STRATEGIC DESIGN RESEARCH JOURNAL

From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing.

Silvia Gasparotto [a]

[a] University of the Republic of San Marino, Department of Economics, Science and Law: San Marino, Republic of San Marino.

Corresponding author: silvia.gasparotto@unirsm.sm

ABSTRACT

The paper presents an analysis of the evolution of Open Design and Open Manufacturing from 2000 to 2020. The two phenomena are examined by taking into account real experiences in these fields in order to track the most relevant developments. The first step of the research consisted in the identification of the best-known and most often-cited experiences, which have been collected into four different subsets, according to their type, and organized into a chronological visualization. The second step of the research involved the identification and description of three case studies, one for each of the main types: Instructables, OpenStructures and Precious Plastics. Finally, the paper identifies three main time frames, and expresses the constructive and the critical aspects of the two open processes, concluding with a speculation on three possible futures.

Keywords: Open Design; Open Manufacturing; Critical Design; Design History; Future Studies.

INTRODUCTION

Open design (OD) and open manufacturing (OM) have been examined, tested and developed since the 2000s. A new way of "doing design" has grown with the spread of Internet and personal/desktop manufacturing machines. Furthermore, the paradigms of industry 4.0 will change the way we produce, design and work. Numerous publications have sought to explain the phenomenon from different points of view, for example describing processes through frameworks (Raasch, Herstatt & Balka, 2009; Menichinelli, 2016), analyzing the wider concept of openness in design (Marttila, & Botero, 2013; Tooze et al., 2014; Aitamurto, Holland & Hussain, 2015; Gasparotto, 2019), examining the meaning of "making" (Menichinelli & Ustarroz Molina, 2018), or tracing the evolution of new production methods (Walter-Herrmann, & Büching, 2014; Özkil et al., 2017). After twenty years of sometimes perplexed, but more frequently enthusiastic assertions of the potential of OD, OM and the disruptive impact of the maker movement in the development of innovative products and services, an assessment of the current scenario could be useful.

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

To clarify the subject of this paper, it might be helpful to define the meaning of OD and OM. The term Open Design is commonly used to describe a design process at the end of which the designer chooses to share the blueprints of the products under Creative Commons licenses. By doing so, the designer decides to free the project and let other people reproduce or modify the original one (Van Abel, Evers, Troxler & Klaassen, 2011; Marttila & Botero, 2013; Menichinelli, 2014). Open Manufacturing can be considered the natural conclusion of this process because it leads to the production of objects through a distributed network made of digital manufacturing technology, such as 3d printers, laser-cutting or CNC machines (Heyer & Seliger, 2012; Walter-Herrmann & Büching, 2014).

Recent research papers examined the state of the art by framing the literature on the subject (Bakırlıoğlu & Kothala, 2019; Boisseau, Omhover, & Bouchard, 2018). Instead, the present contribution intends to analyze the phenomenon by considering some real experiences which apply the principles of openness – open source, collaboration and access (Gasparotto, 2019) – to the reality.

Historically speaking, the evolution of open design starts some years after the open source movement, born during the 1980s in reaction to the design and dissemination of proprietary software. Boisseau, Omhover and Bouchard pointed out that "the term open-design has been used since the late 1990s", started by "global digitization and the spread of efficient and low-cost Internet access" (Boisseau, Omhover, & Bouchard, 2018, pp. 44). Despite some precursors, such as for example, Enzo Mari with "Autoprogettazione" or the experience of "Global Tools", according to Menichinelli (2014, p. 57), the first case of open design can be considered "Thinkcycle: a web-based collaborative platform for sharing and developing sustainable design projects" developed by MIT Media Lab in the 2000s (Sawhney, Prestero, Maguire & Griffith, 2008).

Since then, many experiences of open design have followed such as, for example, the project called "Hack chair" by Ronen Kadushin developed in 2005, or Open Moko, an open source cellphone, designed and produced in the same year. Among the most cited examples, it is important to remember the self-replicating 3d printer RepRap, which is now the basis for more than 400 customized versions. At the same time, the Fab Lab model, founded at MIT by Neil Gershenfeld in 2001, has become increasingly widespread, reaching approximately 1500 Laboratories in more than 90 countries in 2019. Together with the diffusion of Fab Labs, the 3d printer technology also evolved, reducing costs and increasing efficiency and material options. Various 3d printer models are currently available on the market. They are based on different kinds of technology, for example: Selective Laser Sintering, Full

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

Deposition Modeling or Stereolithography, and they are equally able to print objects, food or biological systems (Menichinelli, 2016b).

Other instruments considered primary for OD and OM are the so-called "crowd-based platforms" (Howard, Achiche, Özkil & Mcaloone, 2012; Hajiamiri M., 2014) which have the merit of involving a great number of people, through the Internet, around a project for creating communities (Dolata & Schrape, 2014).

From 2005 to 2019, different kinds of OD projects started in different fields, such as engineering, architecture, design or fashion, and many OM services and sharing platforms are currently available online and offline.

At this point, we should be able to evaluate the extent of the phenomenon and we can try to draw an evolutionary line. The study proposes, in particular, an assessment of the evolution of OD and OM by tracing and describing real experiences. This evaluation makes it possible to identify the constructive aspects of open processes in design and the critical ones, and to imagine, in conclusion, possible future scenarios that could represent turning points for the phenomenon.

1. METHODOLOGY

This paper aims to analyse if and how OD and OM evolved by understanding how their characteristics have changed over time. In doing so, it was considered useful to take into account real experiences in order to track the most significant signs of change. We chose to use the term "experiences" to identify, generically, different kinds of case studies related to the topic, investigating areas of interest such as tools, devices, events, objects, etc. Later in this paragraph, they will be collected into more specific subsets.

Experiences were selected on the basis of a literature review analysis and fieldwork initiated in 2013. The choice was made to report the experiences most cited in the literature on the subject and those most representative of a type. Nevertheless, is important to point out that the field of OD and OM counts a considerable number of experiences, many of which are not even traceable because they were carried out by private individuals.

A first part of this work had already been done by collecting the experiences most cited in the literature on the subject from 2013 to 2017. The result was published in the paper titled: "Open source, collaboration and access. A critical analysis of "openness" in the design field" (Gasparotto, 2019). Further research has since been conducted to update the list of experiences with papers published in 2018 and 2019.

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

The second step consisted in identifying the same type of experiences, such as different kind of 3d printers or prototyping devices. The selected experiences were examined through Google Trends and consideration was given to the most searched of a type. For example, it was decided to include Arduino/Genuino as the best-known example of open source hardware, even if there are many other tools of the same type, such as AdaFruit or SparkFun. Considering common characteristics, such as purpose, process and nature, experiences were grouped into four main subsets:

- OM and prototyping tools and services
- Sharing platforms and systems
- OD objects
- OD and OM dissemination

The first subset includes those experiences related to the prototyping and production stage of the design process. The second subset collects the platforms and systems that enable the sharing of blueprints and information within the community. The third subset includes different kind of objects designed through an OD process. The last subset collects the "side events" and more specifically those experiences that have contributed to the economic, cultural and technical diffusion of OD and OM.

Table 1. Experiences of open design and open manufacturing

Experiences of OD and OM			
OM and prototyping tools and services	**Sharing platforms and systems**	**OD objects**	**OD and OM dissemination**
Fab Lab	Thinkcycle	Open Source Ecology	P2P Foundation
RepRap	Creative Commons Licences	OpenMoko	Make Magazine
Arduino - Genuino	Etsy	Hack Chair (Ronen Kadushin)	Maker Faire
Ponoko	Instructables	Local Motors	Open Design Now (Book)
Shapeways	Thingiverse	OpenStructures	Autoprogettazione 2.0 (Domus contest)
Precious Plastics	Github	OpenWear	Makers. The New Industrial Revolution. (Book)
SlowD		WikiHouse	
		Open Biomedical Initiative	
		Open Desk	

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

2. ANALYSIS

The first step of the research consisted in the construction of a chronological visualization of the experiences collected in Table 1 (Figure 1). This visualization shows that most of the experiences of OD and OM were initiated between 2005 and 2011. Furthermore, it seems that no new major experiences have emerged in recent years, even though most of them are still existing and, in some cases, have evolved.

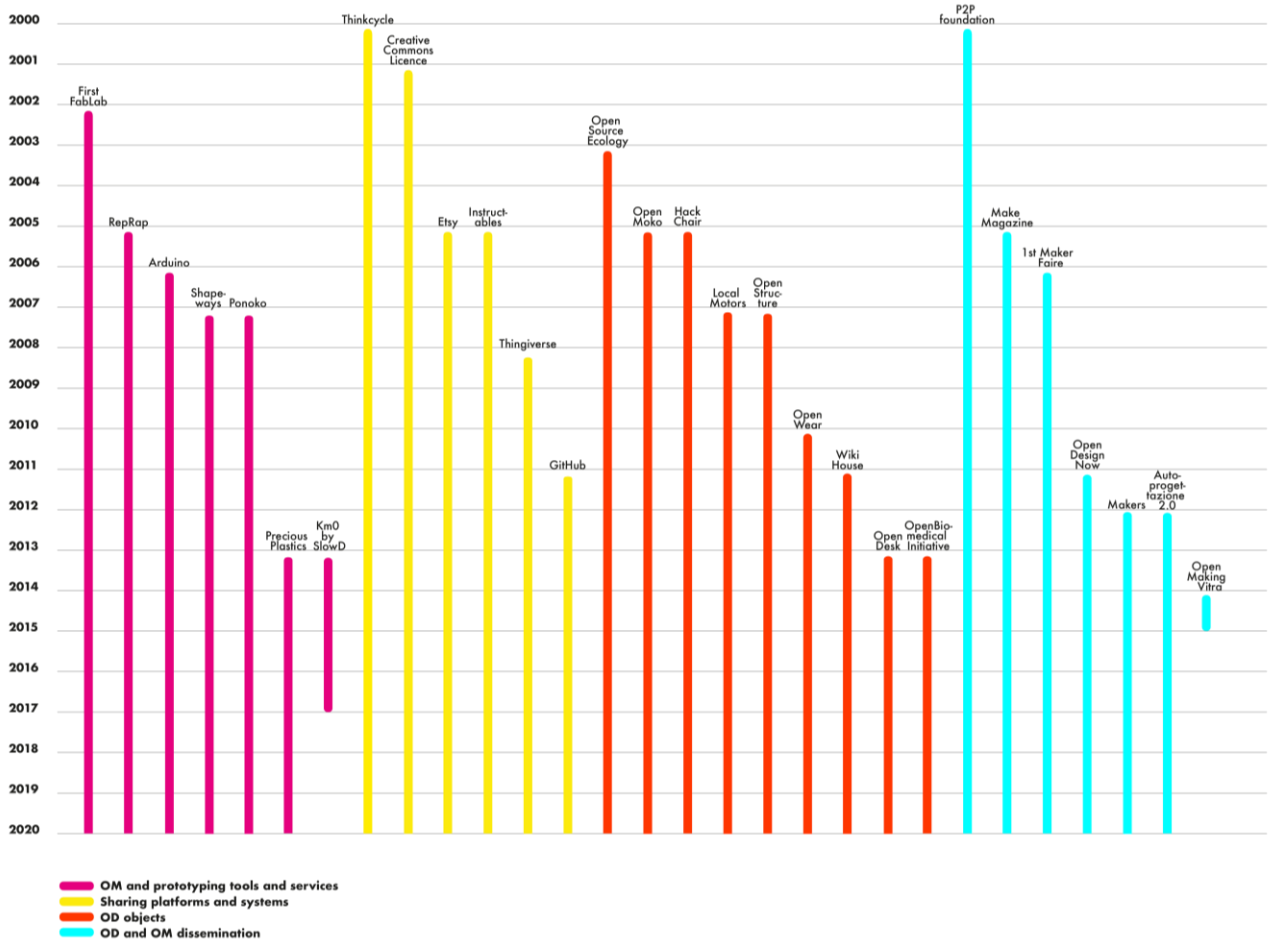

Figure 1. Chronological visualization of OD and OM experiences

The second step of in the research involved the identification and description of three experiences, one for each of the three main subsets of Table 1. It was decided to exclude from this analysis the fourth subset (OD and OM dissemination) because it is considered collateral.

The experiences are very different from one other and, although they can be grouped into subsets, we cannot consider the ones we have selected to be paradigmatic. Nevertheless, we can examine them relying on common key points, and try to understand if the process

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

through which they act is based on common ground. The key-points chosen to describe the case studies are the following:

- Aim – The original purpose and its evolution over time.
- History – The story of each case study and the most significant steps.
- Technology – The use of technology in the case studies.
- Business – How case studies are financed.
- Design Culture – If the design culture is existing and in what terms (aesthetics and functionality).

Information on the case studies was collected through the analysis of web platforms, especially the FAQ (Frequently asked questions) section of the website, and by email.

2.1 Instructables - Sharing platforms and systems

As reported on the homepage of the website "Instructables is a community for people who like to make things." It was born at the MIT Media Lab to "to share their projects, connect with others, and make an impact on the world." (https://www.instructables.com). The original aim was to share the documentation of a kitesurfing project with other people. To do so, the founders of Instructables realized that they needed to create a web-based documentation system.

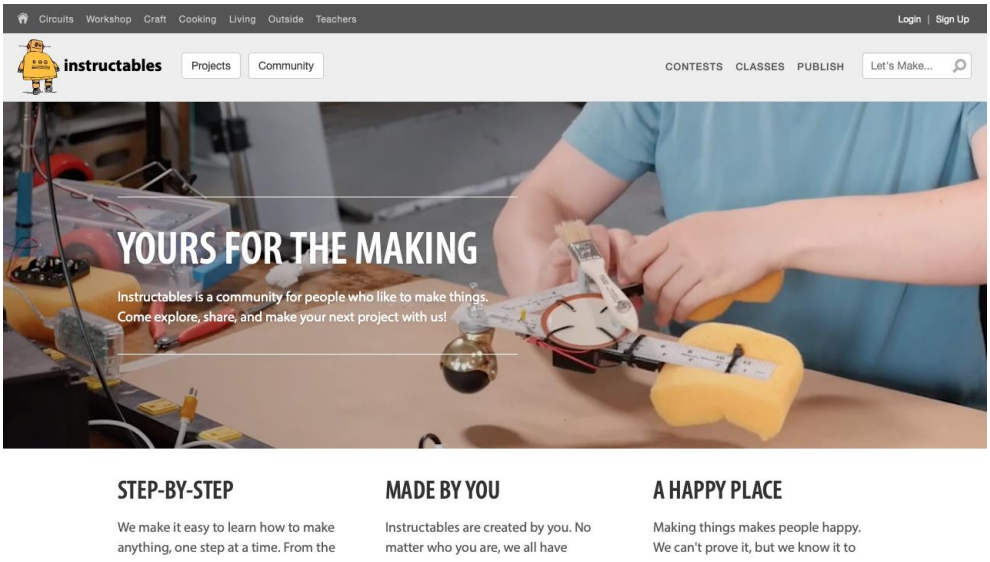

Figure 2. The homepage of Instructables

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

Based on this intuition, the platform was released online in 2005 and in 2019 it now counts over one hundred thousand projects. The nature of these projects is extremely varied: "From cooking to 3d printing, to making just about anything fly, Instructables became the recipient of countless hours of tinkering, soldering, stitching, frying, and fun, making just about anything."

Instructables does not publicly declare its business model, but in 2011 the platform was acquired by Autodesk and even if it didn't change the essence of the website and its community, this acquisition gave it the resources to make improvements.

The platform offers its community a place to share every kind of "recipe" through the use of text, image and video-tutorial. Other sections of the website propose lessons on different subjects and with different levels of complexity, and contests, regularly updated. The website is not linked to a single technology such as, for example, Makerbot with the 3d printing, but it is a general container of all kinds of instructions.

The community of the platform is composed of many different people and professionals, generically called "makers" or DIYers (Do it yourselfers) (Kuznetsov & Paulos, 2010). For this reason, this platform features artifacts of every quality, at both high and low aesthetic and functional levels. Design culture, in this environment, is not considered to be relevant: far more importance is given instead to innovation and creativity.

2.2 OD objects - OpenStructures

OpenStructures is an online platform published in 2007 and developed by the designer Thomas Lommée to try and solve the problem of creating a shared modular language for open, collaborative and sustainable design.

The OpenStructures project is based on a modular matrix used for designing parts that when assembled can become different kinds of objects, for example cabinets, shelves, clothes hangers and other furniture. This matrix ensures that any part can be joined to another from the same system. Parts can be generally manufacture by anyone through 3d printers, CNC-milled or laser cuts, but in some cases, they can be buy from the website due to their complexity.

Thanks to OpenStructures, anyone can design and submit a possible piece to the platform which, after being evaluated by the founder of the OS system, contributes to increase the platform's database. The new website, updated in 2019, collects more than 70 parts and 11 objects most of which were designed by a junior or a professional designer.

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

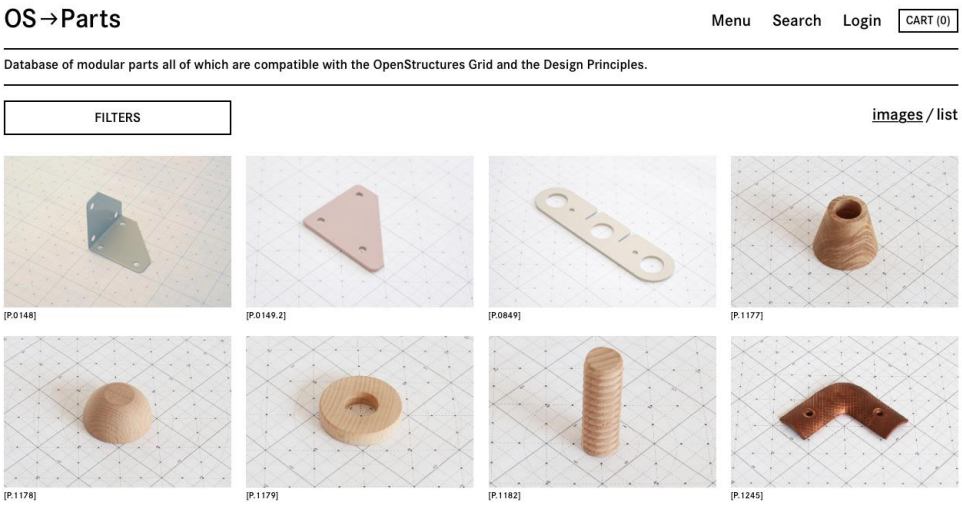

Figure 3. The database of OpenStructures

While the first version of the website was completely open and each part could be downloaded free of charge, the new website was conceived to create a balance between openness and closeness by sharing some parts freely and others for a small fee. As reported in the website (https://openstructures.net/faq):

> "The Platform aims at establishing a balance between openness, fairness and economic viability. Parts are open and accessible enough to allow innovation based on existing designs yet closed enough in order to protect their creative value. Revenue is redistributed between the community and the platform in order to remunerate the work of contributors on the one hand and to maintain the services of the website on the other."

The OS studio, run by Christiane Högner and Thomas Lommée, manages the platform and also organizes collateral activities based on the OpenStructure system, such as coordinating collaborative design processes and workshops, providing educational activities or consulting on open modularity. The OpenStructure system, through this balance between opening and closing, is able to preserve the design culture expressed by both the aesthetic and functional qualities of the website, the parts and the objects.

2.3 OM and prototyping tools and services - Precious Plastic

Among the case studies on open design and open manufacturing, Precious Plastic is probably not considered to be typical. The first classic example of OM to come to mind is usually the RepRap 3d printer. Nevertheless, Precious Plastic is interesting to analyze because it is not just an individual tool, but may be considered a system that uses both OD and OM.

Precious Plastic was invented by designer Dave Hakkens, who in 2013 founded the eponymous platform created to fight plastic pollution. As mentioned on the website

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

(https://preciousplastic.com/en/index.html): "Precious Plastic is a global community of hundreds of people working towards a solution to plastic Pollution. Knowledge, tools and techniques are shared online, for free. So everyone can start (yes, you too!)."

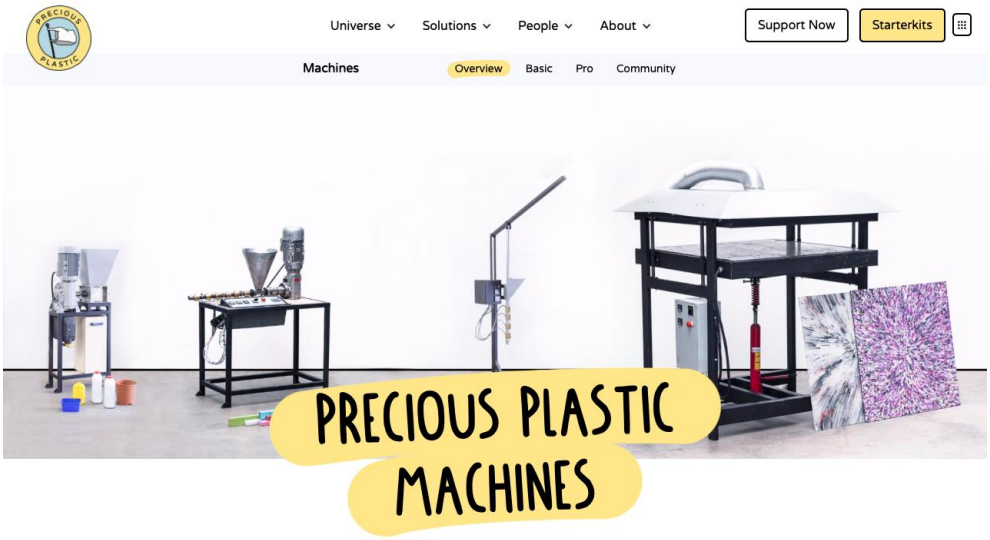

Figure 4. Precious Plastic machines

Dave Hakkens's idea is to sensitize people to recycling and reusing plastic through the construction of manufacturing machinery that processes plastic and gives it a second life by becoming a new object.

To achieve this goal, Hakkens has used all the tools offered by the Internet to the maximum of its possibilities and has developed a system based on sharing the blueprints of open manufacturing machinery. Nevertheless, the fulcrum of the project was the creation of a community of people with a strong common goal.

From 2013 to 2019, different machines and different improved versions were shared online, but basically the system is composed of a shredder machine, an extrusion machine, an injection machine and a compression machine, through which is possible to make small series of plastic objects.

The Precious Plastics community is constantly growing, and the website is about to be updated for the fourth time. The economic income of the site derives from donations which reached 300,000 EUR in 2019 and will be totally reinvested in the project.

As a designer, Hakkens analyzed a problem and found a possible solution by creating a system that involved a large community of different people and professionals. Although it is

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

not possible to fully control the quality of the objects produced by this system – some of them are shared and sell through the platform bazaar – the entire process is controlled by Hakkens and his team, so the design culture of the overall system can be considered fully expressed.

3. DISCUSSION

The case studies described above respectively represent the evolution of a platform on which to share instructions, that of a website which relies on OD and OM tools to design and produce objects for the home, and that of a system of open-source manufacturing machines to give a second life to recycled plastic.

In extrapolating some common information (Table 2) it may be noted that underlying all three experiences was a strong initial motivation. The more ample and shared the goal, the wider the community of participants. It is essential for projects that rely on OD and OM processes to build a community. In the case of Instructables, the platform generated an environment conducive to the formation of a significant and diversified group of makers who share manufacturing instructions among themselves. OpenStructure has gathered a more restricted community around it, composed prevalently of designers and a network of institutions that promote design through the organization of workshops. The last case study in chronological order, Precious Plastics, represents an interesting experience of how a designer, instead of designing an object, approached the problem of environmental sustainability by designing a system and in the final analysis, a community that now consists of 40,000 people. A second consolidated element in the field of OD and OM, is sharing information by building an online platform. Without this interface the system could not function. Finally, it may be noted that the final results of the case studies are all very different. In the first case, the platform offers space for various activities: sharing projects, lessons, workshops and contests. In the second case, Lommée built an actual business around the system, opening a design studio and organizing classes and experimental workshops. In the case of Precious Plastic, various versions of the website were developed (in 2013, 2016 and 2017), the last of which offered up-to-date blueprints of the manufacturing machines, a bazaar that serves as a market to sell the objects made by the self-produced machines, but more importantly, Hakkens succeeded in creating a movement.

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

Table 2. A comparison of the three case studies

Case study	Initial motivation	Aim	How	Community	Result
Instructables (2005)	Common Passion	Sharing projects with other people	By sharing instructions with other people and creating a group of interest	Generalist Community of makers	-Shared projects -Lessons -Workshops -Contests
OpenStructures (2007)	Personal Interest	Design an accessible and sustainable modular system	By sharing parts with CC licenses.	Community of designers	-Database of parts -Experimental workshop -Design Studio
Precious Plastic (2013)	Common/Global interest	Fight against plastic pollution	By creating a community of people around an OM system.	Community of people that wants to fight plastic pollution	-Open manufacturing system -Bazar -Movement

The analysis of the timeline (Figure 1) shows how, when following a chronology, there are three fundamental moments that mark the evolution of the OD and OM phenomena (Figure 5).

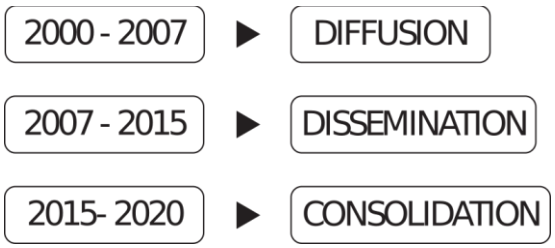

Figure 5. Three fundamental moments of OD and OM.

The first timeframe, between the years 2000 and 2007, is distinguished by the spread of production technologies and the systems that enable them, such as for example the sharing platforms or the Creative Common licenses. The second timeframe, between 2007 and 2015, is characterized primarily by the rise of new experiences in the design of objects and the spread of channels for communication and dissemination. Finally, the last timeframe, from 2015 onwards, may be considered a period of sedimentation distinguished by the consolidation of existing experiences and the growth of the various communities. The scarcity of significant new experiences over the past 5 years confirms a trend that has been corroborated in the research studies conducted by users of the Fab Labs, in particular, in the results of the MAKE-IT research study, funded by the European Horizon 2020 programme. To the question "How disruptive is the Maker movement?", David Langley answers: ""I would

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

currently grade the disruptive potential of the Maker movement with a 4.5 out of 10; that is not very disruptive at all." (Langley, 2017, p. 166). It was thought by some (Rifkin, 2011 & 2014; Troxler, 2013) that OD and OM would radically change the capitalist economy, making room for bottom-up and peer-to-peer social initiatives. Others have claimed that they would stimulate and facilitate the innovation processes carried forward by individuals or groups, rather than companies. After twenty years, it may be observed that, while some experiences have become consolidated and are continuing to develop and expand, the initial enthusiasm has waned. The tools of open design and open manufacturing probably have yet to achieve their expected efficacy. For example, though it is a particularly significant case, even Precious Plastic observes that while manufacturing machines have been built in many parts of the world, the bazaar that sells objects is not supported by this network but relies on the usual method of shipment by courier.

4. CONCLUSION – LOOKING FORWARD

Open Design arose from the application of open source methodologies and dynamics to the design and production of physical objects (Van Abel, Evers, Troxler & Klaassen, 2011; Menichinelli, 2014; Cruickshank, 2016). Open Manufacturing developed thanks to the spread of accessible digital manufacturing technologies and makes it possible for small local production and prototyping centres to make objects designed anywhere in the world (Vallance, Kiani & Nayfeh, 2001; Bianchini & Maffei, 2013;). OD and OM are two processes that were conceived and grew together, often symbiotically given that they rely on the interconnection and collaboration between systems. Though between 2000 and 2019 the phenomenon has grown in terms of projects, dissemination and number of people involved, it cannot be said that to date, it has radically modified the way we produce and consume. The positive characteristics undoubtedly include the capacity of these two processes to generate and coalesce communities around them, the collaboration of groups of people in the realization of shared projects and the drive to experiment and innovate. Critical aspects however remain the limited use and productive possibilities of digital manufacturing technologies, and the finished quality of the artefacts, which inevitably influence the possibility of manufacturing goods locally and hence the overall environmental sustainability of the production system. Although OD and OM have sometimes proved to be marginal, they are very important for the birth and development of new knowledge and virtuous practices, by generating spaces of freedom.

In the final analysis, looking towards what could happen after 2020, it is important to consider the advent of new tools intrinsic to industry 4.0, such as augmented reality, artificial

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

intelligence, the Internet of Things, automation and the Internet of Service (Hermann, et al., 2016). Though it is impossible to predict the future (Voros, 2001), we can try to image how OD and OM might evolve over the next 10 years, postulating a possible future scenario, a probable one and a preferable one (Hancock, T., & Bezold, 1994; Voros, 2003; Candy, 2010).

4.1 Probable future

In 2030 open manufacturing technologies will improve but will not achieve the level required to reach a turning point in their evolution. Digital manufacturing machines will be used to produce highly customised objects or components. Because of the manufacturing costs of the objects, it will not be possible to establish a widespread production system, and the objects manufactured with these machines will be shipped to businesses and final consumers using traditional transportation systems. Lower-quality 3d printers will be sold to the public at affordable prices to fuel the market for replacement parts and materials, and a largely disinterested public will produce objects of doubtful utility, and scarce formal and aesthetic quality. Open design will remain a niche activity practiced by communities with strong shared motivations who rely on the tools of OD and OM primarily for social purposes. Designers will use OD processes for research and promotional activities; they will however rely increasingly on the tools of OD to build prototypes, products or interactive experiences.

4.2 Possible future

In 2030 open manufacturing technologies will be able to manufacture qualitatively irreproachable and economically affordable objects of every kind. The machines will be flexible and capable of production on a large or small scale. Large numbers of laboratories will open in cities that will use automated machinery for various types of productions: from foodstuffs to objects. These hybrid spaces will be managed by different people with different professional backgrounds who will all contribute to the creation of local networks connected with global networks that share the same interests. The laboratories will be differentiated in terms of productive typologies and will collaborate as a system to manufacture complex objects. Technological objects will remain the prerogative of a few large corporations that will be in a position to control the production data in real time and orient the market.

4.3 Preferable future

In 2030, OM will make it possible to manufacture locally using evolved digital technologies. Production will become a customised process, made-to-order and with rapid response times. This system will make it possible to eliminate warehouses and transportation costs. Technological evolution will allow production with exclusively sustainable materials and

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

renewable energy sources, optimizing processes and eliminating waste. This system will be built and implemented by communities of interest that will rely on bottom-up processes and information-sharing to enable the transition towards full environmental sustainability (Manzini, 2015) in a context characterized by the absence of conflict. The diffusion of OD and OM systems will, finally, give people the tools they need to repair objects, with an eye to building awareness.

REFERENCES

Aitamurto, T., Holland, D., & Hussain, S. (2015). The open paradigm in design research. *Design Issues*, 31(4), 17–29. DOI: 10.1162/DESI_a_00348

Bakırlıoğlu, Y., & Kohtala, C. (2019). Framing Open Design through Theoretical Concepts and Practical Applications: A Systematic Literature Review. *Human–Computer Interaction*, 1-44. Doi: 10.1080/07370024.2019.1574225

Bianchini, M., & Maffei, S. (2013). Microproduction everywhere: Defining the boundaries of the emerging new distributed microproduction socio-technical paradigm. *Social Frontiers: The Next Edge of Social Innovation Research*, 1-21.

Boisseau, É., Omhover, J. F., & Bouchard, C. (2018). Open-design: A state of the art review. Design Science, 4. . Doi: 10.1017/dsj.2017.25

Candy, Stuart. (2010). The Futures of Everyday Life: Politics and the Design of Experiential Scenarios. Doi: 10.13140/RG.2.1.1840.0248

Cruickshank, L. (2016). *Open Design and Innovation: facilitating creativity in everyone*. Routledge.

Dolata, U & Schrape, J.F. (2014). Masses, Crowds, Communities, Movements: Collective Action in the Internet Age, *Social Movement Studies*, 15(1), 1-18. Doi: 10.1080/14742837.2015.1055722

Gasparotto, S. (2019). Open Source, Collaboration, and Access: A Critical Analysis of "Openness" in the Design Field. *Design Issues*, 35(2), 17-27. Doi: 10.1162/desi_a_00532

Hancock, T., & Bezold, C. (1994). Possible futures, preferable futures. *The Healthcare Forum Journal* (Vol. 37, No. 2, pp. 23-29).

Hajiamiri, M., & Korkut F. (2014). Perceived values of web-based collective design platforms from the perspective of industrial designers in reference to Quirky and OpenIDEO. *A|Z Itu Journal Of Faculty Of Architecture*, 12(1), 147-159.

Heyer S., Seliger G. (2012). Open Manufacturing for Value Creation Cycles. In: Matsumoto M., Umeda Y., Masui K., Fukushige S. (Eds.) *Design for Innovative Value Towards a Sustainable Society*. Springer, Dordrecht

Hermann, M., Pentek, T., & Otto, B. (2016, January). Design principles for industrie 4.0 scenarios. In *2016 49th Hawaii international conference on system sciences* (HICSS) (pp. 3928-3937). IEEE. Doi: 10.1109/HICSS.2016.488

Howard, J. T., Achiche, S., Özkil, A., & Mcaloone, T. C. (2012). Open Design and Crowdsourcing: Maturity, Methodology and Business Models. *Proceedings of the International Design Conference*. Dubrovnik, Croatia, May 21 - 24.

Kuznetsov, S., & Paulos, E. (2010, October). Rise of the expert amateur: DIY projects, communities, and cultures. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries* (pp. 295-304). ACM.

Langley, D. (2017). How disruptive is the Maker movement? In Menichinelli, M., Ustarroz Molina, M. (Eds.) (2018). *Understanding Collective Awareness Platforms with the Maker Movement. Results,*

Gasparotto, S. (2020). From 0 to 20. An evolutionary analysis of Open Design and Open Manufacturing. Strategic Design Research Journal, volume 13, number 01, January – April 2020. 57-71. Doi: 10.4013/sdrj.2020.131.05

reflections and future strategies from the Horizon 2020 MAKE-IT project. Barcelona: Institute for Advanced Architecture of Catalonia.

Manzini, E. (2015). *Design, When Everybody Designs: An Introduction to Design for Social Innovation*. (R. Coad, Trans.). Cambridge, Massachusetts: The MIT Press.

Marttila, S., & Botero, A. (2013, June 16–19). The 'Openness Turn' in co-design: From Usability, sociability and designability towards openness. Proceedings of CO-CREATE 2013: The Boundary-Crossing Conference on Co-Design in Innovation. Espoo, Finland.

Menichinelli, M., Ustarroz Molina, M. (Eds.) (2018). *Understanding Collective Awareness Platforms with the Maker Movement. Results, reflections and future strategies from the Horizon 2020 MAKE-IT project*. Barcelona: Institute for Advanced Architecture of Catalonia.

Menichinelli, M. (2016a). A framework for understanding the possible intersections of design with open, P2P, diffuse, distributed and decentralized systems. *Disegno: Journal of Design Culture*, 1–2, 44–71.

Menichinelli, M. (2016b). *Fab lab e maker: Laboratori, progettisti, comunità e imprese in italia*. Quodlibet srl.

Menichinelli, M. (2014). L'evoluzione dell'Open design: concetti e tappe. *DIID disegno industriale| industrial design*, 57, 65-74.

Özkil, A. G. (2017). Collective design in 3D printing: A large scale empirical study of designs, designers and evolution. *Design Studies*, 51, 66–89. Doi: 10.1016/j. Destud.2017.04.004

Raasch, C., Herstatt, C., & Balka, K. (2009). On the open design of tangible goods. *R&D Management*, 39(4), 382–393. Doi: 10.1111/j.1467-9310.2009.00567.x

Rifkin, J. (2011). *The third industrial revolution: how lateral power is transforming energy, the economy, and the world*. Macmillan.

Rifkin, J. (2014). *The zero marginal cost society: The internet of things, the collaborative commons, and the eclipse of capitalism*. St. Martin's Press.

Sawhney, N., Prestero, T., Maguire, Y., & Griffith, S. (2008). ThinkCycle: Supporting Open Source Collaboration and Sustainable Engineering Design in Education. Engineering Education in Sustainable Development (EESD), 24-25.

Tooze, J., Baurley, S., Phillips, R., Smith, P., Foote, E., & Silve, S. (2014). Open design: Contributions, solutions, processes and projects. *The Design Journal*, 17(4), 538–559. Doi: 10.2752/175630614X14056185480069

Troxler, P. (2013). *Making the 3rd industrial revolution. FabLabs: Of machines, makers and inven*tors, Transcript Publishers, Bielefeld.

Van Abel, B., Evers, L., Troxler, P., & Klaassen, R. (2011). *Open design now: Why design cannot remain exclusive*. Bis Publishers.

Vallance, R., Kiani, S., & Nayfeh, S. (2001, May). Open design of manufacturing equipment. In *Proceedings of the CHIRP 1st International Conference on Agile, Reconfigurable Manufacturing* (pp. 33-43).

Voros, J. (2001). A primer on futures studies, foresight and the use of scenarios. *Prospect: The Foresight Bulletin*, 6(1).

Voros, Joseph, 2003, 'A Generic Foresight Process Framework'. *Foresight*, 5(3): 10-21. Doi: 10.1108/14636680310698379

Walter-Herrmann, J., & Büching, C. (Eds.). (2014). *FabLab: Of machines, makers and inventors*. transcript Verlag.