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Gamification as an Architecture of Participation: An Investigation of an Innovation Maker Community

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GAMIFICATION AS AN ARCHITECTURE OF PARTICIPATION: AN INVESTIGATION OF AN INNOVATION MAKER COMMUNITY

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Abstract

The objective of this study is to investigate gamification as an architecture of participation in an online innovation community. Gamification is a phenomenon that aims to motivate people through the use of game elements and dynamics in non-game contexts. An architecture of participation (AoP) can be understood as any system that helps transform individual activities into communal resources. The research is a case study of the innovation community Thingiverse. The study seeks to identify the game elements used by the community and seeks to explain how the psychological and social consequences of the game elements lead individuals to engage in behaviours that create value for the innovation community.

Keywords: Gamification, Architecture of Participation, Innovation Sourcing, Innovation Community, Social Mechanisms.

1 Introduction

The use of game elements in online communities has become useful in improving user experience and motivating users to participate in online communities. In the last few years, a large number of gamified technology-based services have been used in marketing, finance, education, health, and other fields to allow interaction with users and consumers (Kankanhalli et al., 2012). Gamification aims to motivate people by applying game elements and game design techniques in nongame contexts (Deterding et al., 2011). The game elements and gamified services are expected to drive behaviour and enhance engagement. Because of its positive influence on people's motivation to engage in action, gamification is closely related to the fields of collective intelligence, crowd science and crowdsourcing (Franzoni and Sauermann, 2014; Vassileva, 2012). Companies increasingly use online communities to 'crowdsource' knowledge, production and innovation capacity not available to them through traditional hierarchical and market relationships (Howe, 2008). Online communities used this way are referred to as innovation communities. Gamification in all its forms focuses on 'fun'. Fun is one of the key reasons people like to play games, and that evokes behaviours such as engagement (Kankanhalli et al., 2012). Empirical findings show that the incorporation of game elements into repetitive and

monotonous tasks makes them more fun and enjoyable (Flatla et al., 2011). Therefore, gamification helps users become more involved with applications (Rapp et al., 2012).

The objective of this study is to investigate the role of gamification as an architecture of participation in an online innovation community in order to identify the underlying mechanisms that motivate people to participate and share their knowledge. This research aims to provide recommendations for organizations about how to leverage the innovation potential of online communities through the incorporation of gamification. The paper begins by briefly discussing the importance of gamification and architectures of participation. Next, we describe the social mechanism–based theory we use to explore the underlying mechanisms of gamification to gain a deeper understanding of how to create communal value through individual activities. We then present an exploratory study of an online maker community that uses various gamification elements. The results identify the gamification elements in the maker community Thingiverse and seek to explain how these elements contribute to the automated value creation for the community by allowing individuals to pursue their own needs.

2 Background

2.1 Architectures of participation

There are different definitions of an architecture of participation. First, an architecture of participation can be understood simply as the 'various technologies and activities designed to facilitate and promote participation, communication and the active co-construction of meanings and knowledge' (Attwell and Elferink, 2007); in other words, they are collections of mechanisms that allow the members of a community or network to interact. Second, the label has been used to describe systems that help transform individual activities into communal resources. Bricklin (2001) observed that the technical characteristics of peer-to-peer music sharing systems like Napster could potentially transform the 'tragedy' of the commons into the 'cornucopia' of the commons, where adding value to the system is an automatic result of using the system. A similar example is the peer-to-peer file sharing system BitTorrent, where the service automatically gets better the more people use it.

Within the open-source context, many different types of architectures have been identified (Feller et al., 2009), including technological architectures (e.g., collaboration and communication platforms, software development kits and application programming interfaces, etc.), legal architectures (e.g., software licences), economic architectures (e.g., direct and indirect incentives and rewards for participation) and social architectures (e.g., shared cultural values, reputation building through participation, etc.).

Building on Bricklin's insight, O'Reilly has applied the concept to open-source software development, where he argues that such architectures 'may actually be more central to the success of open source than the more frequently cited appeal to volunteerism'. According to O'Reilly (O'Reilly, 2005), 'the architecture of Linux, the Internet, and the World Wide Web are such that users pursuing their own 'selfish' interests build collective value as an automatic by-product'. Selfish interest refers to a focus on oneself or one's own personal interests, needs or desires above the well-being of others (Venkatesh, 2008). Collective value refers to resources available to community members that are considered to be a value derived through participation in the community. The automatic creation of value is, for example, evident in the music sharing system Napster. If a user downloads music, their computer automatically acts as a new source for these music files, thereby creating value for others. A current example is BitCoin Mining in the software-based payment system BitCoin. BitCoin uses a decentralised processing approach where users can provide their hardware to process transactions and generate new BitCoins, while at the same time receiving a reward in BitCoins. In this case, users pursuing their selfish needs through earning BitCoins automatically generate new BitCoins for the

network and improve the processing performance of transactions. Finally, an emerging example is the new virtual world High Fidelity. In this case, similar to BitCoin, users pursue their selfish objectives by earning virtual currency by providing their personal devices (e.g., computer, mobile phone) as servers to build and expand the virtual world as well as to improve the processing performance.

2.2 Gamification

Gamification is a phenomenon that aims to motivate people through the use of game elements and dynamics in nongame contexts (Deterding et al., 2011; Seaborn and Fels, 2015). Game design elements refer to game design principles, game mechanics and game dynamics, storytelling and other aspects typically incorporated into games (Kankanhalli et al., 2012). The nongame context can include finance, marketing, education, health and fitness (Deterding et al., 2011). Typically, gamification elements are leader boards, progress bars, points systems, rewards or badges that are usually used in games to motivate players and provide a more enjoyable experience (Zichermann and Cunningham, 2011). Gamified services also use these elements to motivate users, but in a nongame context. For example, the business-oriented social network LinkedIn uses a progress bar to motivate users to complete their profiles. Gamification is also described as a process of enhancing a service with affordances for game experiences in order to support the user's overall value creation (Huotari and Hamari, 2012). Value creation in this context means users creating resources (e.g., designs) and other forms of value (e.g., enjoyment) for themselves and others.

The MDA framework is used for describing the main game design elements used: mechanics, dynamics and aesthetics (Hunicke et al., 2004). First, game mechanics are the functional components that provide various actions, behaviours and control mechanisms to enable user interaction (Hunicke et al., 2004). They represent the incorporated gamification elements previously mentioned (e.g., leader boards, points systems and rewards). Together with the game's content (levels, assets and so on), the mechanics support the overall gameplay dynamics. In a gamification setting, the mechanics available include different gamification elements (Zichermann and Cunningham, 2011). See Table 1. Second, game dynamics describe the effects of these mechanics on the subjective user experience over time (Huotari and Hamari, 2012) and correspond to specific user motives. They determine the individuals' reactions and the run-time behaviour of the mechanics acting on the players' inputs and each other's outputs over time as a response to using the implemented mechanics (Hunicke et al., 2004). These reactions try to satisfy fundamental needs and desires (e.g., desire for reward, achievement, self-expression, altruism or competition) (Bunchball, 2010). For instance, mechanics such as rankings induce competitive dynamics that relate user activities to a reference group and should thus satisfy the pursuit for social recognition. For example, the progress bar used in LinkedIn motivates users to complete their profiles and therefore stirs a desire for achievement. Third, aesthetics describe the emotional responses evoked in the player when they interact with the game system (Hunicke et al., 2004). A taxonomy of aesthetics includes, for example, sensation, fantasy, narrative, challenge, fellowship, discovery, expression and self-expression (Hunicke et al., 2004). Game dynamics create aesthetic experiences. For example, a challenge in a gamified service creates dynamics such as time pressure and opponent play. Aesthetics-like expressions are created by dynamics that encourage individual users to leave their mark (e.g., systems for purchasing, building or earning game items).

Table 1: Gamification elements

Type	Function	Source
Points Systems	Points systems are used to track interaction with the service and report to the system and the player the effect of their choices. They reward users by adding a certain number of points to the user's account for completed actions or combinations of these.	(Cheong et al., 2013); (Thiebes et al., 2014); (Zichermann and Cunningham, 2011); (Hiltbrand and Burke, 2011)
Leader boards	Leader boards are used to track and display action progress. They make one's personal performance visible and make player-to-player performance comparison visible.	(Butler, 2013); (Thiebes et al., 2014); (Hiltbrand and Burke, 2011); (Bunchball, 2010); (Depura and Garg, 2012)
Badges	Badges are visual representations of accomplishments and consist of optional rewards whose fulfilment is stored outside the scope of core activities.	(Li et al., 2012); (Thiebes et al., 2014); (Hamari, 2013)
Rewards	Users can receive rewards for certain actions to support and encourage the player in the game.	(Zichermann and Cunningham, 2011)
Challenges	Challenges drive players to perform predefined tasks and incentive mechanisms (as rewards) to support and encourage the player in the game.	(Zichermann and Cunningham, 2011)
Avatars	Avatars are a visual graphical representation of users.	(Werbach and Hunter, 2012)
Social Graph	Social graphs allow users to see the activities of their friends.	(Werbach and Hunter, 2012)
Progress Bar	Progress bars are feedback mechanisms and indicate the progress of filling in a form and inform the user about any false inputs. They can create a feeling of achievement.	(Huotari and Hamari, 2012); (Hiltbrand and Burke, 2011); (Thiebes et al., 2014)
Levels	User levels document the user's abilities and progress (e.g., expertise or skill maturity level)	(Sampanes, 2013); (Thiebes et al., 2014); (Gnauk et al., 2012);
Collections	Collections provide opportunity for the user to collect certain items.	(Werbach and Hunter, 2012)

2.3 Gamification mechanisms

In this section, we explore the usefulness of mechanism-based theorizing in understanding gamification as an architecture of participation. Mechanisms are 'portable concepts that explain how and why a hypothesized cause, in a given context, contributes to a particular outcome' (Falleti and Lynch, 2009). According to (Mayntz, 2004), social mechanisms state how, by what intermediate steps, a certain outcome follows from a set of initial inputs. The term 'mechanism', therefore, may serve to explicate an observed relationship between specific initial conditions and a specific outcome (e.g., structure or process) or describe a black box with unobservable intermediate steps (e.g., perceptions or thoughts) (Hedström and Swedberg, 1998). Furthermore, a mechanism explains by opening up the black box and showing the cogs and wheels of the internal machinery (Elster, 1989). The cogs and wheels describe the mechanisms, which provide a continuous and contiguous chain of causal or intentional links between the explanans (input) and the explanandum (output).

For example, Hedström and Swedberg (1998) propose that the concept known as a 'self-fulfilling prophesy' (Merton, 1948) can be interpreted as a mechanism. The theory describes a general belief-formation mechanism that states that the number of individuals who perform a certain act signals to others the likely value or necessity of the act, and this signal will influence other individuals' choice of

action (Gross, 2009). It shows how an endogenous and self-reinforcing process can bring about a collective outcome that is unintended by all the individuals involved (Merton, 1968). Nevertheless, explanations of how and why outcomes occur usually cannot be explained by a single mechanism. Rather, mechanism-based theorizing seeks to understand how mechanisms both cascade and operate in conjunction with each other to bring about observed outcomes by affecting the beliefs and desires of individuals as well as their opportunities for action (Hedström, 2005).

In this paper, we investigate gamification as an architecture of participation. To understand the creation of communal value by using gamification elements, we must identify the underlying social mechanisms. Therefore, we investigate the effects of using game mechanics (e.g., leader boards, badges, challenges) on people's behaviour (beliefs, desires, opportunities). For investigating the social mechanisms, we draw on (Hedström and Swedberg, 1998) depiction of Coleman (1986) macro-micro-macro model to conceptualize how macro-level (i.e., individual activities) events and outcomes (i.e., communal good) both trigger and result from micro-level (i.e., individual) beliefs, desires and opportunities for action. To specify the causal mechanisms and interpret changes at the macro (group) level, it is essential to understand (i) how a macro-level event is interpreted, and acted upon, by individuals (micro-level) and (ii) how the actions of individuals collectively result in changes at the macro-level. From the perspective of gamification as an architecture of participation, the first macro-level event may be considered the use of gamification elements in an online innovation community, and the final macro-level event (outcome), the availability of innovation expertise and new products.

In between the first and the last macro-level events, we can expect to find three main mechanisms; the macro-to-micro mechanisms are referred to as 'situational', the micro-to-micro mechanisms as 'action formation', and the micro-to-macro as 'transformational'. Situational mechanisms explain how individual action is enabled or restricted by the social context in which it is embedded and shapes their desires and beliefs. Action-formation mechanisms explain how a specific combination of individual desires, beliefs and opportunities leads or links to specific actions. Transformational mechanisms explain how, through the interaction of individuals, these individual actions are transformed into intended and unintended collective outcomes. For situational and action-formation mechanisms, the actor is the individual and the mechanisms are internal (i.e., psychological or social-psychological). For transformational mechanisms, a number of actors (individuals) are present and the mechanisms are external (i.e., social) (Hedström and Swedberg, 1998).

3 Research Design

The objective of this study is to investigate the role of gamification as an architecture of participation in an online maker community in order to identify underlying mechanisms. The study is exploratory, and we thus employ a single case study to gain a deep understanding of gamification and identify the mechanisms enabled by gamification. In the first research question, we identify the existing gamification elements in the innovation community in order to understanding what mechanisms are provided and how they work. In the second research question, we examine how these gamification elements contribute to the automated value creation of the community in order to identify the architectures of participation. According to (Yin, 2014), case study is very suitable for an exploratory research (i.e., this study) because it allows the researcher to trace the case closely over time.

A single case study was conducted with the maker community Thingiverse (details in the next section), with community participants as the embedded unit of analysis. The maker community Thingiverse was chosen because of its popularity for 3-D printing designs and because the research had access to an innovation community for data collection. We first conducted an analysis of the community using netographic observation. This is being followed by interviews with community participants using the rep grid technique (Tan and Hunter, 2002) with laddering to elicit the social/psychological mechanisms in order to answer RQ2. We expect to conduct 15 to 25 interviews in

order to reach theoretical saturation. We employ the coding techniques proposed by Corbin and Strauss (2007) to analyse the data. The main ideas and concepts were determined using open and axial coding, thereby revealing construct categories and subcategories. Mechanisms are identified from constructs by using the A-P-H-R chain (Gross 2009) to reveal the operation and use of these constructs identified during open coding.

4 Thingiverse

Thingiverse started in November 2008 as a companion site to MakerBot Industries, a DIY 3-D printer kit company. Thingiverse is an open and dynamic community where designers share user-created digital design files that can be used to create 3-D printed objects or other physical objects. Thingiverse creations vary in levels of complexity and applicability, ranging from toys and mugs to robots and quadcopters (Kyriakou and Nickerson, 2014). Users choose the type of user license they wish to attach to the designs they share. Primarily, open-source hardware designs licensed under the GNU GPL or Creative Common licenses are used. 3-D printers, laser cutters, and other technologies can be used to physically create the files.

The Thingiverse web page has three main parts: Dashboard, Explore and Create. On the Dashboard, users can follow other users like in Twitter. With this opportunity, the user will not miss any recently published designs of other users. The Explore section allows users to explore others' designs, called 'Things'. Users can choose amongst different categories (e.g., Art, Fashion, Household, Learning, Hobby, Tools) and sort the designs by certain criteria (e.g., Newest, Featured, Popular, Makes, Remixes, Customizable, Collections, Randoms). Customizable designs allow users to use and adjust different design parameters (e.g., size, single parts) and create a new design. Furthermore, users can view and participate in current design challenges and explore implemented apps of the community. For example, MakerBot created the app 'Customizer' to allow other users to customize their designs. Within the Create section, users can upload a new design. In this process, the user has to upload the design files and write some instructions and a description of the design. Furthermore, they can customize a design or create a new app.

The main processes in Thingiverse are these: (i) create and upload new designs, (ii) remix other designs, and (iii) participate in challenges. Users can create new designs and share them with the community to generate communal value. Other users can just use these designs and build a real physical product or remix these designs to create something new. By remixing a design, a user builds new designs that are based on an existing design. In this process, the community members modify or combine each other's ideas. Such a remixing process, under different names, has been seen as an integral part of innovation for many decades (van den Bergh, 2008; Kogut and Zander, 1996; Schumpeter, 1934). The designs can be customized with the embedded 'Customizer' app by changing different design parameters. This remix community allows people not only to prototype at a minimal cost but also to work on projects they are genuinely interested in (Acosta, 2009; Dougherty, 2012). Remixing communities creates a norm of reuse, and remixed designs will generate interest from other users (Fleming et al., 2007; Wang et al., 2010; Yu and Nickerson, 2011). Thingiverse makes it possible to observe novice users acquiring tacit knowledge while interacting with experts (Miller et al., 2006). It is also possible to see how and how often the ideas are implemented (Baer, 2012). In the case of Thingiverse, participants link their designs to parent designs, thereby creating a design inheritance network. Essentially, they remix other CAD files, drawing upon the work of others in order to produce new work (Lessig, 2008). Their links are a direct acknowledgement of the information they have used. Furthermore, users can participate in challenges. Every challenge has a fixed deadline to submit a design.

5 Gamification Elements in Thingiverse

Table 2 presents the eight gamification elements found in Thingiverse. See Table 1 for a description of the function of each element.

Table 2: Gamification elements

Type	Description
Points Systems	Users receive points for their designs (e.g., likes, comments, views, remixes).
Badges	Badges are awarded for featured designs or winners of a challenge.
Challenges	Users participate in different challenges on specific topics (see table 3).
Avatars	Users have the option of uploading a personal picture and editing their profiles.
Social Graph	Users see the activities of their friends on a dashboard (e.g., publishing a new design).
Progress Bar	Users can see the progress of the upload of a new design.
Rewards	Users get a prize for being amongst the highest three entrants in a challenge.
Collections	Users can add the designs of other users to their own collections.

Users have the option to award designs with points. Every design page has its own statistics field, which shows the number of likes, collections, comment creations, remixes and views. For example, a users' design can be liked by clicking the like button. Besides, the like button shows the total number of likes. Designs that win a challenge or get featured usually have more likes. For example, the number of likes of the winners' designs of the T-Rex Remix Challenge is 244. Simultaneously, the number of collections, comments, remixes and creations of these popular designs is also higher than other designs'. Furthermore, users can collect the designs of other users. By clicking on 'collect', they can create their own collections or put their favourite designs in an existing collection. The design is then saved in the account of the user. When a user collects a design, the collections counter will increase by one. Also, the points systems show the number of comments, creations, views and remixes. The individual statistics are an expression of expertise, knowledge and creativity. For liking or commenting a design, the user needs to be logged in with a created account.

Users can receive a badge in two ways. First, they can participate in a challenge and receive a badge for the best design. The winning design will then be presented with a badge for the best design. Second, they can receive a badge for featured designs. A design gets featured after a certain number of likes. There are different ways that badges can motivate users to participate in a challenge or design something creative. A badge can be a representation of an achievement or a symbol of importance for users. It can have a special style, which is why users want to collect them. Furthermore, it is a credential for the expertise and creativity of the user.

Users have the option to participate in different design challenges (table 3). Every challenge has a certain topic for which designs can be submitted. Each design submission has the following associated information: Design Name, Design Creator, Published Date, Thing Info, Instructions, Thing Files, Comments, Made, Watch, Collections, Remixes, Views, Downloads, Category. Some of the challenges are in cooperation with major companies (e.g., NASA). These companies benefit from the expertise, creativity and ideas of the submitted designs and can use them for real projects. Designs are submitted to a panel of employees of Thingiverse, and the company. Judging the designs, for example, focuses on scientific feasibility, creativity and printability.

Table 3: Challenge entries in Thingiverse

Challenge Name	Description	Entries Submitted
Customizer	Remix an existing design with the embedded 'Customizer' app.	328
Birdhouse	Design a creative and functional birdhouse.	171
#backtoschool	Design school supplies (e.g., pencil case, ruler, pencil topper).	87
GnomeRemix	Remix a garden gnome design.	60
Academy Math Manipulatives	Design math manipulatives that allow teachers to print 3-D tools for teaching math.	162
Ornament	Design an ornament for a Christmas tree or other display.	296
'On Such a Full Sea' Fish	Design a fish sculpture to represent characters from the new book by Chang-Rae Lee.	109
T-Rex Remix	Remix an existing dinosaur skull design.	99
Mars Base	Design a housing facility to withstand the conditions on planet mars (in conjunction with NASA)	228

Every user can create a personal profile and upload an avatar picture. Avatars serve as a visual graphical representation of users. A profile page of a user consists of a short personal description of the user, their published designs, collections, creations, likes, followers and followed users. Users can follow other users to see their new published designs on the dashboard. Furthermore, it is possible to send users a private message. On the dashboard of Thingiverse, users can see the current and past activities of other users on a timeline. Such activities are, for example, new creations of physical objects, new published designs, comments, remixed designs and others. Users can only see the activities of users they are following. In a menu on the right side, they can find new people to follow or edit the dashboard feeds. Therefore, users can personalize their dashboard by following their favoured users. When users want to upload a design, they can do so by following three main steps: upload a design file, create a description to build it, and publish it. On the uploading site, users can see the supported file types and some guidelines for sharing designs. By completing the steps, users can see the progress of uploading a new design on the page and receive feedback in this way. After completion, the user gets a confirmation. Users get rewarded with prizes after winning a challenge. For example, they can win a 3-D printer by MakerBot. Only the top 3 places of a challenge receive a prize for their submitted designs. As already mentioned in the points systems element, users can collect the designs of other users. They can create their own collections using their favourite designs

6 Future Work

To date, the analysis has focused on describing the operation of game elements in Thingiverse. Future work will involve understanding how the psychological and social consequences of the game elements lead individuals to engage in behaviours that create value for the innovation community.

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