training to start using 3D printers, laser cutting, creative electronics and chiptune[3] music, to name a few examples. The objective of all these learning sessions is rooted in the promotion and strengthening of a community of practice that can serve as a nexus linking the different individuals who take part in this space at some time whether temporarily or not. The dynamics of empowerment and informal learning that persistently succeed constitutes an exciting target for research which we would like to highlight in future studies. We also agree with other authors in the change that is experimenting education thanks to technology towards a more productive model where students are active participants and not passive ones [44].

4 Current crossroads and challenges

After having described these new movements and spaces we would like to emphasize several challenges and potential threats we envisage in the forthcoming decades. Current gaps in the legal framework and the disruptive nature of these new open technologies lead us to think that it will be of outmost importance the alignment of policy makers, academia, industry and society. It is well known how hackerspaces can foster collaboration between a wide range of social actors [45] but this potential needs also a backup by an accurate framework provided by the civil society.

[3] Chiptune music refers to music made by the sound chips found within early gaming systems and microcomputers. Mainly 8-bit music.

4.1 Digital commons need to be protected

We would like to start drawing attention to the lack of criteria for the standardization of final products and safety of materials [46]. For instance, we have observed a real risk of excessive legal protection by policy makers in the literature reviewed [47]. This defense of technology rights could hamper innovation and new business opportunities that could be spurred by new organizational processes associated with these new disruptive open-source technologies. In our opinion, proper dissemination of these new technologies must be performed vis-à-vis with policy makers, legal experts and society as a whole. The current situation does not entail any intellectual property right violations (in most cases due to gaps in the current legal frameworks) but it is easy to envisage forthcoming legal battles. The different lobbies affected by these new open innovation ecosystems are probably prone to defend their current positions in case they feel threatened by the push of non-proprietary tech [48]. Not ensuring the benefits of free access could hamper many of the potential benefits of the social appropriation of these technologies in society [47]. And at the same time, it will be a way to deny the increasingly prosumerism basis of the new innovation society [49, 50].

4.2 Evaluating the impact

On the other hand, we would like to explore different questions regarding the return of investment in hackerspaces. While it is true that they are often self-organized movements that attempt to obtain the necessary resources for their existence, in our research we also detected that many municipalities or regional authorities help financing this type of spaces. The idea behind this funding is an attempt to recover urban areas that have been deteriorated due to de-industrialization processes. In our humble opinion, further research has to be developed in order to fulfill several gaps in the literature related with this topic. It is still not obvious what kind of social capital can create these spaces. As we have argued, we tend to think that the variety of activities play an important role working as a “citizen hub” but it is really difficult to determine to what extent. It is also true that community cohesion [51] is at the core of these spaces because local interventions are at the backbone but we think that there is room to explore this kind of impacts on the territory. Although some impacts have been considered in the literature [52], it is necessary to go further of the classical economic indicators and analyze the diverse impacts on the area.

Moreover, we would like to point out the need for an effective systemization of their repositories of knowledge. The main threat of Web 2.0 platforms is the fragmentation [39, 53] of the information that is produced and it is important to raise the importance of the digital space as an extension of the urban scene nowadays. The popularization of digital technologies and the flows of people caused by the globalization have provoked that the accessibility of the information on the Web and the Internet became really important by different urban collectives and individuals. In this sense we agree with other authors in the need for investment of knowledge [54] and foster community cohesion through local intervention [51].

4.3 Towards a Social Manufacturing?

"Social Manufacturing" has been used in reference to cloud-based services platforms [56], in relation to the value chain of fabrication processes [57], and also to express the combination of social innovation with advanced fabrication [58] or "rapid prototyping" [59]. But the meaning that we would like to propose in this article is related to new forms of customized fabrication that have become possible due to open technologies, involving at the same time a collaborative system of production and informal learning. The ability of transforming digital objects into physical ones [5] is been combined with the potential of virtual communities of innovators that are managed through the Internet [27]. This mixture is making possible products that tend towards a marginal cost of zero [60] and that leads us to think that we are witnessing a new paradigm in manufacturing. A new basis between production of goods and its relationship with society and design [61]. That is why we would like to propose "Social Manufacturing" as a term that implies expressions of digital production that is characterized by:

- A p2p production basis.
- Using of open source & non-proprietary technologies.
- Promotion of informal learning (offline and online).

We believe that these three factors are the quintessence of the new innovation ecosystems that are based in p2p and open manufacturing. These spaces are also learning ecosystems that can pave the way for future social innovations and business opportunities. The real challenge is how to scale up these ecosystems to other scenarios like traditional manufacturing factories [23] and how society can evolve to a space where knowledge can be easily shared, replicated and transferred.

5 Conclusions

As we have stated previously, we tend to think that it is critical to safeguard the society´s future interests and resist forthcoming expected pressures that some lobbies will impose to policy-makers. These are a few of the key factors which might arise when it comes to facilitating a change in society's relationship with the production of consumer goods [61].

Some potential benefits have yet to be fully envisaged but we already see some signals in sectors such as education and the creative and cultural industries. We strongly think that an emphasis must be put on social dissemination [62] of these open and non-proprietary technologies in order to facilitate the evolution of the society to a much more prosumerism basis. The public perception of this phenomenon tends to adopt techno-optimistic views [30] but we clearly envisage room for fruitful experimentation between different stakeholders [23]. The need for a "learning by doing" educational approach where skills have recently gained significant importance incline us to think that the use of technology in education is pushing a more productive model where peers learn together [44]. This is something that "making" could help to achieve in the next years.

Last, we emphasize the need to push forward research in order to determine the socioeconomic impact of these spaces in the territory due to the gaps that we have stressed. We envisage research opportunities that can contribute to the development of theoretical frameworks that help us to understand the role of "Social Manufacturing" and its impact in society.

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