UNIVERSITY OF
BATH

University of Bath

27th CIRP Design 2017

Social Product Development: The Democratization of Design, Manufacture and Innovation

Hannah Forbes[a] and Dirk Schaefer[a]*

a)   *University of Bath, Department of Mechanical Engineering, Bath, BA2 7AY, UK*

* Corresponding author. Tel.: +44(1225) 386 163. *E-mail address:* d.schaefer@bath.ac.uk

Abstract

With increasing globalization and 21st century trends such as the personalization and commoditization of technology, product design has become a level playing field for both engineering professionals and members of the maker's communities. Terms associated with this shift in the industry include crowdsourcing, cloud-based design and manufacture, mass collaboration and Open Innovation. While academics have considered the impact of these phenomena individually, there has yet to be a discussion on how these terms work together to influence the process of product development. This paper serves as an introduction to a new area of research that treats these terms as tenants of a multi-faceted term labelled Social Product Development. By considering the relationships and impacts of these modern phenomena as a group for the first time, progress can be made in evolving traditional product development frameworks to take advantage of the tools the 21st century has to offer. In this paper, the authors present an overview of the tenants of Social Product Development and discuss what they actually mean in the context of 21st century product development. Future work is then discussed which considers how an SPD framework could be formed.

1. Introduction

Social Product Development (SPD) is a term that represents a new approach to engineering and design processes. It encompasses several exciting phenomena such as crowdsourcing, open innovation and mass collaboration [3] but is a relatively undeveloped and unexplored term within both academia and the context of technology transfer to industry. This paper aims to serve as an introduction to Social Product Development by first describing Social Product Development in the context of the post Globalization 3.0 era towards the 4th Industrial Revolution, which is often hailed to be the future of Design and Manufacturing [2]. The core concepts that surround Social Product Development and their place in this industrial change are illustrated in Figure 1. The tenants are placed chronologically, according to when the term and concept was first introduced.

Figure 1 provides an overarching view of the key tenants of Social Product Development but what encourages a true understanding of this concept is recognizing the cultural, technological and societal changes that "link the chain". In other words, this paper will not only explore these concepts but also the interfaces between them. Furthermore, the exploration of each concept will be accompanied by modern examples; concreting the understanding of these ideas in the context of the 21st century.

After a detailed description of SPD and its context, the focus of this paper will shift to the future of SPD. This paper aims to initiate a discussion on how Social Product Development can complement traditional design methods and move from a set of ideas to a standard approach in mainstream product development and production engineering.
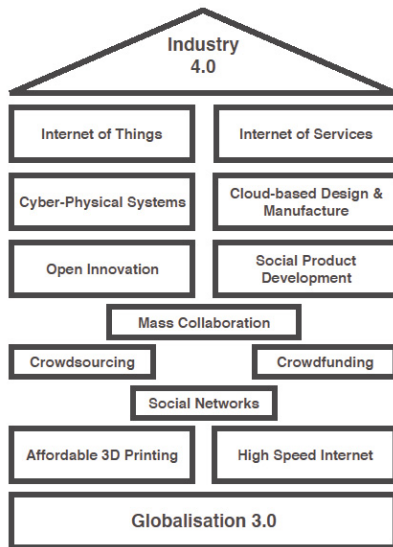
Fig. 1. The Tenants of Social Product Development in the context of the post Globalization 3.0 era (Original artwork)

2. Defining Social Product Development

Social Product Development is an overarching term for a group of technologies and approaches [3] referred to in this paper as the tenants of SPD. While its tenants are important to the concept, they individually represent types and aspects of SPD as opposed to completely defining it [18].

Abhari, Davidson and Xiao in "Measuring the Perceived Functional Affordances of Collaborative Innovation Networks in Social Product Development" [1] refer to Social Product Development in the following statement:

"The social product development model extends open innovation beyond customer-involvement models to socially-engaged individual actors fully involved in ideation and development of new products" [1]

Social Product Development is suggested here to be an extension of open innovation and this extension refers specifically to the types of participators in co-innovation. While Abhari et al. [1] do not aim to explore the definition alone, it again suggests that Social Product Development is perhaps not recognized as an individual concept, but as a group of methodologies.

In "The Rise of Social Product Development", Bertoni et al. [3] define SPD based on the problems it seeks to solve. Several transitions in the engineering industry are described, such as the increasing geographical dislocation of design teams, and SPD is highlighted as a means to adapt to these new ways of working. As with several other investigations of this topic, however, a definition is hinted at but not explicitly stated.

This paper aims to describe Social Product Development by considering each of these tenants and how they contribute to this multi-faceted concept. Social Product Development has been defined in this case, to represent the multi-faceted nature

of the term, as "the use of social computing technologies, tools, media, influencing the product lifecycle at any stage through the use of a defined and qualified crowd" [3].

3. Globalization 3.0

Globalization 3.0 is the "globalization of the individual" [21]. While previous iterations of Globalization have mainly represented a shift in the behavior of companies and organizations [23], Globalization 3.0 represents changes in industry that have empowered the individual. As Peterson and Schaefer [16] describe, Globalization 3.0 is a product of several "flatteners" including the birth of Netscape, the first internet browser, and a trigger in over investment in fiber optic networks [16]. Other "flatteners" included the availability of open source software such as Linux, the introduction of offshoring and finally, Wireless Access and VoIP, described as the "steroids" of Globalization 3.0 [16]. The word "flatteners" itself describes the ultimate outcome of Globalization 3.0. It is a movement that has brought down towering tenants of the global supply chain such as mass manufacture, and made them accessible to the masses.

The "flattening" effect of Globalization 3.0 created an environment that encouraged the growth and expansion of Social Product Development. Traditional methodologies such as the systematic Pahl & Beitz design approach [15] support the work of a design team that works in the same vicinity, with the same members, for the duration of the project. The progress of Globalization 3.0 means that these constants are no longer enforced. For example, offshoring is one aspect of Globalization 3.0 that has caused a geographical dislocation of the product supply chain. A design team must be expected to engage with manufacturers throughout the design process which leads to, as Bertoni et al. [3] call "the virtualization of design decisions". Traditional design processes are not optimized for global teams, hence the need for Social Product Development has arisen.

Both Globalization 3.0 and Industry 4.0 represent many shifts and changes, while other aspects of Figure 1 are more specific. The link between these concepts and SPD will therefore be described in the following sections in more detail.

4. High Speed Internet and Affordable 3D Printing

High-speed internet and affordable 3D printing are represented in Figure 1 as separate tenants in the transition from Globalization 3.0 to Industry 4.0. However, while other aspects of Figure 1 have emerged as a result of the transition, the introduction of high-speed internet and affordable 3D printing has accelerated this transition.

High-speed internet, as mentioned in the Globalization 3.0 section, was a consequence of over-investment in fibre optic networks [23]. By making it easier and quicker to connect to the internet, the size of the world was essentially shrunk. All of the terms mentioned in this paper rely on a core element; communication, and high-speed internet is the main enabler of 21st century communication. A specific example of a popular 21st century communication platform is Skype. Founded in 2003, Skype was the first mainstream example of video calling for the masses. In "The Rise of Social Product Development"

[3], video calling is described as the ultimate enabler of virtual decision making [3]. While voice calls and emails allow communication, body language, facial expressions and facial familiarity are found to be most important in making effective decisions [3]. High-speed internet therefore allows geographically dislocated teams to make more effective decisions, a vital feature to the success of Social Product Development.

The increased affordability of 3D printing has been one of the most significant motivators [18] for the democratization of design, manufacture and innovation. The democratization of design, manufacture and innovation defines empowerment of the masses [18] in product development. It is the process whereby power has been taken from those with wealth and given to those with innovative ideas. Previously, the main barrier that stood before these individuals was manufacturing [2], but now affordable 3D printing means prototyping and production is easily accessible. In Maplin, the high-street retailer, [24] 3D printers can be bought for less than £1000. More recently, products such as the 3Doodler Pen [25] have increased accessibility through easy and familiar operation. With many options available to engineers, relying on manufacturers is no longer a hindrance to the design process. Traditional frameworks for product development do not recognise this new-found flexibility.

5. Social Networking

Mass collaboration, crowdsourcing, crowdfunding and social networking are represented in Figure 1 in a group. While others fit into the transition represented in Figure 1 in a linear fashion, these four concepts influenced and accelerated each other. Social Networking can be described as a vehicle for crowdsourcing, crowdfunding and mass collaboration. Firstly, it encourages communication with others in a way that has not been seen before. Users can communicate with individuals, users can communicate with groups of people, and multiple users can communicate with multiple users at the same time. Furthermore, this information is viewable all over the world. This means that phenomena like crowdfunding have never had a more effective arena in which to operate. Furthermore, social networking is an ongoing example of mass collaboration and crowdsourcing. For example, on Twitter, if a broadcaster communicates a piece of news, the comments alongside often elaborate on the story and provide new perspectives. In this example the story is expanded in a collaborative effort, with users sourcing information on behalf of the cooperation. Social networking therefore plays a key role in Social Product Development as an incredibly effective communication platform that acts as a catalyst for many other tenants of SPD. Engineers can expose their crowdfunding campaign on Facebook, crowdsource ideas using Twitter, invite users to create an album of sketch designs on VSCO Cam and all with great ease and minimum cost.

6. Crowdfunding

Accessibility to the masses has been mentioned with regards to 3D printing. Affordable manufacturing, however, is not the only barrier when it comes to releasing a product. Innovators require funds throughout product development and this can be provided by crowdfunding. Crowdfunding is defined as the process of taking a project or business, in need of investment, and asking a large group of people to supply this investment. It currently exists in four models; reward-based, money in exchange for current or future goods, donation-based, charitable giving, equity-based, money in exchange for a percentage stake in a company and lending-based, peer-to-peer lending [4]. Each model represents opportunities for innovators to gain the funds they need outside of traditional means. For example, in the case of reward-based platform Kickstarter [11], the project creator can sell a product that had not yet been produced and use the income to fund manufacture. Crowdfunding, in this transition from Globalization 3.0, means the industry again favors innovation over wealth. A Social Product Development framework needs to recognize this alternative investment form by perhaps altering the design process to prepare a product for a crowdfunding campaign.

7. Crowdsourcing

Crowdsourcing is defined as "the act of taking a job, traditionally performed by a designated agent [. . .] and outsourcing it to a [. . .] large group of people" [20, 14]. Crowdsourcing is distinguished from mass collaboration by the role of the idea provider. In mass collaboration participating parties have an equal role to play in the full product development process. Crowdsourcing is often initiated by a leading party and those who provide ideas participate in only one stage of the product development process [9]. An example is the Walker's crisps campaign to select a new flavor. Walker's promoted their "Do Us a Flavor" campaign using social media, allowing anyone to send in a suggestion [19]. The winner was given a prize of £1m but the publicity benefits, as well as the sales of the new flavor will well exceed this value [19]. Crowdsourcing is another aspect of Social Product Development that emphasizes the power of the masses. Opening the ideation stage to the masses means opening this stage to diverse ideas produced from different cultures, professions, ages and lifestyles, which encourages stronger results.

8. Mass Collaboration

Mass collaboration is a "form of collective action" [18] and a process that can "harness the intelligence and ideas of many to find innovative solutions to complex problems" [7]. It involves the simultaneous work of many individuals. A modern example of mass collaboration is Wikipedia where users constantly provide and update information. Mass collaboration allows projects to be completed by those most qualified to do so and, in the case of Wikipedia, the site is able to tap into the expertise in all industries and in all locations. Mass collaboration is an enabler of Social Product Development since it spans the entire product development process and lifecycle. In the case of Wikipedia, should contributions to the site end, content would become outdated and irrelevant and it would no longer be fit for use. Peterson and Schaefer [16] state that all forms of mass collaboration are also considered forms of Social Product Development.

9. Open Innovation

Open Innovation involves exposing varying amounts of proprietary information to the public, opening the problem solving process to a larger group of people [5]. Traditionally, all company information was kept protected [5] but as the effectiveness of mass collaboration was recognized, the idea of Open Innovation is more vastly accepted. Making data and tools available to the public is often an essential aspect of Social Product Development. While this carries a risk, the potential benefits are enormous. A well-known example is The Goldcorp Case [17]. Traditionally, in the gold mining industry, geological data was considered confidential and safely guarded. This was changed by Rob McEwan, after a couple of unsuccessful years had left his company, Gold Corp, unable to yield a meaningful profit. Inspired by Trovalds' success with the open-source operating system Linux, McEwan started the "Goldcorp Challenge". A wealth of data was released to the public with the incentive of $575,000 to winning entries. Of the five top entries, four were been drilled and four "struck gold" [17]. As a consequence of Open Innovation, Goldcorp has grown to a 9 billion dollar company [17], as is seen in Figure 2.
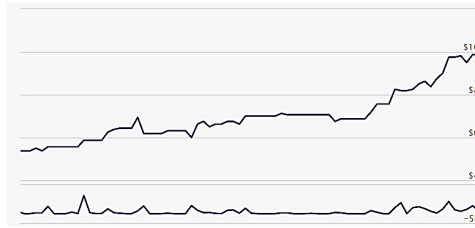

Fig. 2. Increase in share prices of Gold Corp between March 2000 and May 2000. The crowdsourcing initiative was initiated in March 2000 [8]

While the majority of the tenants represented in Figure 1 are mechanisms of Social Product Development, Open Innovation is another enabler as well as a significant contributor to the fundamental belief system of Social Product Development. Open Innovation nurtures the idea that engaging the masses in product development is the route to the best solution. While the majority of tenants represented in Figure 1 are mechanisms of Social Product Development, Open Innovation is another enabler as well as a significant contributor to the fundamental belief system of Social Product Development. Open Innovation nurtures the idea that engaging the masses in product development is the route to the best solution.

10. Cloud-Based Design and Manufacture

Cloud-based design and manufacture refers to two services, cloud-based design and cloud-based manufacture, that are gaining significant momentum in the industry. They essentially refer to the services that enable design and manufacture via the internet. Examples of cloud-based design include free CAD software, available online, such as Fusion 360 and OnCAD. An example of facilitating cloud-based manufacture is alibaba.com, an internet-based service that allows any individual with internet access to manufacture their designs.

Alibaba offers an immense range of options and flexibility and at a relatively small cost. The internet can, for example, also allow an individual in Australia to lend their 3D Printer to an individual in Germany, another exciting form of cloud-based manufacture.

Cloud-based design & manufacture encourages the use of mass collaboration in product development by ensuring essential tools and processes can be accessed all over the world. The conceptualization process has been explored with the virtualization of decision making and CBDM has brought the other significant aspects of product development to the masses. This again encourages the democratization of design, manufacture and innovation.

11. The Internet of Things & The Internet of Services

The Internet of Things (IoT) and The Internet of Services (IoS) sit near the peak of the post-Globalization 3.0 era (Figure 1). The Internet of Things describes the now vast set of cyber-physical devices and systems that are internet-enabled. An example is the Oombrella [11] that tracks precipitation levels via the internet, ensuring its owner is reminded to take the umbrella on a rainy, or potentially rainy day.

Mulholland [13] describes The Internet of Services as an evolution of The Internet of Things by suggesting an internet-enabled service is a group of internet-enabled "things". In other words, The Internet of Services is enabled by The Internet of Things. In this case, examples include an internet-enabled smart home, providing services such as adjusting the heating based on the environment temperature, and switching the kettle on by predicting the time of your commute according to traffic reports. This example shows an internet-enabled service that is comprised of a set of internet-enabled "things".

The IoS and The IoT are important to SPD because they are creating an intertwined network of data collection, communication and innovation. Open Innovation is fuelled by open data, for example, if data from every IoT fridge was collected by supermarkets, stock levels could be adjusted to maximise efficiency and reduce food waste. They not only define our outcomes of SPD but they also assist the process. IoS such as VoIP directly enable collaboration and decision making in geographically-dislocated teams.

12. Industry 4.0

The Fourth Industrial Revolution has been described in several contexts including in reference to the introduction of Virtual Reality in Manufacturing [2] as well as the development of The IoS [12]. The ultimate phenomenon that is Industry 4.0, however, encompasses all these ideas. As Maynard [12] states "the framework represents a coalescing of digital and physical technologies along the product value chain in an attempt to transform the production of goods and services".

A concept that has been born in the Fourth Industrial Revolution is the emergence of advanced hardware capabilities as a consequence of the convergence between hardware and software. An exciting example of this is the AutoPilot [12] feature due to be realized on the Tesla Motors Model S vehicle. Industry 4.0 can be tied to Social Product Development through

one simple philosophy; when the Industry experiences an enormous change, the methodologies and processes that power the industry must also adapt.

13. Discussion

This paper has served as a detailed introduction to both the overall concept of SPD and each of the tenants. The next step is to put this puzzle of concepts together and study SPD as a whole. Figure 3 is Figure 1 rearranged to consider these tenants, not in the context of the post-Globalization 3.0 era, but in the context of Social Product Development.
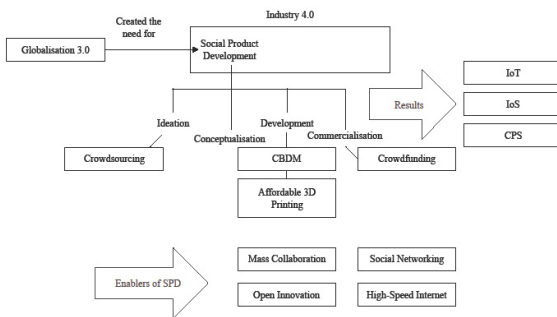

Fig. 3. The tenants of Social Product Development in the context of Social Product Development (Original artwork)

Figure 3 has summarized the relationships between the tenants of SPD and the overall concept of SPD. What this demonstrates is the nature of this concept and the potential of future research. Firstly, Figure 3 shows that several of these tenants fit into Social Product Development when it is split into stages that resemble traditional product development phases such as conceptualization, development and commercialization. The potential to develop a product development framework that incorporates these tenants i.e. A Social Product Development Framework is clear. To expand on this concept, while the links between the traditional framework and these tenants is clear (e.g. "Cloud-based Design & Manufacture" fits into "Manufacture") these links represent a huge potential change in how these tradition phases could operate. The development of a Social Product Development Framework will therefore completely reconsider how these phases are completed and update them for a modern context.

Figure 3 shows SPD to represent a progressive framework. Mass Collaboration, Open Innovation and Social Networking, however, are not represented in the phases of this framework but as vehicles, designed to accelerate engineers through this development process. Social Product Development will therefore evolve as effective methods for taking advantage of these tools are realized. As this framework is developed and refined various methods of validation will be implemented. Initial plans include dissecting various aspects of the framework and testing them at The University of Bath in an educational setting. As the framework continues to evolve, plans to use the framework to guide aspiring entrepreneurs will be considered as part of The University of Bath's

Entrepreneurial Scholarship Program within the Department of Mechanical Engineering. This program encourages students to bring their products, developed during their final year, to market. There is therefore potential to validate the complete framework on its effectiveness at guiding the creation of valuable and successful products. Finally, towards the end of the project, the authors plan to consult industrial partners in a third and final stage of validation. The ultimate aim of future research is to build a product development framework that will be used as standard in product development in both education and in industry, in the 21st century.

14. Conclusion

Social Product Development has, until now, been introduced as a collection of modern terms. While individually these terms have been explored within academia, their role as part of the developing concept of SPD has not. This paper first considers each tenant in the context of the post-Globalization 3.0 era with modern 21st century examples. By considering their links with SPD, a new diagram can be drawn that shows these tenants in the context of this modern approach to product development. As a consequence great potential emerges for the development of a Social Product Development Framework. Furthermore, other opportunities for research arise such as the consideration of virtual human interaction, how to use crowdsourcing in a traditional ideation stage and how Open Innovation can be embodied in all stages of product development. Overall, Social Product Development is shown to play a key role in the Fourth Industrial Revolution and consequently, play a key role in the exciting changes in the engineering industry.

References

[1] Abhari K., Davidson, E. J., Xiao B. Measure the Perceived Functional Affordance of Collaborative Innovation Networks in Social Product Development. 49th Hawaii International Conference on System Sciences 2016;929-938

[2] Bartissol P. The Fourth Industrial Revolution ISE ; Industrial and Systems Engineering at Work 48.7 2016;36-41

[3] Bertoni M., Larsson A., Ericson Å., Chirumalla, K., Larsson T., Isaksson O., Randall H. The Rise of Social Product Development International Journal of Networking and Virtual Organisations 2012;1;2;188-207

[4] Bock J. A., Frydrych D., Kinger T., Koeck B. Exploring Entrepreneurial legitimacy in reward-based Crowdfunding Venture Capital. 2014;16;247 – 269.

[5] Chesbrough H. W., Vanhaverbeke W., West J. Open innovation : researching a new paradigm Oxford : Oxford University Press 2006

[6] CPSE Labs, 2016 [Online] Available from: http:www.cpse-labs.eu/cps.php [Accessed: 27th October 2016]

[7] Doan A., Ramakrishnan R., Haley A. Y. Mass Collaboration Systems on the World-Wide Web: The Age-Old Practice of Mass Collaboration is Transforming the Web and Giving Rise to a New Field University of Wisconsin, Yahoo! Research, Google Inc. 2010

[8] Gold Corp Stock from GoldCorp.com Analytics [Online] Available from: http://www.goldcorp.com/English/Investor-Resources/Stock-Information/default.aspx?Indice=TSE:G.CAhtml [Accessed: 18th January 2017]

[9] Lang M., Bharadwaj N., Di Benedetto C. A. How crowdsourcing improves prediction of market-oriented outcomes Journal of Business Research 2016;69;10;4168-4176

[10] Leenders R.T. A. J., Dolfsma W. A. Social Networks for Innovation and New Product Development: Social Networks for Innovation and New

Product Development Journal of Product Innovation Management 2016;33;2;123-131

[11] Kickstarter: The Umbrella by Kickstarter, 2016 [Online] Available from:https:www.kickstarter.com/projects/wezzoo/oombrella-unforgettable-umbrela [Accessed: 27th October 2016]

[12] Maynard A. D. Navigating the Fourth Industrial Revolution Nature Nanotechnology, Vol. 10, December 2015 [Online] Available from:www.nature.com/naturenanotechnology [Accessed: 27th October 2016]

[13] Mulholland A. Internet of Things – No, it's the Internet of Services, 2014 Constellation Research [Online] Available from: https:www.constellationr.com/blog-news/internet-things-no-it-s-internet-sevices [Accessed: 27th October 2016]

[14] Panchal J. H. Using Crowds in Engineering Design - Towards a Holistic Framework. Purdue University, United States of America 2015

[15] Pahl G., Beitz W., Feldhusen J., Grote K. Engineering Design: A Systematic Approach. Springer-Verlag London 2007

[16] Peterson A., Schaefer D. Social Product Development: Introduction, Overview, and Current Status Product Development in the Socio-sphere: Game Changing Paradigms for 21st Century Breakthrough Product Development and Innovation, 2014;1 -34

[17] Rozario K. The story of the Goldcorp challenge, 2012 [Online] Accessiblefrom: https:www.keithrozario.com/2012/07/opensource-gold-the-greatest-crwdsourcing-story-ever-told.html [Accessed 27th October 2016]

[18] Schaefer D. Product Development in the Socio-sphere: Game Changing Paradigms for 21st Century Breakthrough Product Development and Innovation Springer eBooks 2014

[19] The Mirror: Walkers "Do Us a Flavour Campaign" 2014 [Online] Available from:http:www.mirror.co.uk/news/uk-news/crisp-fan-dreams-up-new-4473 50 [Accessed: 27th October 2016]

[20] Unterberg B. Kapitel & Crowdsourcing in Social Media Theorien, Methoden, Modelle. 2010;1;121 – 135.

[21] Walker M. Globalization 3.0 The Wilson Quarterly (1976-), 1 October 2007;31;4;16-24

[22] Wolfgang, Grallert W. H., Stefan Wess Towards the Internet of Services The THESEUS Research Program Springer International Publishing 2014

[23] Zhang Y. The Standard of 'Civilisation' Redux: Towards the Expansion of International Society 3.0? Millennium - Journal of International Studies 2014;42;3;674-696

[24] 3D Printing Products 2017 [Online] Available from: http://www.maplin.co.uk/3d-printer [Accessed 18th January 2017]

[25] 3Doodler Pen: The first 3D Printing Pen [Online] Available from: www.3doodler.com [Accessed 18th January 2017]