

Collective design in 3D printing: A large scale empirical study of designs, designers and evolution

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This paper provides an empirical study of a collective design platform (Thingiverse); with the aim of understanding the phenomenon and investigating how designs concurrently evolve through the large and complex network of designers. The case study is based on the meta-data collected from 158 489 designs and 247 768 users; and it reveals that (i) Designs can be shared and quickly evolved into other designs through a distributed network of designers, (ii) only a small portion of the users are designers and (iv) collective design has deep and strong evolutionary roots. Better understanding of collective design platforms can help design practitioners to identify lead users in their respective domains and to discover latent needs that stem from different sub-communities or geographic regions.

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The last few years have witnessed the rise of the ‘Maker Movement’, which is often referred as the third industrial revolution and its progression is compared to the early years of the Internet (Anderson, 2012). At core, driving forces behind the maker movement are digital manufacturing technologies. These technologies – such as 3D printing – are called ‘disruptive’ (Campbell, Williams, Ivanova, & Garrett, 2011; Lipson & Kurman, 2013; Mota, 2011; Petrick & Simpson, 2013) because they can help break the traditional boundaries between designers and users and enable ‘design anywhere, build anywhere model of product development’ (Rosen, 2014). With strong ties to open design (Howard, Achiche, Ozkil, & McAloone, 2012), maker movement is a grassroots movement, where all makers are encouraged to share, use and improve each other’s designs.

Several platforms have emerged to serve the ever-growing network of makers and designers by providing content, infrastructure or manufacturing capacity as services. On one side, there are cloud manufacturing platforms like Shapeways, iMaterialize and Ponoko, which provide public access to a number of additive manufacturing technologies and provide designers an online market place and an infrastructure to sell their designs without worrying about the

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actual manufacturing process. On the other side, there are online sharing platforms that were established by hardware (e.g. Thingiverse.com: Makerbot Industries, Cubify.com: 3D Systems, Youmagine.com: Ultimaker) or software companies (e.g. Autodesk 123D Design, GrabCAD) to encourage users to share designs and ultimately support their main lines of businesses. Through these online and distributed environments Collective Design emerges as a paradigm; where designers get inspired by each other and communicate through loosely formed and informal design networks.

Collective design platforms attract large number of users and the underlying digital manufacturing technologies are becoming more and more available. Both as an online phenomenon and as a research area; collective design is still at infancy and its constituents, outreach and potential impact are unknown (Nickerson, 2015; Paulini, Murty, & Maher, 2012). We believe that there is a lack of empirical research on what these platforms offer, how they emerge and how they facilitate design activities through the participation of large numbers of users.

This paper aims to address this gap by investigating:

- How collective design platforms are used?
- How designs disperse within communities?
- What are the underlying characteristics of the designs and designers network?

We base our case study on the Thingiverse, which is the one of the most popular collective design platforms in terms of the number of designs and registered users (Figure 1). Based on the metadata of 158 489 publicly available designs and 247 768 registered users that are collected from Thingiverse; our analysis aims to uncover the intrinsic characteristics of the platform, naturally complex design patterns that have evolved through a number of generations, and the underlying network of designs and designers.

1 Background and related work

The last two decades witnessed the wide availability of communication technologies and resulting changes in management practices, which have promoted the concept of communities; where participants share knowledge around common interests or job roles (Preece & Maloney-Krichmar, 2005). From the professional perspective, there has been significant work on collaborative design, resulting in a number of online design collaboration tools and professional social networks (Zhang, Ackerman, & Adamic, 2007). While similarities can be drawn from research conducted in participatory design (PD), collaborative product development (CPD) and computer supported cooperative work (CSCW); research in collective design is very young and empirical

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