RECONCEPTUALIZING DESIGN THINKING AND EQUIPPING DESIGNERS FOR THE NEXT WAVE OF DIGITAL INNOVATION

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Abstract

With the advent of a third wave of digitization designers are facing new challenges to create products and services. We believe that the far-reaching user involvement and the flexible functionalities of third-wave digital innovation is radically changing the work field of designers.
The paper focuses on two main effects of third-wave digital innovation; convergence and generativity. We analyzed the consequence of these two effects on three process-oriented roles of the designer that make up an important part of Design Thinking: (1) the designer as integrator; (2) the designer as boundary creator; and (3) the designer as the user's advocate.
Based on this analysis, we propose three new roles that better fit the third wave of digital innovation: (1) designers as function orchestrators; (2) designers as gatekeepers of initiatives; and (3) designers as advocates of human desire. To fulfill these new roles and to equip designers for the new wave of digital innovation, we belief that there is a need for reconceptualizing Design Thinking.

Keywords: Design Thinking, Digital Innovation, Design theory, Service design

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1 INTRODUCTION

Over the past decades, designers have developed expertise in digital innovation when working on computer hardware, and on the informational structure and user interface for web pages, games, apps, etc. The design expertise that has been developed for such types of digital innovation has centered on creating well-defined plans for the production of products and services with rather fixed functionalities. Yet, with the advent of a third wave of digitization designers are facing new challenges to create products and services, through a *"mash-up"* of *"different media across different product architectural boundaries"* (Yoo *et al.,* 2010 p.12*).* Such "mash-ups" have lead to the Internet of things, Web2.0 sites such as Facebook and LinkedIn, 3D printing and crowd sourcing platforms, etc. What these digital innovations have in common is that they allow, or even require, that users co-create parts of the structure and content of the digital medium, leading to a remixing and/or repurposing of its functionalities.

We believe that the far-reaching user involvement and the flexible functionalities of third-wave digital innovation is radically changing the work field of designers. This paper adopts Yoo *et al.*'s (2010, p.6) definition of this type of digital innovation: "*By digital innovation we mean an innovation enabled by digital technologies that lead to the creation of new forms of digitization. By digitization we mean the transformation of socio-technical structures that were previously mediated by non-technical artifacts or relationships into ones that are mediated by digitized artifacts and relationships. It involves organizing new socio technical structures with digitized artifacts as well as changes in the artifacts themselves."* Third-wave digital innovation can have an impact on the work practices of designers based on three characteristics: digital materiality (the embeddedness of digital capabilities into physical artifacts and vise versa), convergence (collaborative innovation across traditionally separated industries), and generativity (the reprogrammability of the digital capabilities by design, as well as in-use).

Traditionally, designers involved in innovation processes have taken on multiple roles. In case studies on the different roles of designers in external consultancies (Bohemia, 2002) and internal design departments (Valencia, Person and Snelders, 2013) two types of design roles have been distinguished: product-oriented design roles (relating to shaping the look and feel of products), and process-oriented design roles (relating to facilitating the innovation process). We believe that digital innovation may impact both the product- (and service)-oriented roles of the designer as well as the process-oriented roles. Among the characteristics of digital innovation, digital materiality has the strongest connection to product-oriented roles, whereas convergence and generativity are related more to the process-oriented roles. In line with other scholars and practitioners, we termed the design activities that a designer executes to fulfill process-oriented roles Design Thinking (see e.g. (Cross, 1982; Brown, 2009; Dorst, 2011). In this paper we focus on the effects of convergence and generativity on three process-oriented roles of the designer that make up an important part of Design Thinking: (1) the designer as integrator; (2) the designer as boundary creator; and (3) the designer as the user's advocate.

The structure of this paper is as follows: we start with a detailed explanation of convergence and generativity as characteristics of third-wave digital innovation. We then continue with a discussion of the process-oriented roles of a designer in more traditional innovation processes, focusing on three above mentioned roles. We will argue that convergence and generativity have an impact on the process-oriented roles of a designer. Third-wave digital innovation requires changes to these process-oriented roles of designers, and Design Thinking has to change accordingly.

2 CHARACTERISTICS OF DIGITAL INNOVATION THAT INFLUENCE PROCESS-ORIENTED DESIGN PRACTICES

This section describes two important characteristics of digital innovation that will impact process-oriented design practices: convergence and generativity. We show that the converge effect in digital innovation leads to dynamic innovation teams that consist of multiple industry networks, operating over a long period of time, over various cycles of innovation. Furthermore, the generative nature of digital innovation leads to 'wakes of innovation' that are hard to predict in terms of functionalities and use. The flexibility that arises from third-wave digital innovation creates endless possibilities for design that are hard to capture in a single frame.

2.1 Convergence

Digital innovations have a layered modular architecture (Yoo *et al.*, 2010), consisting of four layers: (1) the device layer, which is the physical artifact. One of the first examples of such a device layer is the iPhone; (2) the network layer, which is the connecting, layer between the device layer and the digital devices. The Apps on the iPhone are examples of the network layers; (3) the service layer which is the functionality that is offered to users. A health monitor is an example of the service layer; (4) the content layer that captures, transmits and uses data (e.g. the heart rate). To develop these four different layers and to integrate functionalities, multiple capabilities are needed. Most often these capabilities extend the capabilities of single firms, and even of single industries, and digital innovations are therefore executed in a network of heterogeneous actors that innovate collaboratively. The intensifying connectedness of different industries through the four modules of digital innovation is called *convergence* (Yoo *et al.*, 2010).

Converge connects industries and communities that were traditionally separated (Yoo, *et al*. 2010). Its actors try to combine multiple functionalities with multiple partners, resulting in dynamic collaborative processes that are messy and ambiguous (Boland, Lyytinen and Yoo, 2007). Furthermore, the convergence effect creates the need and the possibility to create multiple communities around innovations that may (or may not) change over time.

2.2 Generativity

Generativity refers to the (re)programmability of the digital artifacts in digital innovations, leading to inherently dynamic and malleable innovation processes (Yoo *et al.*, 2012). The (re)programmability of digital innovations makes it possible to separate the semiotic functional logic of the device from the physical embodiment that executes it (Yoo, Henfridsson and Lyytinen, 2010). The homogenization of digital data makes it possible that digital innovations are continuously reinterpreted, expanded, and refined. Both the innovators as well as the users of the innovation create these new functionalities. Boland, Lyytinen and Yoo (2007) called this emerging nature of digital innovations 'wakes of innovation', because the digital innovations overlap and interact with each other in ways that form a turbulent, self-propagating system of innovations, just as a wake propels itself through the water in front of a ship.

The generative nature of digital innovation leads to possibilities for creating new functionalities during product use, on each of the four layers of the digital innovation (Yoo, Henfridsson and Lyytinen, 2010). First, the device layer can get new functionalities because new digital functionalities can be connected to it. An example of a new functionality could be the digital version of a health encyclopedia on the iPhone, which makes the iPhone a phone and a health information system. Second, the network layer can be reprogrammed leading to new functions. An example of this is could be a new health app on the iPhone that monitors your heartbeat. Third, the service layer will be enriched over time, as new services can be added on a continuous basis. An example of this can be an alarm service could be added to the heartbeat monitor that reacts as soon as the heartbeat stops or shows a problematic pattern. Fourth, the content layers capture data over prolonged periods, leading to 'big data'. These 'big data' can allow for a training program to improve heart rate related health indicators. Additionally, 'big data' allow innovators to (re)interprete the use phase of the digital innovation. This analysis could form the starting point to generate new digital products and services. Thus, generativity provides users flexibility to change and add functionalities, according to their individual needs and desires. Different types of users will add different types of functionalities. This flexibility of the user complicates the design of these digital innovations from a user perspective.

3 PROCESS-ORIENTED ROLES OF A DESIGNER IN INNOVATION

This section describes three process-oriented roles of a designer in traditional innovation contexts. We show that designers have the capabilities to integrate the knowledge of team members as long as they are continuously present in the team. Furthermore, designers use requirements and constrains to scope innovation projects. An important input for these constraints is the client or the user's needs and demands. Designers have multiple tools and methods to gather user information and to test the designed concept with the user. These methods require a predetermined context of use and functionality.

3.1 Designer as integrator

Designers are often characterized as T-shaped (see e.g. Brown, 2008), by which is meant that they are both creative (the vertical stroke), and they have the capability to collaborate with actors from different backgrounds (the horizontal stroke). A designer operating in an innovation process needs these two characteristics to become an integrator. The vertical stroke is necessary for combining the knowledge bases of the team members in a creative manner. The horizontal stroke is necessary to for facilitating collaborations within the innovation team.

The designers' rich communication skills (e.g. visualizing and prototyping) support them during problem-solving processes together with a team. Kleinsmann *et al.*'s (2012) analysis of conversations between design professionals shows that designers empathize with others in the team. They actively summarize and interpret the implications of people's ideas from the perspectives of everyone in the team, including themselves. Furthermore, research shows that designers are capable of understanding what (design-relevant) information is available in the team and they are also capable of weighting the benefits and costs of shared and unshared knowledge (Boos, 2007; Kleinsmann *et al.*, 2012).

How companies value the role of a designer as integrator may be depending on their relation to designers. In a study with design consultants working for a design-extensive industry (mining), Bohemia (2002) showed that companies do not always value the role of designer as integrator. On the other hand, in a case study of a company with a long-standing and much valued design department, Valencia, Person and Snelders (2010) showed that role of the designer as integrator was highly valued. What these two studies have in common is that both framed the designer as integrator role from the perspective of a designer who works in a multidisciplinary team executing an innovation project with a single company. These multidisciplinary teams often innovate while using integrated product development or innovation models that require the participation of all disciplines involved throughout the entire innovation process (see e.g. Buijs, 2007).

3.2 Designer as boundary creator

While designing, designers see the complexity of the design problem at hand. Rather than dwelling on complexity, designers attempt to derive general guiding principles or schemata to address the design problem, to create a problem/solution space that has well-defined boundaries (Lawson, 2004; Ball, Onarheim, and Christensen, 2010). Furthermore, expert designers are good at prioritizing criteria, based upon the complex information available (Cross, 2003). By prioritizing they set aside the 'noise' of a design problem and they are capable of reducing a design problem to its fundamentals (Petre, 2004).

Designers in practice use many methods to deal with the complexity of the design problem. Examples of these models are checklists (see e.g. Pahl and Beiz, 1988) and QFD methods (see e.g. Pugh, 1991). These methods are seen as helpful in determining and evaluating design requirements and constraints (Chakrabarti, Morgenstern and Knaab, 2004; Ball *et al.*, 2010). These methods are important, as the quality of the methods used has a strong impact on the quality of the final design (Chakrabarti, Morgenstern and Knaab, 2004). Methods that focus on requirements often relate to the artifact's functionality, structure and behavior (Simon, 1969; Ball, Onarheim, and Christensen, 2010), while methods focusing on constraints typically have an external origin (e.g. clients), which tends to limit solution possibilities (Simon, 1969). Ball, Onarheim, and Christensen (2010) state that designers use requirements and constraints in a *generative* as well as in an *evaluative* manner. By using design requirements and constraints in this manner, designers are thought to create well-defined problem/solution spaces.

3.3 Designer as the advocate of the user

Innovating is often an act of balancing desirability, viability and feasibility (Brown, 2008). In multidisciplinary teams in an organization, designers are often gatekeepers for desirability, as other team members are responsible for viability and feasibility. Designers are equipped with many types tools and techniques that support them to gather in-depth knowledge about the user of the innovation. There are two important types of approaches for user centered design that are executed at different stages of the innovation process: *participatory design* and *design for usability*.

First, designers often use participatory design methods in the fuzzy front end of the innovation process, because they need information about the contexts of user interactions with products in order

to design products that fit into the lives of users (Sleeswijk-Visser *et al.*, 2005). Participatory design methods allow the designer to co-create with the user, thus creating a deep understanding of the context of use as well as the (latent) needs and desires of the user. A famous methods to execute this type of generative user research is context mapping (see e.g. Sleeswijk Visser *et al.*, 2005; Sanders and Stappers, 2013). Second, design for usability has its origin in the field of ergonomics and it is often used at a later stage in the innovation process, when there is a concept that the designer can test. Usability is developed to test the relationship between products and humans (Van Kuijk, 2010). These tests often focus on the functionality and how the structure of the artifact supports particular behavior.
Both participatory design and design for usability enable designers to engage and empathize with the user. Designers also developed rich communication tools such as customer journeys and user scenarios to communicate the knowledge about the user to the rest of the innovation team.

4 PROCESS-ORIENTED ROLES OF DESIGNERS IN DIGITAL INNOVATION

There is not much literature about process-oriented roles of designers in digital innovations. Past research in the field of business innovation shows the importance of investigating the role of Design Thinking in the creation and adoption of the digital innovations (e.g., see Hargadon and Douglas, 2001). Research in the field of design provides deep insights in the practices of designers creating artifacts in complex environments (Schön, 1984; Simon, 1996, Cross, 2001; Lawson, 2004). However, this research does not describe potential additional roles of a designer in digital innovation.
Yet, we believe there is a mismatch between the characteristics of third-wave digital innovation, and the process-oriented roles of designers identified in the literature. The aim of this section is to identify the main causes for the mismatch and at the same time determine new roles for a designer in third-wave digital innovation practices.

4.1 Designer as orchestrator of functions

The previous section showed that designers tend to be good integrators of knowledge. The research on which this conclusion is based investigated multidisciplinary innovation teams following innovation models that require the participation of all disciplines throughout the entire innovation process (see e.g. Buijs, 2007). However, this is not the situation in third-wave digital innovation.
As a consequence of the convergence effect, digital innovation requires crossover collaborations between heterogeneous actors, coming from different organizations and industries. In addition to this, the generative nature of the digital innovation process means that partners in the ecosystem can enter and re-enter the system at different times. This fluctuation of partners makes the integration of knowledge of different partners more dynamic than in traditional innovation practice.
Because of the higher degree of heterogeneity of the ecosystem, and the cyclic nature of the digital innovation process, the designer needs to transform from an integrator of knowledge to an orchestrator of functions within the innovation process. Various parties in the ecosystem can be more or less active in the system and there is a role for designers to bring together those functions in the systems that can create meaningful innovations at various layers and modules of the product/service architecture. It is unknown what additions are needed to the design process, and thus to the concept of Design Thinking, to incorporate such dynamic practices of functional orchestration. We identify this as a first area for further research.

4.2 Designer as gatekeeper of initiatives

Designer tend to use requirements and constraints as a way to determine the problem/solution space and to create solutions. The (natural) restrictions that physical artifacts have provide designers with guidance during the innovation process. Designers not only use requirements and constraints during idea generation, but they also use them during the evaluation of ideas with other stakeholders. The characteristics of third-wave digital innovation limit the applicability of these traditional guiding principles for several reasons:
First, the convergence effect creates a complex network of stakeholders with their own requirements and constraints. Second, while physical artifacts are rather fixed, digital artifacts can be changed easily. These characteristics can result in an enormous set of (contradicting) requirements and constraints that will paralyze designers instead of helping them. The material constraints that traditionally exist in product innovation are alleviated here, and partners have to find new ways to

direct themselves (Van de Garde-Perik, Snelders and Thompson, 2013). Third, the effect of generativity is making the products and services of the digital innovation carriers of rich data. These data can create new input for the new rounds of innovation. Designers need to develop new capabilities to incorporate this new type of information into innovation processes (Thompson, Van de Garde-Perik and Snelders, 2014).
The above discussion shows that the characteristics of digital innovation provide the designer with unbounded possibilities, from which s/he has to recognize the most valuable opportunities. The designer has to make these opportunities visible for the partners so that they see and understand the value. Yet, Design Thinking in its current form does not equip designers to generate solutions in a space that has so few, and such unclear restrictions. The unbounded possibilities also hamper the evaluation of alternatives. As a result, there is a potential addition to the design process to be made, and thus to Design Thinking. Next to a leading role as boundary creator, the designer must also become a strategic gatekeeper of the near endless possibilities that could arise through initiatives of others. We identify this as a second area for further research.

4.3 Designer as advocate of human desire

Designers in innovation processes often have the role of being the advocate of the user. This role assumes that there is a sense of who the user is and in what context s/he will use the product or service. Yet, in third-wave digital innovation it is often not known (or not ethical to know) who the user is. For this reason, it is difficult for a designer to determine the impact of digital innovations on people's lives (Gardien *et al.*, 2014). This is because the convergence effect often creates an intricate system of multiple users, at multiple layers in the system architecture. Some of these people are like traditional end-users, while others are intermediate (professional) users of the system. At the same time, all these parties are potentially co-productive and co-creative of the very system they are using, implying that the design phase and the use phase of digital innovations (partly) overlap. Furthermore, most digital innovations follow evolutionary, wake-like patterns. These patterns create uncertainty about the characteristics of the intended innovation, which hinders the determination of envisaged target groups. As a result, the current design processes that help designers to be user centered (and thus also the concept of Design Thinking) does not apply to third-wave digital innovation. What might replace such processes is are approaches aimed at identifying desires of people operating in and around evolving systems of digital products and services. Whether such people are users or professionals, attention to their desires will maintain the main task of designers to attend to issues of desirability, next to issues of feasibility and viability. Developing such processes will be the third area of future research.

5 WHY DESIGN THINKING HAS TO ACCOMODATE FOR DIGITAL INNOVATION

Design Thinking already provided designers with capabilities to take on process-oriented roles such as the integrator of knowledge, the boundary creator, and the users' advocate since the 1980's (Rowe, 1987 in Dorst, 2011). The basic principles of Design Thinking refer back to Simon's *Science of the Artificial* (1969) and most design activities stem from an industrial age in which the creation physical artifacts formed the main domain of a designer.
However, the industrial economy has long lost its dominance, and we now live in a knowledge economy that initiated the third wave of digitization. This wave of digital innovation is having an enormous impact on people's lives, with the advent of a whole new type of products and services for people. As a result, digital innovation is radically changing the work field of designers, and this paper draws out some lines along which these changes are becoming manifest. Instead of knowledge integrators, designers are also becoming function orchestrators; instead of setting boundaries around problem/solution spaces, designers must also become gatekeepers of the initiatives of others; and instead of being the advocate of a defined set of users, designers must now attend the desires of all people who inhabit the systems created by digital innovations.
As a limitation of the analysis presented in this paper, it can be argued that not only process-oriented roles of designers will be affected by digital innovations, but that also product- (or service-) oriented roles will be affected by it. More recent descriptions of Design Thinking have put greater stress on the materiality of design, for example in the form of using prototyping as a way of doing design-based

research (Hassi and Laakso, 2011) As we pointed out in the introduction, digital innovations tend to create their own type of 'digital materiality,' that are designed to support user actions that are often temporary and emergent (Orlikowski, 2007). The fixed nature of physical materiality and the flexible nature of digital materiality may create tensions in the product-oriented roles of designers, including the prototyping work that is now sometimes also incorporated into Design Thinking. For reasons of succinctness we have not gone into the relation of digital innovation and product-oriented roles of designers, even if they may have an additional impact on how we can reconceptualize Design Thinking for the digital age.

To conclude, this paper proposes to adapt the concept of Design Thinking in a way that allows for three process-oriented roles for designers in third-wave digital innovation. In order to reach this aim, we will start research projects with key (industrial and institutional) players in digital innovation. We believe that by collaborating closely with practice a number of changes can be made to Design Thinking, to warrant its vitality in the future.

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